Nobuko Yamamoto¹, Hiroshi Ikeda² and Takuji Hoshino¹:
Cytotaxonomical studies of flowering plants in Yakushima Island, Kagoshima Prefecture, Japan
Part I: dwarf taxa

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Abstract
Chromosome counts of 33 taxa of dwarf plants collected from Yakushima Island are reported. Chromosome counts for the following 23 taxa are published for the first time: Coptis ramosa (2n=18), Sarothra laxa f. hanaeogoeensis (2n=16), Astrilbe glaberrima var. saxatilis (2n=14), Parnassia palustris var. yakusimensis (2n=18), Saxifraga fortunei var. minima (2n=22), Viola boissieana var. pseudoselkirkii (2n=24), V. verecunda var. yakusimana (2n=24), Circaea alpina f. minima (2n=22), Angelica longiradiata var. yakushimensis (2n=22), Tripteropsernum japonicum var. tenue (2n=46), Galium pogonanthum var. yakumontanum (2n=22), Mitchella undulata var. minor (2n=22), Neanotis hirsuta var. yakusimensis (2n=24), Clinopodium multicaule var. yakusimense (2n=20), Scutellaria huromidakensis (2n=26), Melampyrum laxum var. yakimense (2n=18), Cirsium yakushimense (2n=68), Helionopsis breviscapa var. yakusimensis (2n=34), Metanarthecium luteo-viride f. yakusimense (2n=52+1B), Smilax biflora var. biflora (2n=30), Tofieldia yoshiiana (2n=30), Luzula campestris var. yakusimensis (2n=12), Pseudosasa ovata (2n=48). Chromosome counts for a further ten taxa agree with those already published: Ranunculus yakushimensis (2n=14), Hypericum kiusianum var. yakusimense (2n=32), Mitella doiana (2n=28), Fragaria nipponica var. yakusimensis (2n=14), Sanicula lamelligera (2n=16), Lysimachia japonica var. minutissima (2n=20), Plantago asiatica var. yakusimensis (2n=24), Cacalia yakusimensis (2n=60), Solidago minutissima (2n=18), Paris tetraphylla var. yakusimensis (2n=10). No differences were found when comparing these chromosome numbers of dwarf plants with those of closely related non-dwarf taxa.

Key words: chromosome number, cytotaxonomy, dwarf taxa, endemism, Yakushima Island.

Yakushima Island is located about 60 km to the south of the mainland of Kyushu. Masamune (1934) enumerated 861 species of vascular plants in his floristic study of Yakushima Island. Flora of Yakushima Island is characterized by high rate of endemism, and Yahara et al. (1987) listed 72 endemic taxa. Another characteristic of the flora is that many dwarf forms grow on the upper part of the island, and Sugimoto (1957) listed 101 taxa on the island which exhibited dwarfisms. Such endemic or dwarf taxa might be differentiated on the island as a result of restriction of gene flow by isolation from the mainland.

Cytological variation, such as polyploidy or aneuploidy, is one cause of speciation in higher plants (Grant 1981). Therefore, it is possible that cytological variations might play an important role for differentiation on endemic or dwarf taxa in Yakushima Island. Although cytological studies on plants in Yakushima Island have been undertaken for several genera, such as Mitella (Wakabayashi 1973 a), Oxalis (Terao 1979), Solidago (Huziwar 1965) and Cacalia (Koyama 1968), there are not enough data to reveal the cytological characteristics of the plants of Yakushima Island.

This is a series of papers reporting cytological characteristics of flowering plants found on Yakushima Island. This first part is concerned with the chromosome numbers for the dwarf taxa.

Materials and methods
Thirty three taxa in 32 genera and 17 families...
were collected from across Yakushima Island (Table 1). Root tips or shoot apices were pre-treated with 2 mM 8-hydroxyquinoline solution for 4-5 hours at room temperature, or one hour at room temperature and then kept 15 hours at 4°C. Following this they were fixed with Newcomer’s fluid (Sharma and Sharma 1980). Thick materials were hydrated by soaking in a 1 N HCl solution for ten minutes at 60°C, before transfer into Schiff’s reagent at room temperature for one hour. Materials were macerated with a mixture of 2% cellulase and 2% pectinase for 0.5-1 hour at 37°C, and then washed in distilled water. Slender materials were hydrated and macerated with 1 N HCl for ten minutes at 60°C and washed in distilled water. After maceration, the meristematic tissues were placed on slide glasses and squashed with an 2% lacto-propionic orcein. Chromosomes were observed using a Nikon Eclipse E-600 microscope.

Voucher specimens are deposited in the Herbarium of Okayama University of Science (OKAY).

Results and discussion

Chromosome numbers of 33 taxa in 32 genera in 17 families of flowering plants on Yakushima Island were counted and presented in Appendix. The chromosomes observed in a somatic cell of several species of flowering plants on Yakushima Island were counted and presented in Appendix. In 1987 he reported the chromosome numbers of H. kiusianum with var. yakusimense as 2n=32, and our study confirms this report. Kogi (1984) reported counts of 2n=16, 18, 24 and 32 chromosomes from eight Japanese taxa of Hypericum, and mentioned that the taxa with 2n=16, 24 and 32 were diploid, triploid, and tetraploid, respectively. According to our result and those of previous reports, H. kiusianum var. yakusimense is probably a tetraploid with basic chromosome number x=8.

3. Hypericum kiusianum Koidz. var. yakusimense (Koidz.) T.Kato : (Fig. 1 C).

Hypericum kiusianum var. yakusimense is endemic to Yakushima Island and grows on wet places or moist banks besides forestry trails at higher elevations. It was originally described at a specific rank (Koidzumi 1929), but Kimura (1951) reduced it to a variety of H. pseudopetiolatum R. Keller.

Kato (1985, 1986, 1987) made a series of taxonomical studies of H. pseudopetiolatum complex. In 1987 he reported the chromosome numbers of H. kiusianum with var. yakusimense as 2n=32, and our study confirms this report. Kogi (1984) reported counts of 2n=16, 18, 24 and 32 chromosomes from eight Japanese taxa of Hypericum, and mentioned that the taxa with 2n=16, 24 and 32 were diploid, triploid, and tetraploid, respectively. According to our result and those of previous reports, H. kiusianum var. yakusimense is probably a tetraploid with basic chromosome number x=8.

4. Sarothra laxa (Blume) Y.Kimura f. hananoegeonis (Masam.) Y.Kimura : (Fig. 1 D).

Sarothra laxa f. hananoegeonis is endemic to Yakushima Island and grows on moors at higher elevations. Chromosome number for this form, 2n=16, was counted for the first time, and is the first reported for the genus.

The genus Sarothra is closely related to Hypericum (Kimura 1951). Sarothra laxa f. hananoegeonis might be diploid, because the basic chromosome number of Hypericum was reported as x=8 (Kogi 1984).

Saxifragaceae

5. Astilbe glaberrima Nakai var. saxatilis (Nakai) H.Ohba : (Fig. 1 E).

Astilbe glaberrima was described from a speci-
<table>
<thead>
<tr>
<th>Family</th>
<th>Taxon</th>
<th>Locality and voucher specimen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ranunculaceae</td>
<td>Coptis japonica</td>
<td>Hanogawa Tozan−guchi --- Hanogawa hut, 1,380 m alt. (Ikeda et al. 04042305)</td>
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<td></td>
<td>Ranunculus yakushimensis</td>
<td>Hanogano−ego Moor --- Nageshi−daira Col, 1,660 m alt. (Ikeda &amp; Yamamoto 05060921)</td>
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<tr>
<td>Guttiferae</td>
<td>Hypericum kiusianum var. yakusimensis</td>
<td>Near Hanogano−ego Moor, 1,630 m alt. (Yamamoto 06012003)</td>
</tr>
<tr>
<td></td>
<td>Sarothra laxa f. hananoegoensis</td>
<td>Near Hanogawa Tozan−guchi, 1,360 m alt. (Ikeda et al. 05091902)</td>
</tr>
<tr>
<td>Saxifragaceae</td>
<td>Astilbe glaberrima var. saxatilis</td>
<td>Hanogano−ego Moor --- Nageshi−daira Col, 1,690 m alt. (Yamamoto 06012011)</td>
</tr>
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<td></td>
<td>Mitella doiana</td>
<td>Near Arakawa Dam, 610 m alt. (Yamamoto 06012012)</td>
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<tr>
<td></td>
<td>Saxifraga fortunei var. minima</td>
<td>Near Shikano−sawa hut, 1,560 m alt. (Ikeda et al. 05092101)</td>
</tr>
<tr>
<td>Rosaceae</td>
<td>Fragaria nipponica var. yakusimensis</td>
<td>Hanogano−ego Moor --- Nageshi−daira Col, 1,660 m alt. (Yamamoto 06012010)</td>
</tr>
<tr>
<td>Violaceae</td>
<td>Viola boissieuana var. pseudoselkirkii</td>
<td>Near Hanogawa Tozan−guchi, 1,320 m alt. (Ikeda et al. 04042224)</td>
</tr>
<tr>
<td></td>
<td>V. verecunda var. yakusimensis</td>
<td>Near Hanogano−ego Moor, 1,650 m alt. (Ikeda &amp; Yamamoto 05060901)</td>
</tr>
<tr>
<td>Onagraceae</td>
<td>Circaea alpina f. minima</td>
<td>Near the summit of Mt. Miyanoora, 1,920 m alt. (Ikeda et al. 05092203)</td>
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<tr>
<td>Umbelliferae</td>
<td>Angelica longiradiata var. yakusimensis</td>
<td>Shikanosawa hut --- Mt. Nagata, 1,790 m alt. (Ikeda et al. 05092114)</td>
</tr>
<tr>
<td></td>
<td>Sanicula lamelligera</td>
<td>Near Arakawa Dam, 610 m alt. (Ikeda et al. 04042210)</td>
</tr>
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<td>Primulaceae</td>
<td>Lysimachia japonica var. minutissima</td>
<td>Hanogano−ego Moor --- Nageshi−daira Col, 1,670 m alt. (Ikeda et al. 04042899)</td>
</tr>
<tr>
<td>Gentianaceae</td>
<td>Tripterospermum japonicum var. tenue</td>
<td>Hanogano−ego Moor --- Mt. Nagata, 1,790 m alt. (Ikeda et al. 05092111)</td>
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<td>Rubiaceae</td>
<td>Gaulium gogonanthum var. yusumontanum</td>
<td>Hanogano−ego Moor --- Nageshi−daira Col, 1,680 m alt. (Ikeda &amp; Yamamoto 05060903)</td>
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<td>Mitchellia undulata var. minor</td>
<td>Shiratani−unsuikyo Gorge, 850 m alt. (Ikeda et al. 04102315)</td>
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<td>Neanotis hirsuta var. yakusimensis</td>
<td>Near Hanogawa Tozan−guchi, 1,320 m alt. (Ikeda et al. 04042224)</td>
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<td>Sanicula lamelligera</td>
<td>Near Hanogano−ego Moor, 1,650 m alt. (Ikeda &amp; Yamamoto 05060901)</td>
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<td>Labiatae</td>
<td>Clinopodium multifidae var. yakusimensis</td>
<td>Hanogano−ego Moor, 1,570 m alt. (Yamamoto 06012004)</td>
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<td></td>
<td>Scutellaria kuromidakensis</td>
<td>Hanogano−ego Moor, 1,370−1,620 m alt. (Ikeda &amp; Yamamoto 05060823)</td>
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<td>Scrophulariaceae</td>
<td>Melampyrum laxum var. yakusimensis</td>
<td>Hanogano−ego Moor, 1,620 m alt. (Ikeda &amp; Yamamoto 05060807)</td>
</tr>
<tr>
<td>Plantaginaceae</td>
<td>Plantago asiatica var. yakusimensis</td>
<td>At the top of Mt. Miyanoora, 1,935 m alt. (Yamamoto 06012009)</td>
</tr>
<tr>
<td>Compositae</td>
<td>Cocalia yakusimensis</td>
<td>Nageshi−daira Col --- summit of Mt. Miyanoora, 1,720 m alt. (Ikeda et al. 04102208)</td>
</tr>
<tr>
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<td>Cirsium yakusimensese</td>
<td>Yodogawa Tozan−guchi, 1,360 m alt. (Ikeda et al. 05091901)</td>
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<tr>
<td></td>
<td>Solidago minutissima</td>
<td>Near Nageshi−daira Col, 1,700 m alt. (Yamamoto 06012001)</td>
</tr>
<tr>
<td>Liliaceae</td>
<td>Heloniopsis breviscapa var. yakusimensis</td>
<td>Nageshi−daira Col --- summit of Mt. Miyanoora, 1,710 m alt. (Yamamoto 06012005)</td>
</tr>
<tr>
<td></td>
<td>Metanarthecium luteo-viride f. yakusimensis</td>
<td>Near Shikanosawa hut, 1,560 m alt. (Yamamoto 05092100)</td>
</tr>
<tr>
<td></td>
<td>Paris tetraphylla var. yakusimensis</td>
<td>Hanogano−ego Moor --- Nageshi−daira Col, 1,680 m alt. (Ikeda &amp; Yamamoto 05060911)</td>
</tr>
<tr>
<td></td>
<td>Strilaz biflora var. biflora</td>
<td>Hanogano−ego Moor --- Nageshi−daira Col, 1,670 m alt. (Ikeda &amp; Yamamoto 05060914)</td>
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<td>Juncaceae</td>
<td>Luzula campestris var. yakusimensis</td>
<td>Hanogano−ego Moor --- Nageshi−daira Col, 1,660 m alt. (Ikeda &amp; Yamamoto 05060906)</td>
</tr>
<tr>
<td>Gramineae</td>
<td>Pseudosasa owatarii</td>
<td>Mt. Nagata --- Mt. Miyanoora, 1,810 m alt. (Ikeda et al. 05092202)</td>
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</table>
men collected in Yakushima Island by Nakai (1922). He recognized two types in this species, a larger one (“lusus terrestris”) and a smaller one (“lusus saxatilis”). We examined the small-sized individuals (var. saxatilis) on wet mossy rocks at 1,690 m above sea level, and report a chromosome number of 2n=14, the first count for this species. Nishikawa (1996) reported the same chromosome number of 2n=14 for the allied species, *A. thunbergii* (Siebold et Zucc.) Miq. var. congesta H.Boissieu.

6. *Mitella* *doiana* Ohwi : (Fig. 1 F).

*Mitella* *doiana* is endemic to Yakushima Island and grows moist places at the edges of broad-leaved forest. Wakabayashi (1973 a) revised the taxonomy of the genus *Mitella* and found a polyploid series of 2n=14, 28 and 42. He reported the chromosome number of *M. doiana* as 2n=28 and the present study confirms this. Wakabayashi (1973 a) discussed *Mitella* in Japan and speculated that *M. doiana* was close related to *M. furusei* Ohwi, *M. leiopetala* Ohwi et Okuyama (=*M. furusei* var. *subramosa* Wakab.), *M. makinot* H.Hara and *M. stylosa* H.Boissieu which all possessed 2n=28 chromosomes.

7. *Parnassia palustris* L. var. *yakusimensis*
Parnassia palustris var. yakusimensis is endemic to Yakushima Island and grows on wet places at higher elevations. The chromosome number for this taxon, 2n=18, has been counted for the first time, and agrees with the number for the typical variety that was reported by Nishikawa (1985).

8. Saxifraga fortunei Hook.f. var. minima Nakai : (Fig. 1 H).

Saxifraga fortunei var. minima is endemic to Yakushima Island and grows on wet rocks at higher elevations. The chromosome number for this taxon, 2n=22, is reported for the first time, and agrees with the chromosome numbers for other infraspecific taxa: S. fortunei var. incisolobata (Engl. et Irmsch.) Nakai and obtusocuneata (Makino) Nakai (Wakabayashi 1973 b).

Rosaceae

9. Fragaria nipponica Makino var. yakusimensis (Masam.) Masam. : (Fig. 1 I).

Fragaria nipponica var. yakusimensis is endemic to Yakushima Island and grows on grassy places at higher elevations. The chromosome number for this taxon, 2n=14, is consistent with the previous report by Iwatsubo and Naruhashi (1989). Iwatsubo and Naruhashi (1989) examined chromosome numbers of three species of Japanese Fragaria, and found the same chromosome number of 2n=14.

Violaceae

10. Viola boissieana Makino var. pseudoselkirki (Nakai) Yahara : (Fig. 2 A).

Viola boissieana var. pseudoselkirki is endemic to Yakushima Island and grows on moist banks along forestry trails between the upper montane zone and higher elevations. The chromosome number of this taxon, 2n=24, has been counted for the first time, and is the same as that of the typical variety reported by Miyaji (1929).

11. Viola verecunda A. Gray var. yakusimana (Nakai) Ohwi : (Fig. 2 B).

Viola verecunda var. yakusimana is endemic to Yakushima Island and grows on moors at higher elevations. The chromosome number for this taxon, 2n=24, was counted for the first time, and is the same as that for the typical variety reported by Miyaji (1929).

Onagraceae

12. Circaea alpina L. f. minima Mitsuta (nom. nud.) : (Fig. 2 C).

Circaea alpina f. minima is a dwarf form of C. alpina and grows on moist places near the summits of mountains. Mitsuta gave the name without description (Mitsuta and Nagamasu 1984), and so it awaits formal publication. Tanaka et al. (1988) reported the chromosome number of C. alpina as 2n=22, the same number as the present study.

Umbelliferae

13. Angelica longiradiata (Maxim.) Kitag. var. yakushimensis (Masam. et Ohwi) Kitag. : (Fig. 2 D).

Angelica longiradiata var. yakushimensis is endemic to Yakushima Island and grows on sunny wet mossy rocks. The chromosome number for this taxon, 2n=22, was counted for the first time, and is the same as that for the typical variety reported by Okazaki and Sakata (1995).

14. Sanicula lamelligera Hance : (Fig. 2 E).

Sanicula lamelligera is distributed in Yakushima Island and the Ryukyu Islands, central to south China and Taiwan. In Yakushima Island this species grows on moist ground under coniferous forest in the montane zone. In the present study the chromosome number for this species was counted as 2n=16. Chuang et al. (1963) reported the gametophytic chromosome number for this species as n=8, which is the same as the somatic chromosome number reported here.

Primulaceae

15. Lysimachia japonica Thunb. var. minutissima Masam. : (Fig. 2 F).

Lysimachia japonica var. minutissima is endemic to Yakushima Island and grows on moist banks beside forestry trails at higher elevations. The chromosome number for this taxon, 2n=20, is consistent with the earlier count by Kurosawa and Hara (1960). Different chromosome numbers have been reported for L. japonica : 2n=18 for
materials from eastern Himalaya (Sarker 1988), 2n=20 for materials from Tokyo (Hara and Kurosawa 1959), and 2n=22 for materials from Hokkaido (Nishikawa 1989). From the chromosome number and geographical distribution, var. minutissima might be differentiated from the ancestral plants distributed in western Japan with the chromosome number 2n=20.

Gentianaceae
16. *Tripterospermum japonicum* (Siebold et Zucc.) Maxim. var. *tenue* (Masam.) Honda : (Fig. 2 G).

*Tripterospermum japonicum* var. *tenue* is endemic to Yakushima Island and grows on moist banks beside forestry trails at higher elevations. The chromosome number for this taxon, 2n=46, is counted here for the first time and is the same as for the typical variety reported by Nishikawa (1981) and Shigenobu (1984).

Rubiaceae

17. *Galium pogonanthum* Franch. et Sav. var. *yakumontanum* T.Yamaz. : (Fig. 2 H).

*Galium pogonanthum* var. *yakumontanum* is endemic to Yakushima Island and grows on moist banks beside forestry trails. The chromosome number for this taxon, 2n=22, was counted for the first time. Chromosome number for this taxon, 2n=22, was reported here for the first time.

18. *Mitchella undulata* Siebold et Zucc. var. *minor* Masam. : (Fig. 2 I).

*Mitchella undulata* var. *minor* is endemic to Yakushima Island and grows on mossy tree trunks or rocks in coniferous forests. The chromosome number for this taxon, 2n=22, is reported here for the first time. Chromosome number for the typical var. *undulata* was reported the same number, 2n=22, by Robbrecht et al. (1991).

Yokoyama et al. (2003) examined morphological and genetical variation in *M. undulata*, and they could not find any genetic difference between varr. *undulata* and *minor*.

19. *Neanotis hirsuta* (L. f.) W. H. Lewis var. *yakusimense* (Masam.) W. H. Lewis : (Fig. 2 J).

*Neanotis hirsuta* var. *yakusimense* is endemic to Yakushima Island and grows in moist places in the montane zone. The chromosome number for this taxon, 2n=24, was counted for the first time.

Labiatae

20. *Clinopodium multicaule* (Maxim.) Kuntze var. *yakusimense* (Masam.) Yahara : (Fig. 3 A).

*Clinopodium multicaule* var. *yakusimense* was originally described from materials collected in Yakushima Island (Masamune 1930), and has now also been reported from Mt. Kasuga in Nara Prefecture (Murata 1981), Awaji Island in Hyogo Prefecture (Kobayashi 1992). The chromosome number for this taxon, 2n=20, is reported here for the first time.

21. *Scutellaria kuromidakensis* (Yahara) T.Yamaz. : (Fig. 3 B).

*Scutellaria kuromidakensis* is endemic to Yakushima Island and grows beside forestry trails or between rocks at higher elevations. Yahara et al. (1987) recognized two taxa, *S. rubropunctata* var. *yakusimensis* and *S. kiusiana* var. *kuromidakensis* at higher elevations in the island. Murata and Yamazaki (1993) treated these two as conspecific and named *S. kuromidakensis*. The chromosome number for this taxon, 2n=26, has been counted for the first time. Sawanomukai et al. (2003) reported chromosome numbers of 16 species and two varieties of Japanese *Scutellaria* and reported 2n=26, 28 and 30. They reported 2n=26 chromosomes for nine species and two varieties in ser. *Indicae*, and found no numerical variation in the series. Morphologically, *S. kuromidakensis* belongs to ser. *Indicae* (Murata and Yamazaki 1993), and we similarly found no chromosomal variation in this species as Sawanomukai et al. (2003) noted.

Scrophulariaceae

22. *Melampyrum laxum* Miq. var. *yakusimense* (Tuyama) Kitam. : (Fig. 3 C).

*Melampyrum laxum* var. *yakusimense* is endemic to Yakushima Island and grows on grassland or in forest margins at higher elevations. The chromosome number of 2n=18, is here reported for the first time.

Plantaginaceae

23. *Plantago asiatica* L. var. *yakusimensis* (Masam.) Ohwi : (Fig. 3 D).

*Plantago asiatica* var. *yakusimensis* is a dwarf form of *P. asiatica*, described from materials collected from Yakushima Island (Masamune 1930). This taxon has since been reported from Izu islands, Tokyo Prefecture, southern Korea (Ohwi 1953) and in Miyajima Island, Hiroshima Prefecture (Seki et al. 1975). The chromosome number we observed for this taxon, 2n=24, was the same as previous reports (Matsuo and Noguchi 1989; Ishikawa et al. 2006).
Compositae
24. Cacalia yakuimensis Masam. : (Fig. 3 E).

*Cacalia yakuimensis* is endemic to Yakushima Island and grows on moist ground of rocky places. The chromosome number for this taxon, 2n=60, is consistent with the count by Koyama (1968). Koyama (1961, 1968) reported the chromosome number of *C. hastata*, close related species to *C. yakuimensis*, as the same number 2n=60.

25. Cirsium yakuimensense Masam. : (Fig. 3 F).

*Cirsium yakuimensense* is endemic to Yakushima Island and grows on open grassland at higher elevations. The chromosome number for this taxon of 2n=68, is here reported for the first time.

26. Solidago minutissima (Makino) Kitam. : (Fig. 3 G).

*Solidago minutissima* is endemic to Yakushima Island and grows on wet mossy rocks at higher elevations. The chromosome number recorded for this taxon, 2n=18, is consistent with that by Huziwara (1965). The chromosome number of the closely related species, *S. virgaurea* L. subsp. *asiatica* Kitam. ex H. Hara, was also reported as 2n=18 (Matsuura and Suto 1935; Huziwara 1962).

Liliaceae
27. Heloniopsis breviscapa Maxim. var. *yakuimensis* (Masam.) H. Hara : (Fig. 4 A).

*Heloniopsis breviscapa* var. *yakuimensis* is endemic to Yakushima Island and grows on moist places at higher elevations. The chromosome number reported for this taxon, 2n=34, is here reported for the first time. Although *H. breviscapa* is sometimes treated as a variety of *H. orientalis* (Thunb.) Tanaka (Ohwi 1953; Satake 1982), Hara (1947) considers it as an independent species. Chromosome numbers of the typical var. *breviscapa* and allied species, *H. orientalis*, have also been reported as 2n=34 (Suto 1936; Okuyama 1962).

28. Metanarthecium luteo-viride Maxim. f. *yakuimensis* Masam. : (Fig. 3 H).

*Metanarthecium luteo-viride* f. *yakuimensis* is endemic to Yakushima Island and grows on moist places at higher elevations. The chromosome number for this taxon, 2n=52+1 B, is here reported for the first time. The chromosome number of 2n=52 for the typical f. *luteo-viride* (Satō 1942) is consistent with our result, except that we report an accessory chromosome.

29. Paris tetraphylla A. Gray var. *yakuimensis* Masam. : (Fig. 4 B).

*Paris tetraphylla* is well known for its considerable morphological variation (Hara 1969; Yamanaka 1970; Kawano et al. 1980). Plants of *P. tetraphylla* in Yakushima Island are characterized in having small leaves and tepals, and are treated as var. *yakuimensis*. These plants grow on moist banks beside forestry trails at higher elevations. The chromosome number of *P. tetraphylla* has been reported as 2n=10 across its whole geographic range (Miyamoto and Kurita 1990; Miyamoto et al. 1991; Miyamoto et al. 1992; Uchino and Wang 1997), and our count is consistent with this.

30. Smilax biflora Siebold ex Miq. var. *biflora* : (Fig. 4 C).

*Smilax biflora* var. *biflora* is distributed in Yakushima and Amami Islands. In Yakushima Island, this species grows on open moist places at higher elevations. The chromosome number for this taxon, 2n=30, is reported here for the first time.

31. Tofieldia yoshiiana Makino : (Fig. 4 D).

*Tofieldia yoshiiana* is endemic to Yakushima Island and grows on wet mossy rocks at higher elevations. The chromosome number for this taxon, 2n=30, is reported here for the first time.

Juncaceae
32. Luzula campestris DC. var. *yakuimensis* Masam. : (Fig. 4 E).

*Luzula campestris* var. *yakuimensis* is endemic to Yakushima Island and grows on grassy banks beside forestry trails. The chromosome number for this taxon, 2n=12, is here reported for the first time. Halkka (1964) reported the gametophytic chromosome number for the typical var. *campestris* as n=6 from the materials collected in Finland. The same in somatic chromosome number was found for the Yakushima Island material counted in this study.

Gramineae
33. Pseudosasa owatarii (Makino) Makino ex
Pseudosasa owatarii is endemic to Yakushima Island and makes gregarious communities on ridges or near the summit at higher elevations. The chromosome number for this taxon, 2n=48, is reported here for the first time.
We examined chromosome numbers of 33 dwarf taxa. The chromosome numbers of 23 taxa are counted for the first time. In addition, chromosome number of *Sarothra* is the first report for the genus. Chromosome numbers of other 10 taxa agree with earlier reports.

Among the 11 species, 7 endemic species (*Coptis ramosa, Ranunculus yaku shimense, Astilbe glaberrima, Mitella doiana, Scutellaria kuromidakensis, Cacalia yakushimensis* and *Solidago minutissima*) have same chromosome numbers with related species respectively. While among the 22 infraspecific taxa, 15 endemic taxa (such as *Hypericum kiusiana var. yakusimense, Parnassia palustris var. yakusimensis, Saxifraga fortunei var. minima, Fragaria nipponica var. yakusimensis, Viola boissieana var. pseudoselkirkii, V. verecunda var. yakusimana, Angelica longiradiata var. yakusimensis, Lysimachia japonica var. minutissima, Tripterospermum japonicum var. tenue, Mitchella undulata var. minor, Plantago asiatica var. yakusimensis, Heloniopsis breviscapa var. yakusimensis, Metanarthecium luteoviride f. yakusimense, Paris tetraphylla var. yakusimensis and Luzula campestris var. yakusimensis) have same chromosome numbers with their typical taxa.

Yokoyama et al. (2003) examined morphological and molecular variation in *Mitchella undulata*, and they noted that *M. undulata var. minor* did not show apparent morphological discontinuity nor unique genetical difference from other populations in Japan. On the other hand, Ishikawa et al. (2006) examined morphological and molecular variation in *Plantago asiatica*, and they found materials collected in Yakushima Island (var. *yakusimensis*) did not show apparent morphological discontinuity from other populations in Japan, but possessed a specific genotype, although the substitution level was low.

Yakushima Island had been connected to Kyushu mainland several times during the ice age, but is isolated at present (Kimura 1996; Kuroda and Ozawa 1996). Our results suggest that the dwarfism for plants in Yakushima Island was established in a relatively short time by environmental factors as well as genetic isolation.

Acknowledgments

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山本仲子'・池田 博cio'・星野卓三'：鹿児島県屋久島
産高等植物の細胞分類学的研究 I. 矮小化した分類群

鹿児島県屋久島に生育する植物の中には、屋久島を南限 - 北限とする分類群や屋久島に固有な分類群、あるいは極端に矮小化した分類群が多く知られている。したがって、屋久島に特微的に分布する分類群は、島嶼型環境における植物の分化 - 多様化を研究する上でのよい材料であると考えられる。ここでは、屋久島産高等植物のうち、矮小化した分類群の染色体数を報告する。

矮小化した分類群 17 科 32 属 33 分類群について
染色体数を算定した。その結果、23 分類群（オオゴカヨウウレン（2n=18）、ヒメコケオトギリ（2n=16）、ヤクシマショウウマ（2n=14）、ヤクシマウメバチソウ（2n=14）、ヤクシマダイモンジソウ（2n=22）、ヤクシマミヤマミスミレ（2n=24）、ヒメスミレ（2n=24）、ヒメミヤマタニヒ（2n=22）、ヤクシマミシシセリ（2n=22）、ヤクシマツルリンドウ（2n=46）、ヤクシマミヤマムグラ（2n=22）、ヒメツルウリオ（2n=22）、ヤクシマハシカグサ（2n=24）、コケトウバナ（2n=20）、ヤクシマヒキ（2n=26）、ヤクシママコトウ（2n=18）、ヤクシマアザミ（2n=68）、ヤクシマショウウマバカマ（2n=34）、ヤクシマノギラン（2n=52+1 B）、ヒメカカラ（2n=30）、ヤクシマチャブセキショウ（2n=30）、ヤクシマムズメノヒエ（2n=12）、ヤクシマダケ（2n=48））については、今回はじめて染色体数を算定した。特にヒメコケオトギリについては、
コケオトギリ属としても初めての染色体数の報告となる。また、10 分類群（ヒメウマノシガタ（2n=14）、ヤクシマコトウギリ（2n=32）、ヒメチャルメルソウ（2n=28）、ヤクシマショボナヘビイチゴ（2n=14）、ヒメウマノツバ（2n=16）、ヤクシマコナスビ（2n=20）、ヤクシマオオバコ（2n=24）、
ヤクシマコウモリ（2n=60）、イッサンキンカ（2n=18）、ヤクシマツクバネソウ（2n=10））については、これまでに報告があり、これまでの報告と同じ染色体数が算定された。矮小化した分類群と、母種または最も近縁と考えられる分類群の染色体数を比較したところ、すべて同じ染色体数であった。

今回の研究では、矮小化と細胞学的変異との関連は見出せなかった。これは、屋久島が氷河期に何度も九州本土と陸続きになった時期があり、鳥として隔離されてからの時間が短いためではないかと考えられる。

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### Appendix

Present and previous chromosome counts of examined taxa.

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<th>Taxon</th>
<th>Present counts</th>
<th>Previous counts</th>
<th>References</th>
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</thead>
<tbody>
<tr>
<td>Ranunculaceae</td>
<td>Coptis ramosa (オオゴゴヨウオウレン)</td>
<td>2n=18&lt;sup&gt;*&lt;/sup&gt;</td>
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<td>Kurita (1955)</td>
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<td>Guttiferae</td>
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<td>2n=32</td>
<td>Kurita (1955)</td>
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<td>Saxifraga fortunei var. minima (ヤクシマダイモンジソウ)</td>
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<td>Mitella doiana (ヒメマノメルソウ)</td>
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<td>2n=28</td>
<td>Wakabayashi (1973 a)</td>
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<td>Parnassia palustris var. yakusimensis (ヤクシマメガチソウ)</td>
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<td>2n=14</td>
<td>Iwatsubo and Naruhashi (1989)</td>
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<td>V. verucunda var. yakusimana (コケスミレ)</td>
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<td>Onagraceae</td>
<td>Angelica longiradiata var. yakushimensis (ヤクシマツクシゲリ)</td>
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<td>Sanicula lamelligera (ヒメマノミツバ)</td>
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<td>Rubiaceae</td>
<td>Galium pogonanthum var. yakumontanum (ヤクシマヤマツグラ)</td>
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<td>Mitchella undulata var. minor (ヒメサルアリドオシ)</td>
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<td>Neonotis hirsuta var. yakusimensis (ヤクシマハツカサ)</td>
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<td>Plantaginaceae</td>
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<td>Cirsium yakushimense</td>
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<sup>*</sup>: First record of chromosome numbers.