Cytological Studies of the Genus *Carex* (Cyperaceae) in the Osumi Islands (Kagoshima Prefecture) II. Chromosome Counts of Four Species Collected from Kuroshima Island

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Four species of the genus *Carex* from Kuroshima Island were used for karyomorphological studies. Intraspecific aneuploidy, \(2n = 38 = 19I + 1\), and \(58\), were found in *C. atroviridis* var. *scabrocaudata* and these chromosome numbers are reported for the first time in this study. Chromosome numbers of *C. multiflora* var. *pallidissquama* (\(2n = 72\)), *C. tokarensis* (\(2n = 26 = 13I\)), and *C. tsushimensis* (\(2n = 32 = 16I\)) were determined for the first time. *Carex atroviridis* var. *scabrocaudata* and *C. tokarensis* are endemic to the Kuroshima and Tokara Islands. Our results suggest a close relationship among *C. atroviridis* var. *scabrocaudata*, *C. conica*, and *C. oshimensis*. *Carex tokarensis* is also considered to be closely related to *C. reinii*, because these two species had the same chromosome number.

**Key words:** *Carex*, chromosome number, Cyperaceae, intraspecific aneuploidy, Kuroshima Island.

Kuroshima Island belongs to the Osumi Island group, and is located about 55 km southwest of the Satsuma Peninsula in Kagoshima Prefecture, Japan (30ºN, 129ºE). Sako and Maruno (1983) reported that the northern-most or southern-most distributions of many vascular plants are found on this island, including representatives of the genus *Carex*. There are more than 200 *Carex* species in Japan (Ohwi 1936, Akiyama 1955, Koyama 1962, Katsuyama 2005), and 11 species have been reported from the Kuroshima Island (Sako and Maruno 1983). *Carex atroviridis* var. *scabrocaudata* and *C. tokarensis* are endemic to the Kuroshima and Tokara Islands (Katsuyama 2005), and Kuroshima Island is the northern limit of both these species (Sako and Maruno 1983).

The chromosome numbers of Japanese species of *Carex* have been reported by Tanaka (1948), Hoshino (1981, 1992), Hoshino and Okamura (1994), and Hoshino and Waterway (1994). They also reported the existence of extensive interspecific and intraspecific aneuploidy. However, there have been no published reports of cytological studies of the genus *Carex* from Kuroshima Island. The purpose of this paper is to report the chromosome numbers of four species of the genus *Carex* from Kuroshima Island, and to discuss their relationships to allied species.

**Materials and Methods**

Materials collected from four species of the genus *Carex* from Kuroshima Island, all
endemic to Japan (Katsuyama 2005), were used for karyomorphological observations. The materials examined are listed in Table 1. Somatic chromosomes were observed in the meristematic cells of root tips. The root tips were pretreated in 0.002 M 8-hydroxyquinoline solution for 1 h at 23°C and then 15 h at 4°C. They were then fixed in acetic alcohol (1:3) for at least 16 h at –20°C or for 1.5 h at 23°C, stained using Feulgen’s nuclear reaction, macerated in a mixture of 2% pectinase and 2% cellulase for 1 h at 37°C, restained in 1% aceto-orcein, and then squashed. Meiotic chromosomes were also observed in pollen mother cells. Spikelets were fixed in acetic alcohol (1:3) for at least 6 h at –20°C. Anthers were stained in 1% aceto-orcein and then squashed. Voucher specimens are deposited in the Herbarium of Okayama University of Science (OKAY).

Results and Discussion
The chromosome numbers determined in this study are shown in Table 1. Carex atroviridis var. scabrocaudata had intraspecific aneuploidy, 2n = 38 = 19II, 39 = 19II + I, and 58, and these chromosome numbers are reported here for the first time. Somatic metaphase chromosomes ranged from 0.9 to 1.9 µm in length (Fig. 1A–C).

The 2n = 38 plant had the normal 19 bivalents in meiotic division and the length of meiotic metaphase chromosomes ranged from 1.0 to 1.8 µm (Fig. 2A). The 2n = 39 plant had 19 bivalents and one univalent in meiotic division. The 19 bivalent chromosomes ranged from 1.0 to 1.5 µm in length and the one univalent chromosome was less than 0.5 µm in length (Fig. 2B). Intraspecific aneuploids with many irregular meiosis configurations have been reported in C. blepharicarpa, C. conica, C. duvaliana, and C. stenostachys (Hoshino et al. 1993, Hoshino and Okamura 1994, Hoshino and Onimatsu 1994, Hoshino and Waterway 1994). These authors suggested that these aneuploids with many irregular meiotic configurations originated from chromosome fission or fusion. In the present study, intraspecific aneuploids of C. atroviridis var. scabrocaudata, 2n = 38, 39, and 58, were found in the same population. The 2n = 39 plant had one small univalent chromosome, which might have originated from chromosome fission. The 2n = 58 plant may have quite a different origin. It could have originated from fusion of an unreduced gamete of 2n = 39 and a reduced gamete of 2n = 38 (i.e., 2n = 58 = 39 + 19). Further studies should involve examination of the meiotic

Table 1. Species, localities, and voucher specimens, and chromosome numbers of four species of the genus Carex collected from Kuroshima Island in Kagoshima Prefecture, Japan

<table>
<thead>
<tr>
<th>Species</th>
<th>Locality and Voucher specimen</th>
<th>Chromosome number; 2n (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carex atroviridis Ohwi var. scabrocaudata T. Koyama</td>
<td>Mishima, Nakasato; Hoshino &amp; al. 19395 (OKAY)</td>
<td>38 (19II)</td>
</tr>
<tr>
<td>Mishima, Mt. Yagura; Hoshino &amp; al. 19398 (OKAY)</td>
<td>39 (19II+I)</td>
<td></td>
</tr>
<tr>
<td>Mishima, Mt. Yagura; Hoshino &amp; al. 19399 (OKAY)</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>Mishima, Mt. Yagura; Hoshino &amp; al. 19401 (OKAY)</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td>C. multiflora Ohwi var. pallidisquama Ohwi</td>
<td>Mishima, Mt. Yagura; Hoshino &amp; al. 19400 (OKAY)</td>
<td>72</td>
</tr>
<tr>
<td>C. tokarensis T. Koyama</td>
<td>Mishima, Nakasato; Hoshino &amp; al. 19393 (OKAY)</td>
<td>26 (13II)</td>
</tr>
<tr>
<td>Mishima, Mt. Kamuko to west valley; Hoshino &amp; al. 19418 (OKAY)</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>C. tsushimensis (Ohwi) Ohwi</td>
<td>Mishima, Nakasato, Inokuchi river-side; Hoshino &amp; al. 19422 (OKAY)</td>
<td>32 (16II)</td>
</tr>
</tbody>
</table>
Fig. 1. Photomicrographs of somatic metaphase chromosomes of four species of the genus Carex from the Kuroshima Island. A, B, C. C. atroviridis var. scabrocaudata (2n = 38, 39, and 58). D. C. multiflora var. pallidisquama (2n = 72). E. C. tokarensis (2n = 26). F. C. tsushimensis (2n = 32). Arrows indicate two large chromosomes (L).
configurations of more samples in order to clarify the origins of intraspecific aneuploids in this species.

*Carex atroviridis* var. *scabrocaudata* was described from Nakanoshima Island of Tokara Islands by Koyama (1957). Hatusima (1986) and Katsuyama (2005) considered that this variety is closely related to *C. conica* used a combination *C. conica* var. *scabrocaudata* but this combination has not been valid by published. Morphologically this variety, *C. conica* and *C. oshimensis*, share dark-brown staminate spikes and elliptical achenes. *Carex atroviridis* var. *scabrocaudata* differs from *C. atroviridis* in cylindrical pistillate spikes with dense perigynia. The chromosome number of *C. atroviridis* was 2n = 70 (Yano et al. unpublished). The chromosome number of *C. conica* was reported as being 2n = 34, 35, and 38 by Tanaka (1948). Hoshino and Waterway (1994) also reported 2n = 32, 33, 34, 36, 37, and 38 for *C. conica*. Tanaka (1948) reported 2n = 34 and 38 for *C. oshimensis*. Our results show a close relationship between *C. atroviridis* var. *scabrocaudata*, *C. conica*, and *C. oshimensis*, but not of *C. atroviridis* to them. New combination for this variety

Fig. 2. Photomicrographs of meiotic metaphase I chromosomes of three species of the genus *Carex* from the Kuroshima Island. A, B. *C. atroviridis* var. *scabrocaudata* (2n = 38 = 19II and 39 = 19II + I). C. *C. tokarensis* (2n = 26 = 13II). D. *C. tsushimensis* (2n = 32 = 16II). Arrows indicate univalent (u) and large bivalent (L) chromosomes.
will be proposed in another report.

*Carex multiflora* var. *pallidisquama* had a chromosome number of 2n = 72, the first number to be determined for this species. Somatic metaphase chromosomes ranged from 0.6 to 1.3 µm in length (Fig. 1D). Katsuyama (2005) reported that *C. multiflora* var. *pallidisquama* is closely related to *C. multiflora* var. *multiflora*. The chromosome number of *C. multiflora* var. *multiflora* was reported to be 2n = 70 by Hoshino (1981). Our results support the close relationship between these two varieties.

*Carex tokarensis* had the chromosome number of 2n = 26 = 13II, the first number to be determined for this species. Somatic metaphase chromosomes ranged from 0.6 to 1.3 µm in length (Fig. 1D). Katsuyama (2005) reported that *C. multiflora* var. *pallidisquama* is closely related to *C. tokarensis* with 13 normal bivalents pairing in meiotic division. Meiotic metaphase chromosomes ranged from 1.1 to 2.0 µm in length (Fig. 1E). *Carex tokarensis* was assigned to section Decorae together with *C. reinii*.

*Carex tsushimensis* had the chromosome number of 2n = 32 = 16II, the first number to be determined for this species. Somatic metaphase chromosomes ranged from 1.0 to 1.6 µm in length (Fig. 1F). *Carex tsushimensis* had 16 normal bivalents pairing in meiotic division. Meiotic metaphase chromosomes ranged from 1.1 to 1.6 µm in length (Fig. 2D). Koyama (1962) recognized *C. tsushimensis* as a variety of *C. sociata*. Katsuyama (2005) reported that *C. tsushimensis* is closely related to *C. sociata* and *C. uber*, sharing pale-green staminate spikes and rhombic achenes. Ohkawa et al. (2000) reported 2n = 40-44 for *C. sociata* and 2n = 54 for *C. uber*. Our results also suggested that *C. tsushimensis* was cytologically distinguished from *C. sociata* and *C. uber*.

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**References**


矢野秀一*, 伊藤久美子*, 星野卓二**: 鹿児島県大隅諸島産カヤツリグサ科スゲ属植物の細胞学的研究 II. 黒島より採集した4種の染色体数

大隅諸島黒島より採集したカヤツリグサ科スゲ属植物4種について染色体数を報告した。トカラカンスゲ（Carex atroviridis var. scabrocaudata）が2n = 38 = 19II, 39 = 19II + I, 58であり、種内異数体が観察された。アオミヤマカンスゲ（C. multiflora var. pallidissquama）が2n = 72、フサカンスゲ（C. tokarensis）が2n = 26 = 13II、ツシマスゲ（C. tsushimensis）が2n = 32 = 16IIであった。これらの4種については今回初めての報告である。これらのうち、トカラカンスゲとフサカンスゲは黒島とトカラ列島に固有である。トカラカンスゲはヒメカンスゲ（C. conica）あるいはオオシマカンスゲ（C. oshimensis）と細胞学的に近縁であることが明らかとなった。フサカンスゲは近縁種とされているコカンスゲ（C. reinii）と同じ染色体数であった。

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