Once more: Intraspecific polyploidy of *Parnassia palustris* var. *multiseta* (Saxifragaceae sensu lato) collected in the Altai Mountains in Russia and Mongolia

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**ABSTRACT.** *Parnassia palustris* var. *multiseta* collected in the Altai Mountains in Russia and Mongolia showed four cytotypes with the respective chromosome numbers of 2n=18, 27, 36 and 45. They could be diploid, triploid, tetraploid and pentaploid respectively, if the basic chromosome number of x=9 was accepted. The chromosome number of 2n=45 was reported here for the first time in the Russian plants studied, while the other chromosome numbers verified the previous reports.

**KEYWORDS:** Altai Mountains, Intraspecific polyploidy, *Parnassia palustris* var. *multiseta*, Russia and Mongolia

**Materials and Methods**

**Plant materials** Total 78 living plants of *Parnassia palustris* var. *multiseta* were collected in nine localities in the Altai Mountains in Russia and Mongolia (Fig. 1, Table 1). These plants were brought back to Japan and cultivated in unglazed plant-pots in shaded place in the experimental garden of Showa Pharmaceutical University.

Taxonomical treatments followed Ku (1987) and Ku and Hultgård (2001). The voucher specimens were stocked in Funamoto’s personal herbarium in Showa Pharmaceutical University.

**Chromosome observations** Fleshly growing root-tips were harvested from the plants cultivated to observe somatic chromosomes. They were cut off 5-10 mm long, and pretreated in 2mM 8-hydroxyquinoline for 4 h at ca 20°C before fixed in 45% acetic acid for 10 min at ca 2°C. Then, they were macerated in a mixture of 45% acetic acid and 1N hydrochloric acid (1:1) for 20-23 sec at ca 60°C, and then, stained in 2% aceto-orcein for about 30 min at room temperature in a moist chamber with 45% acetic acid. Slide preparations were made with the conventional squash method with 2% aceto-orcein.

Crassification of chromosome complements by centromeric positions at mitotic metaphase followed Levan et al. (1964).
Table 1. Collection sites, sample numbers and chromosome numbers of *Parnassia palustris* var. *multiseta* collected in the Altai Mountains, Russia and Mongolia

<table>
<thead>
<tr>
<th>Collection site</th>
<th>Sample number</th>
<th>Chromosome number (2n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mongolia, Hovd Province, Erdenburen sum, Chavtsaliin gol, 48°40' 23&quot; N, 091°19' 94&quot; E, alt. 1,260 m</td>
<td>4</td>
<td>18</td>
</tr>
<tr>
<td>Mongolia, Hovd Prov., North of Hovd city, Erdenburen sum, Uvdugiin gol, 48°35' 91&quot; N, 091°11' 65&quot; E, alt. 1,540 m</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>Russia, Altai Territory, Altai Republic, Kosh-Agacz District, Kuektanar, 50°08' 91&quot; N, 088°18' 03&quot; E, alt. 1,700 m</td>
<td>10</td>
<td>18</td>
</tr>
<tr>
<td>Russia, Altai Terr., Altai Rep., Kosh-Agacz Dist., vicinity of Suhodol river, 50°09' 50&quot; N, 088°17' 64&quot; E, alt. 1,680 m</td>
<td>7</td>
<td>18</td>
</tr>
<tr>
<td>Russia, Altai Terr., Altai Rep., Ulagan Dist., vicinity of Czulgshman river, 50°56' 76&quot; N, 088°09' 41&quot; E, alt. 710 m</td>
<td>8</td>
<td>18</td>
</tr>
<tr>
<td>Russia, Altai Terr., Altai Rep., Ulagan Dist., about 29 km from Aktaash to Ulagan, 50°30' 43&quot; N, 087°40' 55&quot; E, alt. 1,910 m</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td>Russia, Altai Terr., Altai Rep., Ulagan Dist., about 13.5 km from Aktaash to Ulagan, 50°24' 34&quot; N, 087°35' 88&quot; E, alt. 1,830 m</td>
<td>6</td>
<td>36</td>
</tr>
<tr>
<td>Russia, Altai Terr., Altai Rep., Ulagan Dist., about 10 km north from Aktaash village, 50°20' 72&quot; N, 087°24' 77&quot; E, alt. 1,090 m</td>
<td>10</td>
<td>18</td>
</tr>
<tr>
<td>Russia, Altai Terr., Altai Rep., Onguday Dist., near Mnt. Pass of Seminskiy, 50°59' 81&quot; N, 085°38' 92&quot; E, alt. 1,400 m</td>
<td>8</td>
<td>36</td>
</tr>
<tr>
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</tbody>
</table>
RESULTS AND DISCUSSION

The sample plants of *Parnassia palustris* L. var. *multiseta* Ledeb. observed in this study showed four different chromosome numbers (Fig. 2). The collecting sites (Fig. 1 and Table 1) showed 57 samples in seven localities in the Russian and Mongolian Altai with the chromosome number of 2n=18 (Fig. 2a), five samples in one locality in the Russian Altai with the chromosome number of 2n=27 (Fig. 2b), 14 samples in two localities in the Russian Altai with the chromosome number of 2n=36 (Fig. 2c), and two samples in one locality in the Russian Altai with the chromosome number of 2n=45 (Fig. 2d). These chromosome numbers were seemed to be diploid, triploid, tetraploid and pentaploid respectively, if the basic chromosome number of x=9 was accepted. Any other chromosome number was not observed during the course of investigation. The chromosome number of 2n=45 was here newly reported to Russia, while it was previously documented in a plant collected in Southern Sweden by Hultgård (1987), and Lökvist and Hultgård (1999). In contrast, the plants with the chromosome numbers of 2n=18, 27 and 36 verified the previous reports (e.g., Murin et al. 1984; Gornall 1985; Hultgård 1987; Gornall and Wentworth 1993; Wentworth and Gornall 1996; Lökvist and Hultgård 1999; Borgen and Hultgård 2003; Funamoto et al. 2006).

Four cytotypes of *Parnassia palustris* var. *multiseta* had similar karyotypes with similar characteristics in size of chromosome, mono-modal decrease in chromosome size from the largest to the smallest chromosomes, and chromosome complement in centromeric position (Fig. 3, Table 2). A little large dot-shaped satellite was sometime observed on the short arm of submedian centromeric chromosomes. However, position ranks of sat-chromosome(s) in size in the chromosome complements of the diploid and tetraploid cytotypes were different from each other (Fig. 3a, c). Many more sample collections and detailed karyotype analyses are necessary.

The plants with the chromosome number of 2n=18 were commonly found along the riverine and forest.
meadows in the Russian Altai, and along the riverine and bog in the Mongolian Altai, those with the chromosome number of 2n=27 were found together with the plants with the chromosome number of 2n=18 in the Russian Altai, while those with the chromosome number of 2n=36 were commonly found in narrow stream in mountain forests and mountain meadow in the Russian Altai and those with the chromosome number of 2n=45 were rarely found together with the plants with the chromosome number of 2n=36 in the Russian Altai (Fig. 1, Table1). According to these observations, the *Parnassia palustris* complex seemed very diversified with respect to chromosome characters in the Russian Altai. These cytological phenomena have been reported elsewhere.

Table 2. Karyotype comparisons in four cytotypes of *Parnassia palustris* var. *multiseta* observed in this study

<table>
<thead>
<tr>
<th>Chromosome number</th>
<th>Cell No.</th>
<th>The longest Mean±SD (Range)</th>
<th>The Shortest Mean±SD (Range)</th>
<th>Total Mean±SD (Range)</th>
<th>Average Mean±SD (Range)</th>
<th>Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>2n=18 (diploid)</td>
<td>14</td>
<td>2.8±0.23 (2.0-2.4)</td>
<td>2.0±0.16 (2.2-1.7)</td>
<td>41.7±3.02 (45.8-36.5)</td>
<td>2.32±0.17 (2.54-2.03)</td>
<td>m+sm</td>
</tr>
<tr>
<td>2n=27 (triploid)</td>
<td>9</td>
<td>2.7±0.19 (3.0-2.5)</td>
<td>1.9±0.15 (2.1-1.7)</td>
<td>58.7±4.06 (66.3-54.9)</td>
<td>2.17±0.16 (2.46-2.03)</td>
<td>m+sm</td>
</tr>
<tr>
<td>2n=36 (tetraploid)</td>
<td>8</td>
<td>2.7±0.17 (3.0-2.4)</td>
<td>1.8±0.14 (2.0-1.6)</td>
<td>78.1±3.53 (83.3-74.2)</td>
<td>2.18±0.1 (2.32-2.06)</td>
<td>m+sm</td>
</tr>
<tr>
<td>2n=45 (pentaploid)</td>
<td>3</td>
<td>2.7±0.07 (2.7-2.6)</td>
<td>1.8±0.0 (1.0-1.8)</td>
<td>99.4±2.51 (101.6-97.1)</td>
<td>2.21±0.07 (2.26-2.16)</td>
<td>m+sm</td>
</tr>
</tbody>
</table>

SD: standard deviation; m: median-centromeric chromosome; sm: submedian-centromeric chromosome
(Hultgård 1987; Lökvist and Hultgård 1999; Funamoto et al. 2006). Thus, it considered that plants with the chromosome number of $2n=27$ and those with the chromosome number of $2n=45$ might be caused by pollination between non-disjunction diploid gametes producing diploid and tetraploid ovules ($2x$ and $4x$) and normal male gamete for diploid pollen ($x$), since any plant with the chromosome number of $2n=27$ had not been found within the populations of the plants with the chromosome number of $2n=36$. This factor might be caused by various geographical conditions and extremes of climate temperature.

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**LITERATURE CITED**


