

Morphological Characteristics and Karyotypic Analysis of *Aster spathulifolius* According to Native Area

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ABSTRACT

The growth characteristics and karyotypes of *Aster spathulifolius* collected from 5 sites including coastal and island region on the Korean peninsula, were analysed. Several morphological characteristics of the plants such as leaf length, leaf width, top internode, medium internode, spike branching, flower diameter, number of petal, leaf color, leaf form, stem and leaf hair, viscosity, and serration of the plants were distinctly different depending on the native region from which they were collected. Karyotypic analysis showed that the chromosome number was all diploid ($2n=18$), with one pair of submetacentric satellite chromosomes. The chromosome composition included 7 pairs of metacentric chromosomes and 2 pairs of submetacentric chromosomes in all plants. However, chromosome order and the ranges of the chromosome lengths were a little different from plant to plant according to their native growing regions. The plants from Geoje-Do especially showed large differences in the chromosome lengths between the longest and the shortest compared to the plants from other places. This results provide important data to support the classification of the species into several sub-species.

Key words: chromosome composition, chromosome number, growth characteristics

INTRODUCTION

Aster spathulifolius is found to be native in southern part of Korea, and compositae southwestern part of Japan and some islands of Korea and Japan. And different varieties of morphological characteristics such as size, shape and width of leaves, length of the hair, shape and distribution depend on the native areas. It is necessary to analyze the details within the species. The karyotypic analysis which is based on the analysis of

the chromosomes, uses the number of a chromosome distinctive to the species and morphological compositions. It is useful in searching for genetics of species and family relation among the species (Kim and Yoon, 2002; Kim *et al.*, 2004a, b).

The research on chromosomes of the species have been reported by Huziwara (1957), Kang and Paik (1966), Hong *et al.* (2003). However, they simply limited their research on the number of chromosomes and morphological compositions in general. So it is

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necessary to further research the existence of the satellite chromosomes which are distinctive in karyotypic analysis and detailed chromosome length analysis.

This research focuses on *A. spathulifolius*, which are native in five different areas including coastal areas and islands of Korea and studies morphological characteristics based on native areas and karyotypic analysis. By studying the relation between morphological varieties based on native areas and the research results of cytogenetics, and by studying whether the morphological differences are from the genetics or due to environmental causes, it provides the basic information on analysis of species and the possibilities of detailed analysis within species.

MATERIALS AND METHODS

The plants used for studies were collected from three island areas of Korea (Ulneung-Do, Hong-Do, Geoje-Do) and two coastal areas (Chonlipo and Sokcho) between Sep. 2002 and Nov. 2003, and were grown in experimental field of Sahmyook University. The analysis on growth characteristics are based on research

method of You *et al.* (2005). The karyotypic analysis was somewhat modified from Kim and Yoon (2002) methods. The fresh root tips from the rooting were cut and 18°C temperature was maintained in 2 mM 8-hydroxyquinoline solution. After 5hrs of pre-treatment was treated over 2 hrs in fixing fluid of aceto-ethanol (acetic acid : ethanol=1:3 v:v) and refrigerated in 70% ethanol. The stored root tips were hydrolyzed at 60°C in 1 N HCl for 10 secs. The growing points were cut and were torn apart in 45% acetic acid and dyed with 1% aceto-orcein and samples were taken using squashing method.

The selected samples were studied under Olympus BX 51 microscope and images were taken from ER-3339 CCD camera which is set up by Applied Imaging company (U.S.A), and Genus version 3.1 program was used to analyze the karyotype. The chromosomes were arranged based on the length and the shape of chromosomes were named using the arm ratio calculation from Levan *et al.* (1964) method.

RESULTS AND DISCUSSION

The pictures of *Aster spathulifolius* that are studied

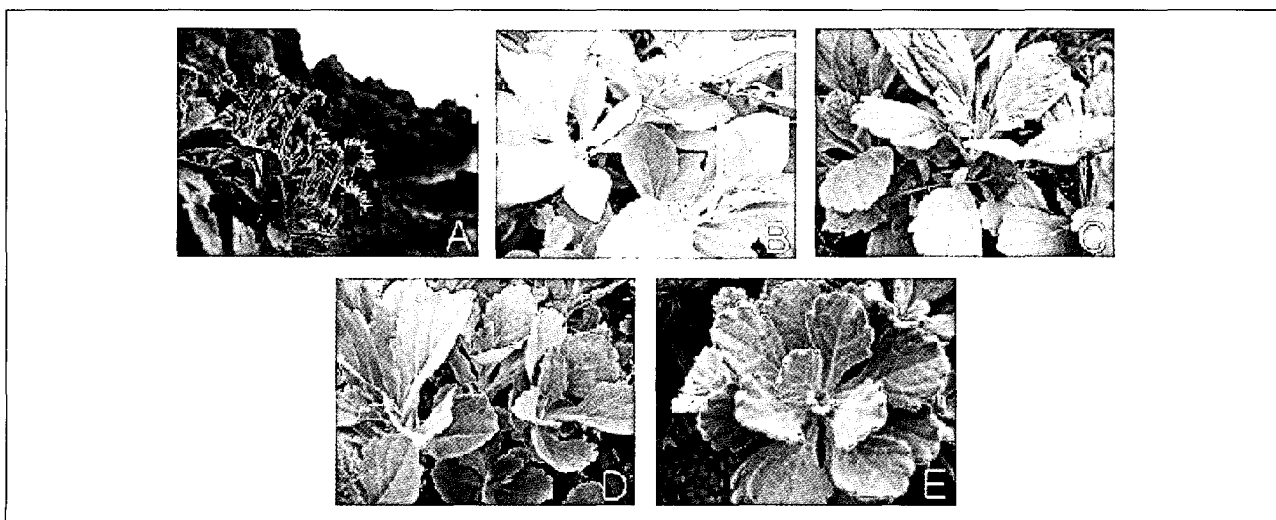


Fig. 1. Native area growing form of *Aster spathulifolius* ; A) Chonlipo, B) Ulneung-Do, C) Hong-Do, D) Sokcho, E) Geoje-Do.

in this research which are native in five different areas are shown in Fig. 1 and the study results of morphological characteristics are shown in Table 1 and 2.

The length and width of leaves of the species are grown bigger in Ulneung-Do and Sokcho compared to the plants grown in other areas. The top internode of the plants from Sokcho are grown much taller than other areas. The medium internode were similar in height compared in different native areas. The number of petals of Sokcho were less than the plants in other areas. The diameter of flower of Geoje-Do, Hong-Do areas which are south coastal areas, were bigger than other areas. The number of ligulate flowers were less in island regions such as Hong-Do and Ulneung-Do.

The color of flowers was not different from areas to

areas. The color of leaves in Geoje-Do were green with tint with a lot of hairs on the leaf surfaces. The forms of leaves of Ulneung-Do were long and rounded as verses oval shape in other areas. The hairs of the leaves of Ulneung-Do were almost non existent but ones of Geoje-Do had a lot more hairs. The viscosity of Geoje-Do that had a lot of hairs on leaves were high and that of Ulneung-Do and with no hair had no viscosity either. It shows some relation between not having any hair on leaves and not having any viscosity. The plants in Ulneung-Do had no serration and the edges of leaves were very smooth, but plants of other areas had some serrations.

The metaphase photomicrograph of *A. spathulifolius* chromosomes depending on different native areas and

Table 1. Analysis of external morphological characteristics in *Aster spathulifolius* according to native growing regions.

characteristics native region	flower color	leaf width	top internode	medium internode	spike branching	flower diameter	number of petal
Chonlipo	4.2 d	2.1 d	0.19 d	1.8 b	8.3 a	3.71 b	44.7 a
Ulneung-Do	11.9 a ^z	6.1 a	0.67 c	2.3 a	7.2 b	3.12 c	37.2 bc
Hong-Do	7.0 c	3.0 c	1.26 b	1.8 b	7.1 b	4.37 a	34.3 c
Sokcho	9.8 b	4.8 b	6.03 a	1.5 bc	4.8 c	3.65 b	41.3 ab
Geoje-Do	4.5 d	2.2 d	0.66 c	1.4 c	7.0 b	4.38 a	42.6 a

z ; mean separation within columns by Duncan's multiple range test at 5% level.

Table 2. Analysis of external morphological characteristics in *Aster spathulifolius* according to native regions.

characteristics native region	leaf length	leaf color	leaf form	stem & leaf hair	viscosity*	serration
Chonlipo	blue violet	green	obovate	short	2	yes
Ulneung-Do	blue violet	pale green	elliptical obovate	none	1 ^z	none
Hong-Do	blue violet	pale green	round obovate	short	2	yes
Sokcho	blue violet	green	obovate	short	3	yes
Geoje-Do	blue violet	white green	round obovate	long	5	yes

* 1 (little) → 5 (much).

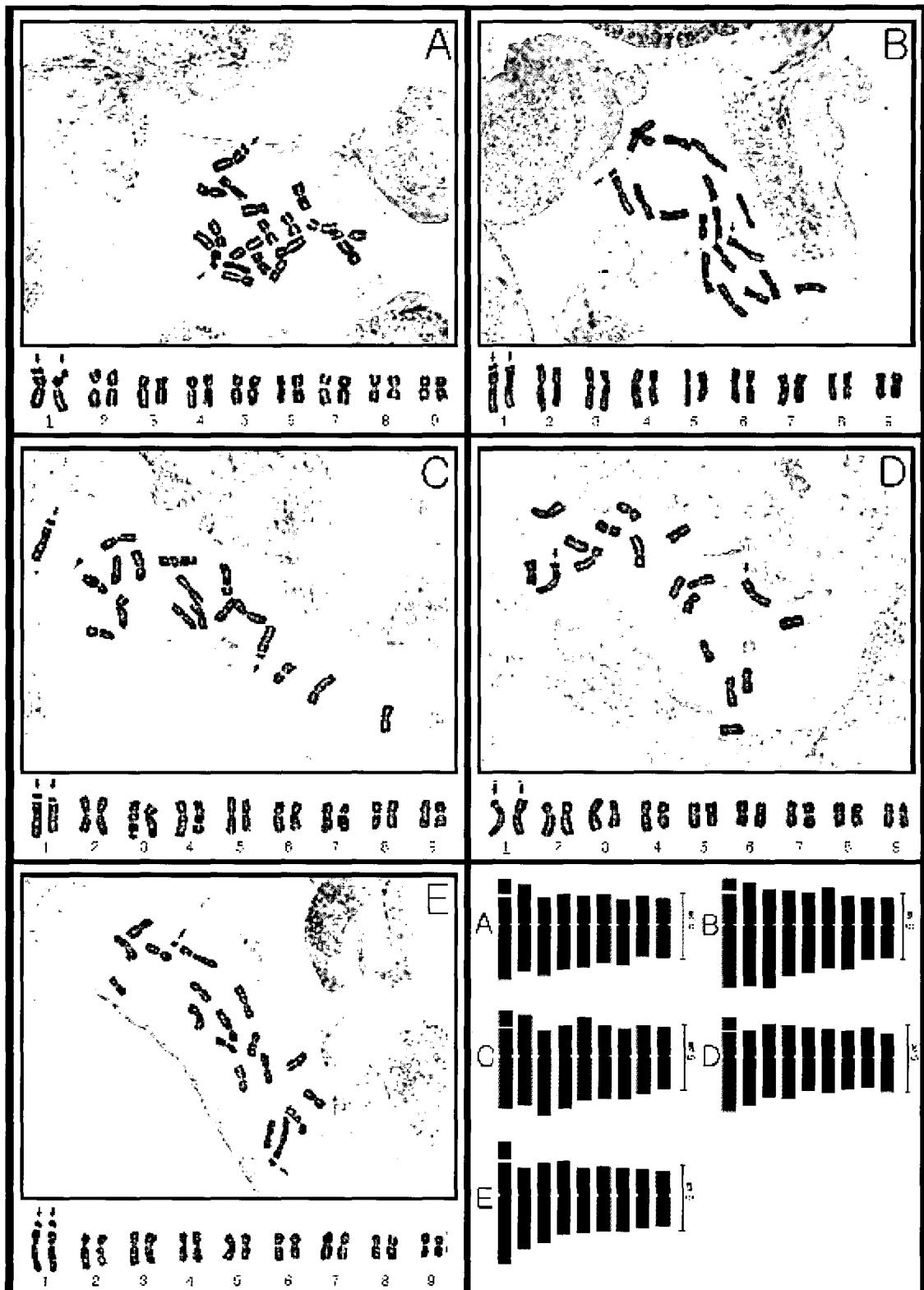


Fig 2. Metaphases and karyotypic idiograms of *Aster spathulifolius*. according to native growing regions. A:Chonlipo, B:Ulleung-Do, C:Hong-Do, D:Sokcho, E:Geoje-Do. arrows; satellite chromosomes.

the karyotypic analysis are shown in Fig. 2 and Table 3.

The number of chromosomes of all five different native areas were $2n=18$ and had a pair of satellite chromosomes (number 1 chromosome). The compositions of chromosomes of all five areas were seven pairs of metacentric and 2 pairs of submetacentric. The order of chromosomes were varied depending on areas. The areas like Chonlipo, Ulneung-Do and Hong-Do areas had number one and three submetacentric chromosomes. And Sokcho and Geoje-Do had number one and two submetacentric chromosomes. The satellite chromosomes of all five areas showed submetacentric shapes. The length of chromosomes were varied depending on the different areas. For example, the length of Chonlipo areas were 4.5-7.48 μm , Ulneung-Do were 4.62-8.08 μm , Hong-Do were 4.81-7.25 μm , Sokcho were 4.53-7.01 μm and Geoje-Do were 4.19-9.22 μm . It showed the gradual decrease in length correlation with the order of chromosomes. The length of chromosomes can be varied depending on the process of cell division of the samples and the process of experiments, but the length of chromosomes within the cell are relatively consistent. Using the chromosomes of Chonlipo, as an example, the *A. spathulifolius* of Chonlipo and Ulneung-Do had similar length of chromosomes, and Hong-Do and Sokcho had the shortest length of chromosomes. The length of the longest chromosomes were relatively short. In general, it showed differences

in morphological characteristics depending on native areas. Especially, the difference between the longest chromosomes, number 1 and the shortest, number 9 of Geoje-Do were relatively bigger compared to other areas.

As a result, *A. spathulifolius* showed different growth characteristics which depends on different native regions. Based on this study, karyotypic analysis showed differences in the length of chromosomes in different native regions, this can be useful information for a detailed classification of *A. spathulifolius*.

To find out whether the differences in length of the chromosomes are from the differences in the structural variation of the chromosomes, further studies like the chromosome banding analysis that studies the structure of the chromosomes in more detail or the FISH experiment that uses the DNA molecular markers, need to be performed in the future.

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Table 3. Analysis of somatic chromosome composition in *Aster spathulifolius* according to native regions.

Native region	Chromosome no. (2n)	Chromosome range (μm)	Karyotype formula
Chonlipo	18	4.50~7.48	2sm*+2m+2sm+2m+2m+2m+2m+2m+2m
Ulneung-Do	18	4.62~8.08	2sm*+2m+2sm+2m+2m+2m+2m+2m+2m
Hong-Do	18	4.81~7.25	2sm*+2m+2sm+2m+2m+2m+2m+2m+2m
Sokcho	18	4.53~7.01	2sm*+2sm+2m+2m+2m+2m+2m+2m+2m
Geoje-Do	18	4.19~9.22	2sm*+2sm+2m+2m+2m+2m+2m+2m+2m

* satellite chromosome, m; metacentric, sm; submetacentric.

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