The Nepal Himalaya is known for high levels of diversification of many vascular plants (Ohba 1988). With over 5000 species the Cyperaceae is one of the largest monocot families (Goetghebeur 1998), with about 180 taxa in 19 genera recorded from Nepal (Koyama 1978). Cytological analyses have proven useful for understanding the diversification of several taxa in the Nepal Himalaya (Wakabayashi and Ohba 1988, Akiyama et al. 1992, Ikeda and Ohba 1999), and the present study contributes to assessing its value with respect to Nepalese Cyperaceae.

Roalson (2008) summarized the many past cytological studies on the Cyperaceae including chromosome counts for 851 species of 31 genera. In particular, chromosome numbers of Cyperaceae from the Himalaya and adjacent regions have been reported by several authors, such as Mehra and Sachdeva (1971, 1975a, 1975b, 1976, 1979), Dietrich (1972), Sachdeva (1977), Bir et al. (1986, 1988, 1991, 1992), Cheema et al. (1992, 1993), and Hoshino et al. (2000). Most of these cytological works used material collected from India, except Dietrich (1972) and Hoshino et al. (2000) from Nepal. For understanding the evolution and diversification of Cyperaceae in the Nepal Himalaya, more cytological studies are necessary from the region. This is the first of a series of papers reporting cytological characteristics of Cyperaceae in the Nepal Himalaya and adjacent regions.
Table 1. Species, localities, voucher specimens and chromosome numbers of fourteen species of *Cyperaceae* collected from the Manaslu Himalaya and adjust regions in Central Nepal

<table>
<thead>
<tr>
<th>Species, locality and voucher specimen</th>
<th>Chromosome number (2n)</th>
<th>Previous report (2n)</th>
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<tbody>
<tr>
<td><em>Blysmus compressus</em> (L.) Panz. ex Link</td>
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</table>

*Carex atrofuscata* Schkuhr subsp. *minor* (Boott) T. Koyama
| Samagaon, on way to Manaslu Base Camp, 4130 m (Ikeda & al. 20814087) | 48 | 48 (Dietrich 1972) |

*C. filicina* Nees
| Bimthang – Gho, 2990 m (Ikeda & al. 20814112) | 46 | 42 (Mehra and Sachdeva 1971, 1975b) 44 (Nijalingappa and Leela 1990) 48 (Sachdeva 1977, Mehra and Sachdeva 1979) |

*C. inanis* Kunth
| Ghap – Namrung, 2130 m (Ikeda & al. 20814044) | 42 |                      |
| Ghap – Namrung, 2390 m (Ikeda & al. 20814050) | 42 |                      |

*C. rufulistolon* T. Koyama
| Samagaon, on way to Manaslu Base Camp, 4220 m (Ikeda & al. 20814089) | 46 |                      |

*C. speciosa* Kunth
| Ghap – Namrung, 2330 m (Ikeda & al. 20814049) | 44 |                      |
| Gho – Tal, 2490 m (Ikeda & al. 20814115) | 44 |                      |

*Cyperus haspan* L.

*Eleocharis congesta* D. Don
| Syange – Bhulbhule, 1130 m (Ikeda & al. 20814120) | 20 | 20 (Tanaka 1948, Nijalingappa 1972, Yano et al. 2004) |

*Fimbristylis dichotoma* (L.) Vahl
| Gorkha town, 1270 m (Ikeda & al. 20814002) | 20 | 20 (Mehra and Sachdeva 1971) |

*F. littoralis* Gaudich.
| Khanchok – Arughat, 960 m (Ikeda & al. 20814009) | 10 | 10 (Nijalingappa 1975) |

*F. schoenoides* (Retz.) Vahl

*Isolepis setacea* (L.) R. Br.
| Ghap – Namrung, 2240 m (Ikeda & al. 20814046) | 32 | 26 (Davies 1956) 28 (Mičieta 1986, Hoshino et al. 2000) |

*Lipocarpha chinensis* (Osbeck) Kern
| Khanchok – Arughat, 960 m (Ikeda & al. 20814010) | 26 | 26 (Sanyal and Sharma 1972, Rath and Patnaik 1974, Tejavathi and Nijalingappa 1990) |

*Schoenoplectus juncoides* (Roxb.) Palla
| Khanchok – Arughat, 960 m (Ikeda & al. 20814014) | 74 | 74 (Iwasaki and Ueki 1979, Yano and Hoshino 2005) |

| Syange – Bhubhule, 1130 m (Ikeda & al. 20814121) | 74 |                      |
regions. This part focuses on the chromosome numbers of Cyperaceae collected around Manaslu Himalaya, Central Nepal.

Materials and Methods

Karyomorphological observations were conducted on 14 species of eight genera in Cyperaceae mostly collected from Manaslu Himalaya and adjacent areas, Central Nepal (Table 1). Somatic chromosomes were observed in the meristematic cells of root tips. Root tips were harvested and prepared from material whilst in the field, pretreated in 2 mM 8-hydroxyquinoline solution for 3–6 hours at 10–20°C, and then fixed with Newcomer’s fluid (see Sharma and Sharma 1980). In the laboratory the fixed roots were hydrated with an alcohol series (70%, 30%, 15%) and distilled water, then hydrolyzed with 1N HCl for 10 minutes at 60°C, and then stained with leuco-basic fuchsin for 1 hour at 23°C. The samples were then macerated in a mixture of 2% pectinase and 2% cellulase for 1 hour at 37°C, restained with 1% aceto-orcein, and squashed. Voucher herbarium specimens are kept in the Herbarium of the University of Tokyo (TI), with duplicates available in the National Herbarium in Nepal (KA TH) and Royal Botanic Garden, Edinburgh (E).

Results and Discussion

Chromosome numbers determined in this study are shown in Table 1. Primary constriction was not observed in any species.

1. Blysmus compressus (L.) Panz. ex Link (2n = 40, Fig. 1A)

Blysmus compressus is widely distributed in Europe and Asia (Iran, Pakistan, Nepal, North India, and Southwest China) (Koyama 1978). The chromosome numbers of B. compressus were reported as 2n = 44 (Håkansson 1928, Tischler 1934, Rohweder 1937, Pogan and Izmailow 1983, Stoeva 1992a) and 2n = 79 (Stoeva 1992b) from Europe. Mehra and Sachdeva (1975b) observed 2n = 44 from the Kashmir Himalaya. In this study, a new number, 2n = 40, was observed. Somatic metaphase chromosomes were less than 1.2 µm in length.

2. Carex atrofusca Schkuhr subsp. minor (Boott) T. Koyama (2n = 48, Fig. 1B)

Carex atrofusca subsp. minor is distributed in Pamir, the Himalayas (Nepal to Bhutan), and Eastern Tibet (Koyama 1975, 1978). Chromosome number of the species from the Manaslu Himalaya was 2n = 48, confirming the previous report from the Mahalangur Himal in eastern Nepal (Dietrich 1972). Somatic metaphase chromosomes were less than 1.3 µm in length.

3. Carex filicina Nees (2n = 46, Fig. 1C)

Carex filicina is distributed in the Himalaya, Eastern India, East China, Taiwan, and South to Malaysia (Koyama 1978). In this study, a new number, 2n = 46, was observed from the material from the Manaslu Himalaya. Somatic metaphase chromosomes were less than 1.3 µm in length. Several chromosome numbers of C. filicina were reported in the previous reports. Chromosome numbers of 2n = 42 were reported by Mehra and Sachdeva (1971, 1975b) from Nainital in the West Himalaya, 2n = 48 by Sachdeva (1977) and Mehra and Sachdeva (1979) from Darjeeling in the East Himalaya, and 2n = 44 by Nijalingappa and Leela (1990) from Tamilnadu and Karnataka in South India. It is thought that C. filicina has a series of aneuploids in the species.

4. Carex inanis Kunth (2n = 42, Fig. 1D)

Carex inanis is distributed from the highlands of Central Asia, and Kashmir to the Sikkim Himalayas (Koyama 1978). We have not found any earlier chromosome number for C. inanis and so our count of 2n = 42 is the first to be determined for this species. Somatic metaphase chromosomes were less than 1.3 µm in length.
Carex rufulistolon T. Koyama (2n = 46, Fig. 1E)

Carex rufulistolon is endemic to the alpine regions in Nepal (Koyama 1978, Katsuyama 2008). The chromosome number of C. rufulistolon was found to be 2n = 46, the first record for this species. Somatic metaphase chromosomes were less than 1.1 µm in length.
6. *Carex speciosa* Kunth (2n = 44, Fig. 1F)

*Carex speciosa* is distributed from India, Nepal, China to Southeast Asia (Liang et al. 2000). *Carex speciosa* had the chromosome number of 2n = 44, the first chromosome count be determined for this species. Somatic metaphase chromosomes were less than 1.3 µm in length.

7. *Cyperus haspan* L. (2n = 26, Fig. 1G)

*Cyperus haspan* is widely distributed in the tropical, subtropical and warm-temperate regions of both hemispheres (Koyama 1978). In this study, we record a chromosome number of 2n = 26 for this species, and somatic metaphase chromosomes of less than 1.3 µm in length. The chromosome numbers of *C. haspan* have been variously reported as 2n = 16 (Sharma and Sarkar 1967–1968, Sanyal 1972), 2n = 26 (Nijalingappa et al. 1978, Rath and Patnaik 1978, Tejavathi and Nijalingappa 1990, Matoba and Uchiyama 2009), 2n = 30 (Baquar 1978), 2n = 32 (Tanaka 1948), and 2n = 36 (Mehra and Sachdeva 1971, 1975b). It is thought that *C. haspan* has series of aneuploids, and the chromosome count from the Manaslu Himalaya coincides with several specimens from India (Nijalingappa et al. 1978, Rath and Patnaik 1978, Tejavathi and Nijalingappa 1990).

8. *Eleocharis congesta* D. Don (2n = 20, Fig. 1H)

*Eleocharis congesta* is distributed in India, Nepal, Indo-China, China, and Japan (Koyama 1978). *Eleocharis congesta* from the Manaslu Himalaya had the chromosome number of 2n = 20, confirming previous reports from India (Nijalingappa 1972) and Japan (Tanaka 1948, Yano et al. 2004). Somatic metaphase chromosomes ranged between 1.9 and 2.2 µm in length. Although Koyama (1961) noted that Japanese *E. congesta* had longer perianth bristles than those from the Himalaya, there was no karyomorphological difference between Japanese and the Himalayan samples.

9. *Fimbristylis dichotoma* (L.) Vahl (2n = 20, Fig. 1I)

*Fimbristylis dichotoma* is widely distributed from the tropical to the temperate zones (Koyama 1978). *Fimbristylis dichotoma* from the Manaslu Himalaya had the chromosome number of 2n = 20, confirming a previous report from Nainital in the West Himalaya (Mehra and Sachdeva 1971). Somatic metaphase chromosomes ranged between 1.4 and 2.0 µm in length. Intraspecific polyploidy (2n = 10 and 20) has been reported previously in this species from India by Mehra and Sachdeva (1975b, 1979) and Bir et al. (1986, 1988, 1992). Our chromosome number of 2n = 20 is considered to be tetraploid with the basic chromosome number x = 5. Although many intraspecific taxa have been described in *F. dichotoma* (Ohwi 1944, Koyama 1961, 1974, Kern 1974), Yano and Hoshino (2006a) demonstrated the polyphyly of *F. dichotoma* using DNA sequence data. Further studies, comparing morphological variation and cytological variation with DNA sequence data, will be needed to clarify the relationships between taxonomy and intraspecific polyploidy for this widespread and variable species.

10. *Fimbristylis littoralis* Gaudich. (2n = 10, Fig. 1J)

*Fimbristylis littoralis* is widely distributed in pantropical regions (Koyama et al. 2000). We recorded a chromosome number of 2n = 10 for this species and somatic metaphase chromosomes ranged between 1.4 and 1.9 µm in length. This chromosome numbers agrees with a previous record from India (Nijalingappa 1975).

11. *Fimbristylis schoenoides* (Retz.) Vahl (2n = 10, Fig. 1K)

*Fimbristylis schoenoides* is distributed in Nepal, India, Indo-China, Southern China, Malaysia, and North Australia (Koyama 1978). *Fimbristylis schoenoides* had the chromosome number of 2n = 10, and somatic metaphase chromosomes ranged from 1.4 to 1.9 µm.

12. *Isolepis setacea* (L.) R. Br. (2n = 32, Fig. 1L)

*Isolepis setacea* is widely distributed in the Himalayas, Asia, Europe, and Africa (Katsuyama 2008). The chromosome number of *I. setacea* was reported to be 2n = 26 by Davies (1956), and 2n = 28 by Mičieta (1986) and Hoshino et al. (2000). Among them, Hoshino et al. (2000) reported 2n = 28 (n = 14II) from the Langtang Himal in Central Nepal. In our study a new number, 2n = 32, was counted from the Manaslu Himalaya. It is thought that this species has intraspecific aneuploids. The somatic metaphase chromosomes were less than 1.1 µm in length.

13. *Lipocarpha chinensis* (Osbeck) Kern (2n = 26, Fig. 1M)

*Lipocarpha chinensis* is distributed in the tropical and subtropical regions of Africa, Asia, south to Malaysia, and North Australia (Koyama 1978). *Lipocarpha chinensis* from the Manaslu Himalaya was found to have a chromosome number of 2n = 26, confirming previous reports from India (Sanyal and Sharma 1972, Rath and Patnaik 1974, Tejavathi and Nijalingappa 1990). Somatic metaphase chromosomes ranged between 1.1 and 1.4 µm in length.

14. *Schoenoplectus juncoides* (Roxb.) Palla (2n = 74, Fig. 1N)

*Schoenoplectus juncoides* is distributed in the Himalayas, India, Indo-China, China, Japan, and Malaysia (Koyama 1978). *Schoenoplectus juncoides* from the Manaslu Himalaya had the chromosome number of 2n = 74, confirming previous reports from Japan (Iwasaki and Ueki 1979, Yano and Hoshino 2005). Somatic metaphase chromosomes were less than 0.9 µm in length.

In this study, chromosome numbers of *Carex inanis* (2n = 42), *C. rufulistolon* (2n = 46), and *C. speciosa* (2n = 44) were determined for the first time. *Carex inanis* and *C. rufulistolon* belong to section Trachychlaenae (Koyama 1954, Liang et al. 2000). Heilborn (1924) pointed out that closely related species in *Carex* shared similar chromosome numbers. Yano et al. (2008) also reported that Japanese *Carex* within the same section possessed similar chromosome numbers. Hipp (2007) suggested that chromosome numbers in *Carex* section Ovales indicated an evolutionary clade-specific equilibrium, based on DNA sequence data. In the present study our cytological results, in particular the similarity of chromosome number, support a close relationship between *C. inanis* and *C. rufulistolon*.

The chromosome numbers of *Blysmus compressus*, *Carex filicina*, and *Isolepis setacea* differ from those of previous reports. These three species are widely distributed and they may all have intraspecific aneuploids. Cytogeographically, two types of intraspecific aneuploidy have been reported in *Carex* and *Eleocharis*: one is populational variation (Hoshino et al. 1993, Hoshino and Okamura 1994, Hoshino and Onimatsu 1994, Yano and Hoshino 2006b), and another is geographic variation (Hoshino 1992, Hoshino and Waterway 1994, Ohkawa et al. 2000). Future studies including further sampling are needed to understand the basis for intraspecific aneuploidy in these three species.

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矢野興一，池田 博，M. F. ハトソン，K. R. ラジバンダー，大場秀章：ネパールヒマラヤ産カヤツリグサ科植物の細胞学的研究 I. マナスルヒマラヤ（中央ネパール）より採取した 14 種の染色体数

マナスルヒマラヤ（中央ネパール）より採取したカヤツリグサ科植物14種について染色体数を報告した。Carex inanis Kunth (2n = 42), C. rufulistolon T. Koyama (2n = 46), C. speciosa Kunth (2n = 44) の3種については、今回が初めての報告である。また、Blysmus compressus (L.) Panz. ex Link (2n = 40), C. filicina Nees (2n = 46), Isolepis setacea (L.) R. Br. (2n = 32) の3種については、これまでの報告と異なった染色体数が算定された。Carex atrofusca Schkuhr subsp. minor (Boott) T. Koyama (2n = 48), Cyperus haspan L. (2n = 26), Eleocharis congesta D. Don (2n = 20), Fimbristylis dichotoma (L.) Vahl (2n = 20), F. littoralis Gaudish (2n = 10), F. schoenoides (Retz.) Vahl (2n = 10), Lipocarpha chinensis (Osbeck) Kern (2n = 26), Schoenoplectus juncoides (Roxb.) Palla (2n = 74) の8種については、これまでの報告と一致していた。