日本産ヨモギ属3 種の核型

著者	Iwatsubo Yoshikane, Kobayashi Tomoharu, Miura Norihito
著者別表示	岩坪 美兼, 小林 知春, 三浦 憲人
journal or publication title	The journal of phytogeography and taxonomy
volume	57
number	1
page range	23-27
year	2009-10-30
URL	http://doi.org/10.24517/00053408

Yoshikane Iwatsubo[1], Tomoharu Kobayashi[1,2] and Norihito Miura[3] : **Karyotypes of three species of *Artemisia* (Asteraceae) in Japan**
岩坪美兼[1]・小林知春[1,2]・三浦憲人[3]：日本産ヨモギ属 3 種の核型

The genus *Artemisia* L. (Asteraceae) occurring mainly in the temperate area of northern hemisphere, is comprised of about 350 species worldwide (Mabberley 2008), with 30 species native to Japan (Koyama 1995). This genus is known to show variations in chromosomal number with 2n=14, 16, 18, 25, 27, 34, 36, 45, 51, 52, 53, 54, ca.72 and 78 (Fedorov 1969), and to be a polybasic genus of x=8, 9, 17 and 26. Among these, multiples of 8 and 9 are considered to serve as primary basic chromosome numbers while multiples of 17 and 26 serve as the secondary basic chromosome numbers by polyploidy origin (Darlington and Wylie 1955 ; Arano 1962 ; Kawatani and Ohno 1964).

The study of karyotypes in this genus provides insight into the karyotypic evolution that accompanies diversification of basic chromosome numbers. This paper is the first report of our karyotypic descriptions of this genus and deals with the following three diploid *Artemisia* species : *A. monophylla* Kitam., *A. sinanensis* Y. Yabe and *A. stelleriana* Besser.

Materials and methods

The plants used in this study include : three specimens of *A. monophylla* collected at Shiraki-mine, Toyama City, Toyama Prefecture ; three specimens of *A. sinanensis* collected along a pathway from Ichinokoshi to Higashi-ichinokoshi, Mt. Tateyama, Tateyama-machi, Toyama Prefecture ; nine specimens of *A. stelleriana* collected from two sites in Utabetsu (five plants) and the Erimo Cape (four plants), at the coast of Erimo-cho, Horoizumi-gun, Hokkaido.

Karyotypic analysis of cell nuclei from the plant root tips was performed. Actively growing root tips collected from plants grown in clay pots were pretreated in a 2 mM 8-hydroxyquinoline solution at room temperature (ca. 25℃) for 1 h, and then kept at ca. 6℃ for 15 h. Root tips were fixed in a 1 : 3 acetic acid and ethyl alcohol mixture for 15 min, macerated in 1 N hydrochloric acid at 60℃ for 6 min, and then washed in tap water. They were stained in 1.5% lacto-propionic orcein. Standard squash technique was applied for the examination of their karyotypes. A cell with fully-spread metaphase chromosomes was selected from each plant, and its chromosomal form was expressed according to the nomenclature of Levan et al. (1964).

Results and discussion

Descriptions of the somatic chromosome complements of *A. monophylla*, *A. sinanensis* and *A. stelleriana* are as follows :

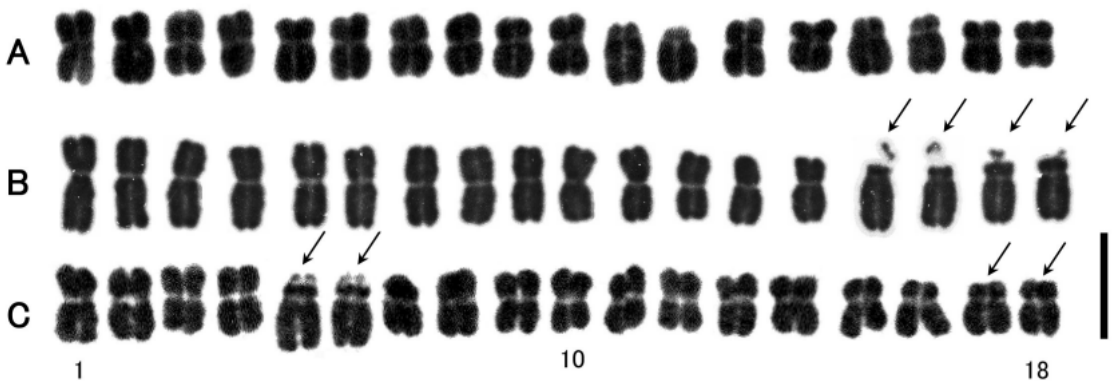

Fig.1. Karyotypes of three species of *Artemisia* in Japan. A : *A. monophylla* (2n=18). B : *A. sinanensis* (2n=18). C : *A. stelleriana* (2n=18). Arrows indicate satellite chromosomes. Bar represents 5 μm.

(1) *A. monophylla* (Fig. 1 A)

This plant is an endemic alpine perennial herb from Honshu, Japan (Koyama 1995). All three specimens examined had a somatic chromosome count of 18 in agreement with previous reports of this species (Suzuka 1950, 1952 ; Masumori 1961 ; Arano 1962, 1968). Karyotype was examined in one specimen. Somatic metaphase chromosomes ranged from 2.1 to 3.3 μm in length and 1.0 to 4.0 in arm ratio (Table 1), and were divided into 3 groups : 14 metacentric (M+m) chromosomes, 2 submetacentric (sm) chromosomes, and 2 subtelocentric (st) chromosomes. This somatic chromosome complement is formulated as 2n =18=14 (M+m) +2 sm+2 st.

Table 1. Measurements at somatic metaphase chromosomes of *Artemisia monophylla*

No.	Length(μm)	Total(μm)	Arm ratio	Form
1	1.4+1.9	3.3	1.4	m
2	1.3+1.9	3.2	1.5	m
3	1.5+1.5	3.0	1.0	M
4	1.4+1.5	2.9	1.1	m
5	1.1+1.8	2.9	1.6	m
6	1.2+1.6	2.8	1.3	m
7	1.2+1.5	2.7	1.3	m
8	1.3+1.4	2.7	1.1	m
9	1.0+1.6	2.6	1.6	m
10	1.1+1.5	2.6	1.4	m
11	0.6+1.9	2.5	3.2	st
12	0.5+2.0	2.5	4.0	st
13	1.2+1.3	2.5	1.1	m
14	1.2+1.3	2.5	1.1	m
15	0.8+1.7	2.5	2.1	sm
16	0.7+1.8	2.5	2.6	sm
17	0.9+1.4	2.3	1.6	m
18	0.9+1.2	2.1	1.3	m

M : exact metacentric chromosome. m : metacentric chromosome. sm : submetacentric chromosome. st : subtelocentric chromosome.

Masumori (1961) reported that this species from Shin-koshinokkoshi in Mt. Narusawa-dake, the boundary between Toyama Prefecture and Nagano Prefecture in central Japan, had 4 satellite chromosomes. However, Arano (1962) did not find any satellite chromosomes in the karyotype of this species from Mt. Nasudake in the Tochigi Prefecture. The karyotype found in the present study was in conformity with that of Arano (1962).

(2) *A. sinanensis* (Fig. 1 B)

This species is also an endemic alpine perennial herb in Honshu, Japan (Koyama 1995), and is known to be a diploid species with 18 chromosomes (Matsuura and Sutô 1935 ; Arano, 1963, 1968 ; Kawatani and Ohno 1964).

All three specimens examined showed 18 chromosomes, in agreement with the reported chromosome count of this species (Matsuura and Sutô 1935 ; Arano 1963, 1968 ; Kawatani and Ohno 1964).

The karyotypes of the three specimens were nearly the same, demonstrating somatic metaphase chromosomes ranging from 3.6 to 5.4 μm in length and 1.0 to 5.2 in arm ratio (Table 2), divided into 2 groups : 14 metacentric chromosomes and 4 subtelocentric chromosomes. All of the 4 subtelocentric chromosomes had tiny satellites on their short arms. The somatic complement of *A. sinanensis* was thus formulated as 2n=18=14 (M+m) +4^{t}st.

The karyotype of this species had been reported by Arano (1963) on a plant collected in Mt. Tateyama, where also the plants used in this study were gathered, and was found to have one pair of subtelocen-

Table 2. Measurements at somatic metaphase chromosomes of *Artemisia sinanensis*

No.	Length(μm)	Total(μm)	Arm ratio	Form
1	2.1+3.3	5.4	1.6	m
2	2.2+3.2	5.4	1.5	m
3	2.4+3.0	5.4	1.3	m
4	2.3+3.0	5.3	1.3	m
5	2.4+2.7	5.1	1.1	m
6	2.3+2.8	5.1	1.2	m
7	2.5+2.5	5.0	1.0	M
8	2.4+2.5	4.9	1.0	M
9	2.0+2.6	4.6	1.3	m
10	2.0+2.5	4.5	1.3	m
11	2.1+2.3	4.4	1.1	m
12	2.1+2.3	4.4	1.1	m
13	1.8+2.4	4.2	1.3	m
14	1.8+2.4	4.2	1.3	m
15	t-0.6+3.1	3.7	5.2	st
16	t-0.6+3.0	3.6	5.0	st
17	t-0.8+2.8	3.6	3.5	st
18	t-0.8+2.8	3.6	3.5	st

t : satellite. M : exact metacentric chromosome. m : metacentric chromosome. sm : submetacentric chromosome. st : subtelocentric chromosome.

tric chromosome with a satellite. Such a difference in reported karyotype may be due to the tiny size of the satellites.

(3) *A. stelleriana* (Fig. 1 C)

This species occurs in the coastal regions of the Aleutian Islands, Korea, Sakhalin, Kurile Island, Kamchatka, Okhotsk region, the Maritime Province and Japan (Koyama 1995). In Japan, this plant is distributed in both Hokkaido and the northern part of Honshu. In this species, we obtained a diploid chromosome count of 18 in all nine specimens examined.

Our findings were consistent with all previous reports of the chromosome numbers for this species (Suzuka 1950, 1952 ; Sokolovskaya 1960, 1966 ; Arano 1962, 1968 ; Masumori 1963 ; Kawatani and Ohno 1964 ; Korobkov 1972 ; Taniguchi et al. 1975 ; Morton 1981 ; Nishikawa 1981 ; Probatova and Sokolovskaya 1981 ; Rudyka 1995). Within the nine specimens, one plant was used to assess the karyotype. The chromosomes at metaphase ranged from 2.5 to 3.3 μm in length with arm ratios of from 1.0 to 4.0 (Table 3). The 18 chromosomes were divided into 12 metacentric chromosomes, 2 submetacentric chromosomes, 2 submetacentric chromosomes with satellites at the ends of their short arms, and 2 subtelocentric chromosomes with satellites on their short arms. The somatic chromosome complement was thus formulated as $2n=18=12(M+m)+2\,sm+2^{t}sm+2^{t}st$. Arano (1962) reported that the plant from Genseikaen, Abashiri City, Hokkaido Prefecture, had 2 satellite chromosomes ; while Masumori (1963) reported that the plant from Toyotomi-cho, Hokkaido Prefecture, had 4 satellite chromosomes. The karyotype found in our study was almost completely in conformity with that of Masumori (1963).

The present study shows that a total of 16 metacentric and submetacentric chromosomes are found in both *A. monophylla* and *A. stelleriana*, and 14 metacentric chromosomes in *A. sinanensis*. These features show that they have all symmetric karyotypes.

In contrast, the number of reported satellite chromosomes sometimes differs by account. Such variation suggests that the secondary constrictions of satellite chromosomes in *Artemisia* do not always appear or that karyotypes are diversified within each species.

We are grateful to Dr. Kyoko Sato for providing *A. stelleriana*. We thank late Dr. Teisaku Kobayashi, a member of the Planting Research Committee of Tateyama Route Area, for provided young *A. sinanen-*

Table 3. Measurements at somatic metaphase chromosomes of *Artemisia stelleriana*

No.	Length(μm)	Total(μm)	Arm ratio	Form
1	1.5＋1.8	3.3	1.2	m
2	1.5＋1.8	3.3	1.2	m
3	1.4＋1.6	3.0	1.1	m
4	1.3＋1.7	3.0	1.3	m
5	t-0.6＋2.4	3.0	4.0	st
6	t-0.6＋2.3	2.9	3.8	st
7	1.3＋1.5	2.8	1.2	m
8	1.3＋1.5	2.8	1.2	m
9	1.2＋1.6	2.8	1.3	m
10	1.3＋1.4	2.7	1.1	m
11	1.3＋1.3	2.6	1.0	M
12	1.3＋1.3	2.6	1.0	M
13	1.1＋1.5	2.6	1.4	m
14	1.0＋1.5	2.5	1.5	m
15	0.9＋1.6	2.5	1.8	sm
16	0.9＋1.6	2.5	1.8	sm
17	t-0.9＋1.6	2.5	1.8	sm
18	t-0.9＋1.6	2.5	1.8	sm

t : satellite. M : exact metacentric chromosome. m : metacentric chromosome. sm : submetacentric chromosome. st : subtelocentric chromosome.

sis plants after they had been used for a germination experiment of the seeds of this species.

References

Arano, H. 1962. Cytological studies on subfam. Carduoideae of Japanese Compositae. VI. Karyotype analysis in the genus *Artemisia*. Bot. Mag. Tokyo **75** : 356–368. (in Japanese with English summary)

Arano, H. 1963. Cytological studies in subfamily Carduoideae (Compositae) of Japan XIV. The karyotype analysis on genus *Artemisia*. Bot. Mag. Tokyo **76** : 459–465.

Arano, H. 1968. The karotypes and the geographical distribution in some groups of subfamily Carduoideae (Compositae) of Japan. La Kromosomo **72-73** : 2371–2388. (in Japanese)

Darlington, D. C. and Wylie, A. P. 1955. Chromosome atlas of flowering plants. pp. 266–267. George Allen and Unwin, London.

Fedorov, A. A. 1969. Chromosome numbers of flowering plants. pp.66–70. Komar. Bot. Inst. Acad. Sci. USSR, Leningrad. (in Russian)

Kawatani, T. and Ohno, T. 1964. Chromosome numbers in *Artemisia*. Bull. Natl. Inst. Hygienic Sci. **82** : 183–193.

Korobkov, A. A. 1972. On the cytotaxonomical characteristics of some species of the genus *Artemisia* L. in the North-East of the U.S.S.R. Bot. Zurn. **57** : 1316–1327. (in Russian)

Koyama, H. 1995. *Artemisia* L. Iwatsuki, K., Yamazaki, T., Boufford, D. E. and Ohba, H. (eds.). Flora of Japan vol. IIIb, pp. 79–88. Kodansha, Tokyo.

Levan, A., Fredga, K. and Sandberg, A. A. 1964. Nomenclature for centromeric position on chromosomes. Hereditas **52** : 201–220.

Mabberley, D. J. 2008. Mabberley's plant-book, 3 rd ed. 1021 pp. Cambridge University Press, Cambridge.

Masumori, S. 1961. Cytological studies on *Artemisia* I. Karyotypes of five diploid species. Bull. Fac. Educ. Yamaguchi Univ. **11** : 43–56.

Masumori, S. 1963. On the karyotype of *Artemisia stelleriana*. Bull. Fac. Educ. Yamaguchi Univ. **13** : 45–49. (in Japanese with English summary)

Matsuura, H. and Sutô, T. 1935. Contributions to the idiogram study in phanerogamous plants. I.

Jour. Fac. Sci. Hokkaido Imp. Univ. Ser. 5, Bot., **5** : 33–75.
Morton, J. K. 1981. Chromosome numbers in Compositae from Canada and the U.S.A. Bot. J. Linn. Soc. **82** : 357–368.
Nishikawa, T. 1981. Chromosome counts of flowering plants of Hokkaido (5). Rep. Taisetsuzan Inst. Sci. **16** : 45–53. (in Japanese with English summary)
Probatova, N. S. and Sokolovskaya, A. P. 1981. Goldblatt, P. (ed.). Index to plant chromosome numbers 1982–1983, p. 34. Missouri Botanical Garden Press, St. Louis.
Rudyka, E. G. 1995. Chromosome numbers in vascular plants from the southern part of the Russian Far East. Bot. Zurn. **80** : 87–90. (in Russian)
Sokolovskaya, A. P. 1960. Geografitscheskoe rasprostranenie poliploidnykh vidov rastenii (Issledovanie flory o. Sachalina). Vestn. Leningr. Univ., Ser. Biol. **4** : 42–58. (in Russian with English summary)
Sokolovskaya, A. P. 1966. Geografitscheskoe rasprostranenie poliploidnykh vidov rastenii. Issledovanie flory Primorskogo kraya. Vestn. Leningr. Univ., Ser. Biol. **1** : 92–106. (in Russian with English summary)
Suzuka, O. 1950. Chromosome numbers in genus *Artemisia*. Jpn. J. Genet. **25** : 17 18. (in Japanese)
Suzuka, O. 1952. Chromosome numbers in *Artemisia*. I. Seiken Ziho : Rept. Kihara Inst. Biol. Res. **5** : 68–77. (in Japanese with English summary)
Taniguchi, K., Tanaka, R., Yonezawa, Y. and Komatsu, H. 1975. Types of banding patterns of plant chromosome by modified BSG method. La Kromosomo **100** : 3123–3135. (in Japanese with English summary)

摘　要

ヒトツバヨモギ(*Artemisia monophylla*), タカネヨモギ(*A. sinanensis*), それにシロヨモギ(*A. stelleriana*)の3種について核型の観察を行った。ヒトツバヨモギの染色体の長さは2.1–3.3 μm, 腕比が1.0–4.0であり, 核型式は2n=18=14(M+m)+2 sm+2 stであった。Masumori(1961)は4本のサテライト染色体を認めているが, 今回の観察では確認されず, Arano(1962)の報告と一致した。

タカネヨモギの染色体の長さは3.6–5.4 μm, 腕比が1.0–5.2であり, 核型は2n=18=14(M+m)+4^{t}stで表された。Arano(1963)はサテライト染色体を2本認めているが, 今回の観察では4本存在した。

シロヨモギの染色体の長さは2.5–3.3 μm, 腕比が1.0–4.0であり, 核型は2n=18= 12(M+m)+2 sm+2^{t}sm+2^{t}stで表された。この植物についてArano(1962)は2本のサテライト染色体を, Masumori(1963)は4本のサテライト染色体を報告している。今回の観察はMasumori(1963)と一致した。

これら3種におけるサテライト染色体数の報告による違いは, ヨモギ属では二次狭窄がしばしば出現しない, またはそれぞれの種内で核型に多様性が存在するかのいずれかであると考えられる。

([1]Department of Biology, Faculty of Science, University of Toyama, Gofuku 3190, Toyama 930–8555, Japan ; [2]Present address : Hachiman 1027–4, Komoro 384–0051, Japan ; [3]Graduate School of Science and Engineering, University of Toyama, Gofuku 3190, Toyama 930–8555, Japan [1]〒930–8555 富山市五福3190 富山大学理学部生物学科 ; [2]現住所 : 〒384–0051 小諸市八満1027–4 ; [3]〒930–8555 富山市五福3190 富山大学大学院理工学教育部)