

Cytotaxonomical Studies of *Rubus* (Rosaceae) II. Chromosome Numbers of 21 Species and 6 Natural Hybrids

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キイチゴ属 (バラ科) の細胞分類学的研究 II.
21 種ならびに 6 自然雑種の染色体数

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Somatic chromosome numbers are presented for 21 species and 6 natural hybrids of *Rubus* (Rosaceae); 13 species and 5 natural hybrids are $2n=14$, 6 species and one natural hybrid are $2n=28$, one species is $2n=42$, and one species is $2n=84$. This presents the first report of chromosome numbers for *R. × babae* ($2n=14$), *R. commersonii* ($2n=14$), *R. corchorifolius* ($2n=14$), *R. grayanus* ($2n=14$), *R. hayata-koidzumii* ($2n=28$), *R. leucocarpus* ($2n=28$), *R. × medius* ($2n=14$), *R. minusculus* ($2n=14$), *R. nesiotetes* ($2n=28$), *R. × nigakuma* ($2n=14$), *R. × nikaii* ($2n=14$), *R. okinawensis* ($2n=14$), *R. pseudojaponicus* ($2n=14$), *R. setchuenensis* ($2n=28$), *R. tiliaceus* ($2n=28$), *R. × utchinensis* ($2n=28$), *R. vernus* ($2n=14$), and *R. × yenoshimanus* ($2n=14$). Additional determinations of chromosome numbers for *R. foliolosus*, *R. innominatus*, *R. niveus*, *R. pectinellus*, *R. phoenicolasius*, *R. pseudoacer*, *R. simplex*, *R. tricolor*, and *R. ursinus* confirm previously published numbers.

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Rubus, one of the largest genera in the Rosoideae, is composed of about 300 species and a few thousands of microspecies with worldwide distribution, but mainly in the temperate and subtropical zone of the northern hemisphere. The chromosome number has been reported for a few hundred species (Ferodov 1969); however, the majority remain unexamined. This series of papers is intended to increase knowledge concerning

chromosome numbers, karyotypes and genomic relationships of *Rubus*, which can lead to a better understanding of the phylogenetic relationships among taxa. This is our second cytological report for this genus and deals with the somatic numbers of 21 species and 6 natural hybrids.

Materials and methods

Twenty-one species and 6 natural hybrids of

Table 1. Collection locality or source of studied taxa in *Rubus*.

Taxa	Collection locality or source
<i>R. × babae</i> Naruhashi	Azumayama**, Tosu-shi, Saga Pref.* Chausu-yama, Kudamatsu-shi, Yamaguchi Pref.*
<i>R. commersonii</i> Poir.	The Botanic Garden, Kew, U.K.
<i>R. corchorifolius</i> Linn. f.	Katagihara, Kyoto-shi, Kyoto Pref.*
<i>R. foliolosus</i> D. Don	Xiaoshao, Yunnan Prov., China
<i>R. grayanus</i> Maxim.	Minamitane-cho, Kumage-gun, Kagoshima Pref.*
<i>R. hayata-koidzumii</i> Naruhashi	The Botanical Garden, Univ. British Columbia, Canada
<i>R. innominatus</i> S. Moore	Lushan, Jiangxi Prov., China
<i>R. leucocarpus</i> Arn.	Sri Lanka
<i>R. × medius</i> O. Ktze.	Shimoda-shi, Shizuoka Pref.*
<i>R. minusculus</i> Lévl. et Vant.	Ikeda-cho, Miyoshi-gun, Tokushima Pref.*
<i>R. nesioties</i> Focke	Okinawahonto, Okinawa Pref.*
<i>R. × nigakuma</i> Oka et Naruhashi	Nanao-shi, Ishikawa Pref.*
<i>R. × nikaii</i> Ohwi	Yokota-cho, Nitta-gun, Shimane Pref.*
<i>R. niveus</i> Thunb.	Dhampus, Mustang Distr., Dhaulagiri Zone, Nepal
<i>R. okinawensis</i> Koidz.	Minamitane-cho, Kumage-gun, Kagoshima Pref.*
<i>R. pectinellus</i> Maxim.	Ooyama-machi, kaminiikawa-gun, Toyama Pref.*
<i>R. phoenicolasius</i> Maxim.	Ogi-machi, Sado-gun, Niigata Pref.*
<i>R. pseudoacer</i> Makino	Gero-cho, Mashita-gun, Gifu Pref.*
<i>R. pseudojaponicus</i> Koidz.	Miyakawa-mura, Yoshiki-gun, Gifu Pref.*
<i>R. setchuenensis</i> Bur. et Franch.	Dujiangyan Municipality, Sichuan Prov., China
<i>R. simplex</i> Focke	The Botanical Garden, Univ. British Columbia, Canada
<i>R. tiliaceus</i> Smith	Pothana, Kaski Distr., Gandaki Zone, Nepal
<i>R. tricolor</i> Focke	The Botanical Garden, Univ. British Columbia, Canada
<i>R. ursinus</i> Cham. et Schl.	Newport, Oregon State, USA
<i>R. × utchinensis</i> Koidz.	Katsuu-dake, Nago-shi, Okinawa Pref.*
<i>R. vernus</i> Focke	Tateyama-machi, Nakaniikawa-gun, Toyama Pref.*
<i>R. × yenosimanus</i> Koidz.	Nyuzen-machi, Shimoniikawa-gun, Toyama Pref.*

*: in Japan

**: Type clone

Rubus cultivated in the botanic garden of Toyama University were used for the study. The taxa and each of the original collection localities are listed in Table 1. For observation of chromosomes, root tips collected from potted plants were pretreated in a 2mM 8-hydroxyquinoline solution for one hour at room temperature, and subsequently held at 5°C for 15 hours. After fixation in a 1:3 acetic acid and ethyl alcohol mixture for one hour, the root tips were hydrolyzed in 1N HCl at 60°C for 11.5 minutes, and immersed in distilled water. Meristematic cells of the root tips were stained in 1.5% lacto-propionic orcein, and the usual

squashing method was employed for the examination of chromosomes.

Results and discussion

Chromosome numbers found in the present study were: $2n=14$ in *R. × babae*, *R. commersonii*, *R. corchorifolius*, *R. foliolosus*, *R. grayanus*, *R. innominatus*, *R. × medius*, *R. minusculus*, *R. × nigakuma*, *R. × nikaii*, *R. niveus*, *R. okinawensis*, *R. phoenicolasius*, *R. pseudoacer*, *R. pseudojaponicus*, *R. simplex*, *R. vernus* and *R. × yenosimanus*; $2n=28$ in *R. hayata-koidzumii*, *R. leucocarpus*, *R. nesioties*, *R. setchuenensis*, *R. tiliaceus*,

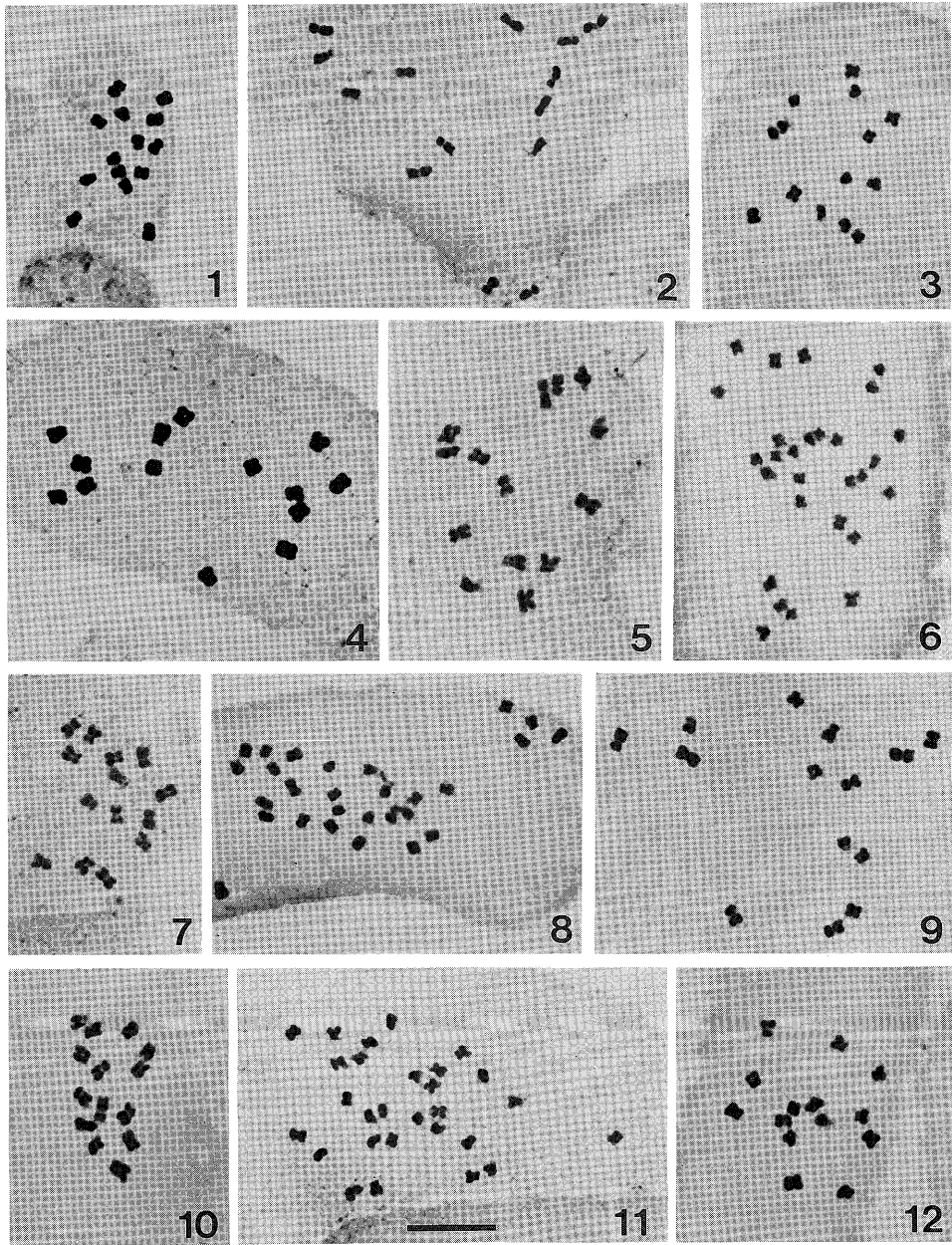


Fig. 1. Somatic metaphase chromosomes of 21 species and 6 natural hybrids of *Rubus*. 1. *R. × babae* ($2n=14$). 2. *R. commersonii* ($2n=14$). 3. *R. corchorifolius* ($2n=14$). 4. *R. foliolosus* ($2n=14$). 5. *R. grayanus* ($2n=14$). 6. *R. hayata-koidzumii* ($2n=28$). 7. *R. innominatus* ($2n=14$). 8. *R. leucocarpus* ($2n=28$). 9. *R. × medius* ($2n=14$). 10. *R. minusculus* ($2n=14$). 11. *R. nesiotus* ($2n=28$). 12. *R. × nigakuma* ($2n=14$). Bar represents 7 μm .

Table 2. Present and previous cytological studies of the *Rubus* taxa examined.

Taxa	Present counts (2n)	Previous counts (2n)	References
<i>R. × babae</i> Naruhashi	14*		
<i>R. commersonii</i> Poir.	14*		
<i>R. corchorifolius</i> Linn. f.	14*		
<i>R. foliolosus</i> D. Don	14	14	Malla et al. (1977)
<i>R. grayanus</i> Maxim.	14*		
<i>R. hayata-koidzumii</i> Naruhashi	28*		
<i>R. innominatus</i> S. Moore	14	14	Longley and Darrow (1924)
<i>R. leucocarpus</i> Arn.	28*		
<i>R. × medius</i> O. Ktze.	14*		
<i>R. minusculus</i> Lévl. et Vant.	14*		
<i>R. nesiotetes</i> Focke	28*		
<i>R. × nigakuma</i> Oka et Naruhashi	14*		
<i>R. × nikaii</i> Ohwi	14*		
<i>R. niveus</i> Thunb.	14	14	Crane (1940), Thomas (1940), Malik (1965)
		28	Crane and Darlington (1927)
<i>R. okinawensis</i> Koidz.	14*		
<i>R. pectinellus</i> Maxim.	42	42	Jinno (1951, 1958a, b)
<i>R. phoenicolasius</i> Maxim.	14	14	Longley and Darrow (1924) Jinno (1958a, b)
<i>R. pseudoacer</i> Makino	14	14	Jinno (1958a)
<i>R. pseudojaponicus</i> Koidz.	14*		
<i>R. setchuenensis</i> Bur. et Franch.	28*		
<i>R. simplex</i> Focke	14	14	Vaarama in Fedorov (1969)
<i>R. tiliaceus</i> Smith	28*		
<i>R. tricolor</i> Focke	28	28	Keep (1958)
<i>R. ursinus</i> Cham. et Schl.	84	42, 56, 63, 70, 77, 84	Brown (1943) etc.
<i>R. × utchinensis</i> Koidz.	28*		
<i>R. vernus</i> Focke	14*		
<i>R. × yenoshimanus</i> Koidz.	14*		

*: First record of chromosome numbers

R. tricolor and *R. × utchinensis*; 2n=42 in *R. pectinellus*; 2n=84 in *R. ursinus* (Fig. 1, Table 2). Since the basic chromosome number of *Rubus* has been considered to be x=7 (Fedorov 1969), these counts are interpreted as diploid, tetraploid, hexaploid and dodecaploid levels, respectively. Chromosome counts published for the first time in this paper are for 12 species and 6 natural hybrids: *R. × babae*, *R. commersonii*, *R. corchorifolius*, *R. grayanus*, *R. hayata-koidzumii*, *R. leucocarpus*, *R. × medius*, *R. minusculus*, *R. nesiotetes*, *R. × nigakuma*, *R. × nikaii*, *R. okinawen-*

sis, *R. pseudojaponicus*, *R. setchuenensis*, *R. tiliaceus*, *R. × utchinensis*, *R. vernus* and *R. × yenoshimanus*. As shown in Table 2, the counts for the other 9 species substantiate the chromosome numbers previously reported.

Five of the natural hybrids examined in this study were diploid; *R. × babae*, *R. × medius*, *R. × nigakuma*, *R. × nikaii* and *R. × yenoshimanus*, and one, *R. × utchinensis*, was tetraploid. The parents of these natural hybrids are thought to be as follows: *R. × babae* is a hybrid between 2 diploid species, *R. corchorifolius* and *R. hirsutus*

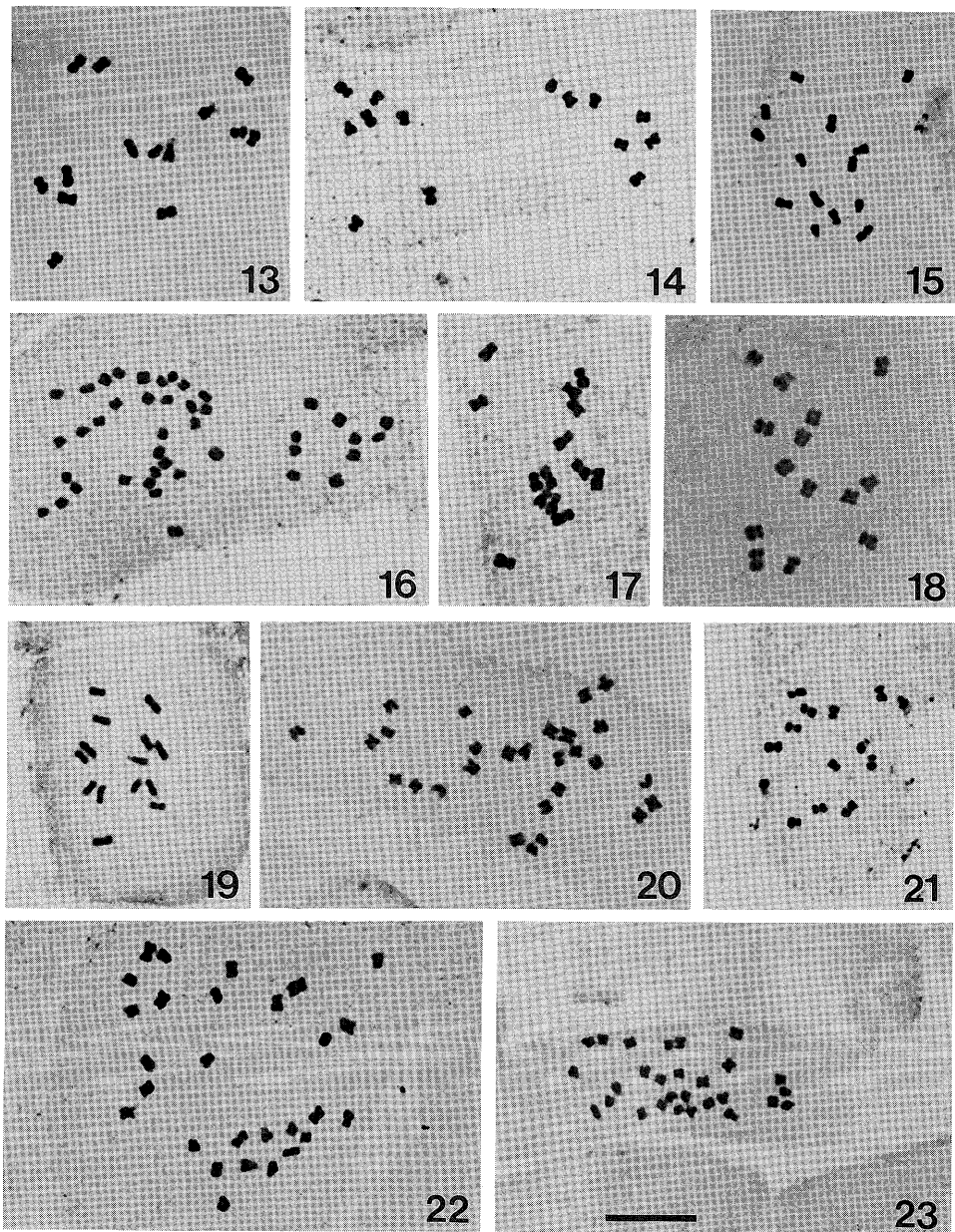


Fig. 1 (continued). 13. *R. × nikaii* ($2n=14$). 14. *R. niveus* ($2n=14$). 15. *R. okinawensis* ($2n=14$). 16. *R. pectinellus* ($2n=42$). 17. *R. phoenicolasius* ($2n=14$). 18. *R. pseudoacer* ($2n=14$). 19. *R. pseudojaponicus* ($2n=14$). 20. *R. setchuensis* ($2n=28$). 21. *R. simplex* ($2n=14$). 22. *R. tiliaceus* ($2n=28$). 23. *R. tricolor* ($2n=28$). Bar represents $7\ \mu\text{m}$.

(Naruhashi 1979); *R. × medius* is a hybrid between 2 diploid species, *R. microphyllus* and *R. trifidus* (Ohwi 1953); *R. × nigakuma* is a hybrid between 2 diploid species, *R. crataegifolius* and *R.*

microphyllus (Naruhashi 1971); *R. × nikaii* is a hybrid between 2 diploid species, *R. parvifolius* and *R. phoenicolasius* (Ohwi 1949); *R. × yenosimanus* is a hybrid between 2 diploid species, *R.*

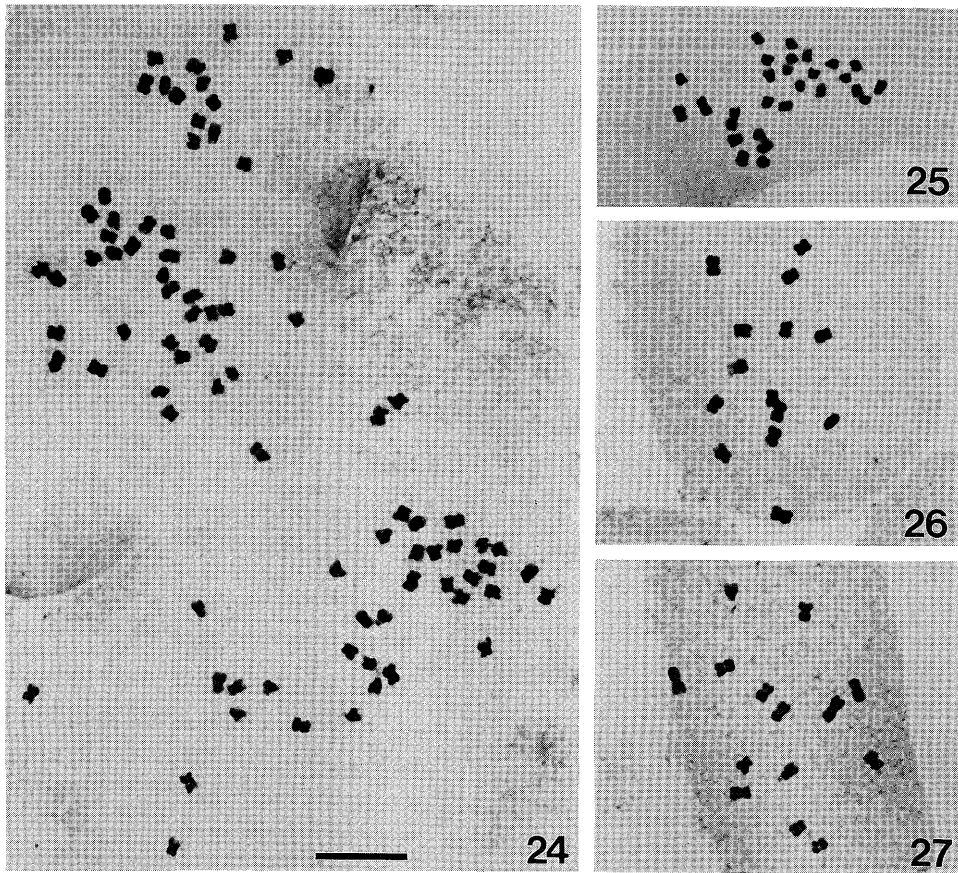


Fig. 1 (continued). 24. *R. ursinus* ($2n=84$). 25. *R. \times utchinensis* ($2n=28$). 26. *R. vernus* ($2n=14$). 27. *R. \times yenoshimanus* ($2n=14$). Bar represents $7 \mu\text{m}$.

palmatus and *R. trifidus* (Ohwi 1953); *R. \times utchinensis* is a hybrid between 2 tetraploid species, *R. nesiotetes* and *R. sieboldii* (Hatusima 1971). Thus, the ploidy levels of the 6 natural hybrids agreed with those of the putative parents.

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要 旨

キイチゴ属 21種ならびに6自然雑種について染色体数を調査した。それぞれの染色体数は、

Rubus babae(2n=14), *R. commersonii*(2n=14), *R. corchorifolius*(2n=14), *R. foliolosus*(2n=14), *R. grayanus*(2n=14), *R. hayata-koidzumii*(2n=28), *R. innominatus*(2n=14), *R. leucocarpus*(2n=28), *R. × medius*(2n=14), *R. minusculus*(2n=14), *R. nesiototes*(2n=28), *R. × nigakuma*(2n=14), *R. × nikaii*(2n=14), *R. niveus*(2n=14), *R. okinawensis*(2n=14), *R. pectinellus*(2n=42), *R. phoenicolasius*(2n=14), *R. pseudoacer*(2n=14), *R. pseudojaponicus*(2n=14), *R. setchuenensis*(2n=28), *R. simplex*(2n=14), *R. tiliaceus*(2n=28), *R. tricolor*(2n=28), *R. ursinus*(2n=84), *R. × utchinensis*(2n=28), *R. vernus*(2n=14), *R. × yenoshimanus*(2n=14)であった。このうち *Rubus*×*babae*, *R. commersonii*, *R. corchorifolius*, *R. grayanus*, *R. hayata-koidzumii*, *R. leucocarpus*, *R. × medius*, *R. minusculus*, *R. nesiototes*, *R. × nigakuma*, *R. × nikaii*, *R. okinawensis*, *R. pseudojaponicus*, *R. setchuenensis*, *R. tiliaceus*, *R. × utchinensis*, *R. vernus*, *R. × yenoshimanus* の染色体数は、初めての報告である。