CYTOLOGICAL STUDIES ON SOME EASTERN HIMALAYAN PLANTS AND THEIR RELATED SPECIES

by

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This report comprises the results of my cytological studies on flowering plants collected by the Botanical Expeditions to Eastern Himalaya organized by the University of Tokyo in 1967 and 1969. It also includes some additional data based on the collections of our previous Expeditions to Eastern Himalaya since 1960, and of my trip to Darjeeling, Simla and Kashmir in 1970. Some supplementary data which are closely related to those of the Eastern Himalayan ones were also given in this paper.

The materials were fixed either at the habitats or in Tokyo or Karuizawa where the plants were cultivated. The methods used (OQ & W) are the same as those described in my paper in Flora of Eastern Himalaya pp. 658–659 (1966).

The author wishes to express her deep gratitude to Professor Hiroshi Hara for

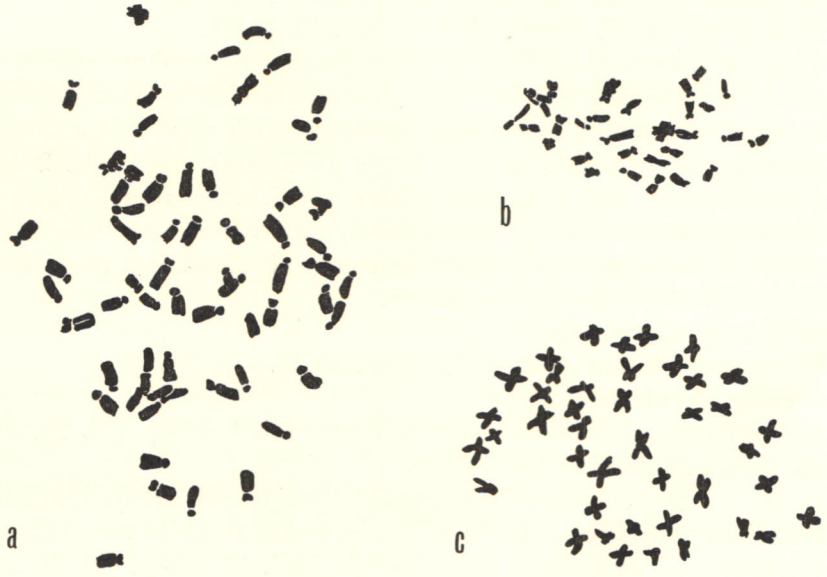

Fig. 57. Somatic chromosomes. a. *Aconogonum campanulatum*, 2n=64, ×1700. b. *Aconogonum molle*, 2n=32, ×1100. c. *Achyranthes bidentata*, 2n=24, ×2500.

his valuable advise and constant encouragement. Thanks are also due to all the members of the Expeditions for their kind help.

MATERIALS STUDIED

Aconogonum campanulatum (Hook. f.) Hara
(*Polygonum campanulatum* Hook. f.)
2n=ca. 64, 60. Bhuspate Danra, E. Nepal, 2500 m (Dec. 1, 1963). [Fig. 57. a (OQ)]

Aconogonum molle (D. Don) Hara
(*Polygonum molle* D. Don)
2n=32. Kakani, C. Nepal, 2200 m (Sep. 24, 1963). [Fig. 57. b (OQ)]
var. **frondosum** (Meisn.) Hara
(*Polygonum paniculatum* Blume)
2n=32. Meghma-Chitrey, Singalila Range, 2700 m (Jul. 22, 1969).

The only report on the chromosome number of this group is that Pauwels (1959) found 2n=ca. 30 in *Polygonum rude* Meisn. cultivated in Botanic Garden at Kew.

Achyranthes bidentata Blume
2n=24. Tonglu, Singalila Range, 3150 m (Jul. 11, 1969). [Fig. 57. c (OQ]

This number has been reported by Pal (1964), and agrees also with that of var. *japonica* Miquel of Japan.

Caltha Govaniana Wall. ex Royle
2n=ca. 80. Phalut, Singalila Range, 3850 m (Jul. 18, 1969).

Caltha palustris L. var. **alba** Hook. f. & Thoms.
n=ca. 24 (PMC). Gulmarg, Kashmir, 2400 m (May 14, 1970).

Caltha palustris L. var. **himalensis** (D. Don) Mukerjee
2n=32. Kalingchok, C. Nepal, 3400 m (Sep. 10, 1970).

It has been well-known that the *C. palustris* group is very polymorphous and also very variable in the chromosome number ranging from 16 to 80. *C. Govaniana* has generally robust erect stems, leaves with numerous small teeth and a closed sinus, larger flowers, and erect follicles with longer (2–3 mm) erect style. 2n=80 has hitherto been reported only in *C. minor* Miller and *C. arctica* subsp. *sibirica* (Regel) Tolm. But morphologically *C. Govaniana* widely differs from these two plants. It is noteworthy that three morphologically distinct wild Himalayan races mentioned above have different chromosome numbers.

Clematis napaulensis DC.
2n=16. Ratsoo, Bhutan, 2000 m (Apr. 11, 1967).

Ranunculus Brotherusi Freyn
2n=32. Sandakphu, Singalila Range, 3970 m (Jul. 4, 1969). [Pl. 21. c (OQ)]

Ranunculus adoxifolius Hand.-Mzt.
2n=ca. 48. Sandakphu, Singalila Range, 3900 m (Jul. 14, 1969). [Pl. 21. b (OQ)]

Ranunculus pulchellus C. A. Meyer var. **Stracheyanus** (Maxim.) Hand.-Mzt.
2n=48. Sabargan, Singalila Range, 3300 m (Jul. 19, 1969). [Pl. 21. a (OQ)]

Podophyllum hexandrum Royle (*P. Emodi* Wall.)
2n=12. Barshong, Bhutan, 3400 m (May 25, 1967). [Pl. 21. d (OQ); Fig. 58]
2n=12+0–2f. Gulmarg, Kashmir, 2400 m (May 14, 1970). [Pl. 21. e (OQ)]

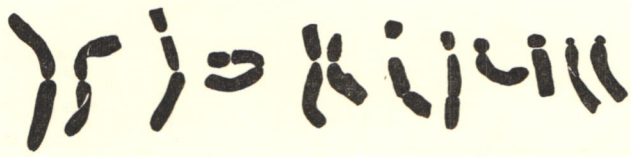

Fig. 58. Somatic chromosomes. *Podophyllum hexandrum*, 2n=12, ×2500.

As previously reported by Litardière (1921), Langlet (1928) and Kuroki (1965), this species has basically 12 somatic chromosomes. But the karyotype seems to vary considerably by population. It has been known that a pair of large submedian chromosomes has submedian secondary constrictions, and in our materials, another pair of smaller subterminal chromosomes also has often submedian or subterminal secondary constrictions. In a wild population collected in Kashmir, one or two very small metacentric chromosomes or B-chromosomes are sometimes found. It is highly probable that in this population occur the similar chromosomal aberrations especially translocations to those observed in *P. peltatum* by Newman (1967).

Agrimonia pilosa Ledebour var. **nepalensis** (D. Don) Nakai

2n=56. Gokarna, Kathmandu, C. Nepal, 1900 m (Sep. 1963).

2n=56. Dhunche, Gosainkund, C. Nepal, 2100 m (Jun. 5, 1969).

2n=56. Akasay, E. Nepal, 2600 m (Dec. 1, 1963).

2n=56. Mane Bhanjang, Singalila Range, 2250 m (Jul. 22, 1969).

The chromosome number and the relationships between the Himalayan plants and the Japanese ones were discussed in detail by Hara & Kurosawa in Journ. Jap. Bot. **43**: 392–400, pls. 20 & 21 (1968).

Fragaria Daltoniana J. Gay

2n=14. Sandakphu, Singalila Range, 3900 m (Jul. 13, 1969).

This number agrees with that reported by Darrow (1937). It became apparent that all the four species occuring on the Singalila Range, *F. nubicola* Lindley, *F. nilgerrensis* Schlecht., *F. rubiginosa* Lacaita and *F. Daltoniana* are diploid (cf. Kurosawa in Fl. E. Himal. 661, 1966).

Desmodium podocarpum DC. subsp. **oxyphyllum** (DC.) Ohashi

2n=22. Orchid Sanctuary, Gangtok, Sikkim, 1700 m (Jun. 27, 1969). [Pl. 21. f (OQ)]

All the species of the genus so far examined cytologically have 22 somatic chromosomes, and Funabiki (1958) suggested the same number for the Japanese species but has never studied them. Sokolovskaya (1966) found 2n=22 in *D. podocarpum* subsp. *oxyphyllum* var. *mandshuricum* (Maxim.) Ohashi, and the author confirmed the same number in subsp. *oxyphyllum*.

Sarcococca Hookeriana Baillon

2n=28. Bhuspate Danra, E. Nepal, 2900 m (Dec. 2, 1963).

Berchemia flavescens (Wall.) Brongn.

2n=24. Langtang Gorge, C. Nepal, 2500 m (Jul. 7, 1970).

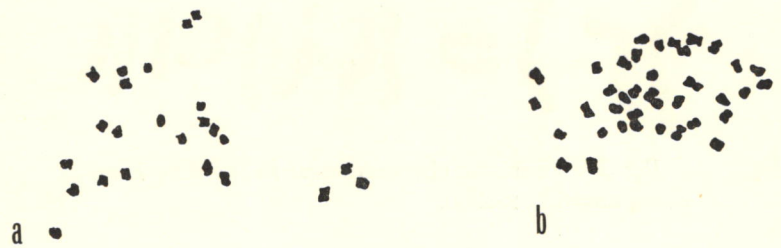

Fig. 59. Somatic chromosomes. a. *Stachyurus Sigeyosii*, 2n=24, ×1800. b. *Helwingia formosana*, 2n=38, ×1500.

Stachyurus Sigeyosii Masamune

2n=24. Taroko, Formosa (Mar. 1966). [Fig. 59. a (OQ)]

As I have reported in 1966, both *S. himalaicus* Hook. f. et Thoms. of E. Nepal and *S. praecox* Sieb. et Zucc. of Japan have also 2n=24 chromosomes. Morphologically the Formosan plants are similar to *S. himalaicus* in some respects, but resemble *S. praecox* var. *lancifolius* (Koidzumi) Hara of southern Japan in the characters of leaves.

Panax pseudo-ginseng Wall. subsp. **pseudo-ginseng**

2n=24. Shioupuri, Kathmandu, 2500 m (Jun. 14, 1969) [Pl. 22. a (OQ)]

subsp. **himalaicus** Hara

2n=24. Phalut, Singalila Range, 3800 m (Jul. 18, 1969).

2n=24. Tonglu, Singalila Range, 3100 m (Jul. 12, 1969).

2n=24. Chitrey–Mane Bhanjang, Singalila Range, 2300 m (Jul. 22, 1969).

2n=24. Western Bhutan (Apr. 1967).

var. **angustifolius** (Burkill) Li

2n=24. Darjeeling, 2200 m (Apr. 1967) [Pl. 22. b, c (OQ)]

2n=24. Darjeeling, 2200 m (Jun. 23, 1969).

The Himalayan races have 2n=24 chromosomes, as reported by Kurosawa (ex Hara 1970). In my previous report (1966), 2n=ca. 48 for a plant from Tonglu was recorded by mistake. But I confirmed that the Japanese plants have 48 somatic chromosomes.

Aucuba chinensis Benth.

2n=16. Shishikyô, Kôshun, Formosa (Mar. 28, 1966).

Aucuba japonica Thunb.

2n=16. Mt. Katsûdake, Okinawa (Jan. 12, 1969). [Pl. 22. d (OQ)]

2n=16. Mt. Yuwan, Amami-Ôshima (Apr. 6, 1970).

2n=16. Anbô, Yakushima Is., 300 m (Feb. 1971).

A. himalaica Hook. f. et Thoms. and *A. chinensis* (Meurman 1930, Kihara & Yamamoto 1935) have been known as diploid, while *A. japonica* Thunb. as tetraploid (2n=32). It was unexpected that the plants of Okinawa in the Ryukyus, Amami-Ôshima and Is. Yakushima are diploid, because they are morphologically more similar to typical *A. japonica* than to *A. chinensis*. Further studies will reveal the detailed relationship between diploid and tetraploid races in Japan.

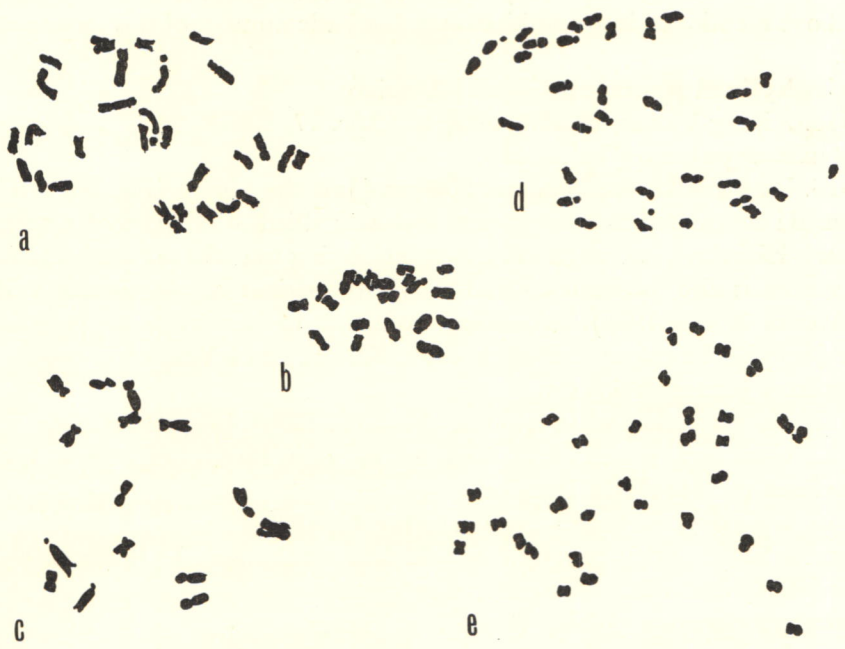

Fig. 60. Somatic chromosomes. a. *Lysimachia evalvis*, 2n=30, ×1700. b. *Lysimachia ramosa*, 2n=20, ×1700. c. *Wulfenia nepalensis*, 2n=16, ×2200. d, e. *Valeriana Jatamansi*, 2n=32, ×1600.

Helwingia formosana Kanehira et Sasaki

2n=38. Keitô Experim. Forest, Formosa, 1300 m (Nov. 13, 1968). [Fig. 59. b (OQ)]

2n=38. Mt. Nankotaisan, Formosa, 1700 m (Aug. 20, 1969).

In my previous reports (1965 & 1966), it was proved that *H. himalaica* Hook. f. et Thoms. from Darjeeling has 2n=38 chromosomes, while *H. japonica* (Thunb.) Dietr. of Japan is a high polyploid with 2n=ca. 114 chromosomes. It is noteworthy that the Formosan plants which bear black fruits have the same number as that of *H. himalaica* with red fruits, and clearly differ from the Japanese ones.

Lysimachia prolifera Klatt

2n=24. Sandakphu, Singalila Range, 3900 m (Jul. 15, 1969). [Pl. 22. e (OQ)]

2n=24. Garibas–Tonglu, Singalila Range, 2900 m (Jul. 21, 1969).

Lysimachia ramosa Wall.

2n=20. East Birch Hill Road, Darjeeling, 2100 m (Jul. 5, 1969). [Fig. 60. b]

Lysimachia evalvis Wall.

2n=30. Darjeeling, 2200 m (Jun. 23, 1969). [Fig. 60. a (W)]

Lysimachia debilis Wall.

2n=84. Chimakhothi, Bhutan, 2350 m (Apr. 21, 1967).

L. prolifera belongs to Sect. Candidae Hand.-Mzt. which has never previously been studied cytologically. In Sect. Apodanthera, *L. sikokiana* Miquel was proved to have

2n=60 chromsomes (Jinno 1956), and taking the numbers of *L. ramosa* and *L. evalvis* above mentioned into consideration, the basic number of this section appears to be 5.

Ellisiophyllum pinnatum (Wall.) Makino

2n=18. Ritang Valley, Bhutan, 2000 m (Apr. 17, 1967).

Wulfenia nepalensis Yamazaki

2n=16. Phulchauki, Kathmandu, 2600 m (Jun. 26, 1967). [Fig. 60. c (OQ)]

Yamazaki considered that the species is closely allied to *W. Amherstiana* Bentham of Western Himalaya (see page 120). It is interesting that the chromosome number of this species is also the same as that of *W. Amherstiana* (n=8, Verma & Dhillon 1967; Mehra & Gill 1968), but differs from that of *W. carinthiaca* Jacquin of E. Europe (2n=18, Favarger & Huynh 1964; Kurosawa ex Yamazaki 1968).

Valeriana Jatamansi Jones

2n=32. Yusmarg, Kashmir, 2100 m (May 16. 1970). [Fig. 60. d (OQ)]

2n=32. Godavari, Kathmandu, 1600 m (May 29, 1969). [Fig. 60. e (OQ)]

Valeriana pyrolaefolia Decaisne

2n=16. Gulmarg, Kashmir, 2400 m (May 14, 1970).

Mehra & Sobti (1955) reported 2n=32 under the name *V. Wallichii* DC., but Kishore (1951) found 2n=28 in the same species.

Peracarpa carnosa (Wall.) Hook. f. et Thoms.

2n=ca. 30. Phalut, Singalila Range, 3850 m (Jul. 18, 1969).

The plants of Phalut have roundish leaves, and agree with the Japanese ones in this respect.

Adenocaulon himalaicum Edgeworth

2n=46. Phulchauki, Kathmandu, 2800 m (Jun. 10, 1969).

2n=46. Ritang Valley, Bhutan, 2000 m (Apr. 16, 1967).

This is the first record on the Himalayan plants, and the chromosome number agrees with that reported on the Japanese plants by D. M. Moore (1963), Arano (1965), and Huziwara (1968). But different numbers such as 2n=20 (Arano 1960), 2n=38 (Arano 1962) and 2n=48 (Koyama 1966) have hitherto been published based on the Japanese plants.

Artemisia indica Willd.

2n=34. Darjeeling, 2150 m (Apr. 1960).

2n=36. Kalapokhari, Singalila Range, 3100 m (Jul. 21, 1969). [Pl. 22. f (OQ)]

2n=36. Tiger Hill, Darjeeling, 2450 m (Jul. 26, 1969).

Artemisia dubia Wall. ex DC.

2n=54. Birch Hill Road, Darjeeling, 2100 m (Mar. 16, 1963).

Stoloniferous 'Mugworts' found very common in the lowlands of Japan, *A. indica* and *A. princeps* Pamp., have 2n=34 chromosomes. It is notable that one population from Darjeeling, as already reported by Koyama ex Kitamura (1966) under the name *A. princeps*, agrees with the Japanese plants in chromosome number, but two other populations from the same district have 2n=36 chromosomes. *A. dubia* with caespitose semiwoody stems is quite distinct from *A. indica* morphologically, and has 2n=54 chromosomes, which number agrees with that of Suzuka (1956). The Indian plants of the *A. vulgaris* complex with n=18 chromosomes reported by

Fig. 61. Somatic chromosomes. *Allium Wallichii*, 2n=14, ×1600.

Khoshoo & Sobti (1958) are probably identical with *A. indica*, and those with n=27 & 2n=54 chromosomes correspond with *A. dubia* Wall., as this species often occurs at lower altitudes.

Arisaema ostiolatum Hara

2n=28. Phalut–Sabargan, Singalila Range, 3400 m (Jul. 19, 1969).

Arisaema Jacquemontii Blume

2n=28. Tonglu, Singalila Range, 2800 m (Jul. 12, 1969).

Arisaema intermedium Blume

2n=28. Phulchauki, Kathmandu, 2900 m (May 29, 1969). [Pl. 23. a (OQ)]

Arisaema consanguineum Schott

2n=28. Kalingchok, C. Nepal, 2000 m (Sep. 10, 1970).

Aletris gracilis Rendle

2n=ca. 52. Pele La, Bhutan, 3000 m (Apr. 12, 1967).

Allium Wallichii Kunth

2n=14. Gosainkund, C. Nepal, 3000 m (Aug. 1969). [Pl. 23. f (OQ), Fig. 61]

There is a pair of large submedian chromosomes with distinct secondary submedian constrictions, and those chromosomes are liable to be detached at the constriction.

Clintonia udensis Trautv. et Meyer var. **alpina** Hara

2n=28. Sandakphu, Singalila Range, 3950 m (Jul. 15, 1969).

Disporum cantoniense (Lour.) Merrill

2n=14. Tonglu, Singalila Range, 3100 m (Jul. 12, 1969).

2n=14. Chimakhothi, Bhutan, 2350 m (Apr. 21, 1967).

2n=16. Phulchauki, Kathmandu, C. Nepal, (May 29, 1969).

2n=16. Tendong, Sikkim, 2900 m (Jun. 29, 1969). [Pl. 23. b (OQ)]

It became apparent that three cytotypes with 2n=14, 16 and 30 chromosomes occur in Eastern Himalaya.

Fritillaria cirrhosa D. Don

2n=24. Sandakphu, Singalila Range, 3900 m (Jul. 14, 1969).

This number agrees with that reported by La Cour (1951).

Paris polyphylla Smith

2n=20. Singhik, Sikkim, 1500 m (Jun. 30, 1969).

2n=20. Badam La, near Kalimpong, 1500 m (Jul. 6, 1969).

2n=20. Ritang Valley, Bhutan, 2000 m (Apr. 17, 1967).

2n=20. Samtengang–Ritang, Bhutan 2700 m (Apr. 11, 1967).

2n=20. Chimakhothi, Bhutan 2350 m (Apr. 21, 1967).

2n=20. Darjeeling, 2150 m (Apr. 1967).

2n=20. Tonglu, Singalila Range, 3100 m (Jul. 11, 1969).

subsp. **marmorata** (Stearn) Hara

2n=10=2A^{m}+2B^{sm}+2Cst+2Dst+2E^{sm}. Pele La, Bhutan, 3000 m (Apr. 17, 1967). [Pl. 23. d (OQ)]

2n=20. Pele La, Bhutan, 3000 m (Apr. 17, 1967).

It is interesting that tetraploid races prevail in Eastern Himalaya, as suggested before (Kurosawa 1966; Hara 1969).

Polygonatum graminifolium Hooker

2n=30. Gosainkund, C. Nepal, 2900 m (Jun. 4, 1969). [Pl. 23. e (OQ)]

Polygonatum singalilense Hara

2n=ca. 46. Phalut, Singalila Range, 3900 m (Jul. 18, 1969).

The Himalayan species especially those of the *P. verticillatum* group are exceedingly polymorphic, and are also variable in chromosome number (see Hara on page 170).

Streptopus simplex D. Don

2n=16. Sandakphu, Singalila Range, 3900 m (Jul. 15, 1969). [Pl. 23. c (OQ)]

Streptopus simplex [Pl. 11. a] characterized by axillary filiform peduncles and campanulate white flowers is the only representative species of the genus in the Himalayas, and has never previously been studied cytologically. It is a diploid with 2n=16 chromosomes, and its karyotype is similar to that of *S. roseus* (Bent & Smith 1969).

Tricyrtis maculata (D. Don) Macbride

2n=26. Gosainkund, C. Nepal, 2800 m (Aug. 1969).

This number agrees with that reported by Miller, E. W. (1930) and Subramanyan & Kamble (1967) under the name *T. pilosa* Wall. All the species of the genus so far examined cytologically are diploid with 2n=26 chromosomes.

Trillium Govanianum Wall. ex Royle

2n=20=4A^{m}+4B^{sm}+2C$_{1}^{st}$+2C$_{2}^{st}$+4Dst+4E^{sm}. Sandakphu, Singalila Range, 3900 m (Jul. 14, 1969). [Pl. 24. a (OQ)]

2n=20. Gulmarg, Kashmir, 2400 m (May 14, 1970).

Trillium Tschonoskii Maxim. var. **himalaicum** Hara

2n=20=4A^{m}+4B^{sm}+4Cst+4Dst+4E^{sm}. Pele La, Bhutan, 3200 m (Apr. 17, 1967). [Pl. 24. b (OQ)]

The genus *Trillium* is represented in the Himalayas only by the two species above mentioned. Their chromosome number and karyotype agree with those reported by Haga & Watanabe ex Hara (1966 & 1969) based on the collections of our previous Expeditions. It is noteworthy that in *T. Govanianum* a pair of the chromosomes with a subterminal centromere are satellited.

Iris Clarkei Baker

2n=38. Tonglu, Singalila Range, 3150 m (Jul. 22, 1969). [Pl. 24. f (OQ)]

Although Simonet (1934) found 2n=40 in *I. Clarkei*, I confirmed the number 2n=38, as reported in 1966.

Iris decora Wall.

2n=ca. 36. Near Kyapcha, Bhutan, 2400 m (Jun. 1, 1967).

It is remarkable that *I decora* (*I. nepalensis*) belonging to subgen. Nepalensis is

variable in chromosome number and pollen type. For the group including *I. Collettii*, such numbers as 2n=24, 28, 30, 40 have been published (Larsen 1963).

Iris Hookeriana Foster

2n=24. Sonamarg, Kashmir, 2600 m (May 13, 1970). [Pl. 24. d (OQ)]

Iris sp.

2n=32. Near Lingshi, Bhutan, 3400–4000 m (May 22, 1967). [Pl. 24. e (OQ)]

I. Hookeriana and *I. kamaonensis* belong to subsect. Pseudoregelia of sect. Hexapogon, and Simonet (1952), La Cour (1955) and Malik (1961) reported 2n=22 and 24 for *I. kamaonensis*.

Iris japonica Thunb.

2n=36. Darjeeling, 2150 m (Apr. 1960). [Pl. 24. c (OQ)]

It is well-known that typical *I. japonica* of Japan is triploid with 2n=54 chromosomes. The plants cultivated at Darjeeling are morphologically similar to *I. japonica*, but have 2n=36 chromosomes and pollen grains with a different mode of reticulum on the surface from both *I. japonica* and *I. formosana* (cf. Chuma in Journ. Jap. Bot. **45**: 281, t. 23, 1970). This interesting race may be the same as that described as '*Iris* sp. (Chinese origin)' by Yasui (1939), and also identical with that reported by Sharma & Talukdar (1960).

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ERRATA

Kurosawa in Hara, Flora of Eastern Himalaya (1966)

Page 669, line 1. read $2n=36=6A^m+12B^{st}+10C^{st}+8D^m$
for $2n=36=3A^m+6B^{st}+5C^{st}+4D^m$