Polyploidy of Reynoutria japonica var. japonica (Polygonaceae) in Japan

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Yoshikane Iwatsubo[1], Goro Kodate[1,2] and Naohiro Naruhashi[1] : **Polyploidy of *Reynoutria japonica* var. *japonica* (Polygonaceae) in Japan**

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Abstract

The chromosome number of *Reynoutria japonica* var. *japonica* was determined based on a total of 305 individuals from 37 localities in central and northern Honshu of Japan. Plants investigated showed three chromosome counts of 2n=44, 66 and 88. Among these, the plants with 2n=66 chromosomes are the first finding in Japan. In the 37 localities studied, 15 localities had two chromosome races of any one of the following three combinations : 2n=44 and 66 ; 2n=44 and 88 ; or 2n=66 and 88, and five localities harbored all the three chromosome races. *Reynoutria* is believed to have a base number of x=11 (Darlington and Wylie 1955). These chromosome counts were consistent with the proposed base number, showing euploid variation of tetraploid (2n=44), hexaploid (2n=66) and octoploid (2n=88). Chromosome sizes of the respective chromosome races were 1.0–1.8 μm in tetraploid (2n=44) plant, 1.1–1.8 μm in hexaploid (2n=66) plant, and 0.9–1.8 μm in octoploid (2n=88) plant. Their chromosome complements had similar ranges in chromosome length.

Key words : karyotype, Polygonaceae, polyploidy, *Reynoutria japonica* var. *japonica*.

Reynoutria Houtt. (Polygonaceae)with an area of original distribution in the temperate region of Asia (Mabberley 1997), constitutes four perennial species (Kitagawa 1982). In Japan two species of *Reynoutria* : *R*. *japonica* Houtt. and *R*. *sachalinensis* (F.Schmidt) Nakai, occur (Kitagawa 1982), in which *R*. *japonica* has four varieties as the following : var. *compacta* (Hook. f.) Hiyama, var. *japonica*, var. *terminalis* Honda and var. *uzenensis* Honda (Kitagawa 1982). At present, both of *R*. *japonica* and *R*. *sachalinensis* are distributed in Europe as garden escapes (Bailey and Stace 1992), and *R*. *sachalinensis* is naturalized in North America (Kitagawa 1982).

The chromosome number of *R*. *sachalinensis* is known to be 2n=44 (Jaretzky 1927, 1928, as 2n=ca. 44 ; Sinoto 1929 ; Sokolovskaya 1960, 1965, under *Polygonum sachalinense* F. Schmidt, in Fedorov 1969 ; Wcislo 1977 ; Bailey and Conolly 1985 ; Májovský and Váchová 1986 ; Bailey and Stace 1992, as n=22 and 2n=44, under the name of *Fallopia sachalinensis* (F. Schmidt) Ronse Decr.), ca. 66 (Menshikova 1964, under *P*. *sachalinense*, in Fedorov 1969), and 102 (Lee 1972), while the chromosome numbers of the four varieties in *R*. *japonica* are reported as follows : var. *compacta* : 2n=44 (Jaretzky 1928, as 2n=ca. 44, under *P*. *compactum* Siebold et Zucc. ; Bailey and Conolly 1985 ; Bailey and Stace 1992, under *F*. *japonica* (Houtt.) Ronse Decr. var. *compacta*) ; var. *uzenensis* : 2n=66 and 88 (Bailey and Stace 1992) ; var. *terminalis* : 2n=44 (Bailey and Stace 1992) ; and var. *japonica* : 2n=44 (Sugiura 1931, 1936, as n=22 ; Doida 1960,1962, under *P*. *cuspidatum* Siebold et Zucc. ; Graham and Wood 1965, under *P*. *cuspidatum* ; Murín 1974, under *Pleuropterus cuspidatus* (Siebold et Zucc.) H. Gross ; Váchová and Feráková 1986 ; Bailey and Stace 1992 ; Kim and Park 2000, under *F*. *japonica* var. *japonica*), 2n=52 (Hsu 1985, in Bailey and Stace 1992), 2n=66 (Kim and Park 2000, under *F*. *japonica* var. *japonica*), 2n=88 (Jaretzky 1928, as 2n=ca. 88, under *P*. *cuspidatum* ; Graham and Wood 1965, under *P*. *cuspidatum* ; Lee 1972, under *P*. *cuspidatum* ; Wcislo 1977, under *P*. *cuspidatum* ; Bailey and Conolly 1985 ; Bailey and Stace 1992, under *R*. *japonica* var. *japonica*

; Hollingsworth and Bailey 2000, under *F. japonica* var. *japonica* ; Kim and Park 2000, under *F. japonica* var. *japonica*), and 2n=110 (Hollingsworth and Bailey 2000, under *F. japonica* var. *japonica*).

In Japanese *Reynoutria*, a somatic chromosome number of 2n=44 was reported for *R. sachalinensis* (Sinoto 1929), and the chromosome number for each of the varieties in *R. japonica* was reported as follows : 2n=44 (Sugiura 1931, 1936, as n=22 ; Doida 1960, 1962 ; Bailey and Stace 1992) and ca. 88 chromosomes (Jaretzky 1928, using plant kept in the Kieler Botanischen Garten) for var. *japonica* ; 2n=44 chromosomes (Bailey and Stace 1992) for var. *compacta* ; 2n =66 and 88 chromosomes (Bailey and Stace 1992) for var. *uzenensis* ; and 2n=44 chromosomes (Bailey and Stace 1992) for var. *terminalis*.

We report in the paper that hexaploid plants with 2n=66 chromosomes, along with tetraploid plants with 2n=44 chromosomes and octoploid plants with 2n=88 chromosomes, are prevalent in *R. japonica* var. *japonica* in Japan.

Materials and methods

Three hundred and five individuals of *R. japonica* var. *japonica* in Japan collected from 37 localities listed in Table 1 were used for the study. In order to observe the chromosomes, the

Table 1. Polyploidy of *Reynoutria japonica* var. *japonica* in Japan

Collection locality	Chromosome number (2n)			Number of individuals investigated
	44	66	88	
Yasuda, Aomori City, Aomori Pref.		6		6
Matsuhodo, Asahi-machi, Nishimurayama-gun, Yamagata Pref.		2		2
Imaizumi, Nagai City, Nishimurayama-gun, Yamagata Pref.			2	2
Joyama, Asahi-machi, Shimoniikawa-gun, Toyama Pref.	4	1	3	8
Takabatake, Uozu City, Toyama Pref.	2	2		4
Sanga, Namerikawa City, Toyama Pref.	1	5	3	9
Ohshima, Namerikawa City, Toyama Pref.	3	2		5
Minowa, Namerikawa City, Toyama Pref.	1	2	2	5
Ashikuraji, Tateyama-machi, Nakaniikawa-gun, Toyama Pref.			15	15
Sakka, Kamiichi-machi, Nakaniikawa-gun, Toyama Pref.			1	1
Hara, Ohyama-machi, Kaminiikawa-gun, Toyama Pref.		1	15	16
Sugusaka, Ohsawano-machi, Kaminiikawa-gun, Toyama Pref.	1	6		7
Kurehayama, Toyama City, Toyama Pref.		1	1	2
Takata, Toyama City, Toyama Pref.			2	2
Teramachi, Toyama City, Toyama Pref.			12	12
Sakuradani, Toyama City, Toyama Pref.		7	3	10
Mizuhashi-tsujigado, Toyama City, Toyama Pref.			25	25
Hiyodorijima, Toyama City, Toyama Pref.			1	1
Usaka, Fuchu-machi, Nei-gun, Toyama Pref.	6	8	3	17
Mita, Yatsuo-machi, Nei-gun, Toyama Pref.		5	17	22
Katakake, Hosoiri-mura, Nei-gun, Toyama Pref.	3	1	6	10
Wakabayashi, Daimon-machi, Imizu-gun, Toyama Pref.			4	4
Ohta, Tonami City, Toyama Pref.	2		11	13
Aoshima, Syogawa-machi, Higashitonami-gun, Toyama Pref.		1		1
Bande, Fukuno-machi, Higashitonami-gun, Toyama Pref.		1	4	5
Tochihara, Taira-mura, Higashitonami-gun, Toyama Pref.	1		8	9
Ohnoden, Taira-mura, Higashitonami-gun, Toyama Pref.			5	5
Suganuma, Kamitaira-mura, Higashitonami-gun, Toyama Pref.	2		7	9
Nobata, Oyabe City, Toyama Pref.		3	17	20
Yanami, Oyabe City, Toyama Pref.	1		11	12
Ao, Himi City, Toyama Pref.			1	1
Nagara, Gifu City, Gifu Pref.	4			4
Suwa, Tajimi City, Gifu Pref.		7	3	10
Oofunato, Kanayama-cho, Mashita-gun, Gifu Pref.			9	9
Kadohara, Gero-cho, Mashita-gun, Gifu Pref.	3			3
Nakakawabe, Kawabe-cho, Kamo-gun, Gifu Pref.	5			5
Kiriyama, Nukata-cho, Nukata-gun, Aichi Pref.	12	2		14
Total	51	63	191	305

plants were grown at the experimental garden of Toyama University. Their root tips harvested from potted plants were pretreated in a 2 mM 8-hydroxyquinoline solution for an hour at 25℃ and subsequently kept for about 15 h at 6℃. The root tips were fixed in a mixture of glacial acetic acid and absolute ethyl alcohol (1 : 3) for 1 h, and then soaked in 1 N HCl for a few hours. After being macerated in 1 N HCl at 60℃ for about 10 minutes, they were immersed in tap water. Their meristems were stained in a drop of 1.5% lacto-propionic orcein on the slide glass and

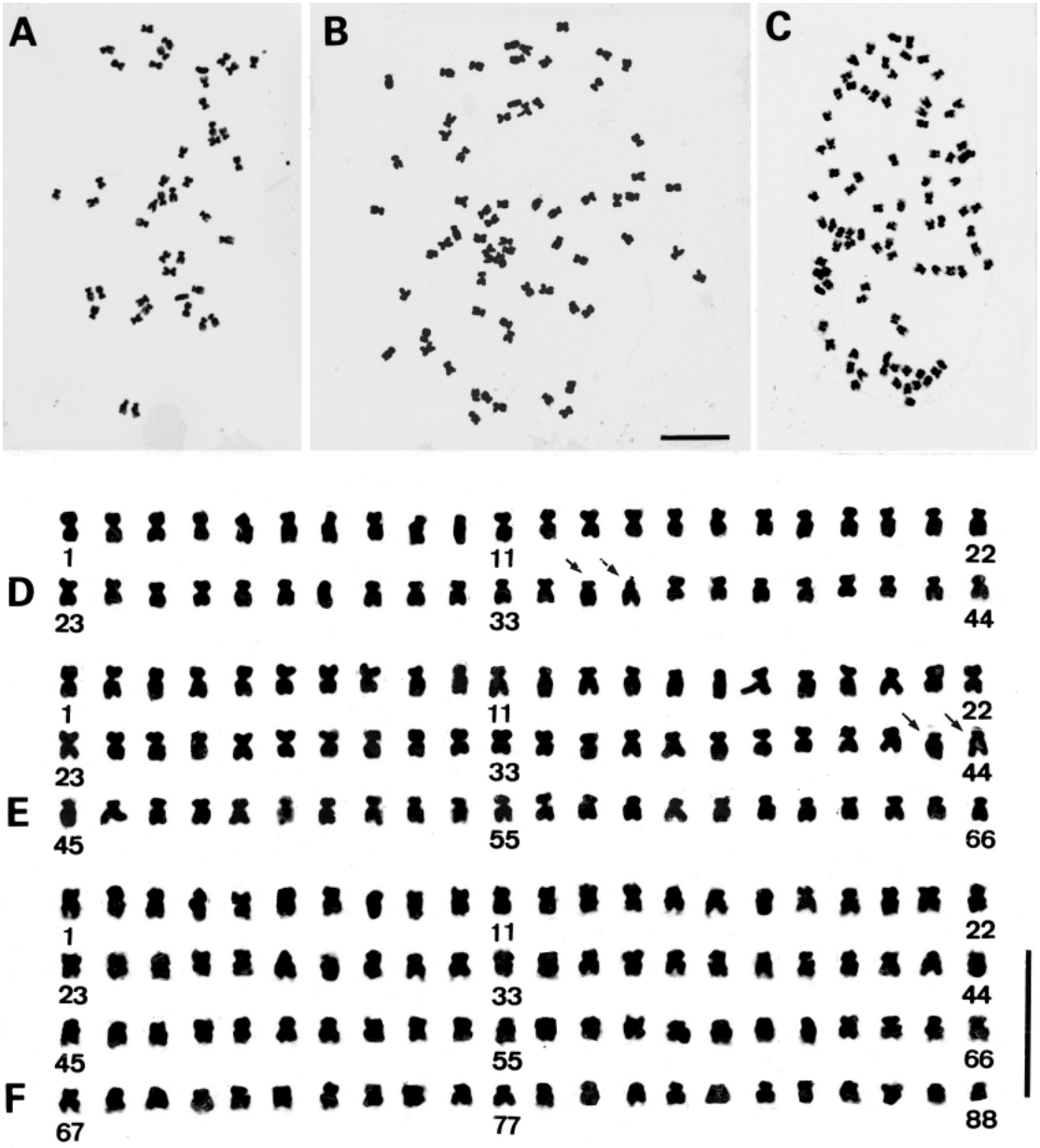

Fig. 1. Somatic metaphase chromosomes (A-C) and karyotypes (D-F) of *Reynoutria japonica* var. *japonica*. Tetraploid with 2n=44 chromosomes (A, D), hexaploid with 2n=66 chromosomes (B, E) and octoploid with 2n=88 chromosomes (C, F). Somatic metaphase chromosomes (A-C) are all equal in magnification, and the three karyotypes (D-F) are produced at the same magnification. Arrows indicate satellite chromosomes. Bars represent 10 μm.

usual squash technique was applied for the examination of somatic chromosomes. The collection localities of the plants for investigating karyotypes were: 2n=44 plant: Ashikuraji, Tateyama-machi, Toyama Pref. ; 2n=66 plant: Mita, Yatsuo-machi, Toyama Pref.; 2n=88 plant: Teramachi, Toyama City, Toyama Pref. Chromosome form was expressed according to the nomenclature of Levan et al. (1964).

Results and discussion

All sampling localities of *R. japonica* var. *japonica* and chromosome counts of them are listed in Table 1. As shown in Table 1 and Fig. 1 A-C, *R. japonica* var. *japonica* investigated showed three chromosome counts of 2n=44, 66 and 88. Among the three chromosome races those with 2n=44 and 88 substantiate the previous reports for Japanese *R. japonica* var. *japonica* (Jaretzky 1928; Sugiura 1931, 1936; Doida 1960, 1962; Bailey and Stace 1992), whereas the plants with 2n=66 are the first report for var. *japonica* in Japan. *Reynoutria* is believed to have a base number of x=11 (Darlington and Wylie 1955). These chromosome counts are consistent with the proposed base number, showing euploid variation of tetraploid, hexaploid and octoploid.

Among the 37 localities studied, 15 localities showed two chromosome races, four had tetraploid and hexaploid plants, four showed tetraploid and octoploid plants, a further seven had hexaploid and octoploid plants and finally another five localities harbored all the three chromosome races of tetraploid, hexaploid and octoploid plants (Table 1).

The result of karyotype analysis for one plant from each of the three chromosome races was as follows :

Karyotype of tetraploid plant (Fig. 1 D)

As shown in Table 2, the chromosomes at metaphase ranged from 1.0–1.8 μm in length and 1.0–4.5 in arm ratio. These chromosomes were divided into three groups: 16 metacentric chromosomes, 22 submetacentric chromosomes and 6 subtelocentric chromosomes. The two subtelocentric chromosomes had satellites on their short arms. The karyotype was formulated as $2n=44=16m + 22sm + 4st + 2^{t}st$.

Karyotype of hexaploid plant (Fig. 1 E)

The chromosomes at metaphase ranged from 1.2–1.8 μm in length and 1.0–4.0 in arm ratio (Table 3). They were classified into three groups: 22 metacentric chromosomes, 34 submetacentric chromosomes, and 10 subtelocentric chromosomes. The two subtelocentric chromosomes had satellites on the short arms. The karyotype was formulated as 2n=66=22m + 34sm

Table 2. Measurements at somatic metaphase chromosomes of tetraploid *Reynoutria japonica* var. *japonica*

Chromosome pair	Length (μm)	Total (μm)	Arm ratio	Form
1	0.9 + 0.9	1.8	1.0	M
2	0.8 + 0.9	1.7	1.1	m
3	0.5 + 1.2	1.7	2.4	sm
4	0.3 + 1.2	1.5	4.0	st
5	0.3 + 1.2	1.5	4.0	st
6	0.5 + 0.9	1.4	1.8	sm
7	0.5 + 0.8	1.3	1.6	m
8	0.5 + 0.8	1.3	1.6	m
9	0.4 + 0.9	1.3	2.3	sm
10	0.4 + 0.9	1.3	2.3	sm
11	0.4 + 0.9	1.3	2.3	sm
12	0.5 + 0.7	1.2	1.4	m
13	0.5 + 0.6	1.1	1.3	m
14	0.4 + 0.7	1.1	2.3	sm
15	0.4 + 0.7	1.1	2.3	sm
16	0.4 + 0.7	1.1	2.3	sm
17	0.4 + 0.7	1.1	2.3	sm
18	t-0.2 + 0.9	1.1	4.5	st
19	0.5 + 0.6	1.1	1.2	m
20	0.3 + 0.8	1.1	2.7	sm
21	0.4 + 0.6	1.0	1.5	m
22	0.3 + 0.7	1.0	2.0	sm

t: satellite.

Table 3. Measurements at somatic metaphase chromosomes of hexaploid *Reynoutria japonica* var. *japonica*

Chromosome pair	Length (μm)	Total (μm)	Arm ratio	Form
1	0.9 + 0.9	1.8	1.0	M
2	0.7 + 1.1	1.8	1.6	m
3	0.8 + 0.9	1.7	1.1	m
4	0.8 + 0.9	1.7	1.1	m
5	0.5 + 1.2	1.7	2.4	sm
6	0.5 + 1.2	1.7	2.4	sm
7	0.5 + 1.2	1.7	2.4	sm
8	0.4 + 1.3	1.7	3.3	st
9	0.4 + 1.3	1.7	3.3	st
10	0.4 + 1.3	1.7	3.3	st
11	0.8 + 0.8	1.6	1.0	M
12	0.8 + 0.8	1.6	1.0	M
13	0.6 + 1.0	1.6	1.7	sm
14	0.6 + 1.0	1.6	1.7	sm
15	0.6 + 1.0	1.6	1.7	sm
16	0.6 + 1.0	1.6	1.7	sm
17	0.6 + 1.0	1.6	1.7	sm
18	0.7 + 0.8	1.5	1.1	m
19	0.7 + 0.8	1.5	1.1	m
20	0.6 + 0.9	1.5	1.5	m
21	0.6 + 0.9	1.5	1.5	m
22	t-0.3 + 1.2	1.5	4.0	st
23	0.3 + 1.2	1.5	4.0	st
24	0.4 + 0.9	1.3	2.3	sm
25	0.5 + 0.8	1.3	1.6	m
26	0.4 + 0.8	1.2	2.0	sm
27	0.4 + 0.8	1.2	2.0	sm
28	0.4 + 0.8	1.2	2.0	sm
29	0.4 + 0.8	1.2	2.0	sm
30	0.4 + 0.8	1.2	2.0	sm
31	0.4 + 0.8	1.2	2.0	sm
32	0.4 + 0.8	1.2	2.0	sm
33	0.4 + 0.8	1.2	2.0	sm

t : satellite.

+ 8st + 2^tst.

Karyotype of octoploid plant (Fig. 1 F)

As shown in Fig. 1 F, the karyotype was not fully analyzed, because we could not obtain any somatic metaphase cells with all chromosomes showing their centromeric positions clearly. In the chromosome complement of this plant, the shortest chromosome measured 0.9 μm and the longest chromosome 1.8 μm.

The three chromosome races of var. *japonica* were not discriminated by their chromosome sizes, because they had small chromosomes with similar ranges of chromosome length : 1.0–1.8 μm in tetraploid plant; 1.1–1.8μm in hexaploid plant; and 0.9–1.8 μm in octoploid plant. The ranges of arm ratios were identical between tetraploid plant and hexaploid plant.

In Korea, *R. japonica* var. *japonica* is known to have three chromosome races of tetraploid, hexaploid and octoploid plants (Kim and Park 2000). The present study showed that the three chromosome races of var. *japonica* reported from Korea (Kim and Park 2000) are also prevalent in Japan.

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岩坪美兼[1]・小舘吾朗[1,2]・鳴橋直弘[1]：日本産イタドリの倍数性

イタドリ（*Reynoutria japonica* var. *japonica*）の染色体数は，国外では 2n=44, 52, 66, 88 が，わが国では n=22, 2n=44, ca.88 が報告されていた。青森県，山形県，富山県，岐阜県，愛知県の 37 カ所から採集した 305 個体について染色体数を調べた。その結果，四倍体（2n=44），六倍体（2n=66），八倍体（2n=88）の個体が見つかり，わが国においても六倍体の個体が存在することが明らかになった。採集を行った 37 カ所のうち，同一地域で四倍体と六倍体の個体が見つかったのは 4 カ所，四倍体と八倍体の個体が見つかったのも 4 カ所，六倍体と八倍体が見つかったのが 7 カ所，そして四倍体，六倍体，八倍体のすべてが見つかったのは 5 カ所であった。この結果，イタドリでは異なる染色体型の個体が同一地域に存在する場合のあることが判った。3 つの型の染色体長は，四倍体では 1.0–1.8 μm，六倍体では 1.1–1.8 μm，八倍体では 0.9–1.8 μm であり，違いは認められなかった。

韓国では四倍体，六倍体，それに八倍体がすでに知られていたが（Kim and Park 2000），わが国にも同様の染色体型のイタドリが分布していた。

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