Bot. Mag. Tokyo **89**: 99–114, 1976

Chromosome Numbers of the Genus *Calamagrostis* in Japan

Tuguo Tateoka

Department of Botany, National Science Museum, Shinjuku, Tokyo 160

Chromosome counts for 783 collections of *Calamagrostis* in Japan are reported. These include the first record for *C. tashiroi* and the reports of new cytotypes in *C. stricta*, *C. hakonensis* and *C. longiseta*. The geographical distribution of different cytotypes of *C. langsdorffii* and *C. hakonensis* is outlined. Counts are also reported for a number of "intermediates" which are supposed to be interspecific hybrids or hybrid derivatives. A summary of chromosome counts for Japanese *Calamagrostis* so far recorded is tabulated. No diploid plants with 2n=14 chromosomes are found. The tetraploid taxa, which are plentiful and seem to have adaptively radiated in Japan, lack any sign suggestive of their recent origin from the diploids. It is suggested that plants with 2n=28 (4X in the traditional sense) may be regarded as semi-diploid and having that behavior, and that speciation of *Calamagrostis* in Japan has occurred principally at this chromosome level. Speciation by means of amphiploidy may have been scarce. It is also suggested that hybridization and polyploidy have greatly contributed to the formation of complicated internal structure of various species.

The genus *Calamagrostis*, which is almost world-wide in geographical distribution and includes more than 150 species, is one of the important components of the mountain flora of Japan. As often stated in the literature, the taxonomy of this genus is extremely difficult because of the fact that the plants are often accompanied by various factors contributing to taxonomic confusion, such as natural hybridization, apomixis and polyploidy. Although these situations give much trouble to taxonomic workers, they seem to involve some aspects which are rather fascinating for biosystematic investigations, as exemplified by the excellent work of Nygren (1946, 1948a, b, 1949, 1951, 1962), who has successfully carried out the studies in the evolutionary differentiation of the European species of *Calamagrostis*. Further, since analyses of the so-called apo-amphimictic complex coupled with polyploidy can sometimes elucidate a probable course of migration, *Calamagrostis* can be regarded as of especial phytogeographical interest.

Chromosome counts for *Calamagrostis* have been most frequently recorded from Europe and North America (cf. Löve and Löve, 1961, 1974; Fedorov, 1969; Moore, 1973). Nevertheless, recent chromosome counts for this genus include those from Siberia and the Far East (Zhukova, 1967, 1969; Zhukova and Tikhonova, 1971, 1973; Zhukova and Petrovsky, 1971, 1975) and from the Himalayas (Mehra and Sharma,

1975). Counts for a few taxa growing in the tropical uplands in the New World have been made by Beaman *et al.* (1962) and Pohl and Davidse (1971). No report from temperate areas in the Southern Hemisphere seems to have been published.

Initial cytological examinations of Japanese *Calamagrostis* have been made by Ono and Tateoka (1953), Tateoka (1954, 1955) and Tateoka and Hayashida (1955), who have reported some chromosome counts and preliminary cytotaxonomical work of a few species. More recently, a project to carry out a comprehensive cytotaxonomical and cytogeographical survey of Japanese *Calamagrostis* has been commenced. In the explorations at a number of localities in Japan performed during the last eight years, more than 1500 collections for cytological examination have been made. Results of the chromosome counts have partly been reported in my previous papers (Tateoka, 1969, 1970a, b, 1972a, b, 1973a, b, 1974a, c), which have mainly dealt with cytotaxonomy or cytogeography of particular species or the relationships among the taxa occurring in particular areas. About half the chromosome counts on Japanese *Calamagrostis* so far obtained have remained unpublished, however, and they are reported in this paper, together with some considerations regarding the evolutionary differentiation of this genus in Japan.

Materials and Methods

Collecting was done at numerous sites in a number of localities ranging from Kyushu to Hokkaido, and was done with care to avoid damaging the organization of the natural biotic community, particularly in cases of explorations in protected areas. Parts of several flowering and vegetative shoots which make up an individual, not the entire individuals, were prepared as herbarium specimens. Root tips were fixed at the same time in the field with Navashin's fluid, and were sectioned according to the usual paraffin method and stained with crystal violet in the laboratory. All the voucher specimens and slides are preserved in TNS (National Science Museum, Tokyo). Collection numbers appearing throughout this paper are the author's.

A taxonomic revision of Japanese *Calamagrostis* is now in progress, and the collections are arranged taxonomically according to the present-day opinion of this author, which is largely in accord with the view of Ohwi (1975). A significant difference between the present scheme of classification and the treatment of Ohwi (1975) is that many collections have been identified as "interspecific intermediates" in the former, but such indications have been scanty in the latter. During the course of the present work, morphological and ecological attributes of each species have been made clearer, and it has become easier to detect the collections showing intermediacy in various morphological features. The present delimitation of four "pure" species (*C. langsdorffii*, *C. longiseta*, *C. nana*, *C. sachalinensis*), which hybridize in the field, slightly deviates from the diagnoses of Ohwi (1975), and their specific morphological features will be described in a subsequent paper. It should also be mentioned that plants referred to the intermediates between *C. fauriei* and *C. longiseta* in this paper roughly correspond to *C. longiseta* var. *longearistata* (Ohwi, 1936). Diagnoses of the other taxa, for which

chromosome counts are reported here, are consistent with those of Ohwi (1975).

Results

As described below, B-chromosomes have been found in various species. These chromosomes have been characterized by small size and are easily distinguished from the ordinary chromosomes in the nuclear plates in which chromosomes are not entangled (see Tateoka, 1974c, Fig. 3). However, the distinction has become less obvious in the plates of collections at higher ploidy levels, since the identification of individual chromosomes is more difficult in plates including many chromosomes. Mixoploidy within one and the same root tip has been observed in two collections (*C. langsdorffii, 10485*; *C. matsumurae, 11435*).

In the following enumeration, chromosome numbers (in gothic), localities and collection numbers (in italic) are given. Before going further, some remarks should be made: (1) when relevant collection numbers are continuous, the initial number and the final figure of the last number are connected by a wave line: e.g., *8412~4* designates three collections with the numbers *8412, 8413, 8414*; (2) when a B-chromosome or B-chromosomes are found besides the ordinary chromosomes, the number of the B-chromosome, preceded by a plus sign, is indicated in parentheses after the collection number, e.g., *8412* (+1B); (3) "A or B" appearing in the description of *Calamagrostis hakonensis* means "autosome or B-chromosome": when the extra chromosomes have been identified to be B-chromosomes with certainty, the figure appearing in parentheses is followed by B, e.g., (+1B): when it is uncertain whether the extra chromosomes are ordinary chromosomes or B-chromosomes, only the number of the extra chromosome is indicated in parentheses, e.g., (+1); (4) when no extra chromosomes have been found, no indication follows the collection number.

Calamagrostis epigeios (L.) Roth

2n=28+0~9B: Toyama Pref., Kamishinkawa-gun, Oritate, 1350 m, *7567* (+1B). Nagano Pref., Kamiminochi-gun, Togakushi Farm, 1150 m, *6566* (+2B), *6568*. Tochigi Pref., Nasu Highland, Daimaru Spa, 1260 m, *8412~3*. Niigata Pref., Niigata City: Yoriihama, seaside, *11001* (+9B), *11004* (+8B), *11005* (+8B): Igarashi – Kamishineicho, 2–10 m, *11007* (+1B), *11008~9*, *11010* (+2B), *11011*; Sekikawa, Takase, 50 m, *7152* (+1B). Iwate Pref., foot of Mt. Yakeishidake, 250 m, *5391*; foot of Mt. Hayachine, 700 m, *7297*. Pref. Aomori, Towada, Yasumiya, 420 m, *10242*. Hokkaido, Iwamizawa, *10034* (+1B), *10044*; Wakkanai, Koetoi, seaside, *12325~6*.

2n=56: Hokkaido, Abashiri, Tokoro, seaside, *12152*.

Calamagrostis pseudo-phragmites (Hall. f.) Koel.

2n=28: Toyama Pref., Mts. Tateyama: Senjugahara, 600 m, *5455~6*: Bijodaira, 1000 m, *5450*; Kamishinkawa-gun, Oritate, 1350 m, *7563, 7566*. Tochigi Pref., Nikko, Chûzenji, 1260 m, *5351*; Nasu Highland, Daimaru Spa, 1260 m, *8411, 8414*. Akita Pref., Kazuno-gun, Towada-minami, 80 m, *11341*.

Calamagrostis langsdorffii (Link) Trin.

2n=28+0~2B: Toyama Pref., Mts. Tateyama: Midagahara – Murodô – Ichinokoshi – Mt. Jôdosan – Zaratôge – Goshikigahara, 2350–2750 m, *5435, 5448, 7390, 7409, 7439, 7442, 7453, 7460, 7470, 7475, 7500, 7573, 7608*. Nagano Pref., Mt. Ontake: Tanohara – Mikasayama, 2180–2200 m, *11572, 11583, 12456*: Tanohara-Ôdakiyama, 2400–2720 m, *11641* (+1B), *11643~4*, *12458* (+1B), *12462, 12467, 12472, 12474, 12479*: near Ninoike, 2900 m, *11622*: Mt. Kiso-

Komagatake: Gokurakudaira – Senjôjiki – Hôkensansô – Komagainoike – Nôgaike, 2600–2850 m, *11462, 11466, 11486, 11507, 11511, 11513, 11529, 11539~40, 11542, 11545, 11550, 11557, 11559*; Mt. Yatsugatake: Minotoguchi – Akadakekôsen, 1540–1720 m, *12333, 12343, 12345~6, 12349*: Akadakekôsen – Mt. Yuwodake, 2350–2500 m, *12403, 12409*. Yamanashi Pref., Mts. Shiramine: Mt. Kitadake, near Shiraneoike, 2330 m, *9538~40, 9543*: Mt. Kitadake, Kusasuberi, 2430–2820 m, *9553, 9557~8, 9561, 9588*: Mt. Nôtoridake, near Nôtori-ryosen-goya, 2700–2770 m, *9682, 9684~5, 9689, 9692*: Mt. Nôtoridake, Daimonzawa, 2650 m, *9719*, 1900 m, *1735*; Mts. Howo: near Ichigodaira, 1900 m, *10485* (+2B): Minamiomurogoya-summit-Howogoya, 2350–2730 m, *10535~6, 10549, 10556, 10578, 10582, 10584, 10586, 10591, 10603*. Niigata Pref., Mt. Naeba, Kaminari Spring – summit, 1880–2090 m, *10413* (+2B), *10419, 10424, 10429~30, 10449, 10459*. Gunma Pref., Mt. Mikuni, Mikunitôge – summit, 1500 m, *12429, 12432, 12434*. Tochigi Pref., Nikko: Mt. Nantai, summit, 2480 m, *5363, 5366, 5370*: Yumoto, 1500–1550 m, *6426~9*: Yumoto – Maeshirane – Konseitôge, 1650–2300 m, *6432, 6435, 6437~8, 6454~7*; Mts. Nasu, Shimizudaira, 1800–1820 m, *7193, 7215, 8437, 8439*.

2n=42: Ehime Pref., Mt. Ishizuchi: Jôju – summit, 1750 m, *5319*: near the summit, 1920 m, *9462*. Nagano Pref., Mt. Kiso-Komagatake: Senjôjiki – Hôkensansô, 2600–2800 m, *11490, 11548~9*: Komagainoike – Nôgaike, 2650–2700 m, *11518, 11526*; Mt. Yatsugatake, Akadakekôsen – Mt. Nakadake, 2580 m, *12374*. Yamanashi Pref., Mts. Shiramine: Mt. Kitadake, Kusasuberi, 2360 m, *9551*: Mt. Nôtoridake, Daimonzawa, 2550 m, *9723*. Iwate Pref., Hachimantai, Mikaeritôge, 1530 m, *10286*.

2n=56: Ehime Pref., Mt. Ishizuchi: Omogo – summit, 1800–1850 m, *5308~9*: summit – Nishinokanmuridake, 1840 m, *9449*. Tokushima Pref., Mt. Tsurugi, near the summit, 1850–1940 m, *5331~6, 9474, 9490, 9500*. Yamagata Pref., Mt. Chôkai: Torinoumiguchi – Senjadani, 1400–1550 m, *5399, 6478~80*: Senjadani, 1860–1950 m, *5411, 6512, 6520*. Iwate Pref., Mt. Hayachine, near the summit, 1700–1900 m, *7340, 7345~6, 7349~50, 7354*; Hachimantai, Tôshichi Spa – Mt. Mokkodake, 1480 m, *10301~2*.

2n=59~ca. 64: Iwate Pref., Hachimantai, Tôshichi Spa – Mt. Mokkodake, 1480–1500 m: 2n=59: *11371~2, 11376, 11378~9*; 2n=60: *11373~4, 11377, 11380*; 2n=ca. 60: *11385*; 2n=ca. 61: *10300*; 2n=ca. 64: *10307*.

Calamagrostis stricta (Timm) Koel. (Syn.: *C. neglecta* Gaertn.)

2n=84: Hokkaido, Nemuro, Tomoshiri, seaside, *6381, 6401, 8225, 8247, 8289*.

Calamagrostis matsumurae Maxim.

2n=28+0~2B: Yamagata Pref., Mts. Zawo: Shibakusadaira, 1660 m, *11424*: Otanokami, 1580 m, *11432* (+2B), *11433~4*: Umanose – Mt. Kattadake, 1700–1750 m, *11435* (+1B), *11437* (+1B), *11440, 11446, 11449*; Mt. Chôkai, near Sensumori, 1600–1750 m, *5402~3, 6496*. Iwate Pref., Mt. Hayachine, Kawarabô – summit, 1070–1200 m, *7323, 7326~8, 7331*. Akita Pref., Hachimantai, Ônuma – Goshogake – summit, 1160–1610 m, *10248~52, 10254~7, 10276~7, 10280*. Aomori Pref., Mt. Hakkoda, Sugayu – Sennintai – Ôdake, 900–1580 m, *10319, 10321, 10325, 10351, 10372, 11343~4, 11345* (+2B).

Calamagrostis sachalinensis Fr. Schm.

2n=28: Nagano Pref., Mt. Kiso-Komagatake: Senjôjiki – Gokurakudaira, 2700–2800 m, *11460, 11473, 11480, 11553, 11556, 11562*: Nôgaike – Komagainoike, 2680 m, *11541*.

2n=42: Nagano Pref., Mts. Yatsugatake: Jizô ridge, 2550 m, *12393*: near Akadakekôsen, 2200 m, *12418*, 2400 m, *12406*. Hokkaido, Isl. Rishiri, Mt. Rishiri, Oshidomari – summit, 360–850 m, *11069~70, 12243, 12245~6, 12250, 12253*.

2n=56: Nagano Pref., Mt. Ontake, Tanohara – Ôdakiyama, 2350–2450 m, *11596, 11598*; Mt. Kiso-Komagatake: Senjôjiki, 2600 m, *11492*: Komagainoike – Hôkensansô, 2750 m, *11510*; Mts. Yatsugatake: Akadakekôsen, 2200 m, *12365, 12397*: Akadakekôsen – Nakadake, 2220–2450 m, *12366, 12369*, 12394. Fukushima Pref., Mt. Aizu-Komagatake, summit-Ôtsuetôge, ridge, 1950 m, *11316*; Mt. Mitsuiwadake, 1000 m, *11326*.

Calamagrostis hakonensis Fr. & Sav.

2n=28: Kanagawa Pref., Hakone: Mt. Sounzan, 780 m, *7616~7, 7619~22*: Ôwakidani – Mt. Kamiyama, 1080–1435 m, *7623~5, 8496~502, 8505~13, 8515*.

2n=42+0~2A or **B**: Ôita Pref., Mts. Kujû: Mt. Kujû, Makinototôge – summit, 1580 m,

6762 (+1B): Mt. Daisen, near the summit, 1750 m, *5531* (+1B). Ehime Pref., Mt. Ishizuchi: Omogo – summit, 1200–1780 m, *9398* (+1B), *9402* (+1B), *9410*, *9421* (+1B), *9426* (+1B): Yoruaketôge, 1750 m, *9466* (+1B). Tokushima Pref., Mt. Tsurugi, Minokoshi – summit – Jirôgyu, 1650–1940 m, *9496* (+1), *9470* (+1B), *9483* (+1B), *9497* (+1). Yamaguchi Pref., Mt. Jakuchi, 1250 m, *9391* (+1), *9392* (+1B). Toyama Pref., Mts. Tateyama, Bijodaira, 1000 m, *5452*; Mt. Yakushidake: Oritate, 1350 m, *7564* (+1), *7565* (+1): near Tarobeidaira, 1950 m, *7521* (+1). Nagano Pref., Mt. Yatsugatake, Minotoguchi – Minoto, 1500–1620 m, *12331* (+1B), *12332* (+1B), *12336* (+1B), *12342* (+1B). Yamanashi Pref., Mts. Shiramine: Mt. Kitadake, Hirogawara – Shiraneoike, 1500–1850 m, *9512* (+2), *9518* (+1B), *9519* (+1B), *9521* (+1B): Mt. Nôtoridake, Daimonzawa, 1650–1720 m, *9743* (+1B), *9744* (+1B); Mts. Howo: Yashajintôge, 1500 m, *10477* (+1B): near Ichigodaira, 1800–1850 m, *10483*, *10484* (+1): near Howogoya, 2350 m, *10602* (+1). Niigata Pref., Minamiuonuma-gun, Yamato, Mizunashikeikoku, 450 m, *8348* (+1), *8350* (+1). Tochigi Pref., Nikko, Chûzenji, 1260 m, *5350*; Nasu Highland: Yumoto, 800 m, *8488* (+1), *8490* (+1), *8491* (+1), *8492* (+1): Daimaru Spa – Minenochaya – Mt. Asahi, 1340–1750 m, *7176* (+1), *7178* (+1B), *8417* (+1), *8418* (+1), *8419* (+1). Fukushima Pref., Aizu: Hinoemata, 1150 m, *11270* (+1): Azuki Spa, 800 m, *11337* (+1B), *11338* (+1B). Yamagata Pref., Mt. Chôkai, Kawarajuku, 1300 m, *5426* (+2). Iwate Pref., foot of Mt. Hayachine, Ômata – Dake – Kawarabô, 450–850 m, *7296* (+1B), *7298* (+1B), *7314* (+1B), *7317* (+1B). Akita Pref., Kazuno-gun, Towadaminami, 80 m, *11339* (+1B); Hachimantai, Ônuma, 950 m, *10246*. Aomori Pref., Towada, Yasumiya, 450 m, *11342* (+1).

2n=49: Niigata Pref., Minamiuonuma-gun, Yamato, Mizunashikeikoku, 800 m, *8347*.

2n=50: Niigata Pref., Tsugawa, Mt. Kirin, 90 m, *11014*.

2n=56+0~2A or B: Ôita Pref., Mt. Kujû, Makinototôge – summit – Hokke Spa – Sugamori, 1350–1600 m, *5520* (+1), *6770* (+1), *6776* (+2), *6777*, *6816* (+1B). Ehime Pref., Mt. Ishizuchi: Omogokei, 700 m, *5303* (+2): Omogo – summit – Nishinokanmuridake, 1600–1950 m, *9403* (+2), *9404* (+1), *9406* (+2), *9408* (+2), *9413*, *9425*, *9435*, *9447* (+1). Tokushima Pref., Mt. Tsurugi, near the summit, 1870–1930 m, *9491*, *9506*. Toyama Pref., Mts. Tateyama: Bijodaira, 1000 m, *5451* (+1): Midagahara, 1900 m, *7515* (+1B). Nagano Pref., Mts. Togakushi, Togakushi Farm – Ichifudo – Mt. Gojizô, 1660–1790 m, *6576* (+1), *6579* (+1), *6584* (+1B); Mt. Ontake, Mikasayama – Tanohara – Ôdakiyama, 2200–2350 m, *11571* (+1B), *11580* (+2), *11581* (+1B), *11594* (+1B), *12454*; Mt. Yatsugatake, Minoto – Akadakekôsen, 2150–2200 m, *12419*, *12428*. Yamanashi Pref., Mts. Shiramine: Mt. Kitadake, Hirogawara – Shiraneoike, 2300–2330 m, *9531*, *9541*: Mt. Nôtoridake, Daimonzawa, 1750–2000 m, *9734* (+1), *9738*; Mts. Howo, Yashajintôge – summit – Tsubakuroatamayama, 1600–2450 m, *10478* (+1B), *10491* (+1), *10493*, *10494* (+1B), *10495* (+1), *10496*, *10512* (+1B), *10513* (+1), *10537* (+1B), *10605* (+1B), *10616* (+1B). Niigata Pref., Mt. Naeba, Wadagoya – summit, 1300–2100 m, *10387* (+1B), *10390*, *10395*, *10396* (+1B), *10407* (+1B), *10408* (+1), *10446* (+1B), *10447* (+1B), *10448* (+1B), *10469* (+1B). Gunma Pref., Mt. Mikuni, 1280 m, *8354*. Tochigi Pref., Nikko: Chûzenji – Mt. Nantai, 1260–1350 m, *5352* (+2), *5354* (+1), *5355*: Yumoto, 1520 m, *6430*; Nasu Highland, Daimaru Spa – Minenochaya, 1280–1650 m, *7171* (+1B), *7173* (+1), *8415* (+1), 8416, *8420* (+1), *8422*. Miyagi Pref., Mt. Daitôsan, summit, 1365 m, *10384*. Yamagata Pref., Mts. Zawo: Mt. Maeyama, 1580–1620 m, *11429*, *11431*: Umanose, 1750 m, *11438* (+1), *11439* (+1B), *11442* (+1B), *11445* (+1), *11447* (+1): Mt. Chôkai, Torinoumiguchi, 1170–1300 m, *6461~2*, *6562*. Iwate Pref., Mt. Hayachine, Dake – Kawarabô – summit, 850–1040 m, *7299* (+1B), *7321*. Iwate Pref., Hachimantai, Mt. Mokkodake, 1480 m, *10316*. Aomori Pref., Mt. Hakkoda, Sugayu – Ôdake – Akakuradake, 1000–1500 m, *10320* (+1), *10341*, *10359*.

2n=63~66: Yamagata Pref., Mts. Zawo, Mt. Maeyama – Sugigamine & Daikokuten – Mt. Kattadake – Umanose, 1550–1750 m: 2n=63: *11427*; 2n=64: *7365*, *7373*, *11463*, *11448*; 2n=65: *7364*, *7371~2*, *7375*, *7387~8*; 2n=66: *11450*, *11452*.

2n=ca. 70: Iwate Pref., Hachimantai, Mt. Mokkodake, 1450 m, *10313*.

2n=77: Yamagata Pref., Mts. Zawo, Umanose, 1750 m, *11444*.

Calamagrostis nana Takeda

2n=28: Nagano Pref., Mt. Ontake, Tanohara – Ôdakiyama, 2500–2900 m, *11600*, *11638~9*, *12459~60*, *12463~4*, *12466*, *12468~70*, *12473*, *12478*, *12480~1*, *12483~5*, *12487*, *12491*, *12493*; Mt. Kiso-Komagatake, Komagainoike – Hôkensansô, 2700–2800 m, *11505~6*; Mts. Yatsugatake: Akadakekôsen – Nakadake, 2380–2670 m, *12368*, *12373*, *12376*, *12378*, *12380~1*; Mt.

Akadake, 2880 m, *12388*: Jizô ridge, 2450 m, *12393*: Akadakekôsen – Mt. Yuwodake, 2400–2450 m, *12405*, *12407*, 2600–2650 m, *12412*, *12415*.

Calamagrostis gigas Takeda*

2n=28: Hokkaido, Shiribeshi: Cape Katanakake, seaside, *6160~1*, *6163*, *6165*: Cape Raiden, seaside, *6182~3*, *6185~8*, *6192~4*, *6196*, *6201~3*; Otaru City, Hariusu, seaside, *6231*, *6233~7*, *6241*.

Calamagrostis longiseta Hack.

2n=28+0~2B: Yamaguchi Pref., Mt. Takadake, 400 m, *9385* (+1B). Toyama Pref., Mts. Tateyama, Midagahara – Murodô – Mt. Jôdosan – Zaratôge, 1860–2600 m, *7472*, *7498*, *7514*; Mt. Yakushidake, Oritate – Tarobeidaira, 1900–2200 m, *7519*, *7522~4*. Nagano Pref., Mts. Togakushi, Ichifudô – Mt. Gojizô, 1650–1910 m, *6573*, *6580*, *6582*, *6593*, *6612*; Mt. Ontake, Tanohara – Ôdakiyama, 2180–2650 m, *11566~7*, *11569*, *11570* (+2B), *11575~6*, *11578*, *11584*, *11586*, *11590*, *11645~7*, *11648* (+1B), *12455*, *12494*, *12496*; Mt. Kiso-Komagatake: Senjôjiki – Gokurakudaira, 2700–2850 m, *11463*, *11474*, *11476~7*, *11481~2*, *11485*, *11487*, *11489*, *11555*, *11563*: Nôgaike – Komagainoike, 2630–2700 m, *11532~5*, *11536* (+1B), *11537~8*; Mts. Yatsugatake, Minoto – Akadakekôsen – Nakadake, 1700–2530 m, *12347*, *12351*, *12355*, *12357*, *12371~2*, *12396*, *12399*, *12404*, *12421*, *12423~5*; Akaishi Range, Mt. Mototani, 2600 m, *8706*. Yamanashi Pref., Mts. Shiramine: Mt. Kitadake, Shiraneoike – Kusasuberi, 2310–2730 m, *9532~4*, *9542*, *9554*, *9556*, *9565~7*, *9569~72*, *9579*, *9581*: Mt. Nôtoridake, near Nôtori-ryosen-goya, 2740 m, *9687*; Mts. Howo, near the summit of Mt. Yakushidake, 2750 m, *10559*, *10561~2*, *10565*. Gunma Pref., Mt. Mikuni, 1350–1500 m, *8359*, *8361*, *8364*, *8367*; Mt. Tairappyo (north of Mt. Mikuni), 1650 m, *8378*. Niigata Pref., Mt. Naeba, Wadagoya – Kaguragamine – summit, 1300–1900 m, *10391*, *10393*, *10398~406*. Fukushima Pref., Mt. Aizu-Komagatake: summit – Ôtsuetoge, 1900–2000 m, *11310*, *11312~3*, *11318*, *11322*: Ôtsuetoge – Kirinte, 1650 m, *11342*. Miyagi Pref., Mt. Daitôsan, summit, 1340 m, *10379~80*.

2n=42+0~1B: Yamanashi Pref., Akaishi Range: Mt. Mototani, 2650 m, *8702~4*: Mt. Kitadake, Kusasuberi, 2700 m, *9573* (+1B). Fukushima Pref., Mt. Aizu-Komagatake, summit – Ôtsuetoge, 1970 m, *11311*.

Calamagrostis fauriei Hack.

2n=28+0~5B: Niigata Pref., Mt. Makihata, saddle between the summit and Nisemakihata, 1800 m, *12441~2*, *12445*, *12448~51*; Tsugawa, foot of Mt. Kirin, 80 m, *6033~8*, *11015*; Sekikawa, Takase – Takanosu, along Riv. Arakawa, 50 m, *11019*, *11025* (+2B), *11026*, *11034*, *11038*; Muramatsu, Takouchi, along Riv. Hayade, 140–180 m, *6048* (+2B), *6049* (+3B), *6050~1*, *6059~60*, *6069~70*. Fukushima Pref., Mt. Aizu-Komagatake, summit – Chûmondake, 2000–2100 m, *11275* (+4B), *11277* (+4B), *11278*, *11279* (+4B), *11280* (+4B), *11282* (+5B), *11284*, *11288* (+3B), *11290* (+5B), *11297* (+4B), *11298*, *11299* (+2B), *11302* (+1B). Yamagata Pref., Mts. Iide, near Asahimata Fall (south of Chôjagahara), 350 m, *11045~7*.

Calamagrostis tashiroi Ohwi

2n=28: Ehime Pref., Mt. Ishizuchi, Omogo – summit, 1660–1690 m, *9415*, *9419~20*.

2n=42: Ehime Pref., Mt. Ishizuchi, Omogo – summit, 1660 m, *9416*: near the summit, 1930 m, *9438*.

Calamagrostis brachytricha Steud.

2n=42: Kagawa Pref., Isl. Shôdo: Chôsikei, 350 m, *5906*, *5921*: Mt. Hoshigajô, 816 m, *5928*, *5932*. Nagano Pref., Nagano City, 400 m, *6003*, *6010*.

Calamagrostis sesquiflora (Trin.) Tzvelev

2n=28: Nagano Pref., Mts. Yatsugatake, summit of Mt. Akadake, 2860–2890 m, *12389*, *12391*. Nagano – Yamanashi Prefs., Akaishi Range: Mt. Shiomidake, Shiomigoya – summit, 2800–3000 m, *8638*, *8679*, *8690*: Mt. Kitadake – Mt. Ainotake – Mt. Nôtoridake, 2900–3160 m, *9603*, *9640*, *9650*, *9662*, *9675*. Hokkaido, Mts. Daisetsu: Ginsendai – Mt. Akadake, 1800 m, *11203*: Mt. Kurodake – Mt. Hokkaidake, 2000 m, *11249*; Isl. Rishiri, Mt. Rishiri, Oshidomari – summit, 1560 m, *11085*; Isl. Rebun, Momoiwa, 200 m, *12322*.

* All the materials examined can be referred to *C. gigas* f. *alpicola* (Ohwi) Ko. Ito (cf. Ito, 1960).

Intermediates between *Calamagrostis fauriei* and *C. longiseta*.

2n=28+0~4B: Toyama Pref., Mts. Tateyama: Murodô – Mt. Jôdosan – Zaratôge – Goshikigahara, 2450–2820 m, *7389*, *7391*, *7430*, *7444*, *7471*. Gunma Pref., Mt. Tairappyo (west of Mt. Tanigawa), 1900–1980 m, *8380~2*, *8393*. Niigata Pref., Mt. Naeba, flat alpine field, 2130–2145 m, *10434~45*; Mt. Makihata, saddle between the summit and Nisemakihata, 1800 m, *12443*, *12444* (+1B), *12446~7*, *12452*. Fukushima Pref., Mt. Aizu-Komagatake: near Komanokoya, 2050 m, *11308*: summit – Ôtsuetôge, 1900–2000 m, *11314*, *11321*; Mt. Mitsuiwadake, near the summit, 2000–2050 m, *11327*, *11329*, *11331~2*, *11334~6*. Yamagata Pref., Mt. Chôkai, Torinoumi – Senjadani, 1350–1900 m, *5414*, *6465~8*, *6474*, *6482~3*. Iwate Pref., Hachimantai: near the summit, 1600 m, *10278* (+4B), *10279* (+1B): Hachimannuma, 1580 m, *10287*, *10288* (+1B), *10289* (+1B), *10290~2*, *10293* (+1B), *10294* (+1B), *10295*: Tôshichi Spa-Mt. Mokkodake, 1450–1500 m, *10296* (+2B), *10298* (+3B), *10299*, *10317* (+2B).

Intermediates between *Calamagrostis langsdorffii* and *C. longiseta*.

2n=28: Nagano Pref., Mt. Ontake, Mikasayama, 2180 m, *11582*. Gunma Pref., Mt. Mikuni, Mikunitôge – summit, 1500 m, *8368*, *12430~1*.

Intermediates between *Calamagrostis langsdorffii* and *C. nana*.

2n=28: Tochigi Pref., Mts. Nasu, Shimizudaira, 1800–1820 m, *7214*, *8442*.

Intermediates between *Calamagrostis langsdorffii* and *C. sachalinensis*.

2n=56: Toyama Pref., Mts. Tateyama, Goshikigahara-Zaratôge, 2400–2500 m, *7454*, *7457~8*; Mt. Yakushidake, Tarobeidaira-summit, 2360 m, *7533*, 2550 m, *7562*; Mt. Ontake, Tanohara-Ôdakiyama, 2350 m, *11595*; Mt. Kiso-Komagatake: Senjôjiki – Gokurakudaira, 2700–2850 m, *11455~6*, *11464*, *11472*, *11479*, *11560~1*: Nôgaike – Komagainoike, 2650 m, *11530*; Mts. Yatsugatake: Akadakekôsen – Gyôjagoya, 2200–2360 m, *12367*, *12395*, *12398*: Akadakekôsen – Mt. Yuwodake, 2500 m, *12408*. Yamanashi Pref., Mts. Howo: Yashajintôge – Ichigodaira, 2350–2370 m, *10507~8*, *10510*: near the summit of Mt. Yakushidake, 2750 m, *10563*: Mt. Kannondake – Akakuranoatama, 2750 m, *10576*. Iwate Pref., Hachimantai, Mikaeritôge, 1550 m, *10281*.

Intermediates between *Calamagrostis longiseta* and *C. nana*.

2n=28: Nagano Pref., Mt. Ontake, Tanohara – Ôdakiyama, 2500–2700 m, *11609*, *12461*, *12465*, *12471*, *12475~7*, *12495*, *12497*.

2n=42: Nagano Pref., Mt. Ontake, Tanohara – Ôdakiyama, 2600 m, *11604*.

Intermediates between *Calamagrostis longiseta* and *C. sachalinensis*.

2n=28: Toyama Pref., Mts. Tateyama, Tengudaira – Jigokudani, 2340 m, *7580*. Nagano Pref., Mt. Ontake, near Tanohara, 2200–2250 m, *11574*, *11592*; Mt. Kiso-Komagatake, Senjôjiki, 2700 m, *11459*, *11554*. Yamanashi Pref., Mts. Shiramine: Mt. Kitadake, Kusasubergi, 2750 m, *9583*: Mt. Nôtoridake, near Nôtori-ryosen-goya, 2730 m, *9691*: Mt. Nôtoridake, Daimonzawa, 2650–2700 m, *9714*, *9718*.

Results obtained in eight (*Calamagrostis pseudo-phragmites*, *C. matsumurae*, *C. sachalinensis*, *C. nana*, *C. gigas*, *C. fauriei*, *C. brachytricha*, *C. sesquiflora*) of the 14 species for which chromosome counts have been enumerated above are in accord with the results reported in previous papers, except that the occurrence of B-chromosomes in *C. matsumurae* and *C. fauriei* is here recorded for the first time. Important references on their chromosome numbers are as follows; *C. pseudo-phragmites*: Löve and Löve 1974, Mehra and Sharma 1975; *C. sachalinensis*: Tateoka 1974a; *C. nana*: Tateoka 1973b; *C. fauriei*: Tateoka 1972a; *C. brachytricha*: Tateoka and Hayashida 1955, Tateoka 1969; *C. matsumurae*, *C. gigas*, *C. sesquiflora*: Tateoka 1973a. Comments are needed as to the remaining six species, as well as "intermediates".

C. epigeios: Plants of this species with 2n=28, 35, 42, 56 and ca. 70 chromosomes are known outside of Japan (cf. Löve and Löve, 1974). The present work shows that

the tetraploids may be predominant in Japan. Only one collection from Abashiri, Hokkaido, has been found to be octoploid. Three collections from Yoriihama, Niigata City, which grew in proximity on sandy soils at the seaside, have shown eight or nine B-chromosomes besides the 28 ordinary chromosomes in root tip cells. The occurrence of such numerous B-chromosomes in *Calamagrostis* is unusual and is reported here for the first time.

C. langsdorffii: Fig. 1 shows the geographical distribution of different chromosome races of *C. langsdorffii* in Japan which has been prepared on basis of the present and previous reports. This species is not distributed in Kyushu and western Honshu. It may be seen from Fig. 1 and the enumeration described above that (1) tetraploids are abundant in central Honshu and Hokkaido, while they have not been found in collections from Shikoku and northern Honshu, (2) hexaploids have been detected at various localities ranging from Shikoku to Hokkaido, but they are not so frequent as tetraploids and octoploids (cf. Tateoka, 1974c); (3) octoploids, at least those which are included within the circumscription of *C. langsdorffii* adopted in this paper have not been discovered in central Honshu,* but those octoploids are not scarce in Shikoku, northern Honshu and Hokkaido; (4) a population, which includes the individuals with 2n= 59~ca. 64 chromosomes besides those with 2n=56, occurs at Hachimantai, northen Honshu. Tateoka (1974c) has presented a list of chromosome numbers reported for *C. langsdorffii* and closely related taxa, to which a recent report of 2n=56 for a collection from Chukotka, Soviet Union, should be added (Zhukova and Petrovsky, 1975).

C. stricta: The five collections of *C. stricta* obtained at a sphagnous marsh located at Tomoshiri, Hokkaido, have shown 2n=84 without exception. This high euploid number (12X) is new for *C. stricta* which is circumpolar in distribution and is mainly composed of tetraploid individuals in Europe (Nygren, 1946, 1958). Despite their high chromosome number, the five collections from Hokkaido have shown good pollen, suggesting that they are sexual in seed formation like the European tetraploid strains (cf. Nygren, 1958). Hedberg (1967) has reported 2n=ca. 40 (presumably 42) for a collection from Quebec, and Johnson and Packer (1968) have discovered the 2n=28 and 2n=42 chromosome types of *C. stricta* (s. lat.) in materials from Ogotoruk Creek, N.W. Alaska.

C. hakonensis: Among the Japanese species of *Calamagrostis*, *C. hakonensis* is most variable in chromosome number (cf. Table 2). This species is also characterized by the fact that the individuals with a B-chromosome are numerous. The summary of the chromosome counts so far made for *C. hakonensis* is indicated in Table 1, and the geographical distribution of the plants at different ploidy levels is illustrated in Fig. 2. It is clear that (1) tetraploids have been found in a small area in central Honshu on the Pacific Ocean side (cf. Tateoka, 1968), (2) hexaploids and octoploids are widespread and often grow sympatrically, (3) a population composed of individuals with different

* Two octoploids (*8647* & *8662*) were reported as *C. langsdorffii* from Mt. Shiomidake (Tateoka, 1972), but a re-examination of their voucher specimens has shown that they must be referred to "intermediates" between *C. langsdorffii* and *C. sachalinensis* according to the present scheme of classification.

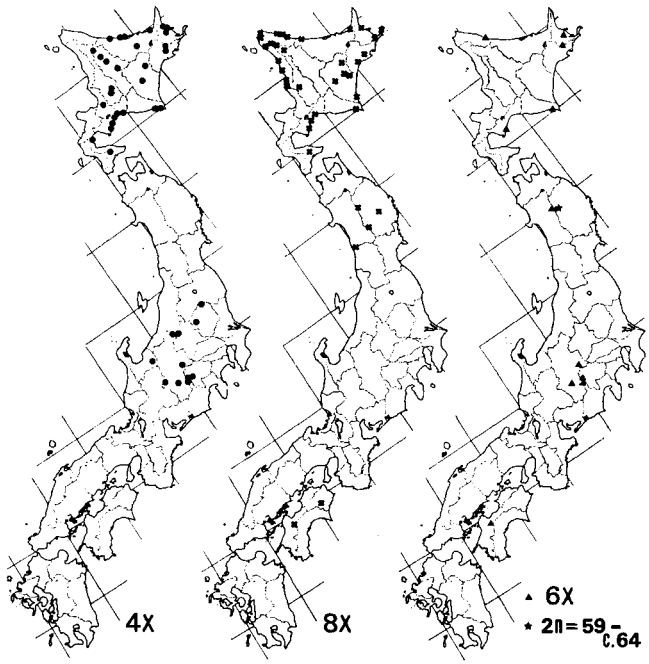

Fig. 1. Distribution of different cytotypes of *Calamagrostis langsdorffii* in Japan, prepared on the basis of the present and previous reports (Tateoka, 1972b, 1973a, 1974c).

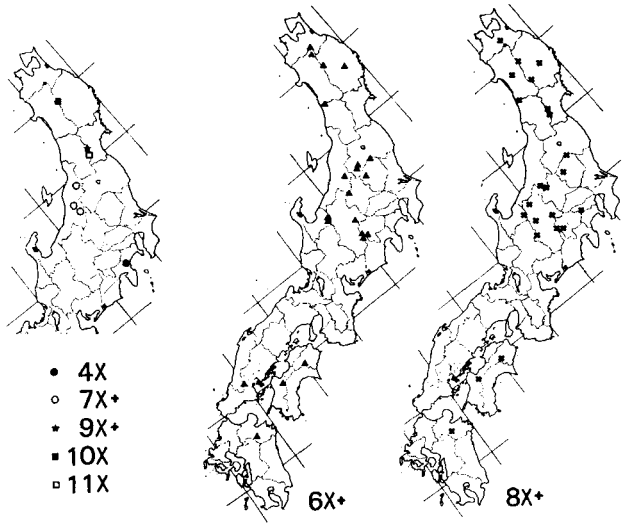

Fig. 2. Distribution of different cytotypes of *Calamagrostis hakonensis* in Japan, prepared on the basis of the present and previous reports (Tateoka, 1954, 1968, 1972b, 1973a). A plus sign means that collections having a few extra chromosomes besides the ordinary chromosomes have been plotted together with those showing respective euploid number.

Table 1. Summary of the chromosome counts for *Calamagrostis hakonensis*.[1]

Locality	4X	6X+[2]	7X+[2]	8X+[2]	9X+[2]	10X	11X
Ôita Pref., Mt. Kujû		2		5			
Ehime Pref., Mt. Ishizuchi		6		9			
Tokushima Pref., Mt. Tsurugi		4		2			
Yamaguchi Pref., Mt. Jakuchi		2					
Toyama Pref., Mts. Tateyama		1		2			
Toyama Pref., Mt. Yakushidake		3					
Nagano Pref., Kamikôchi				1			
Nagano Pref., Mt. Togakushi				3			
Nagano Pref., Mt. Ontake				5			
Nagano Pref., Mts. Yatsugatake		4		2			
Nagano Pref., Mt. Shiomidake		7		7			
Yamanashi Pref., Mts. Shiramine		6		4			
Yamanashi Pref., Mts. Howo		5		11			
Kanagawa Pref., Hakone	39						
Tokyo Pref., Kobotoketôge				1			
Gunma Pref., Mt. Mikuni				1			
Gunma Pref., Hôshi Spa		1					
Niigata Pref., Mt. Naeba				10			
Niigata Pref., Koide			1				
Niigata Pref., Yamato		2	1				
Niigata Pref., Tsugawa			1				
Tochigi Pref., mountains of Nikko		1		4			
Tochigi Pref., Nasu Highland		10		6			
Fukushima Pref., Aizu, Hinoemata		1					
Fukushima Pref., Aizu, Azuki Spa		2					
Miyagi Pref., Mt. Daitôsan				1			
Yamagata Pref., Mts. Zawo				7	13		1
Yamagata Pref., Mt. Chôkai		1		3			
Akita Pref., Kakunodate				2			
Akita Pref., Towadaminami		1					
Akita-Iwate Prefs., Hachimantai		1		1		1	
Iwate Pref., Mt. Yakeishidake				11			
Iwate Pref., Mt. Hayachine		4		2			
Aomori Pref., Towada, Yasumiya		1					
Aomori Pref., Mt. Hakkoda				3			
Total	39	65	3	103	13	1	1

[1] Prepared on the basis of the present and previous reports (Tateoka, 1954, 1968, 1972b, 1973a).
[2] Collections showing respective euploid number and those having a few (mostly one or two) extra chromosomes are included together.

chromosome numbers, 2n=56, 63~66, 77, occurs on Mts. Zawo, (4) a few septaploid or semi-septaploid plants and a decaploid plant have been discovered in a few areas. Morphological, ecological, chemical and reproductive attributes of these collections will be described elsewhere, together with the discussion on the genesis of this highly variable complex.

C. longiseta: The present work proves that *C. longiseta* endemic in Honshu mainly consists of tetraploid strains, though both tetraploids and hexaploids have been discovered. All the previous counts for this species are likewise 2n=28 (a few include one B-chromosome) (Ono and Tateoka, 1953; Tateoka, 1967, 1972a). A hexaploid encountered in Mt. Aizu-Komagatake grew in mixture with tetraploids and might be only ephemeral in existence. On the other hand, the hexaploids on Mt.

Table 2. Diagrammatic representation of the chromosome numbers of *Calamagrostis* in Japan.[1)]

Species	2X	3X	4X	5X	6X	7X	8X	9X	10X	11X	12X	Aneuploid
C. epigeios			●				●					
C. pseudo-phragmites			●									
C. langsdorffii			●		●		●					●
C. stricta											●	
C. matsumurae[2)]			●									
C. sachalinensis[3)]			●		●		●					
C. hakonensis[3)]			●		●	●	●	●	●	●		●
C. autumnalis[2)]			●									
C. nana[2)]			●									
C. gigas[2)]			●									
C. longiseta[2)]			●		●							
C. fauriei[2)]			●									
C. tashiroi[2)]			●		●							
C. adpressi-ramea[2)]			●									
C. brachytricha					●	●	●					●
C. sesquiflora			●									

[1)] Prepared on the basis of the present and previous reports (references in text). B-chromosomes are omitted.
[2)] Species endemic in Japan.
[3)] Species restricted to Japan and adjacent areas.

Mototani in the Akaishi Range seemed to keep on reproducing: three collections from a population situated at the northern side of the summit were hexaploid throughout, while a collection from a colony at the southern side was tetraploid. A hexaploid on Mt. Kitadake in the Akaishi Range was found in proximity with the tetraploids. Further studies are needed to clarify how widespread, particularly within the Akaishi Range, the hexaploids are. This subject may be interesting in relation to the question whether the hexaploids in the Akaishi Range are at an initial stage of the developmental process leading to the establishment of a new polyploid strain.

C. tashiroi: Chromosome numbers of this species which is endemic in Shikoku and Kyushu are here reported for the first time. All the materials used in the present work have come from Mt. Ishizuchi. Although not many individuals have been studied, both tetraploids and hexaploids have been found. One of the two hexaploid collections was made in close proximity with tetraploid collections.

"*Intermediates*": The collections supposed to be interspecific hybrids or hybrid derivatives have been referred to "intermediates". They represent various combinations of the following species: *C. fauriei*, *C. langsdorffii*, *C. longiseta*, *C. nana*, *C. sachalinensis*. It is remarkable that the intermediates between *C. langsdorffii* and *C. sachalinensis* have been numerous at the octoploid level and nil at the tetraploid level. The chromosome examination of many collections from a mixed population of *C. longiseta* and *C. nana* on Mt. Ontake has uncovered the occurrence of an intermediate hexaploid besides many intermediate tetraploids. The intermediates of other combinations have been tetraploid throughout, as the above enumeration shows. The nature and status of these collections will be discussed in subsequent papers, in which their morphological, ecological and reproductive attributes are described.

Discussion

Among the Japanese species of *Calamagrostis*, there remains one species of which the chromosome number is still unknown. That is *C. masamunei* Honda which is restrictedly distributed in the uplands of the Islands of Yaku and is closely related to *C. longiseta*. Also, further chromosomal observations are apparently desirable for various species, such as *C. epigeios* and *C. tashiroi*. Nevertheless, it can be said that chromosome numbers of Japanese *Calamagrostis* have been established to a considerable extent by the present work.

Table 2 diagrammatically indicates the distribution of chromosome numbers in species of *Calamagrostis* in Japan. It is remarkable that the diploid plants with 2n=14, as well as triploids and pentaploids, are completely lacking, despite the fact that in genera related to *Calamagrostis*, such as *Agrostis*, diploid plants with 2n=14 are not scarce (cf. Fedorov, 1969; Moore, 1973). This situation is not restricted to the taxa in Japan, but there is no report of 2n=14 for any of *Calamagrostis* growing outside of Japan.

Plants of *Calamagrostis* can be regarded as growing in Japan at least from the late Miocene period onward (Tateoka, 1974b), and some taxa which grew in old geological times might have been diploid. Nevertheless, it seems unlikely that the majority of the tetraploids now occurring in Japan had their origin as amphidiploids in various combinations of many different diploid species which are at present extinct. If so, we must postulate that the many diploid species have been entirely replaced by polyploids, referring to the data appearing in Table 2. This assumption seems to be remote from the fact, since some diploids are usually found surviving in restricted areas even in polyploid complexes at the mature or declining stages (Stebbins, 1971).

In connection with the above assumption, it must be noticed that even those habitats which can be regarded as having been relatively stable throughout the Neo-Tertiary period, such as the conifer forest belt of the mountains in central Honshu, are actually occupied by some tetraploids. Further, the tetraploid taxa in Japan seem to be adaptively radiated, being a little different in ecological preference as well as in geographical distribution (Tateoka, 1974b). Some of the tetraploid taxa, such as *C. adpressi-ramea* or the tetraploids of *C. hakonensis* (Fig. 2), have ranges limited to particular areas leaving aside the surrounding areas which seem to be suitable for their growth. This suggests that they may be declining. In all probability, the tetraploids of *Calamagrostis* in Japan are long-standing and are devoid of any sign suggestive of their recent origin from the diploids.

Another noteworthy fact is that some plants with 2n=42 chromosomes behave like a triploid plant. In *C. langsdorffii* growing in the lowlands of Hokkaido, plants with 2n=28 and 2n=56 are abundant, while those with 2n=42 are quite scanty and are found only in association with the 28- and/or 56-chromosome plants (Tateoka, 1974c). Although the 42-chromosome plants produce good pollen and are apparently not identical with the ordinal triploid, they do not form their own population and seem to be not so successful as the 28- and 56-chromosome plants in reproduction. A

similar observation has been reported for the 42-chromosome plants of *C. epigeios* in Europe (Nygren, 1946). Plants with 2n=42 are plenty in *C. hakonensis*, *C. sachalinensis* and *C. brachytricha*, but they are almost entirely apomictic in seed formation (Tateoka, 1968, 1969, 1974a) and can reproduce irrespective of whether they are hexaploid or semi-triploid. It can be said that, so far as examined, plants with 2n=28, 56 and 84 (2X, 4X and 6X on basis of X=14) are evidently superior to those with 2n=42 and 70 (3X and 5X on basis of X=14) in the sexually reproducing taxa of *Calamagrostis* (cf. Nygren, 1958).

It follows from the above discussion that the basic number of X=7 may be not so tightly associated with *Calamagrostis* as with a number of the so-called festucoid genera, such as *Triticum* and *Avena*, since a tendency towards X=14 seems to have been more or less developed in *Calamagrostis*. Nevertheless, the sporadic occurrence of plants with 2n=49, 63 and 77 (Table 2) provides evidence that the condition of X=7 is still considerably effective for the chromosomes of *Calamagrostis*, and the basic number of X=14 is not rigidly established in this genus.

Assuming from the situations described above, the 28-chromosome plants of *Calamagrostis* in Japan may be regarded as semi-diploids, behaving like a diploid plant. A polyploid origin, associated with hybridization, is now well known in various plant groups at supraspecific categories (Stebbins, 1975, p. 132). It may not be illogical to suppose that the 28-chromosome plants, which played a significant role as the ancestral taxa for subsequent evolutionary changes, evolved at an incipient stage of divergence of *Calamagrostis* or certain infrageneric groups of it, and that the 28 chromosomes of these plants which were initially composed of two sets of genomes were considerably modified towards one set through the process of diploidization. If this type of 28-chromosome plants was really ancestral to the present-day species of Japanese *Calamagrostis*, the situations described above can be understood.

The above assumption is tenable in regard to the taxa in Japan and also for those in Europe (cf. Nygren, 1962), but it is possible that it is applicable only for parts of, not the entirety of, *Calamagrostis*. A large number of species distributed in the tropics and the Southern Hemisphere remain to be studied cytologically, and the chromosomes of many species in the Northern Hemisphere are also still unexamined. The above assumption does not neglect the possibility that some groups of plants which are within the realm of *Calamagrostis* and are actively evolving with the help of the still extant 2n=14 chromosome plants may be discovered in some parts of the world. As early as in 1953, Gould indicated that the basic number of 30 may have been established for the American species of the section *Amphilophis* of the genus *Andropogon*, despite the fact that the basic number of 10 is predominant in the infrageneric groups of this genus distributed in other parts of the world. It is expected that studies in the future will uncover various examples of this kind. Considering the above circumstances, terms such as "tetraploid" for *Calamagrostis* should be used as usual according to the traditional manner.

Another fact that can be pointed out from the data appearing in Table 2 is that no species is characterized by the hexaploid or octoploid chromosome type only. In *C.*

stricta only dodecaploid plants have been found in Japan, but as stated above, strains of this species at lower ploidy levels are known from Europe and North America. *C. brachytricha* in Japan is mainly hexaploid (cf. Tateoka, 1969), but it is very closely related to a tetraploid species, *C. arundinacea* which is widely distributed in Eurasia. Aside from these species or species complexes, of which only high polyploid strains are found in Japan and *C. masamunei* whose chromosome number is unknown, species of *Calamagrostis* in Japan either are tetraploid or have tetraploid representatives. This fact shows that the formation of species with 2n=42 or 2n=56 by means of amphiploidy has been scarce. Thus, speciation of *Calamagrostis* in Japan may have occurred principally at the tetraploid (viz. 2n=28 chromosome) level.

It is easily supposed, from the distribution of chromosome numbers appearing in Table 2 and the presence of many "intermediates", that polyploidy and hybridization have greatly contributed to the formation of complicated internal structures of various species. This subject will be taken up in subsequent papers.

The author thanks Mr. Y. Ikegami, Niigata City, and Mr. K. Oka, Ogôri City, who kindly helped him in field explorations at various localities. This work was supported by Grant in Aid No. 764126, No. 854161 and No. 948235 from the Ministry of Education, Japan.

References

BEAMAN, J.H., D.C. DEJONG AND W.P. STOUTAMIRE. 1962. Chromosome studies in the alpine and subalpine floras of Mexico and Guatemala. Amer. J. Bot. **49**: 41–50.

FEDOROV, A.A. (ed.) 1969. Chromosome Numbers of Flowering Plants. Academy of Sciences of the USSR, V.L. Komarov Botanical Institute, Moscow.

GOULD, F.W. 1953. A cytotaxonomic study in the genus *Andropogon*. Amer. J. Bot. **40**: 297–306.

HEDBERG, O. 1967. Chromosome numbers of vascular plants from arctic and subarctic North America. Ark. Bot. **6**: 309–326.

ITO, K. 1960. Observations on northern Japanese plants (2). J. Geobot. (Kanazawa) **8**: 72–75.

JOHNSON, A.W. AND J.G. PACKER. 1968. Chromosome numbers in the flora of Ogotoruk Creek, N.W. Alaska. Bot. Not. **121**: 403–456.

LÖVE, A. AND D. LÖVE. 1961. Chromosome numbers of central and northwest European plant species. Opera Bot. **5**: 1–581.

——— AND ———. 1974. Cytotaxonomical Atlas of the Slovenian Flora. Verlag von J. Cramer, Lehre.

MEHRA, P.N. AND M.L. SHARMA. 1975. Cytological studies in some central and eastern Himalayan grasses. III. The Agrostideae, Aveneae, Brachypodieae, Bromeae, Festuceae, Phalarideae and Triticeae. Cytologia **40**: 441–452.

MOORE, R.J. (ed.) 1973. Index to Plant Chromosome Numbers 1967–1971. Regnum Vegetabile **90**: 1–539.

NYGREN, A. 1946. The genesis of some Scandinavian species of *Calamagrostis*. Hereditas **32**: 131–262.

———. 1948a. Further studies in spontaneous and synthetic *Calamagrostis purpurea*. Hereditas **34**: 113–134.

———. 1948b. Some interspecific crosses in *Calamagrostis* and their evolutionary consequences. Hereditas **34**: 387–413.

———. 1949. Apomictic and sexual reproduction in *Calamagrostis purpurea*. Hereditas **35**: 285–300.

———. 1951. Form and biotype formation in *Calamagrostis purpurea*. Hereditas **37**: 519–532.

———. 1958. Investigations on North American *Calamagrostis*, II. Kungl. Lantbrukshögskolans Annaler **24**: 363–368.

———. 1962. Artificial and natural hybridization in European *Calamagrostis*. Symb. Bot. Upsal. **17** (3): 1–105.

OHWI, J. 1936. A revision of the Japanese species of *Calamagrostis*. Acta Phytotax. Geobot. **5**: 225–242.

———. 1975. Flora of Japan (New edition). Shibundo, Tokyo (in Japanese).

ONO, H. AND T. TATEOKA. 1953. Karyotaxonomy in Poaceae. I. Chromosomes and taxonomic relations in some Japanese grasses. Bot. Mag. Tokyo **66**: 18–27.

POHL, R.W. AND G. DAVIDSE. 1971. Chromosome numbers of Costa Rican grasses. Brittonia **23**: 293–324.

STEBBINS, G.L. 1971. Chromosomal Evolution in Higher Plants. Edward Arnold Ltd., London.

———. 1975. Flowering Plants, Evolution above the Species Level. Harvard University Press, Cambridge.

TATEOKA, T. 1954. Karyotaxonomy in Poaceae II. Somatic chromosomes of some species. Cytologia **19**: 317–328.

———. 1955. Karyotaxonomy in Poaceae III. Further studies of somatic chromosomes. Cytologia **20**: 296–306.

———. 1967. Gramineae. In Löve, A.: IOPB chromosome number reports XIV. Taxon **16**: 561–564.

———. 1968. Notes on *Calamagrostis hakonensis* (Gramineae). Bull. Natn. Sci. Mus. Tokyo **11**: 293–298.

———. 1969. A cytotaxonomic study of the *Calamagrostis arundinacea* complex (Gramineae) in Japan. Bull. Natn. Sci. Mus. Tokyo **12**: 293–288.

———. 1970a. Recognition of *Calamagrostis* × *microtis* (Gramineae). Bull. Natn. Sci. Mus. Tokyo **13**: 275–290.

———. 1970b. Disjunctive distribution and taxonomy of *Calamagrostis autumnalis* (Gramineae). Bull. Natn. Sci. Mus. Tokyo **13**: 459–473.

———. 1972a. An analysis of the *Calamagrostis longiseta* complex in Mt. Echigo-Komagatake. Bull. Natn. Sci. Mus. Tokyo **15**: 385–394.

———. 1972b. Cytotaxonomic studies of *Calamagrostis sachalinensis* and its relatives in Mt. Shimoidake. Bull. Natn. Sci. Mus. Tokyo **15**: 461–473.

———. 1973a. A taxonomic study of the genus *Calamagrostis* on Mount Yakeishidake. Bot. Mag. Tokyo **86**: 103–120.

———. 1973b. *Calamagrostis nana*, a revived species of the family Gramineae. Bull. Natn. Sci. Mus. Tokyo **16**: 45–59.

———. 1974a. Phytogeographical studies of *Calamagrostis sachalinensis* (Gramineae) I. Attributes of infraspecific races. Bot. Mag. Tokyo **87**: 133–147.

———. 1974b. Phytogeographical studies of *Calamagrostis sachalinensis* (Gramineae) II. Origin and dispersal. Bot. Mag. Tokyo **87**: 149–164.

———. 1974c. A cytotaxonomic study of the *Calamagrostis purpurea-langsdorffii-canadensis* complex in the lowlands of Hokkaido. Bot. Mag. Tokyo **87**: 237–251.

——— AND Y. HAYASHIDA. 1955. A cytotaxonomic study of *Calamagrostis arundinacea* Roth var. *brachytricha* Hack. J. Jap. Bot. **30**: 336–339 (in Japanese).

ZHUKOVA, P.G. 1967. Chromosome numbers in some species of plants of the north-eastern part of the U.S.S.R. II. Bot. Zh. **52**: 983–987.

———. 1969. Chromosome numbers in certain plant species indigenous to the north-east of of the U.S.S.R. IV. Bot. Zh. **54**: 1985–1990.

——— AND V.V. PETROVSKY. 1971. Chromosome numbers of certain flowering plants of the Wrangel Island. Bot. Zh. **56**: 294–305.

——— AND ———. 1975. Chromosome numbers of some western Chukotka plant species. Bot. Zh. **60**: 395–401.

——— AND A.D. TIKHONOVA. 1971. Chromosome numbers of certain plant species indigenous to the Chukotskiy Province. Bot. Zh. **56**: 868–875.

——— AND ———. 1973. The chromosome numbers of some Chukotka plant species. II. Bot. Zh. **58**: 395–402.

Received January 8, 1976