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Karyomorphological Studies in *Calanthe*, Orchidaceae*

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ラン科エビネ属の核形態学的研究*

石田源次郎**

Introduction

The genus *Calanthe*, the Orchidaceae, which consists of 80 to 100 species (Garay and Sweet 1974, Teuscher 1978), is widely distributed in Asia from Japan to India and down to Indonesia, Africa, Madagascar, Oceania from the South Sea Islands to Australia, and the West Indies. This genus is important as one of the ornamentally cultivated orchids. Numerous interspecific hybrids among the deciduous species of *Calanthe* occurred in South East Asia have been made by artificial hybridization for horticultural purposes.

Since *Calanthe* is highly variable in external morphology and growth habit, several taxonomic treatments of the genus have been made with some technical difficulties by various workers including Lindley (1833, 1854), Hooker (1890), Schlechter (1912), Steiner (1953), Seidenfaden and Smitinand (1961), Holttum (1964), Backer and Van Den Brink (1968), Ito and Karasawa (1969), Maekawa (1971), Garay and Sweet (1974), Seidenfaden (1975), Saigusa and Nagano (1975), Lin (1976, 1977), Hatusima and Amano (1977), Ohwi (1978), Liu and Su (1978), Pradhan (1979), Comber (1981) and Valmayor (1984).

Much general information regarding the chromosome numbers of *Calanthe* has been made Hoffmann (1929, 1930), Miduno (1940), Mutsuura and Nakahira (1958), Nakasone and Moromizato (1964), Tanaka (1965, 1974), Pancho (1965), Larsen (1966), Arora (1960, 1968), Sharma (1970), Mehra (1970, 1982), Mehra and Bawa (1970), Hsu (1971, 1972), Roy and Sharma (1972), Mehra and Sehgal (1974, 1976), Vij *et al.* (1976), Hsu (1976), Teoh and Lim (1978), Mehra and Kashyap(1979, 1984), Teoh (1980, 1984), Tanaka *et al.* (1981), Yang and Zhu (1984) and Lim (1985). Karyomorphological studies in somatic chromosomes in *Calanthe* species, however, have been poorly made in these references, excepting Tanaka *et al.* (1981) have examined and described karyomorphological details in 22 taxa of the genus occurred in Japan.

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Chromosome morphology is studied here in 33 taxa of *Calanthe* mostly occurred in East Asia. Then, the observations were described and discussed together with the previous observations (Tanaka *et al.* 1981) to make the final conclusion on the karyomorphology of the genus *Calanthe*.

Materials and Methods

Thirty-three species in *Calanthe* studied were tabulated in Table 1. They were cultivated in the Hiroshima Botanical Garden, Hiroshima City, Japan. Taxonomic treatments of the species followed mostly Seidenfaden (1975), Lin (1976, 1977) and partly Perrier De La Bathie (1939), Liu and Su (1978), Pradhan (1979), Wood (1981), Tang and Cheng (1981) and Valmayor (1984).

Cytological observations were made in somatic chromosomes of root tip cells and in meiotic chromosomes of pollen mother cells (PMC's). Somatic chromosomes were stained and observed by the aceto-orcein squash method of Tanaka (1959) with a slight modification: Growing root tips were cut into small pieces 0.5–1.0 mm long and pretreated in 0.002M 8-hydroxyquinoline for about 8 hours at 5°C; They were fixed in 45% acetic acid for about 10 minutes at 10°C; They were macerated in the mixture of one part of 45% acetic acid and two parts of 1N hydrochloric acid for about 30 seconds at 60°C; Then, they were stained and squashed in 1% aceto-orcein.

For preliminary observation of meiotic chromosomes small piece (0.5–1.0 mm) of PMC block cut from young anther was smeared in the aceto-orcein solution to determine the right stages of PMC's. When those PMC's were placed at the right stage, whole blocks of the PMC's were fixed in acetic alcohol (1:3) for one or more hours at 10°C, and then were stained and smeared in 1% aceto-orcein.

The chromosomes at resting stage were studied morphologically with respect to their condensation figures and were classified into the types categorized and defined by Tanaka (1971, 1980). During the course of investigation, spherical or rod-shaped condensed bodies over 1 μm diameter were counted and expressed as the chromocentric bodies.

The chromosomes of the mitotic metaphase set in each taxon were arranged in descending order in length and the numbers, 1, 2, 3, etc. represented the chromosomes, graded from the longest to the shortest chromosomes. Arm ratio was calculated by long arm length / short arm length. Position of centromere was expressed by arm ratio; 1.0 to 1.7 for median centromere, 1.8 to 3.0 for submedian centromere, and 3.1 to 7.0 for subterminal centromere according to Levan *et al.* (1964).

Table 1. Sources, number of plants and chromosme numbers of the species of *Calanthe* studied

Species	Source	No. of plants observed	Chromosome number (2n) present count	previous[1)] count
Subgenus Eu-Calanthe				
Section Calothyrsus				
C. argenteo-striata C.Z. Tang and S.J. Cheng	China, Yunnan	1	45	
C. arisanensis Hayata	China, Taiwan	5	40	40
C. aristulifera Reichb. f.	China, Taiwan	2	40	40
C. caudatilabella Hayata	China, Taiwan	2	38	40
C. conspicua Lindl.	Philippines	1	40	
C. cremeo-viridis J.J. Wood	Papua New Guinea	1	46	
C. graciliflora Hayata	China, Taiwan	5	40	40
C. hamata Hand.-Mazz.	China, Guizhou	3	40	40
C. hancockii Rolfe	China, Yunnan	2	40	
C. herbacea Lindl.	India	1	40	40
C. mannii Hook.f.	India	3	40	40
C. masuca (D.Don) Lindl.	China, Taiwan	3	40	40
	India	2	40	40
C. matsudai Hayata	China, Taiwan	3	40	40
C. plantaginea Lindl.	India	2	40	40
C. reflexa Maxim.	China, Taiwan	3	40	40
	China, Sichuan	1	40	
C. sieboldii Decne.	China, Taiwan	3	40	40
C. sylvatica Lindl.	Madagascar	1	40	40
C. tricarinata Lindl.	China, Taiwan	1	40	40
C. triplicata (Willem.) Ames	China, Taiwan	3	40	40
	Philippines	1	40	
Section Styloglossum				
C. clavata Lindl.	China,Guangdong	1	40	40
C. densiflora Lindl.	China, Taiwan	2	40	40
C. formosana Rolfe	China, Taiwan	2	40	40
C. lyroglossa Reichb. f.	China, Taiwan	2	40	40
Section Aceratochilus				
C. kooshunensis Fukuyama	China, Taiwan	2	40	
C. gracilis Lindl.	China, Taiwan	3	40	40
Subgenus Preptanthe				
Section Eu-Preptanthe				
C. cardioglossa Schltr.	Thailand	2	46	c44
C. elmeri Ames	Philippines	1	44	
C. hennisii Loher	Philippines	3	42	
C. hirsuta Seidenfaden	Thailand	2	46	
C. rosea (Lindl.) Benth.	Thailand	1	44	
C. rubens Ridley	Thailand	3	42	44, 42
C. succedanea Gagnep.	Thailand	2	44	
C. vestita Lindl.	Thailand	2	42	40
	Burma	1	42	

1): See the descriptions of the taxa in the text for the literatures.

Observations

Observations on chromosome morphology were made in chromosomes at resting stage and at mitotic prophase and metaphase stages in all the taxa studied. Meiotic chromosomes at metaphase I were observed in one taxon.

Systematic arrangement of 33 taxa representing four sections in two subgenera in *Calanthe* followed Schlechter (1912), however, *C. kooshunensis* Fukuyama and *C. gracilis* Lindl. were, for convenience, treated here to be placed in section Aceratochilus, *Calanthe*.

The results of the observations in 33 taxa in *Calanthe* were described as follows:

I. Subgenus Eu-Calanthe

1. Section Calothyrsus

1) *Calanthe argenteo-striata* C.Z. Tang and S.J. Cheng, 2n=45, Tables 1 and 2, Fig. 1.

A plant was obtained from China, Yunnan. External characteristics of the plant were in accord with the descriptions of the species by Tang and Cheng (1981).

The chromosome number at mitotic metaphase of the plant was 2n=45, which was reported here for the first time.

The chromosomes at resting stage were observed as chromomeric granules, fibrous threads and chromatin blocks scattered throughout the nucleus. The chromatin blocks were round-, rod- and string-shaped and varied in diameter from 1.0–4.0 μm. Their surface sculpture showed numerous irregular depressions. Among the chromocentric bodies appeared in the nucleus average 20 were 1.0 μm or more diameter, larger than the others.

The chromosome features at resting stage were of the complex chromocenter type according to Tanaka's classification (1971).

The chromosomes at mitotic prophase formed several early condensed segments located in the proximal and interstitial regions of both arms. Late condensed segments were observed in the distal regions of the chromosomes. The early condensed segments situated between the condensed segments were observed transforming gradually to the late condensed segments.

The karyotype at mitotic prophase was found to be the interstital type as proposed by Tanaka (1977).

The chromosomes at metaphase varied in length from 4.6–2.3 μm. In the chromosome complement 44 chromosomes showed a gradual decrease in length but the last shortest chromosome was remarkably small. Among the 45 chromosomes of the complement, 31 varied in arm ratio from 1.1–1.6 had their centromeres at the median regions. Twelve chromosomes (Nos. 17–18, 27–30, 35–38, 43–44) varied in arm ratio from 1.8–2.7 had their centromeres at the submedian regions. The other two chromosomes (Nos. 41–42) with arm

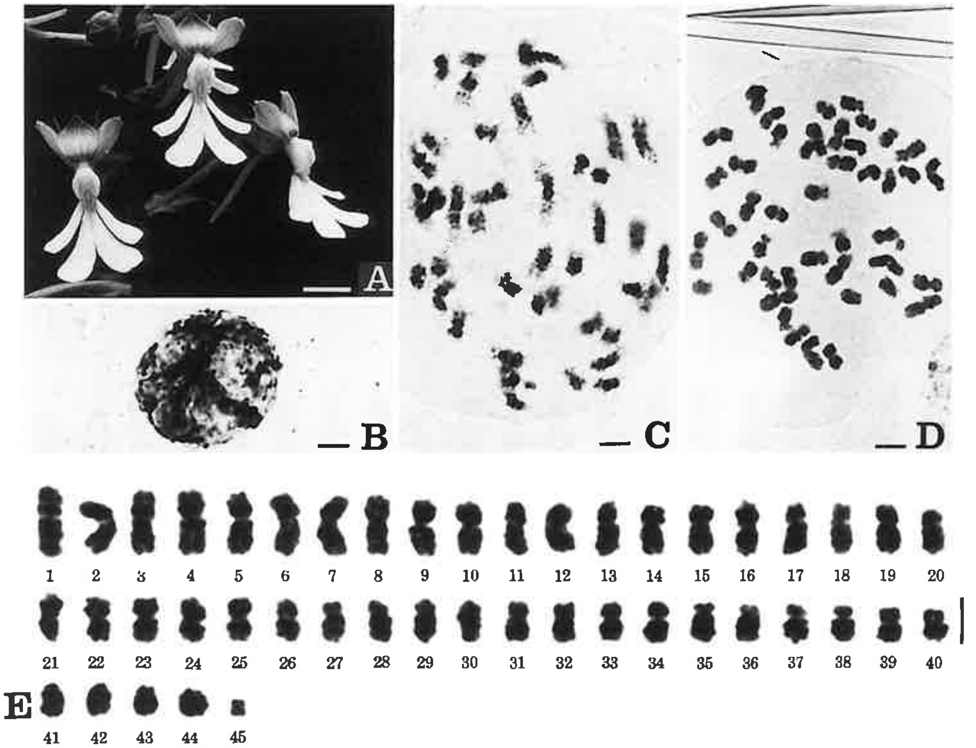

Fig. 1. *Calanthe argenteo-striata*, 2n = 45. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 10 mm in A and 3 μm in B-E.

ratio of 3.4 had their centromeres at the subterminal regions.

No remarkably early condensed block was found at resting stage and prophase, and the 45th chromosome was conspicuously smaller than the other chromosomes. Thus, the smallest chromosome might be a supernumerary chromosome.

Thus, according to the defintion of the karyotype proposed by Tanaka (1980), this species showed a homogeneous, gradual and symmetric karyotype.

2) *Calanthe arisanensis* Hayata, 2n=40, Tables 1 and 3, Fig.2.

Five plants were obtained from China, Taiwan. External characteristics of the five plants were in accord with the descriptions of the species by Lin (1976).

The chromosome number of the five plants at mitotic metaphase was 2n=40, which confirmed Hsu (1976).

The chromosomes at resting stage and mitotic prophase were morphologically similar to those of *C. argenteo-striata* described above. The chromosome features at resting stage were

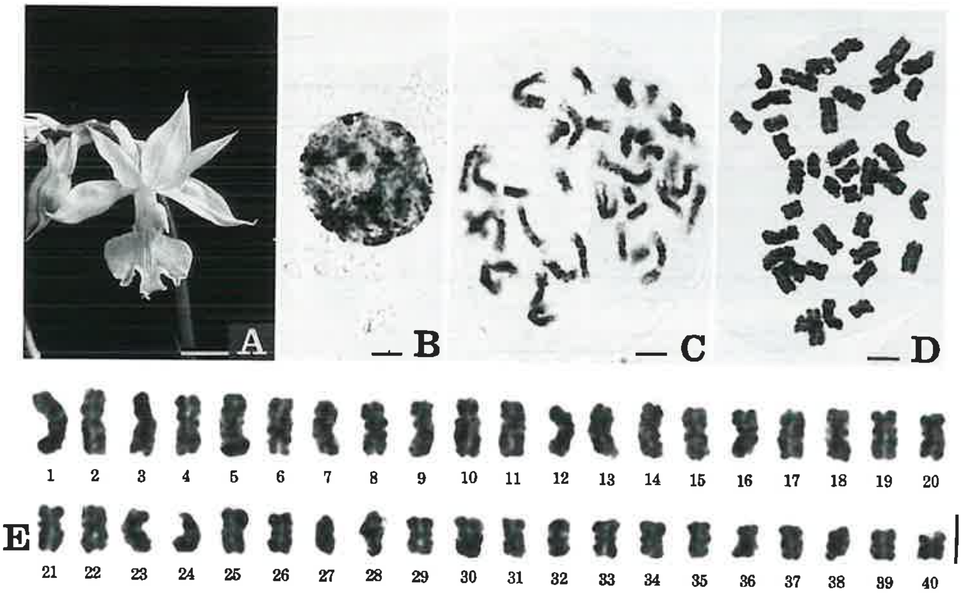

Fig. 2. *Calanthe arisanensis*, 2n=40. A, a flower. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 10 mm in A and 3 μm in B-E.

of the complex chromocenter type.

The 2n = 40 chromosome complement at mitotic metaphase showed a gradual decrease in length from the longest (4.3 μm) to the shortest (2.0 μm) chromosomes. Among the 40 chromosomes in the complement, 24 varied in arm ratio from 1.0–1.7 had their centromeres at the median regions, while the other 16 (Nos. 7–10, 19–22, 25–28, 37–40) varied in arm ratio from 1.8 to 2.5 had their centromeres at the submedian regions.

The majority of the chromosomes at metaphase exhibited small secondary constrictions in the proximal regions of their long arms. No satellite was observed.

Thus, this species showed a homogeneous, gradual and symmetric karyotype.

3) *Calanthe aristulifera* Reichb.f., 2n=40, Tables 1 and 4 , Fig. 3.

Two plants were obtained from China, Taiwan. External characteristics of the two plants were in accord with the descriptions of the species by Maekawa (1971).

The chromosome number of the two plants at mitotic metaphase was 2n=40, which confirmed Tanaka *et al.* (1981), and Hsu (1976) for this species as the synonym of *C. elliptica.*

The chromosomes at resting stage and mitotic prophase were morphologically similar to those of *C. argenteo-striata* described above. The chromosome features at resting stage were of the complex chromocenter type.

The 2n = 40 chromosome set at mitotic metaphase showed a gradual decrease in length

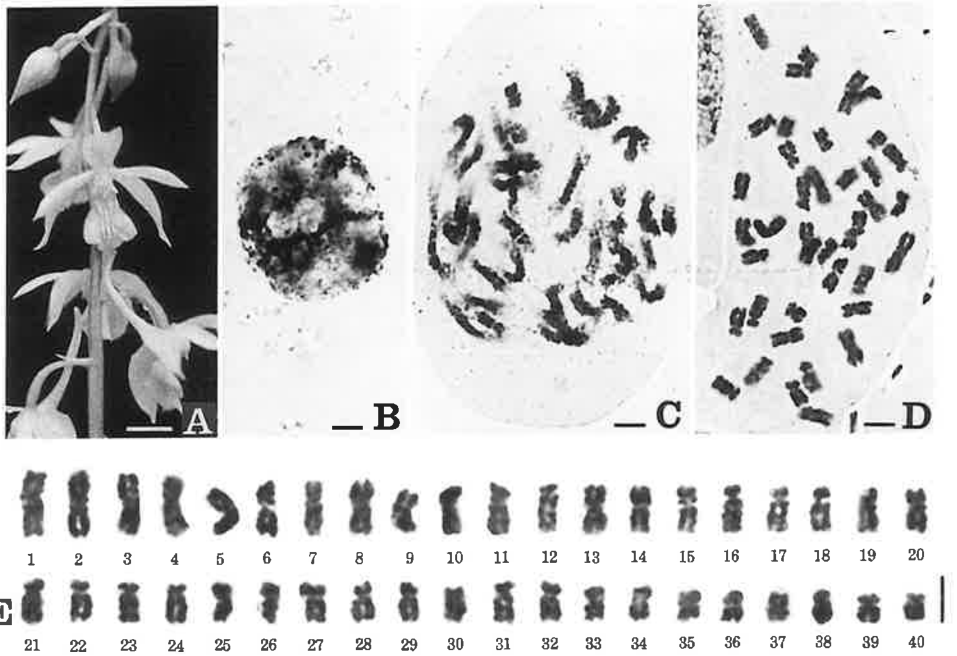

Fig. 3. *Calanthe aristulifera*, 2n=40. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 12 mm in A and 3 μm in B-E.

from the longest (4.4 μm) to the shortest (1.9 μm) chromosomes. Among the 40 chromosomes in the complement, 20 varied in arm ratio from 1.0–1.7 had their centromeres at the median regions, while the other 20 (Nos. 9–12, 15–24, 27–32) varied in arm ratio from 1.8–2.8 had their centromeres at the submedian regions. No satellite was observed.

This species showed a homogeneous, gradual and symmetric karyotype.

4) ***Calanthe caudatilabella*** **Hayata, 2n=38, Tables 1 and 5, Fig. 4.**

Two plants were obtained from China, Taiwan. External characteristics of the two plants were in accord with the descriptions of the species by Lin (1976).

The chromosome number of the two plants at mitotic metaphase was 2n=38, which was different from 2n=40 reported by Hsu (1976). The chromosomes at resting stage were morphologically similar to those of *C. argenteo-striata* described above, but the chromocentric bodies performed more loose aggregations than those of *C. argenteo-striata*. The chromosome features at resting stage were of the loosely aggregated complex chromocenter type. The chromosomes at mitotic prophase were morphologically similar to those of *C. argenteo-striata* described above.

The chromosomes of 2n=38 at mitotic metaphase showed a gradual decrease in length

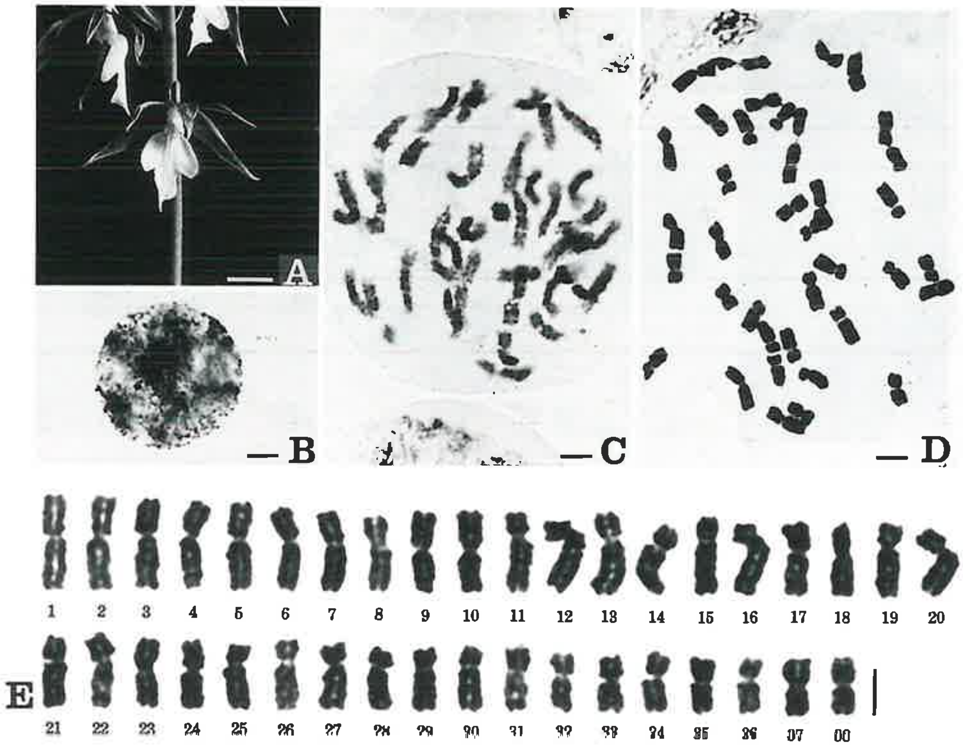

Fig. 4. *Calanthe caudatilabella*, 2n=38. A, a flower. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 8 mm in A and 3 μm in B-E.

from the longest (6.5 μm) to the shortest (3.7 μm) chromosomes. Among the 38 chromosomes in the complement, 22 varied in arm ratio from 1.0–1.6 had their centromeres at the median regions, while the other 16 (Nos. 11–16, 19–22, 25–30) varied in arm ratio from 1.9–2.4 had their centromeres at the submedian regions. No satellite was observed.

Thus, this species showed a homogeneous, gradual and symmetric karyotype.

5) ***Calanthe conspicua* Lindl., 2n=40, Tables 1 and 6, Fig. 5.**

A plant was obtained from the Philippines. External characteristics of the plant were in accord with the descriptions of the species by Valmayor (1984).

The chromosomc number of the plant at mitotic metaphsewas 2n=40, which was reported here for the first time for this species.

The chromosomes at resting stage and mitotic prophase were morphologically similar to those of *C. argenteo-striata* described above. The chromosome features at resting stage were of the complex chromocenter type.

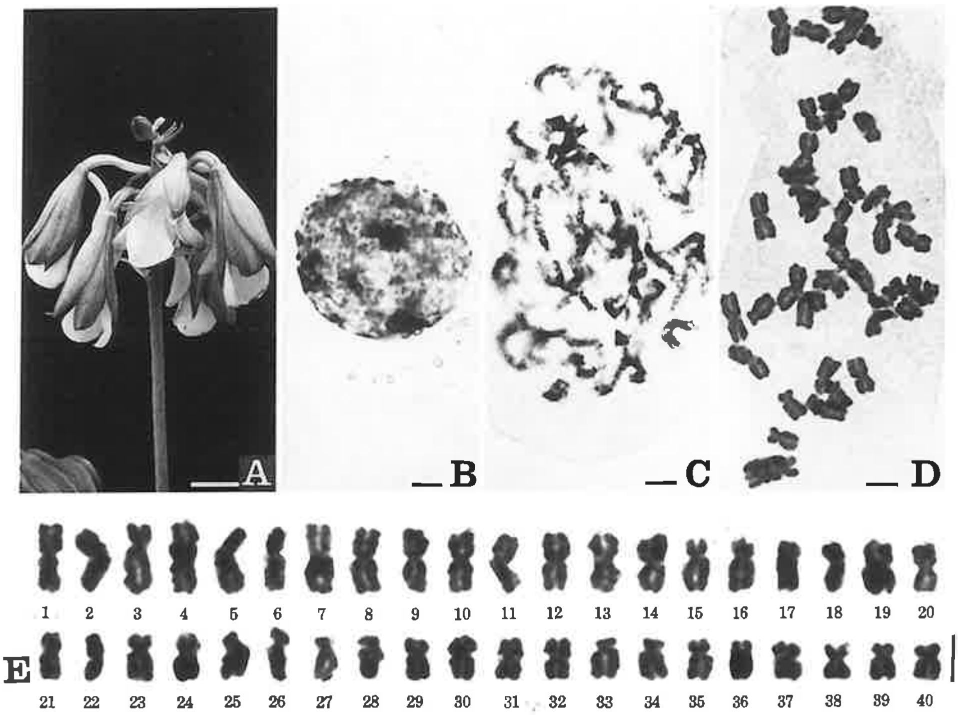

Fig. 5. *Calanthe conspicua*, 2n=40. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 13 mm in A and 3 μm in B-E.

The chromosomes of 2n=40 at mitotic metaphase showed a gradual decrease in length from the longest (4.5 μm) to the shortest (2.2 μm) chromosomes. Among the 40 chromosomes in the complement, 26 varied in arm ratio from 1.0–1.7 had their centromeres at the median regions, while the other 14 (Nos. 3–4, 15–18, 25–28, 33–36) varied from 1.8–2.8 had their centromeres at the submedian regions. No satellite was observed.

This species showed a homogeneous, gradual and symmetric karyotype.

6) *Calanthe cremeo-viridis* J.J. Wood, 2n=46, Tables 1 and 7, Fig. 6.

A plant was obtained from Papua New Guinea. External characteristics of the plant were in accord with the descriptions of the species by Wood (1981).

The chromosome number of the plant was 2n=46 at mitotic metaphase, which was reported here for the first time for this species.

The chromosomes at resting stage and mitotic prophase were morphologically similar to those of *C. argenteo-striata* described above. The chromosome features at resting stage were of the complex chromocenter type.

The chromosomes of the 2n=46 complement at mitotic metaphase showed a gradual de-

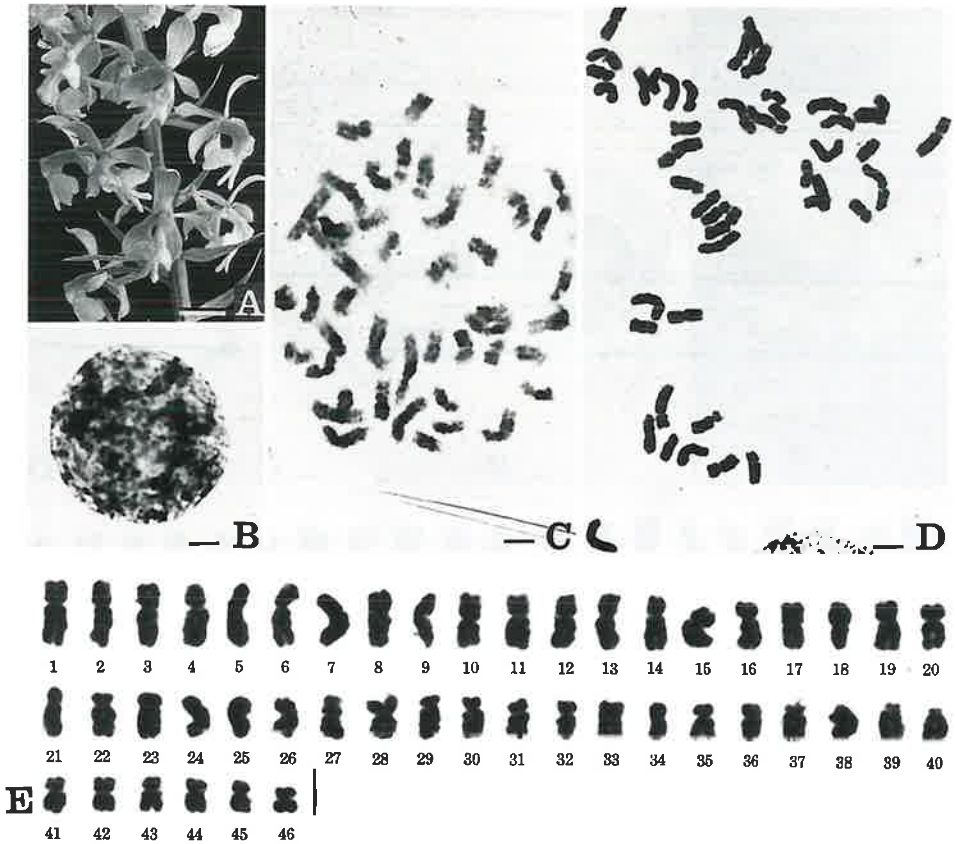

Fig. 6. *Calanthe cremeo-viridis*, 2n=46. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 9 mm in A and 3 µm in B-E.

crease in length from the longest (4.3 µm) to the shortest (1.8 µm) chromosomes. Among the 46 chromosomes in the complement, 34 varied in arm ratio from 1.0–1.6 had their centromeres at the median regions, while the other 12 (Nos. 21–24, 29–32, 37–40) varied in arm ratio from 1.8–3.0 had their centromeres at the submedian regions. No satellite was observed.

Thus, this species showed a homogeneous, gradual and symmetric karyotype.

7) *Calanthe graciliflora* Hayata, 2n=40, Tables 1 and 8, Fig. 7.

Five plants were obtained from China, Taiwan. External characteristics of the plants were in accord with the descriptions of the species by Lin (1976).

The chromosome number of the five plants at mitotic metaphase was 2n=40, which confirmed Hsu (1976).

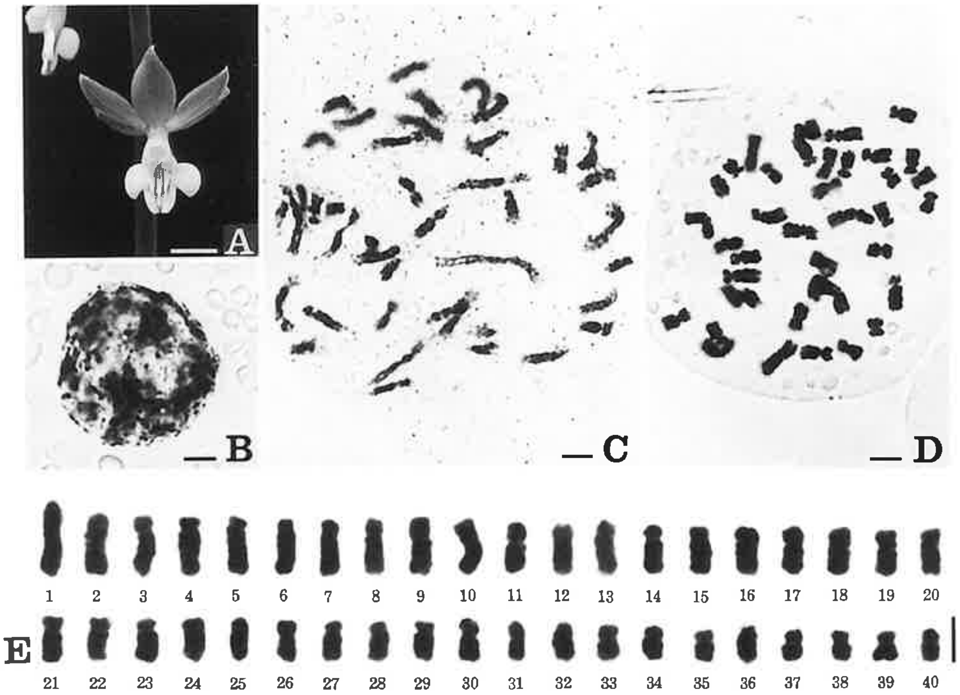

Fig. 7. *Calanthe graciliflora*, 2n=40. A, a flower. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 9 mm in A and 3 μm in B-E.

The chromosomes at resting stage and mitotic prophase were morphologically similar to those of *C. argenteo-striata* described above. The chromosome features at resting stage were of the complex chromocenter type.

The chromosomes of the 2n=40 complement at mitotic metaphase showed a gradual decrease in length from the longest (4.8 μm) to the shortest (2.0 μm) chromosomes. Among the 40 chromosomes in the complement, 18 varied in arm ratio from 1.0–1.6 had their centromeres at the median regions, 20 (Nos. 3–6, 13–16, 21–30, 35–36) varied in arm ratio from 1.8–2.7 had their centromeres at the submedian regions, and other two chromosomes (Nos. 7, 8) with the arm ratio of 4.2 had their centromeres at the subterminal regions. No satellite was observed.

Thus, this species showed a homogeneous, gradual and symmetric karyotype.

8) *Calanthe hamata* Hand.-Mazz., 2n=40, Tables 1 and 9, Fig. 8.

Three plants were obtained from China, Guizhou. External characteristics of the plants were in accord with the descriptions of the species by Institute Botany, Academia Sinica (1980).

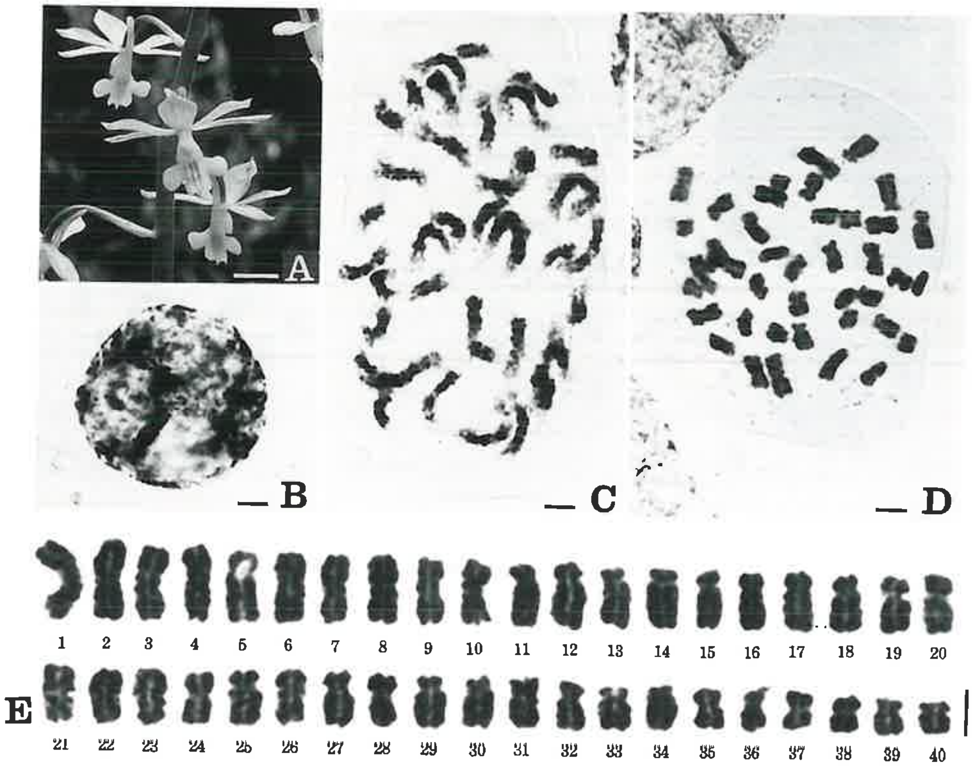

Fig. 8. *Calanthe hamata*, 2n = 40. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 9 mm in A and 3 μm in B-E.

The chromosome number of the three plants at mitotic metaphase was 2n = 40, which confirmed Yang and Zhu (1984).

The chromosomes at resting stage and mitotic prophase were morphologically similar to those of *C. argenteo-striata* described above. The chromosome features at resting stage were of the complex chromocenter type.

The chromosomes of the 2n = 40 complement at mitotic metaphase displayed a gradual decrease in length from the longest (5.6 μm) to the shortest (2.2 μm) chromosomes. Among the 40 chromosomes in the complement, 20 varied in arm ratio from 1.0–1.7 had their centromeres at the median regions, 16 (Nos. 5–6, 9–12, 17–18, 25–30, 33–34) varied in arm ratio from 1.8–2.6 had their centromeres at the submedian regions, and four (Nos.13–16) with the arm ratio of 3.3 had their centromeres at the subterminal regions. Two chromosomes (Nos. 34, 36) formed small satellites.

This species showed a homogeneous, gradual and symmetric karyotype.

9) *Calanthe hancockii* Rolfe, 2n=40, Tables 1 and 10, Fig. 9.

Two plants were obtained from China, Yunnan. External characteristics of the two plants were in accord with the descriptions of the species by Institute of Botany, Academia Sinica (1980), except for their brown-colored sepals and petals.

The chromosome number of the two plants at mitotic metaphase was 2n=40, which was reported here for the first time for this species.

The chromosomes at resting stage and mitotic prophase were morphologically similar to those of *C. argenteo-striata* described above. The chromosome features at resting stage were of the complex chromocenter type.

The chromosomes of 2n=40 at mitotic metaphase showed a gradual decrease in length from the longest (5.3 μm) to the shortest (2.3 μm) chromosomes. Among the 40 chromosomes in the complement, 24 varied in arm ratio from 1.0–1.7 had their centromeres at the median regions, the other 16 (Nos. 5–6, 11–20, 27–28, 35–36) varied in arm ratio from 1.8–2.5 had their centromeres at the submedian regions. One chromosome (No. 9) formed a small satellite.

Thus, this species showed a homogeneous, gradual and symmetric karyotype.

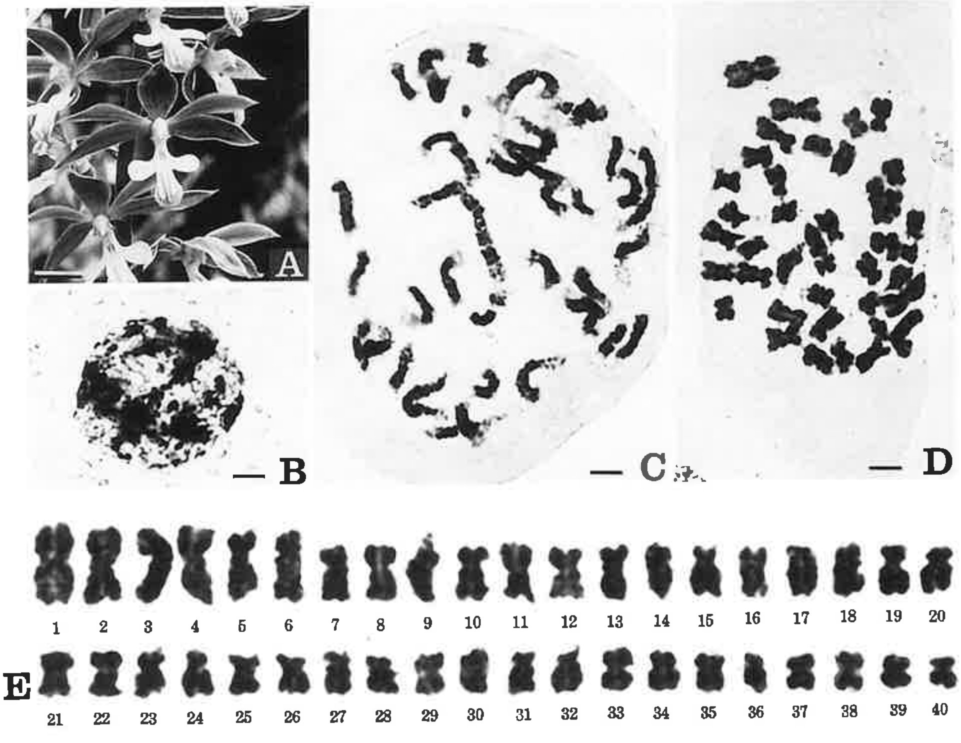

Fig. 9. *Calanthe hancockii*, 2n=40. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 10 mm in A and 3 μm in B-E.

10) *Calanthe herbacea* Lindl., 2n=40, Tables 1 and 11, Fig. 10.

A plant was obtained from India. External characteristics of the plant were in accord with the descriptions of the species by Pradhan (1979).

The chromosome number of the plant at mitotic metaphase was 2n = 40, which confirmed Mehra and Vij (1970), Mehra and Sehgal (1976).

The chromosomes at resting stage and mitotic prophase were morphologically similar to those of *C. argenteo-striata* described above. The chromosome features at resting stage were of the complex chromocenter type.

The chromosomes of the 2n=40 complement at mitotic metaphase performed a gradual decrease in length from the longest (5.3 μm) to the shortest (2.4 μm) chromosomes. Among the 40 chromosomes in the complement, 32 varied in arm ratio from 1.0–1.7 had their centromeres at the median regions, while the other eight (Nos. 29–36) varied in arm ratio from 1.8–2.6 had their centromeres at the submedian regions. One chromosome (No. 27) formed a satellite in the long arm.

Thus, this species showed a homogeneous, gradual and symmetric karyotype.

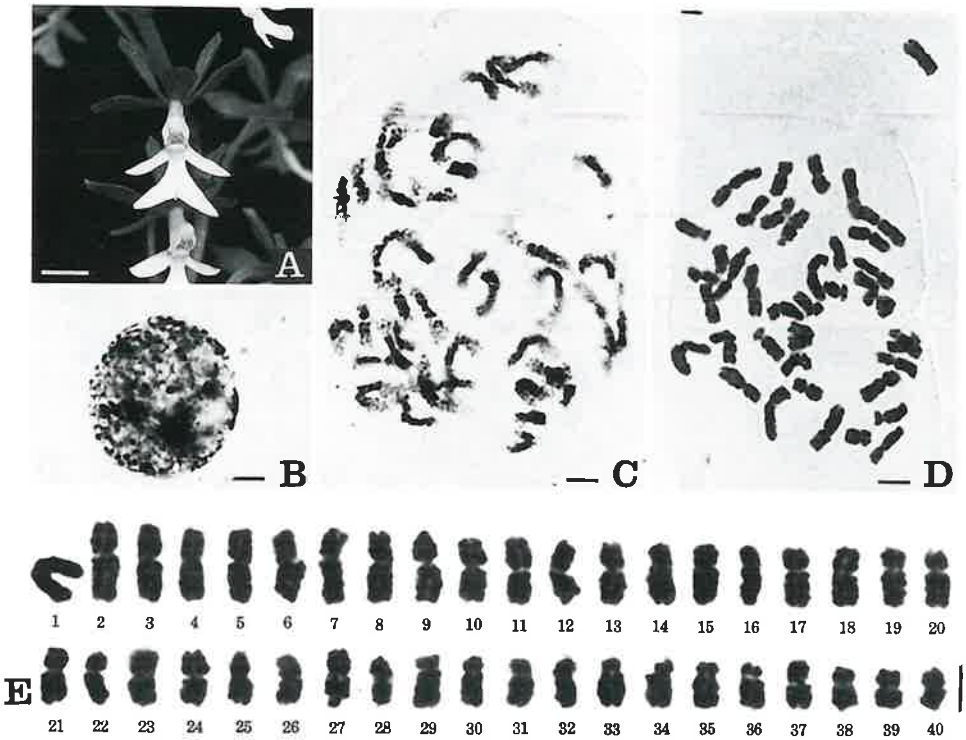

Fig. 10. *Calanthe herbacea*, 2n=40. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 9 mm in A and 3 μm in B-E.

11) *Calanthe mannii* Hook.f., 2n=40, Tables 1 and 12, Fig. 11.

Three plants were obtained from India. External characteristics of the plants were in accord with the descriptions of the species by Pradhan (1979).

The chromosome number of the plants at mitotic metaphase was 2n = 40, which confirmed Mehra and Sehgal (1976), Vij *et al.* (1976).

The chromosomes at resting stage and mitotic prophase were morphologically similar to those of *C. argenteo-striata* described above. The chromosome features at resting stage were of the complex chromocenter type.

The chromosomes of the 2n=40 complement at mitotic metaphase showed a gradual decrease in length from the longest (4.4 μm) to the shortest (1.7 μm) chromosomes. Among the 40 chromosomes in the complement, 20 varied in arm ratio from 1.0–1.7 had their centromeres at the median regions, 18 (Nos. 5–8, 11–12, 15–16, 23–24, 29–36) varied in arm ratio from 1.8 to 2.8 had their centromeres at the submedian regions, and two (Nos. 17, 18) with the arm ratio of 3.2 had their centromeres at the subterminal regions. No satellite was observed.

This species showed a homogeneous, gradual and symmetric karyotype.

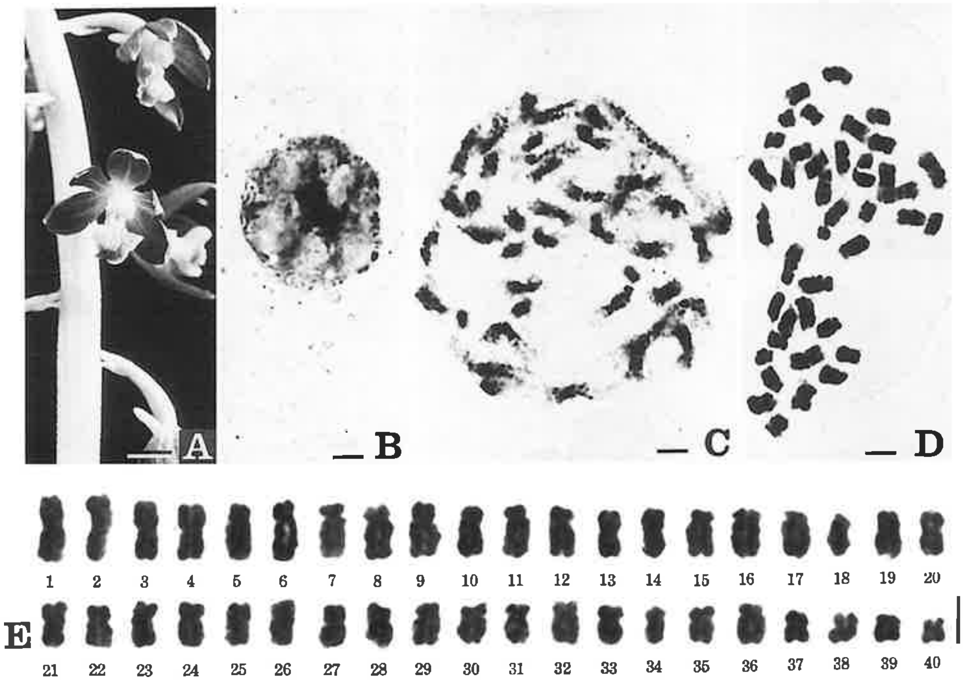

Fig. 11. *Calanthe mannii*, 2n = 40. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metahase. Bars indicate 5 mm in A and 3 μm in B-E.

12) *Calanthe masuca* (D.Don) Lindl., 2n=40, Tables 1 and 13, Fig. 12.

Three plants were obtained from China, Taiwan, and two plants were obtained from India. External characteristics of the five plants were in accord with the descriptions of the species by Lin (1976) and Pradhan (1979).

The chromosome number of the five plants at mitotic metaphase was 2n=40, which confirmed Mehra and Vij (1970), Tanaka *et al.* (1981).

The chromosomes at resting stage and mitotic prophase were morphologically similar to those of *C. argenteo-striata* described above. The chromosome features at resting stage were of the complex chromocenter type.

The chromosomes of the 2n=40 complement at mitotic metaphase exhibited a gradual decrease in length from the longest (4.9 μm) to the shortest (2.6 μm) chromosomes. Among the 40 chromosomes in the complement, 24 varied in arm ratio from 1.0–1.6 had their centromeres at the median regions, while the other 16 (Nos. 15–20, 27–32, 35–38) varied from 1.8–2.8 had their centromeres at the submedian regions. No satellite was observed.

Thus, this species showed a homogeneous, gradual and symmetric karyotype.

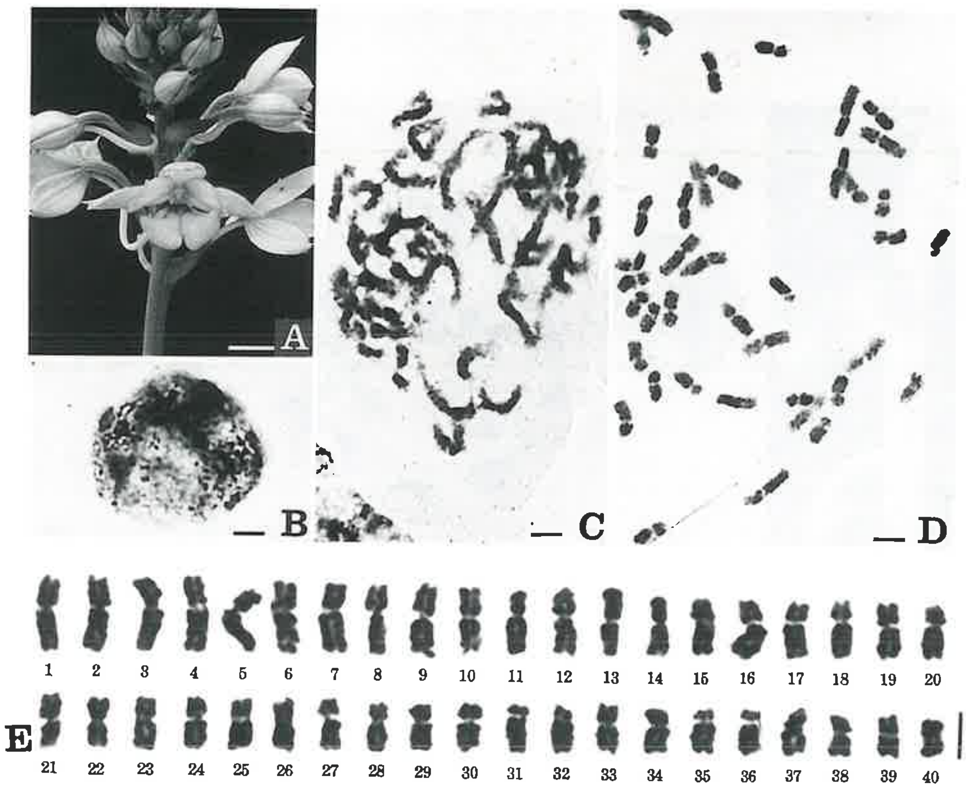

Fig. 12. *Calanthe masuca*, 2n=40. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 13 mm in A and 3 μm in B-E.

13) *Calanthe matsudai* Hayata, 2n=40, Tables 1 and 14, Fig. 13.

Three plants were obtained from China, Taiwan. External characteristics of the three plants were in accord with the descriptions of the species by Lin (1976).

The chromosome number of the plants at mitotic metaphase was 2n = 40 and verified one of the Hsu's results, 2n=40 and 42 for this species (1976).

The chromosomes at resting stage and mitotic prophase were morphologically similar to those of *C. argenteo-striata* described above. The chromosome features at resting stage were of the complex chromocenter type.

The chromosomes of the 2n=40 complement at mitotic metaphase showed a gradual decrease in length from the longest (5.7 μm) to the shortest (2.2 μm) chromosomes. Among the 40 chromosomes in the complement, 22 varied in arm ratio from 1.2–1.7 had their centromeres at the median regions, 16 (Nos. 3–6, 15–16, 19–26, 33–34) varied in arm ratio from 1.8–2.8 had their centromeres at the submedian regions, and the other two (Nos. 17, 18) with the arm ratio of 4.1 had their centromeres at the subterminal regions. No satellite was observed.

Thus, this species showed a homogeneous, gradual and symmetric karyotype.

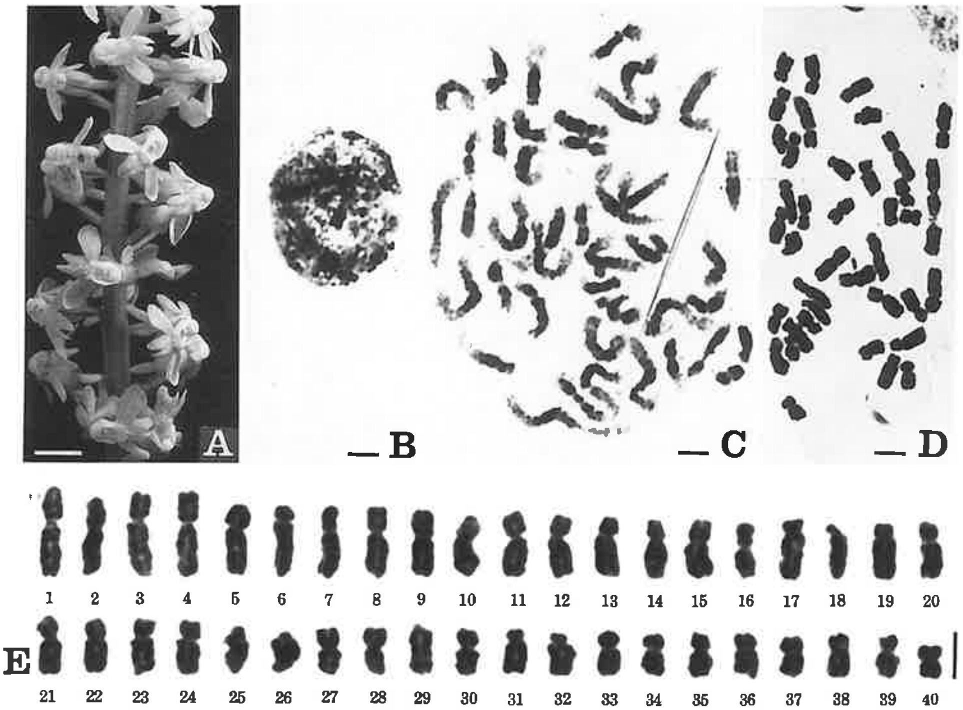

Fig. 13. *Calanthe matsudai*, 2n=40. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 9 mm in A and 3 μm in B-E.

14) *Calanthe plantaginea* Lindl., 2n=40, Tables 1 and 15, Fig. 14.

Two plants were obtained from India. External characteristics of the two plants were in accord with the descriptions of the species by Pradhan (1979).

The chromosome number of the plants at mitotic metaphase was 2n=40 and confirmed Arora (1968).

The chromosomes at resting stage and mitotic prophase were morphologically similar to those of *C. argenteo-striata* described above. The chromosome features at resting stage were of the complex chromocenter type.

The chromosomes of the 2n=40 complement at mitotic metaphase showed a gradual decrease in length from the longest (4.3 μm) to the shortest (2.1 μm) chromosomes. Among the 40 chromosomes in the complement, 16 varied in arm ratio from 1.1–1.6 had their centromeres at the median regions, 18 (Nos. 9–10, 15–26, 29–32) varied in arm ratio from 1.8–2.8 had their centromeres at the submedian regions, and the other six (Nos. 3–8) varied in arm ratio from 3.1–3.6 had their centromeres at the subterminal regions. No satellite was

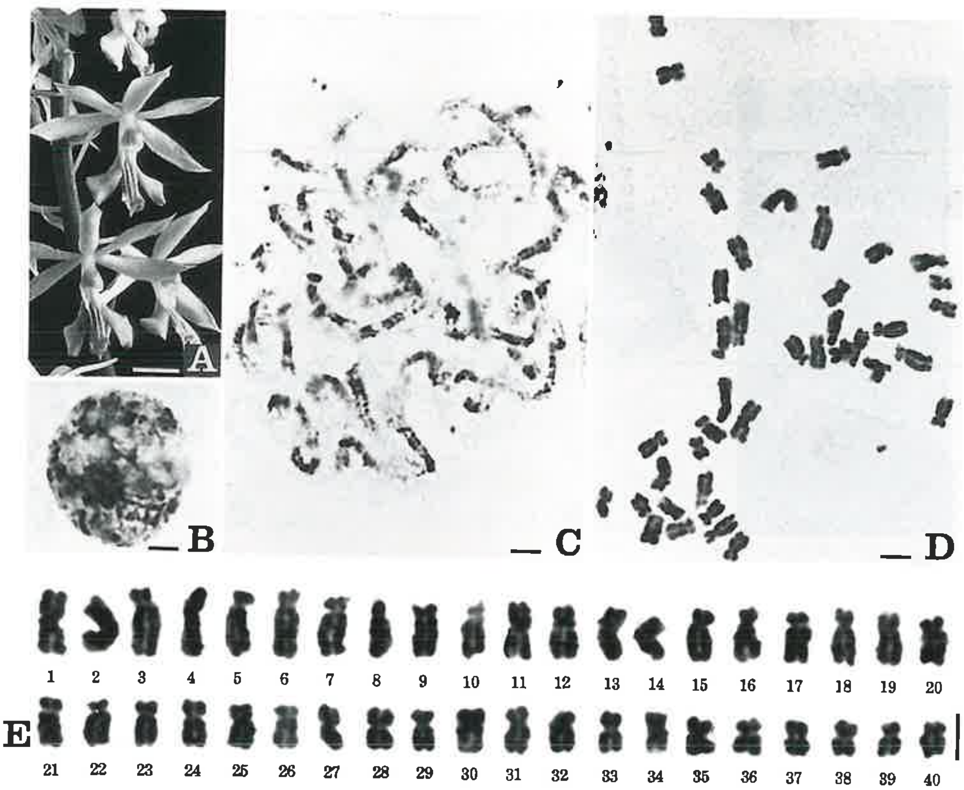

Fig. 14. *Calanthe plantaginea*, 2n=40. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 9 mm in A and 3 μm in B-E.

observed.

Thus, this species showed a homogeneous, gradual and symmetric karyotype.

15) ***Calanthe reflexa*** **Maxim., 2n=40, Tables 1 and 16, Fig. 15.**

Three plants were obtained from China, Taiwan and one plant was obtained from China, Sichuan. External characteristics of the four plants were in accord with the descriptions of the species by Lin (1976).

The chromosome number of the plants at mitotic metaphase was 2n=40 and confirmed Miduno (1940), Tanaka (1965), Hsu (1976), Tanaka *et al.* (1981).

The chromosomes at resting stage were morphologically similar to those of *C. argenteo-striata* described above, but their chromocentric bodies were showed more loose aggregations than those of *C. argenteo-striata*. The chromosomes at mitotic prophase were morphologically similar to those of *C. argenteo-striata* described above. The chromosome features at resting stage were of the complex chromocenter type.

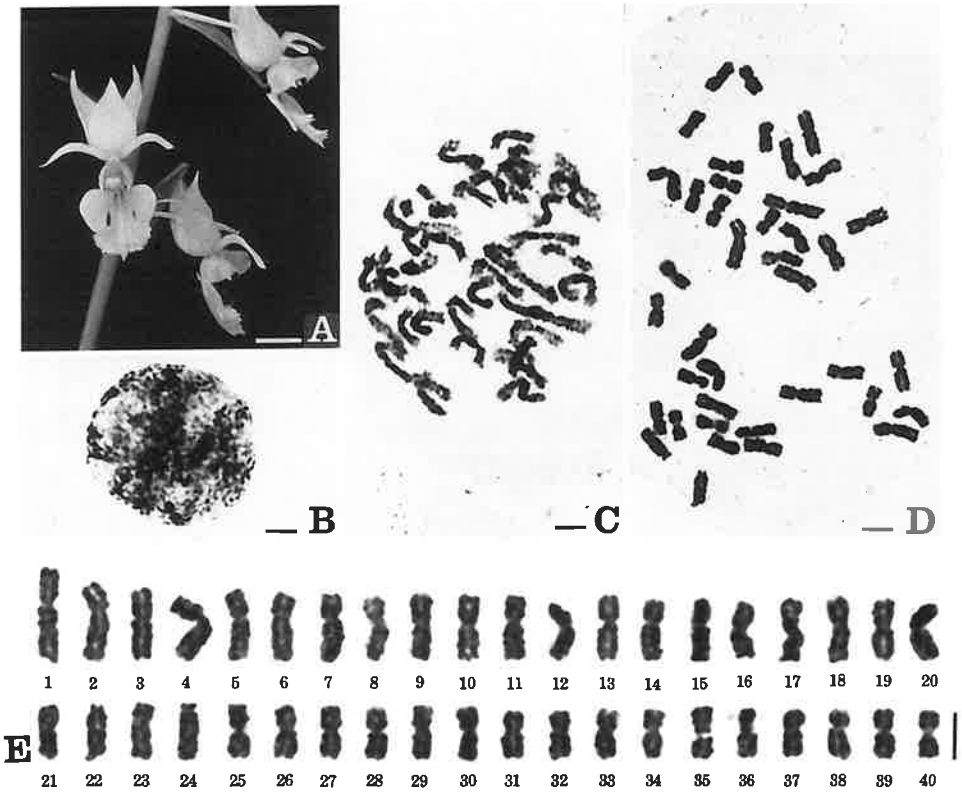

Fig. 15. *Calanthe reflexa*, 2n=40. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 8 mm in A and 3 μm in B-E.

The chromosome lengths at mitotic metaphase varied from the longest one of 5.6 μm to the shortest one of 3.0 μm. The first chromosome was larger than the others which showed a gradual decrease in length from the longest to the shortest chromosomes. Among the 40 chromosomes in the complement, 35 varied in arm ratio from 1.0–1.6 had their centromeres at the median regions, four (Nos. 5–6, 15–16) varied in arm ratio from 1.8–1.9 had their centromeres at the submedian regions, and the rest one (No. 24) with the arm ratio of 6.0 had its centromere at the subterminal region. A pair of the small chromosomes with the median centromeres formed a large secondary constriction in a proximal region of the long arm. At mitotic prophase the secondary constricted chromosomes appeared attached to a nucleolus through its secondary constricted region. These results in this species verified the previous report (Tanaka et al. 1981).

Thus, this species showed a partially heterogeneous, gradual, and highly symmetric karyotype.

16) *Calanthe sieboldii* Decne., 2n=40, Tables 1 and 17, Fig. 16.

Three plants were obtained from China, Taiwan. External characteristics of the three

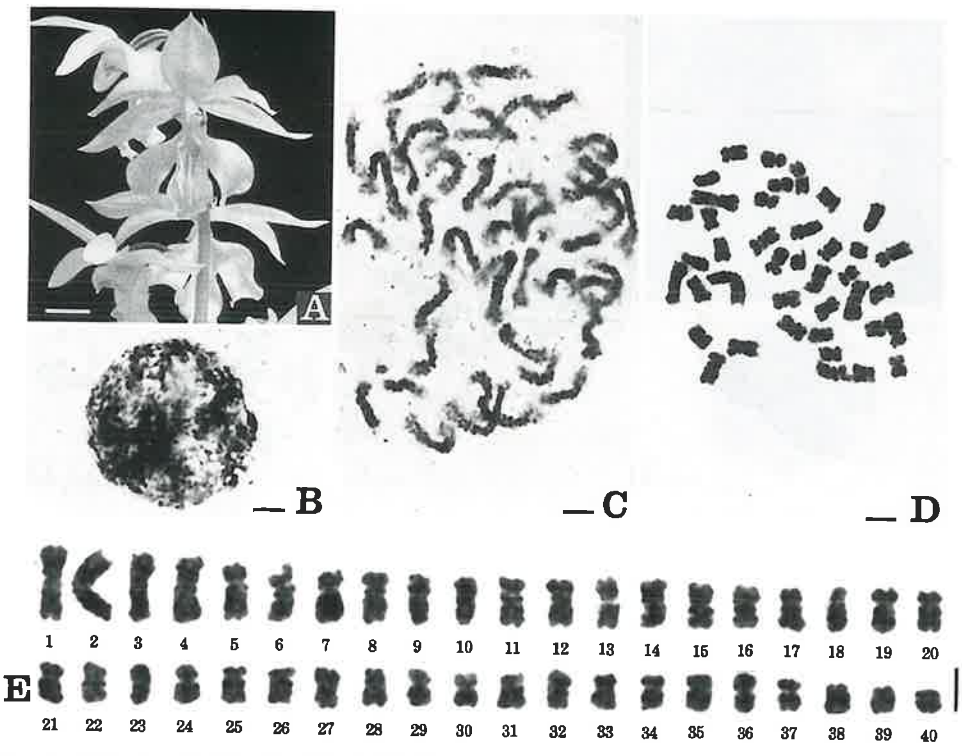

Fig. 16. *Calanthe sieboldii*, 2n=40. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 10 mm in A and 3 μm in B-E.

plants were in accord with the descriptions of the species by Lin (1976).

The chromosome number of the three plants at mitotic metaphase was 2n=40 and confirmed Miduno (1940), Mutsuura and Nakahira (1965), Tanaka (1965, 1974), Hsu (1976), Tanaka *et al.* (1981).

The chromosomes at resting stage and mitotic prophase were morphologically similar to those of *C. argenteo-striata* described above. The chromosome features at resting stage were of the complex chromocenter type. The chromosomes of the 2n=40 complement at mitotic metaphase showed a gradual decrease in length from the longest (4.8 μm) to the shortest (1.5 μm) chromosomes. Among the 40 chromosomes in the complement, 26 varied in arm ratio from 1.0–1.7 had their centromeres at the median regions, while the other 14 (Nos. 5–8, 11–12, 17–20, 25–26, 31–32) varied in arm ratio from 1.8–2.4 had their centromeres at the submedian regions. Many chromosomes at metaphase exhibited small constrictions in the proximal regions of long arms.

Thus, this species showed a homogeneous, gradual and symmetric karyotype.

17) *Calanthe sylvatica* Lindl., 2n=40, Tables 1 and 18, Fig. 17.

A plant was obtained from Madagascar. External characteristics of the plant were in

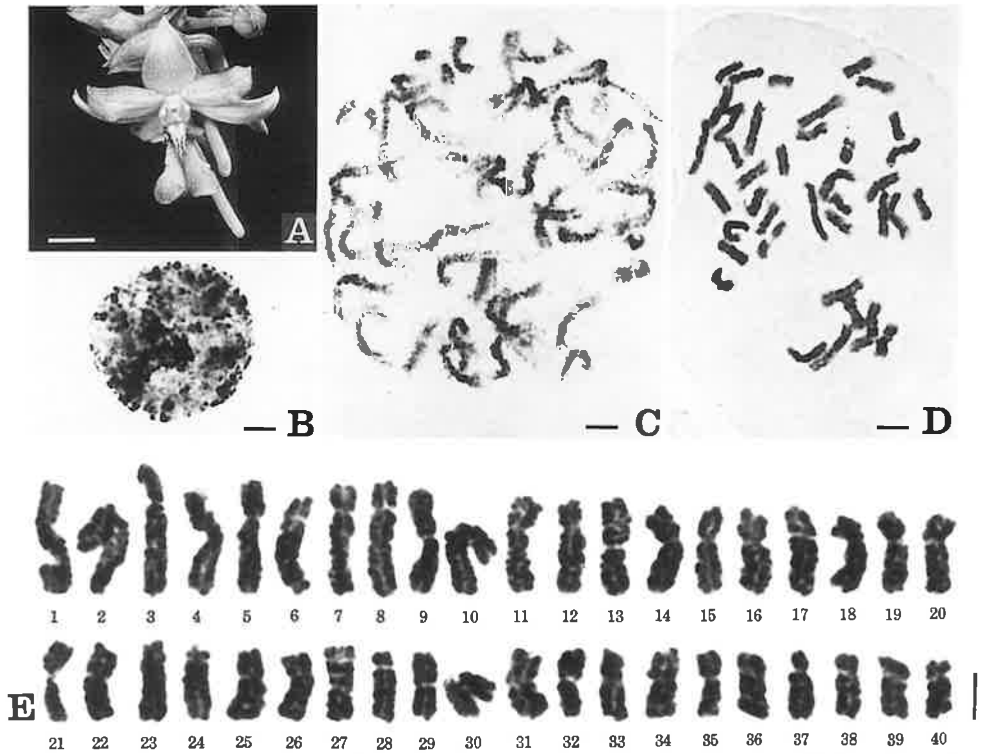

Fig. 17. *Calanthe sylvatica*, 2n=40. A, a flower. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 9 mm in A and 3 μm in B-E.

accord with the descriptions of the species by Perrier De La Bathie (1939). The chromosome number of the plant at mitotic metaphase was 2n=40 and confirmed Chardard (1963).

The chromosomes at resting stage and mitotic prophase were morphologically similar to those of *C. argenteo-striata* described above. The chromosome features at resting stage were of the complex chromocenter type.

The chromosomes of the 2n=40 complement at mitotic metaphase showed a gradual decrease in length from the longest (8.2 μm) to the shortest (3.9 μm) chromosomes. Among the 40 chromosomes in the complement, 16 varied in arm ratio from 1.0–1.7 had their centromeres at the median regions, 14 (Nos. 1–6, 11–12, 17–20, 37–40) varied in arm ratio from 1.9–2.5 had their centromeres at the submedian regions, and the other six (Nos. 7–8, 23–24, 27–28) were varied in arm ratio from 3.1–5.2 had their centromeres at the subterminal regions.

Thus, this species showed a homogeneous, gradual and symmetric karyotype.

18) *Calanthe tricarinata* Lindl., 2n=40, Tables 1 and 19, Fig. 18.

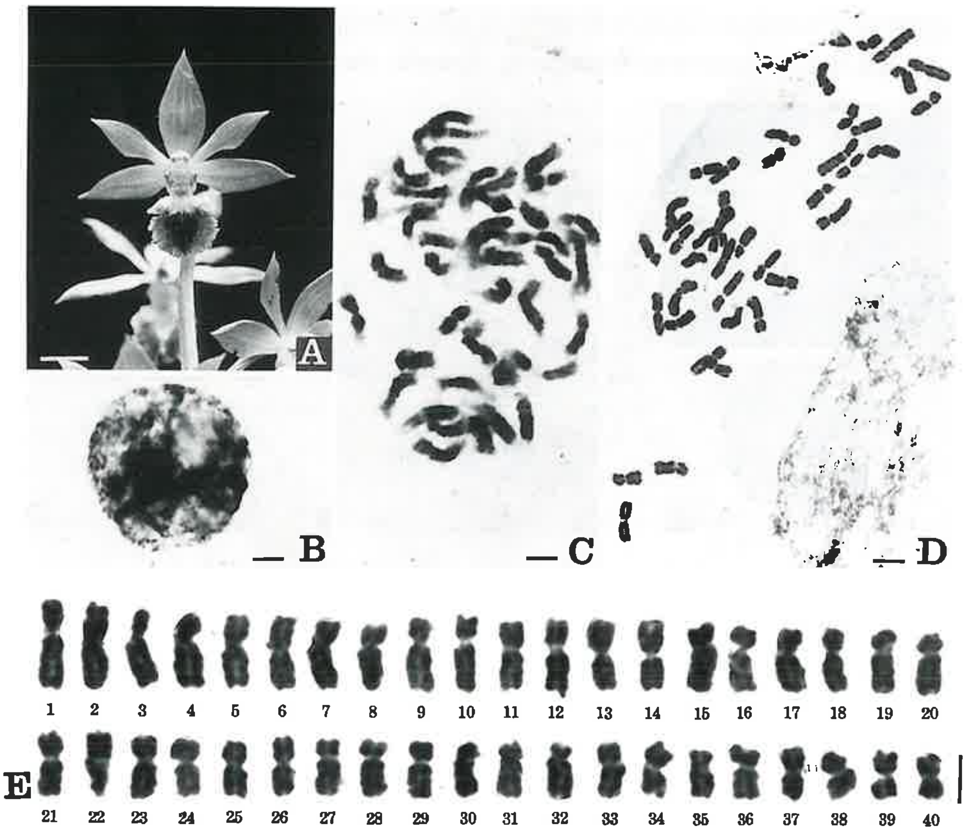

Fig. 18. *Calanthe tricarinata*, 2n=40. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 10 mm in A and 3 μm in B-E.

A plant was obtained from China, Taiwan. External characteristics of the plant were in accord with descriptions of the species by Lin (1976).

The chromosome number of the plant at mitotic metaphase was 2n=40 and confirmed Mutsuura and Nakahira (1958), Mehra and Bawa (1962), Tanaka (1965), Hsu (1976), Tanaka *et al.*(1981).

The chromosomes at resting stage and mitotic prophase were morphologically similar to those of *C. argenteo-striata* described above. The chromosome features at resting stage were of the complex chromocenter type.

The chromosomes of the 2n=40 complement at mitotic metaphase displayed a gradual decrease in length from the longest (5.6 μm) to the shortest (2.7 μm) chromosomes. Among the 40 chromosomes in the complement, 26 varied in arm ratio from 1.0–1.7 had their centromeres at the median regions, 12 (Nos. 9–10, 15–16, 27–30, 35–36) varied in arm ratio from 1.9–2.3 had their centromeres at the submedian regions, and the other two (Nos. 31, 32) with the arm ratio of 3.1 had their centromeres at the subterminal regions.

Thus, this species showed a homogeneous, gradual and symmetric karyotype.

19) *Calanthe triplicata* (Willem.) Ames, 2n=40, Tables 1 and 20, Fig. 19.

Three plants were obtained from China, Taiwan and one plant was obtained from the

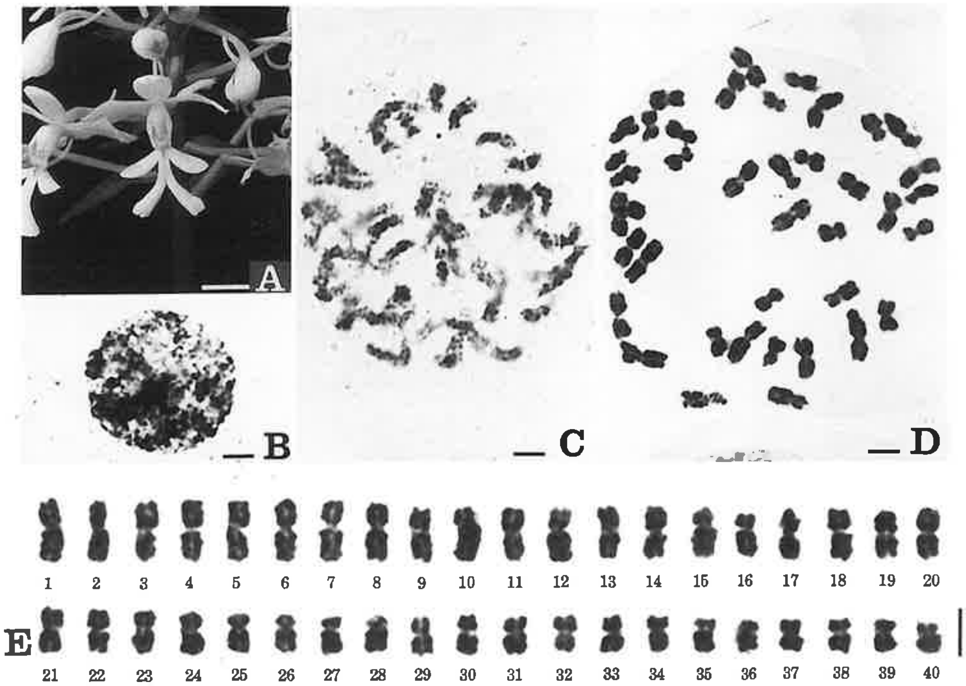

Fig. 19. *Calanthe triplicata*, 2n=40. A, a flower. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 9 mm in A and 3 μm in B-E.

Philippines. External characteristics of the four plants were in accord with descriptions of the species by Lin (1976).

The chromosome number of the plants at mitotic metaphase was 2n=40 and confirmed Arora (1960), Pancho (1965), Tanaka (1965), Larsen (1966), Hsu (1976), Tanaka *et al.* (1981).

The chromosomes at resting stage and mitotic prophase were morphologically similar to those of *C. argenteo-striata* described above. The chromosome features at resting stage were of the complex chromocenter type.

The chromosomes of the 2n=40 complement at mitotic metaphase showed a gradual decrease in length from the longest (4.0 μm) to the shortest (2.0 μm) chromosomes. Among the 40 chromosomes in the complement, 30 varied in arm ratio from 1.0–1.3 had their centromeres at the median regions, and the other 10 (Nos. 15–16, 25–29, 35–36, 39–40) varied in arm ratio from 1.8 to 2.1 had their centromeres at the submedian regions.

Thus, this species showed a homogeneous, gradual and symmetric karyotype.

2. Section Styloglossum

1) *Calanthe clavata* Lindl., Tables 1 and 21, Fig. 20.

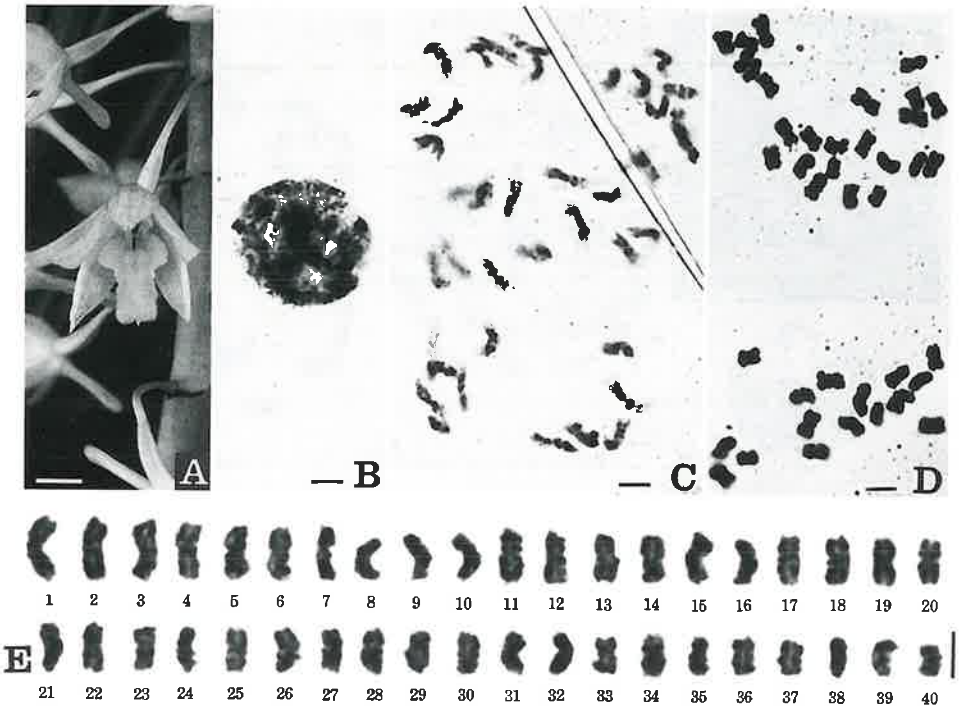

Fig. 20. *Calanthe clavata*, 2n=40. A, a flower. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 7 mm in A and 3 μm in B-E.

A plant was obtained from China, Guangdong. External characteristics of the plant were in accord with descriptions of the species by Seidenfaden (1975).

The chromosome number of the plant at mitotic metaphase was 2n = 40, which confirmed Mehra (1982).

The chromosomes at resting stage were morphologically similar to those of *C. argenteo-striata* described above but formed larger and stronger condensed blocks. Approximately ten chromocentric bodies were counted in each nucleus. The chromosomes at mitotic prophase were morphologically similar to those of *C. argenteo-striata*. The chromosome features at resting stage were of the complex chromocenter type.

The chromosomes of the 2n=40 complement at mitotic metaphase showed a gradual decrease in length from the longest (4.5 μm) to the shortest (2.4 μm) chromosomes. Among the 40 chromosomes in the complement, 36 varied in arm ratio from 1.0–1.7 had their centromeres at the median regions, and the other four (Nos. 9–10, 35–36) varied in arm ratio from 1.8–2.0 had their centromeres at the submedian regions.

Thus, this species showed a homogeneous, gradual and highly symmetric karyotype.

2) *Calanthe densiflora* Lindl., Tables 1 and 22, Fig.21.

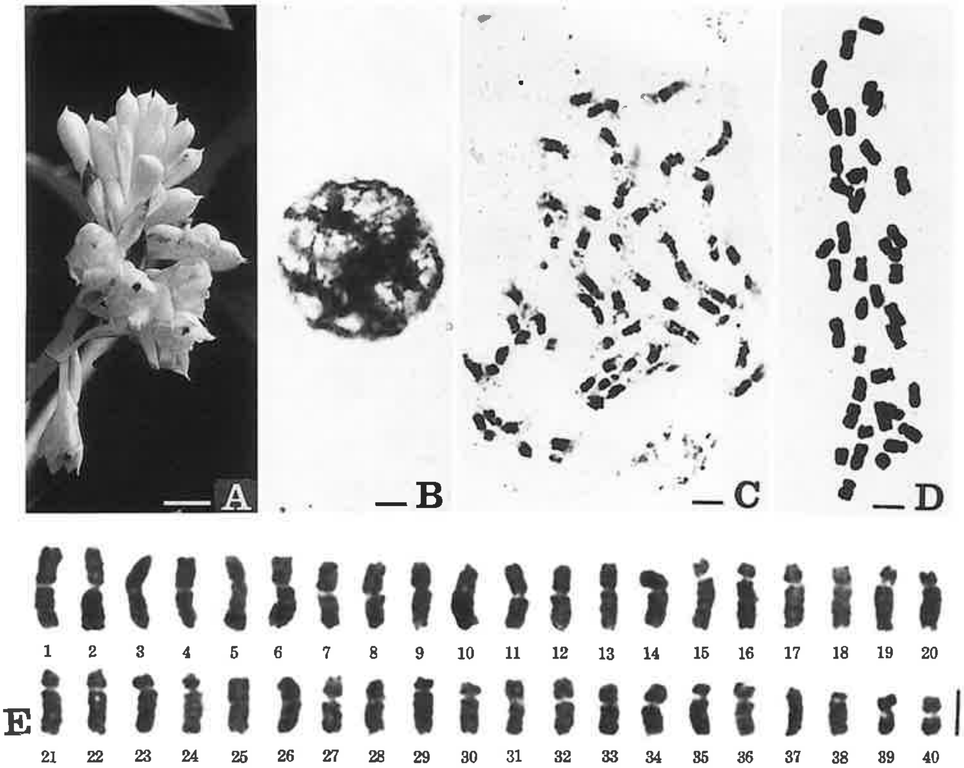

Fig. 21. *Calanthe densiflora*, 2n=40. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 10 mm in A and 3 μm in B-E.

Two plants were obtained from China, Taiwan. External characteristics of the plants were in accord with the descriptions of the species by Lin (1977).

The chromosome number of the plants at mitotic metaphase was 2n=40 and confirmed Hsu (1976), Tanaka *et al.* (1981), Vij and Shekhar (1983).

The chromosomes at resting stage and mitotic prophase were morphologically similar to those of *C. clavata* described above. The chromosome features at resting stage were of the complex chromocenter type.

The chromosomes of the 2n=40 complement at mitotic metaphase showed a gradual decrease in length from the longest (5.1 μm) to the shortest (2.4 μm) chromosomes. Among the 40 chromosomes in the complement, 24 varied in arm ratio from 1.1–1.7 had their centromeres at the median regions, 12 (Nos. 15–18, 21–24, 35–38) varied in arm ratio from 2.4–2.8 had their centromeres at the submedian regions and the other four (Nos. 19–20, 31–32) varied in arm ratio from 3.1–3.2 had their centromeres at the subterminal regions.

Thus, this species showed a homogeneous, gradual and highly symmetric karyotype.

3) *Calanthe formosana* Rolfe, 2n=40, Tables 1 and 23, Fig. 22.

Two plants were obtained from China, Taiwan. External characteristics of the plants

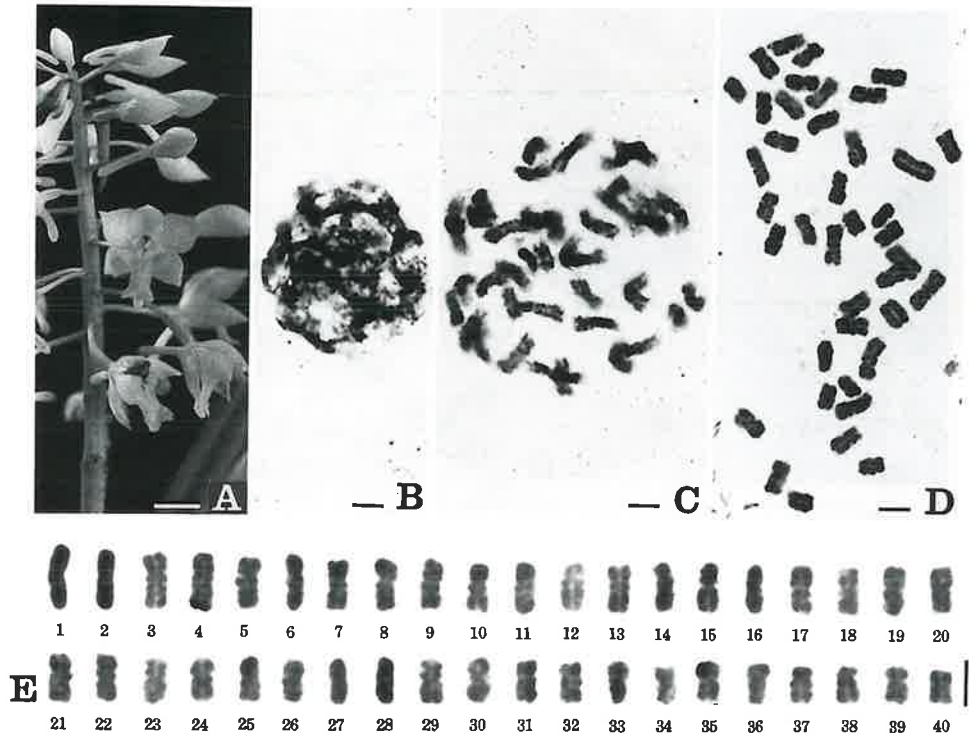

Fig. 22. *Calanthe formosana*, 2n=40. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 11 mm in A and 3 μm in B-E.

were in accord with the descriptions of the species by Lin (1976).

The chromosome number of the plants at mitotic metaphase was 2n = 40, which confirmed Hsu (1976).

The chromosomes at resting stage and mitotic prophase were morphologically similar to those of *C. clavata* described above. The chromosome features at resting stage were of the complex chromocenter type.

The 2n = 40 chromosomes of the mitotic metaphase complement showed a gradual decrease in length from the longest (4.1 μm) to the shortest (2.4 μm) chromosomes. Among the 40 chromosomes in the complement, 34 varied in arm ratio from 1.0–1.7 had their centromeres at the median regions, while the other six (Nos. 5–6, 13–14, 37–38) varied in arm ratio from 1.9–2.1 had their centromeres at the submedian regions.

This species showed a homogeneous, gradual and highly symmetric karyotype.

4) *Calanthe lyroglossa* Reichb.f., 2n=40, Tables 1 and 24, Fig. 23.

Two plants were obtained from China, Taiwan. External characteristics of the plants were in accord with the descriptions of the species by Lin (1976).

The chromosome number of the plants at mitotic metaphase was 2n=40 and confirmed

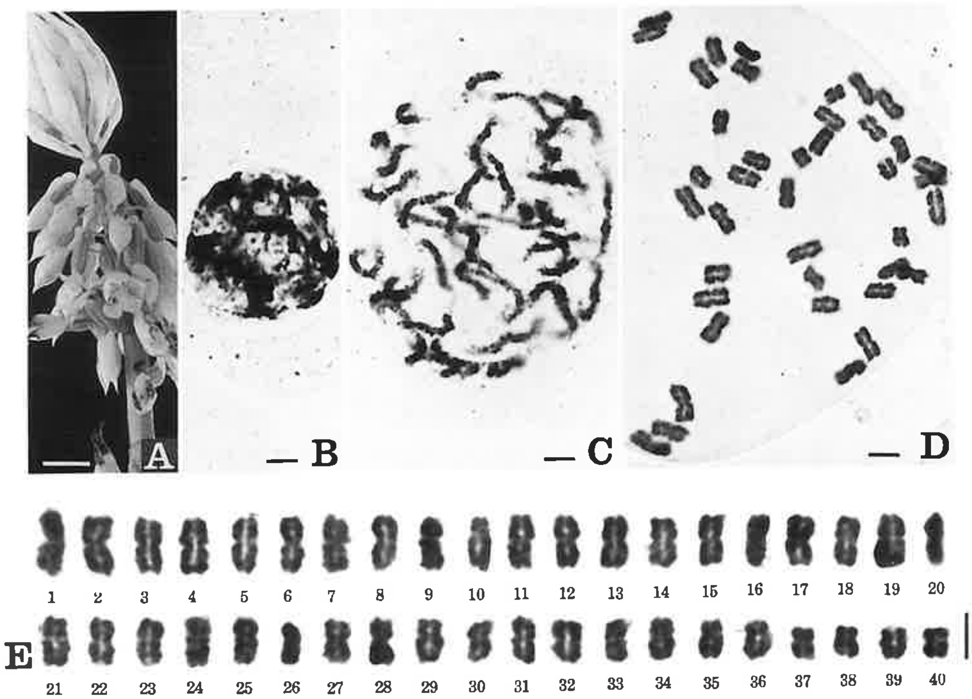

Fig. 23. *Calanthe lyroglossa*, 2n=40. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 13 mm in A and 3 μm in B-E.

Hsu (1976), Tanaka *et al.* (1981).

The chromosomes at resting stage and mitotic prophase were morphologically similar to those of *C. clavata* described above. The chromosome features at resting stage were of the complex chromocenter type.

The chromosome complement of 2n = 40 at mitotic metaphase exhibited a gradual decrease in length from the longest (4.3 μm) to the shortest (2.0 μm) chromosomes. Among the 40 chromosomes in the complement, 36 varied in arm ratio from 1.0–1.6 had their centromeres at the median regions, while the other four (Nos. 9–10, 35–36) varied in arm ratio from 1.8–2.0 had their centromeres at the submedian regions.

Thus, this species showed a homogeneous, gradual and highly symmetric karyotype.

3. Section Aceratochilus

1) *Calanthe kooshunensis* Fukuyama, 2n=40, Tables 1 and 25, Fig. 24.

Two plants were obtained from China, Taiwan. Lin (1976) treated this species into a

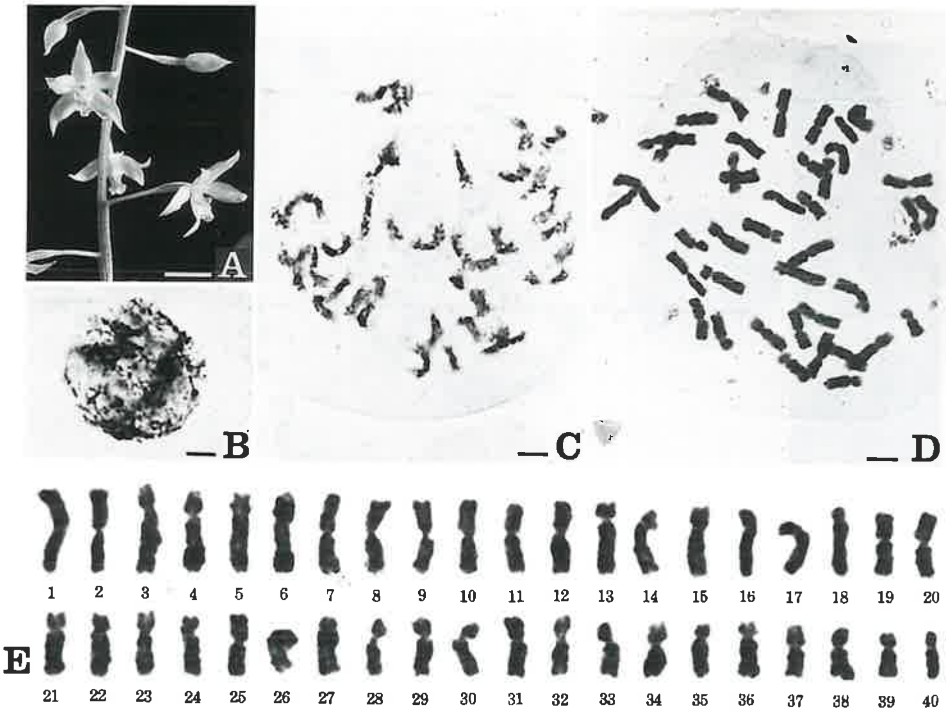

Fig. 24. *Calanthe kooshunensis*, 2n=40. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 9 mm in A and 3 μm in B-E.

synonym of *Phaius longipes* (Hook. f.) Holtt. var. *calantheoides* (Ames) Lin, and Valmayor (1984) treated this species into a synonym of *Cephalantheropsis calantheoides* (Ames) Liu and Su. External characteristics of the plants were in accord with the descriptions by Lin (1976) and Valmayor (1984).

The chromosome number of the plants at mitotic metaphase was 2n=40, which was reported here for the first time for this species.

The chromosomes at resting stage were morphologically similar to those of *C. argenteo-striata* described above. Approximately ten chromocentric bodies were counted in each nucleus. The chromosome features at resting stage were of the complex chromocenter type. The chromosomes at mitotic prophase were morphologically similar to those of *C. argenteo-striata*.

The chromosome complement of 2n=40 at mitotic metaphase exhibited a gradual decrease in length from the longest (5.6 μm) to the shortest (3.2 μm) chromosomes. Among the 40 chromosomes in the complement, 18 varied in arm ratio from 1.0–1.5 had their centromeres at the median regions, 18 (Nos. 3–6, 13–14, 21–24, 27–30, 35–36, 39–40) varied in arm ratio from 1.9–2.5 had their centromeres at the submedian regions, and the other four (Nos. 15–18) varied in arm ratio from 3.3–3.8 had their centromeres at the subterminal regions.

Thus, this species showed a homogeneous, gradual and highly symmetric karyotype.

2) *Calanthe gracilis* Lindl., 2n=40, Tables 1 and 26, Fig. 25.

Three plants were obtained from China, Taiwan. Lin (1976) treated this species into a synonym of *Phaius longipes* (Hook. f.) Holtt. and Valmayor (1984) treated this species into a synonym of *Cephalantheropsis gracilis* (Lindl.) S. Y. Hu. External characteristics of the plants were in accord with the descriptions by Lin (1976) and Valmayor (1984).

The chromosome number of the plants at mitotic metaphase was 2n=40 and confirmed the Tanaka's report (1965) after a treatment of this species into a synonym of *C. venusta* Schltr., and Tanaka, Karasawa and Ishida's report (1981) after another treatment of this species into a synonym of *C. gracilis* Lindl. var. *venusta* (Schltr.) F. Maekawa.

The chromosomes at resting stage and mitotic prophase were morphologically similar to those of *C. kooshunensis* described above. Approximately 12 chromocentric bodies were counted in each nucleus. The chromosome features at resting stage were of the complex chromocenter type.

The chromosomes of the 2n=40 complement at mitotic metaphase showed a gradual decrease in length from the longest (4.3 μm) to the shortest (2.1 μm) chromosomes. Among the 40 chromosomes in the complement, 22 varied in arm ratio from 1.1–1.7 had their centromeres at the median regions, while the other 18 (Nos. 5–10, 15–16, 21–22, 27–32, 37–38) varied in arm ratio from 1.8–2.5 had their centromeres at the submedian regions. Thus, this species showed a homogeneous, gradual and symmetric karyotype.

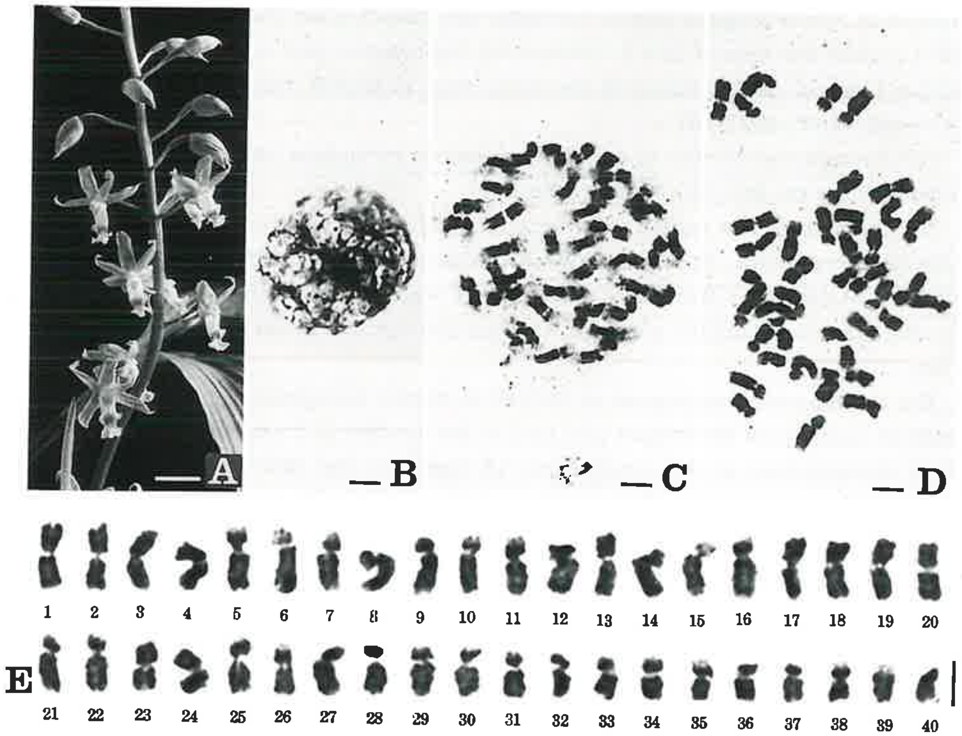

Fig. 25. *Calanthe gracilis*, 2n=40. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 9 mm in A and 3 μm in B-E.

II. Subgenus Preptanthe

1. Section Eu-Preptanthe

1) *Calanthe cardioglossa* Schltr., 2n=46, Tables 1 and 27, Fig. 26.

Two plants were obtained from Thailand. External characteristics of the plants were in accord with the descriptions of the species by Seidenfaden (1975).

The chromosome number of the plants at mitotic metaphase was 2n = 46, which was different from 2n=c44 reported by Larsen (1966).

The chromosomes at resting stage were morphologically similar to those of *C. argenteo-striata* described above, but formed larger and stronger condensed blocks. Approximately 25 chromocentric bodies were counted in each nucleus. The chromosomes at mitotic prophase were morphologically similar to those of *C. argenteo-striata*. The chromosome features at resting stage were of the complex chromocenter type.

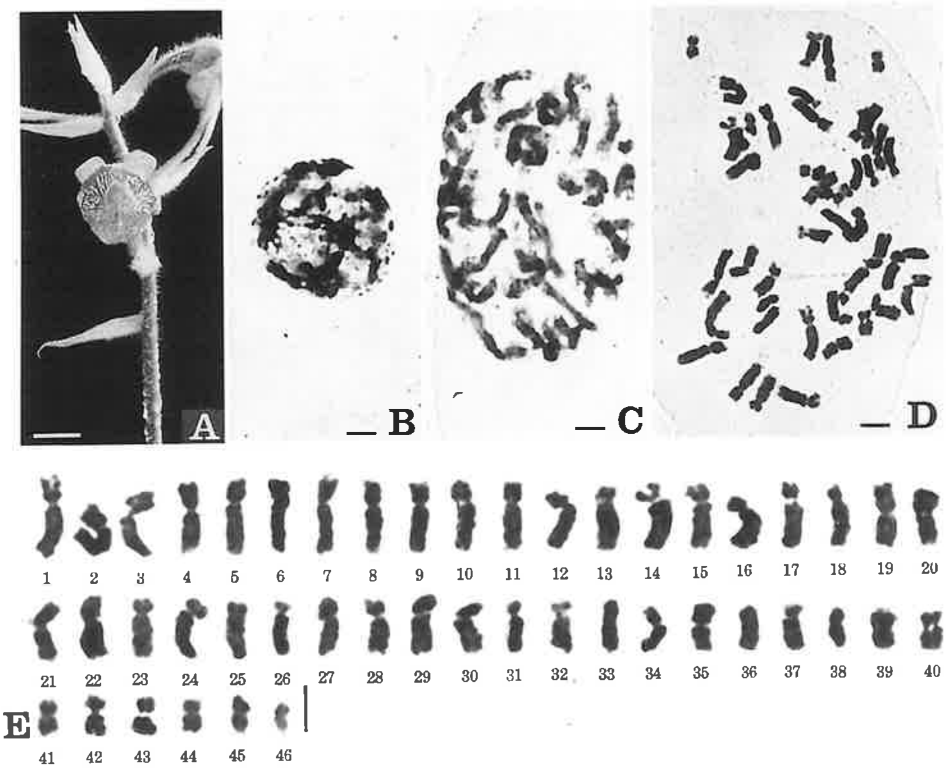

Fig. 26. *Calanthe cardioglossa*, 2n=46. A, a flower. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 14 mm in A and 3 μm in B-E.

The chromosomes of the 2n=40 complement at mitotic metaphase showed a gradual decrease in length from the longest (4.9 μm) to the shortest (1.9 μm) chromosomes. Among the 40 chromosomes in the complement, 20 varied in arm ratio from 1.0–1.6 had their centromeres at the median regions, 18 (Nos. 1–2, 5–12, 15–18, 27–28, 37–38) varied in arm ratio from 2.0–3.0 had their centromeres at the submedian regions, and the other eight (Nos. 13–14, 23–26, 31–32) varied in arm ratio from 3.1–3.8 had their centromeres at the subterminal regions.

Thus, this species showed a homogeneous, gradual and symmetric karyotype.

2) ***Calanthe elmeri* Ames, 2n=44, Tables 1 and 28, Fig. 27**

A plant was obtained from the Pilippines. External characteristics of the plant were in accord with the descriptions of the species by Valmayor (1984).

The chromosome number of the plant at mitotic metaphase was 2n=44, which was reported here for the first time for this species.

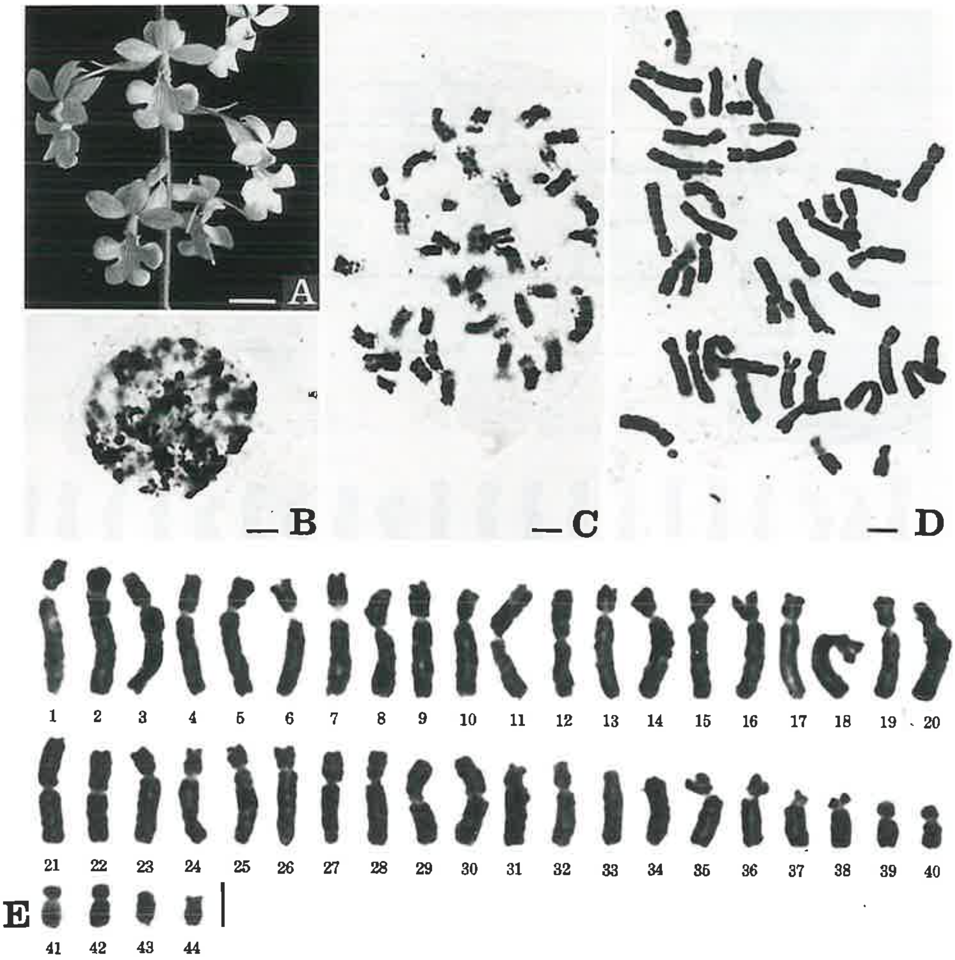

Fig. 27. *Calanthe elmeri*, 2n = 44. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 11 mm in A and 3 μm in B-E.

The chromosomes at resting stage and mitotic prophase were morphologically similar to those of *C. cardioglossa* described above. The chromosome features at resting stage were of the complex chromocenter type.

The 2n = 44 chromosome complement at mitotic metaphase showed a group of bimodality with 36 chromosomes exhibiting a gradual decrease in length from 8.2 to 4.6 μm and the other group of eight chromosomes exhibiting another gradual decrease in length from 3.3 to 1.9 μm. Among the 44 chromosomes in the complement, eight varied in arm ratio from 1.0–1.3 had their centromeres at the median regions, 30 (Nos.3–10, 13–20, 23–24, 27–28, 31–32, 35–36, 39–44) varied in arm ratio from 1.8–2.9 had their centromeres at the submedian regions, and the other six (Nos.1–2, 25–26, 37–38) varied in arm ratio from 3.1–3.7 had their centromeres at the subterminal regions.

Thus, this species showed a homogeneous, gradual and symmetric karyotype.

3) *Calanthe hennisii* Loher, 2n=42, Tables 1 and 29, Fig. 28.

Three plants were obtained from the Philippines. External characteristics of these plants were in accord with the descriptions of the species by Valmayor (1984).

The chromosome number of the plants at mitotic metaphase was 2n=42, which was reported here for the first time for this species.

The chromosomes at resting stage and mitotic prophase were morphologically similar to those of *C. cardioglossa* described above. The chromosome features at resting stage were of the complex chromocenter type.

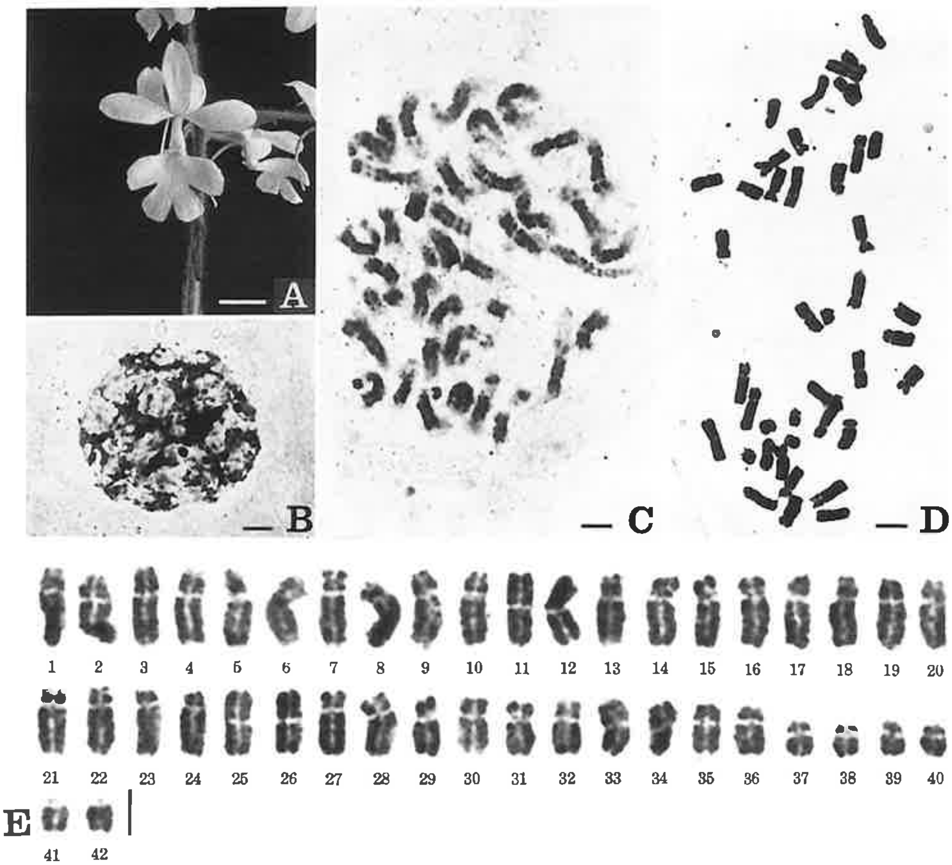

Fig. 28. *Calanthe hennisii*, 2n=42. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 15 mm in A and 3 μm in B-E.

The chromosomes of the 2n=42 complement at mitotic metaphase displayed a bimodality with 36 chromosomes performing a gradual decrease in length from 5.0 to 3.0 μm and six small-sized chromosomes varying in length from 2.1 to 2.0 μm. Among the 42 chromosomes in the complement, ten varied in arm ratio from 1.0–1.7 had their centromeres at the median regions, 30 (Nos. 1–4, 7–10, 3–10, 13–24, 27–30, 35–40) varied in arm ratio from 1.8–2.9 had their centromeres at the submedian regions, and the other two (Nos. 41, 42) with in arm ratio of 5.6 had their centromeres at the subterminal regions.

Thus, this species showed a homogeneous, gradual and symmetric karyotype.

4) *Calanthe hirsuta* Seidenfaden, 2n=46, Tables 1 and 30, Fig. 29.

Two plants were obtained from Thailand. External characteristics of these plants were in accord with the descriptions of the species by Seidenfaden (1975).

The chromosome number of the plants at mitotic metaphase was 2n=46, which was re-

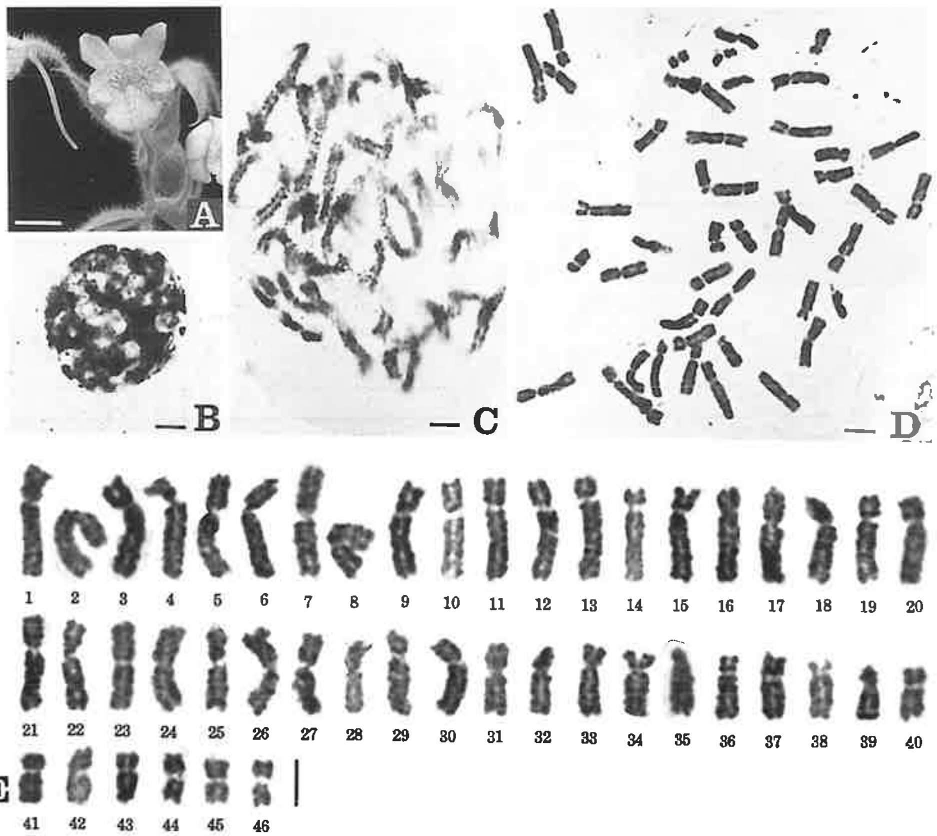

Fig. 29. *Calanthe hirusta*, 2n=46. A, a flower. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 8 mm in A and 3 μm in B-E.

ported here for the first time for this species.

The chromosomes at resting stage and mitotic prophase were morphologically similar to those of *C. cardioglossa* described above. The chromosome features at resting stage were of the complex chromocenter type.

The chromosome complement of 2n = 46 at mitotic metaphase showed a gradual decrease in length the longest (6.7 μm) to the shortest (2.6 μm) chromosomes. Among the 46 chromosomes in the complement, 16 varied in arm ratio from 1.0–1.7 had their centromeres at the median regions, 28 (Nos. 1–6, 9–12, 15–20, 29–30, 33–42) varied in arm ratio from 1.9–3.0 had their centromeres at the submedian regions, the other two (Nos. 13 ,14) with the arm ratio of 4.0 had their centromeres at the subterminal regions.

Thus, this species showed a homogeneous, gradual and symmetric karyotype.

5) *Calanthe rosea* (Lindl.) Benth., 2n=44, Tables 1 and 31, Fig. 30.

A plant was obtained from Thailand. External characteristics of the plant were in accord with the descriptions of the species by Seidenfaden (1975).

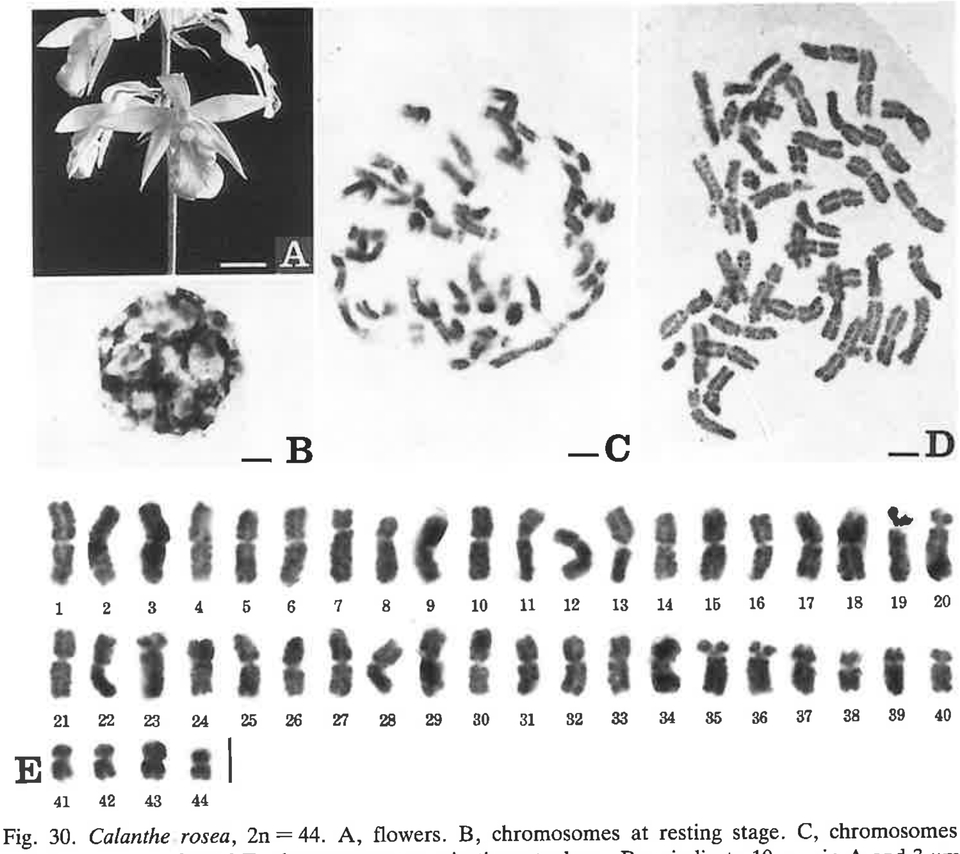

Fig. 30. *Calanthe rosea*, 2n = 44. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 10 mm in A and 3 μm in B-E.

The chromosome number of the plant at mitotic metaphase was 2n=44, which was reported here for the first time for this species.

The chromosomes at resting stage and mitotic prophase were morphologically similar to those of *C. cardioglossa* described above. The chromosome features at resting stage were of the complex chromocenter type.

The chromosomes of the 2n=44 complement at mitotic metaphase showed a bimodality with 36 chromosomes exhibiting a gradual decrease in length from 5.0 to 3.0 μm and eight small-sized chromosomes varying in length from 3.0 to 2.1 μm. Among the 44 chromosomes in the complement, 34 varied in arm ratio from 1.0–1.5 had their centromeres at the median regions, eight (Nos. 7–8, 23–24, 35–36, 39–40) varied in arm ratio from 2.2–2.5, were submedian and the other two (Nos. 19, 20) with the arm ratio of 3.3 had their centromeres at the subterminal regions.

This species showed a heterogeneous, bimodal and symmetric karyotype.

6) *Calanthe rubens* Ridley, 2n=42, Tables 1 and 32, Fig. 31.

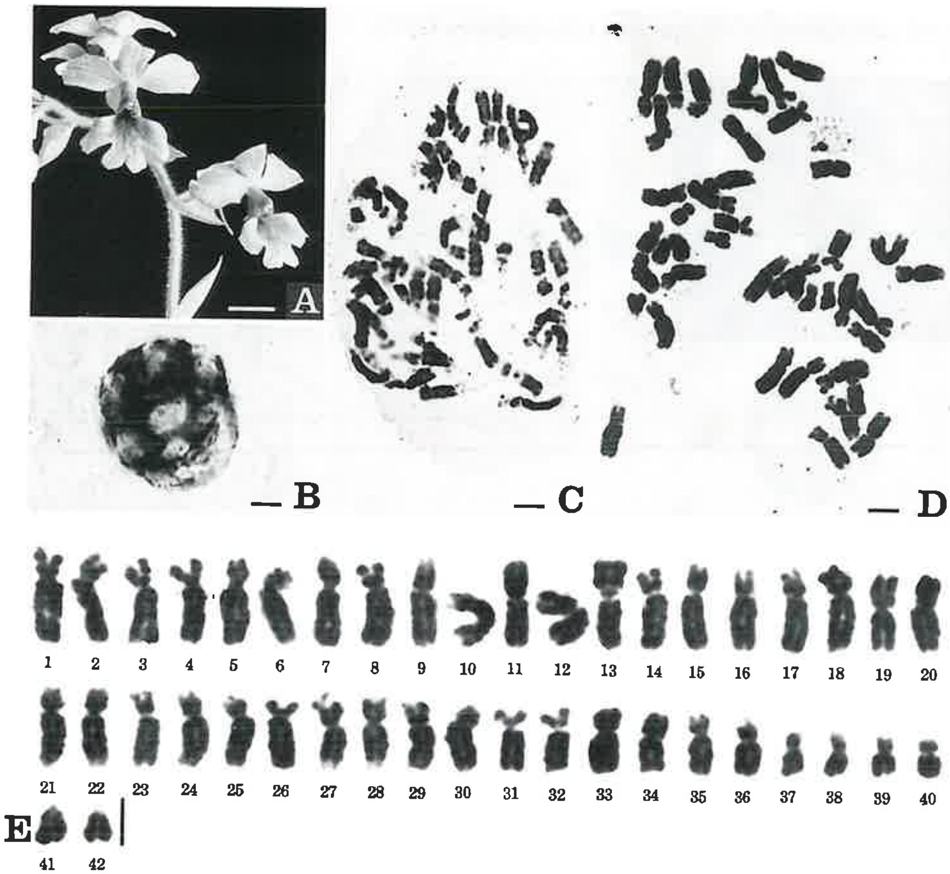

Fig. 31. *Calanthe rubens*, 2n=42. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 10 mm in A and 3 μm in B-E.

Three plants were obtained from Thailand. External characteristics of the plants were in accord with the descriptions of the species by Seidenfaden (1975).

The chromosome number of the plants at mitotic metaphase was 2n = 42, which confirmed Teoh and Lim (1978), but was different from 2n=44 counted by Tanaka (1965).

The chromosomes at resting stage and mitotic prophase were morphologically similar to those of *C. cardioglossa* described above. The chromosome features at resting stage were of the complex chromocenter type. The chromosomes of the 2n = 42 complement at mitotic metaphase formed a bimodality with 36 chromosomes exhibiting a gradual decrease in length from 5.7 to 3.5 μm and six small-sized chromosomes varying in length from 2.8 to 2.3 μm. Among the 42 chromosomes in the complement, 14 varied in arm ratio from 1.3–1.7 had their centromeres at the median regions, 14 (Nos. 1–10, 13–18, 21–26, 29–32) varied in arm ratio from 1.8–2.4 had their centromeres at the submedian regions, and the other two (Nos.41, 42) with the arm ratio of 6.6 had their centromeres at the subterminal regions.

Thus, this species showed a homogeneous, gradual and symmetric karyotype.

7) *Calanthe succedanea* Gagnep., 2n=44, Tables 1 and 33, Fig. 32.

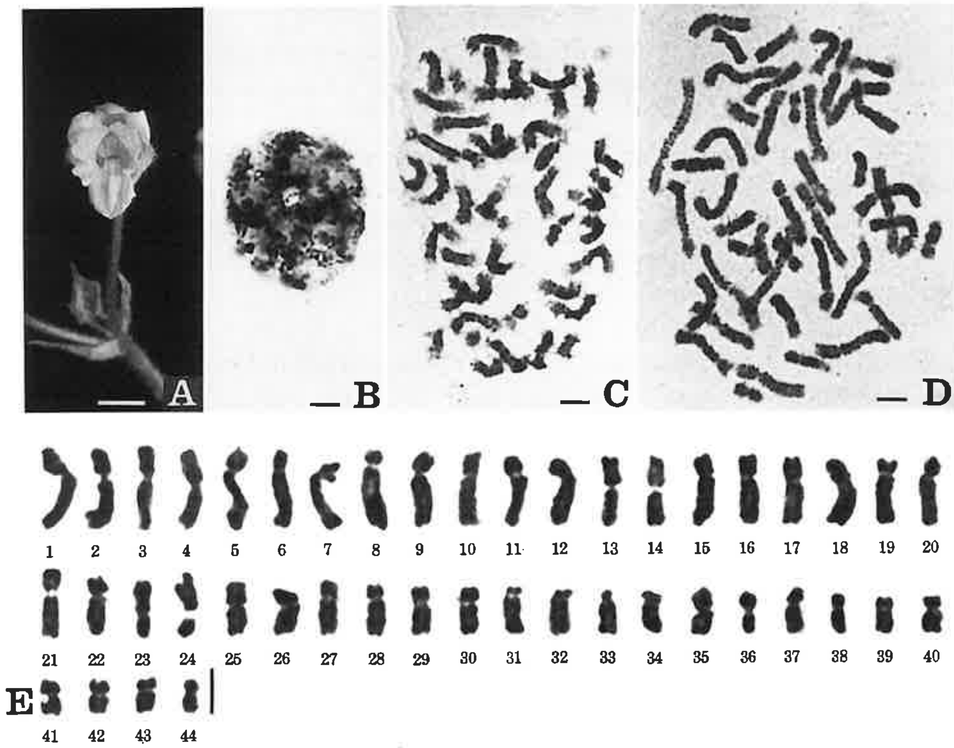

Fig. 32. *Calanthe succedanea*, 2n=44. A, a flower. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 7 mm in A and 3 μm in B-E.

Two plants were obtained from Thailand. External characteristics of these plants were in accord with the descriptions of the species by Seidenfaden (1975).

The chromosome number of the plants at mitotic metaphase was 2n=44, which was reported here for the first time for this species.

The chromosomes at resting stage and mitotic prophase were morphologically similar to those of *C. cardioglossa* described above. The chromosome features at resting stage were of the complex chromocenter type.

The chromosome complement at mitotic metaphase displayed a gradual decrease in length from the longest (5.4 μm) to the shortest (2.1 μm) chromosomes. Among the 44 chromosomes in the complement, 16 varied in arm ratio from 1.0–1.7 had their centromeres at the median regions, 22 (Nos. 1–2, 5–6, 9–12, 15–18, 21–22, 27–30, 35–36, 39–40) varied in arm ratio from 1.8–2.8 had their centromeres at the submedian regions, and the other six (Nos. 7–8, 19–20, 31–32) varied in arm ratio from 3.1–3.8 had their centromeres at the subterminal regions. One of the medium-sized chromosomes with median centromere at mitotic metaphase formed a large secondary constriction in the proximal region of the long arm.

Thus, this species showed a homogeneous, gradual and symmetric karyotype.

8) *Calanthe vestita* Lindl., 2n=42, Tables 1 and 34, Fig. 33.

Two plants were obtained from Thailand and one plant was obtained from Burma. External characteristics of the plants were in accord with the descriptions of the species by Seidenfaden (1975).

The chromosome number of the plants at mitotic metaphase was 2n = 42, which was different from 2n = 40 counted in *C. vestita* var. *regnieri* by Hoffmann (1929, 1930). The chromosomes at resting stage and mitotic prophase were morphologically similar to those of *C. cardioglossa* described above. The chromosome features at resting stage were of the complex chromocenter type.

The chromosomes of the 2n=42 complement at mitotic metaphase indicated a bimodality with 36 chromosomes exhibiting a gradual decrease in length from 5.7–3.7 μm and six small-sized chromosomes varying in length from 2.4–2.1 μm. Among the 42 chromosomes in the complement, 12 varied in arm ratio from 1.0–1.7 had their centromeres at the median regions, 14 (Nos. 1–4, 7–10, 13–18, 21–26, 31–38) varied in arm ratio from 1.8–3.0 had their centromeres at the submedian regions and the other two (Nos. 41, 42) with the arm ratio of 6.0 had their centromeres at the subterminal regions.

Meiosis was studied in the clone from Burma. The chromosomes in each PMC at metaphase I formed 21 bivalents. Most of the bivalent chromosomes were ring shaped and had terminal chiasmata showing very weak assosiation, while a few of them were rod shaped with an interstitial chiasma. The chromosomes at anaphase I moved normally toward the two poles without any lagging chromosomes.

Thus, this species showed a heterogeneous, bimodal and symmetric karyotype.

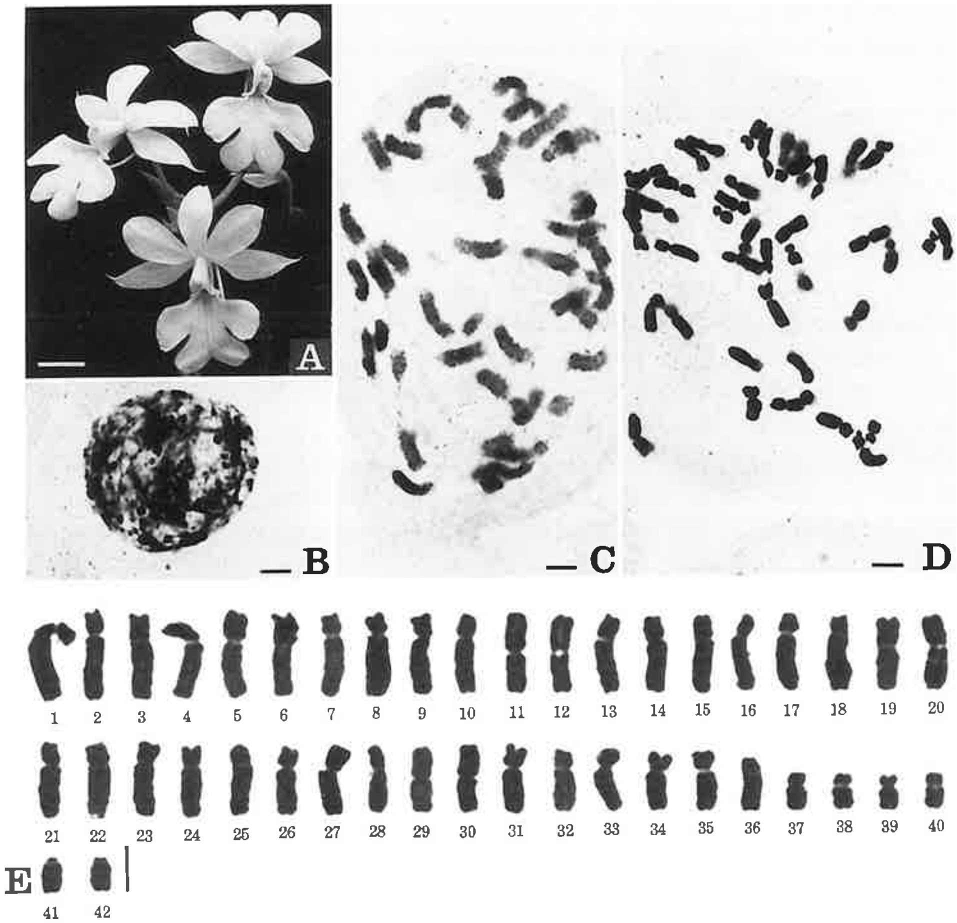

Fig. 33. *Calanthe vestita*, 2n=42. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 10 mm in A and 3 μm in B-E.

Discussion

I. Karyomorphological characteristics

1. Chromosome number

The chromosome numbers of 33 taxa in four sections in two subgenera in *Calanthe* studied were shown in Table 1. Ten taxa shown their chromosome numbers for the first time were listed as follows: *C. argenteo-striata* 2n=45, *C. conspicua* 2n=40, *C. cremeo-viridis* 2n =46, *C. hancockii* 2n=40, *C. kooshunensis* 2n=40, *C. elmeri* 2n=44, *C. hennisii* 2n=42, *C. hirsuta* 2n=46, *C. rosea* 2n=44, *C. succedanea* 2n=44. Three taxa shown the chromosome numbers different from the previous counts were listed as follows: *C. caudatilabella* 2n =38, *C. cardioglossa* 2n=46, *C. vestita* 2n=42. The chromosome numbers of the other 20 taxa confirmed thc previous reports.

Thus, the 33 taxa in *Calanthe* exhibited an aneuploid series with the chromosome numbers of 2n=38, 40, 42, 44, 45 and 46. The chromosome number of 2n=38 was found in one taxon, 2n=40 in 22 taxa, 2n=42 in three taxa, 2n=44 in three taxa, 2n=45 in one taxon and 2n = 46 in three taxa. The chromosome complement of 2n = 45 in *C. argenteo-striata* could be composed of 2n = 44 chromosomes and one supernumerary chromosome. Thus, the basic chromosome numbers of *Calanthe* were x=19, 20, 21, 22 and 23.

Among the seven sections described by Schlechter (1912), four were studied to determine whether or not they could be correlated with their basic chromosome numbers. The results were listed as follows: x = 19 in section Calothyrsus (one taxon), x = 20 in section Calothyrsus (16 taxa), Styloglossum (four taxa) and Aceratochilus (two taxa), x=21 in section Eu-Preptanthe (three taxa), x = 22 in section Calothyrsus (one taxon) and Eu-Preptanthe (three taxa), and x=23 in section Calothyrsus (one taxon) and Eu-Preptanthe (two taxa). Thus, two groups of sections were categorized; the sections with single basic chromosome number and the sections with multiple basic chromosome numbers. These examinations of the chromosome numbers can be valid to clarify the phylogenetic classification and species relationships in *Calanthe*.

2. Chromosome morphology at resting stage

The chromosomes at resting stage throughout the taxa studied were observed as chromomeric granules, fibrous threads and chromatin blocks. The heterochromatic segments aggregated into large blocks as the chromocentral aggregations.

All of the 33 taxa studied showed commonly their chromosomes of the complex chromocenter type at resting stage according to Tanaka (1971), while each of them showed distinct variation of chromocentral aggregation. Degrees of aggregation of chromocenters could be categorized into three groups; the first group was characterized by loose degree of aggregation found in section Calothyrsus (two taxa), the second group was characterized by strong degree of aggregation found in sections Styloglossum (four taxa) and Eu-Preptanthe (eight taxa), and the third group was characterized by moderate degree of aggregation found in section Calothyrsus (17 taxa) and Aceratochilus (two taxa).

These results suggest that the examination of the resting nuclei is valid for clarification of the phylogenetic classification and species relationships in *Calanthe*.

3. Chromosome morphology at mitotic prophase

Numerous early condensed segments at mitotic prophase were observed at the proximal and interstitial regions of both chromosome arms. These condensed segments got joined with each other during the progress of cell division. The distal regions of the chromosomes showed mostly delayed condensations.

4. Chromosome morphology at mitotic metaphase

Among 33 taxa in four sections studied, 27 performed gradual and homogeneous karyotype, accoring to alignment of chromosome length. Five taxa in section Eu-Preptanthe were showed bimodal and heterogeneous karyotype, and one taxon in section Calothyrsus showed the partially heterogeneous karyotype. Thus, the gradual karyotypes were observed in 18 taxa in section Calothyrsus, four taxa in section Styloglossum, two taxa in section Aceratochilus and three taxa in section Eu-Preptanthe. The bimodal karyotypes were observed in five taxa in section Eu-Preptanthe. The taxa showing bimodal karyotype in *Calanthe* were documented here for the first time. In contrast, the Japanese 22 taxa studied by Tanaka et al.(1981) had the gradual karyotypes.

In all of the 33 taxa in four sections, the average chromosome length was 3.8 μm. The average chromosome length in the sections Aceratochilus and Eu-Preptanthe were both 4.4 μm, longer than those in sections Calothyrsus and Styloglossum, 3.5 μm and 3.6 μm respectively. The longest average-chromosome-length was 5.5 μm measured in *C. elmeri*, while the shortest one was 2.8 μm measured in *C. sieboldii*.

The average arm ratio of all of the taxa studied was 1.8. The highest average arm ratio was 2.2 counted in *C. elmeri* and *C. vestita*, while the lowest one was 1.2 in *C. lyroglossa*. According to the sectional comparison in average arm ratio, section Eu-Preptanthe indicated the highest of the average arm ratio of 2.0, section Aceratochilus indicated the second highest of the average arm ratio of 1.8, section Calothyrsus indicated the third of the average arm ratio of 1.7, and section Styloglossum indicated the fourth of the average arm ratio of 1.5.

Although the 33 taxa studied showed the symmetric karyotype, variation of symmetry was observed. According to degree of symmetry, three groups were categorized: the first group was characterized by higher symmetry found in three taxa in section Styloglossum, 12 taxa in section Calothyrsus and one taxon in section Eu-Preptanthe, the second group was characterized by lower symmetry found in two taxa in section Aceratochilus and seven taxa in section Eu-Preptanthe, and the third group was characterized by moderate symmetry found in seven taxa in section Calothyrsus and one taxon in section Styloglossum.

5. Karyomorphological types

On the basis of the chromosome morphology at resting stage and the lengths and the arm ratios of the chromosomes at mitotic metaphase, the 33 taxa studied could be grouped into 15 types as follows:

Type A. $2n=38$; the complex chromocenter type at resting stage, karyotype of loosely aggregated chromocenters; gradual, moderately homogeneous and moderately symmetric karyotype; large-sized chromosome; and represented by *C. caudatilabella*.

Type B. $2n=40$; moderately homogeneous and highly symmetric karyotype; medium-sized chromosome; large secondary constriction in a pair of small chromosomes and a medium-sized chromosome with the centromere at the subterminal region; the other characters similar to Type A; and represented by *C. reflexa*.

Type C. 2n=40; the complex chromocenter type at resting stage, karyotype with moderate aggregation of chromocenters; gradual, moderately homogeneous and moderately symmetric karyotype; small-sized chromosome; and represented by *C. arisanensis, C. aristulifera, C. graciliflora, C. hamata, C. hancockii, C. mannii, C. matsudai, C. plantaginea, C. sieboldii*, and *C. tricarinata*.

Type D. 2n=40; highly homogeneous and highly symmetric karyotype; medium-sized chromosome; the other characters similar to Type C; and represented by *C. conspicua, C. herbacea, C. masuca*, and *C. triplicata*.

Type E. 2n = 46; karyomorphological features similar to Type D with exception of chromosome number and small-sized chromosome; and represented by *C. cremeo-viridis*.

Type F. 2n=44; gradual, moderately homogeneous karyotype; small-sized chromosome; the other characters similar to Type D; and represented by *C. argenteo-striata*.

Type G. 2n=40; low homogeneous and low symmetric karyotype; large-sized chromosome; the other characters similar to Type D; and represented by *C. sylvatica*.

Type H. 2n=40; the complex chromocenter type; karyotype with strong aggregation of chromocenters; gradual, highly homogeneous and highly symmetric karyotype; medium-sized chromosome; and represented by *C. clavata, C. formosana*, and *C. lyroglossa*.

Type I. 2n = 40; moderately homogeneous and moderately symmetric karyotype; the other characters similar to Type H; and represented by *C. densiflora*.

Type J. 2n = 40; highly homogeneous karyotype; large-sized chromosome; the other characters similar to Type C; and represented by *C. kooshunensis*, and *C. gracilis*.

Type K. 2n = 42; the complex chromocenter type; karyotype with strong aggregation chromocenters; bimodal, heterogeneous and low symmetric karyotype; large-sized chromosome; and represented by *C. hennisii, C. rubens*, and *C. vestita*.

Type L. 2n = 44; karyomorphological features similar to Type K with exception of chromosome number; and represented by *C. elmeri*.

Type M. 2n=44; gradual, highly homogeneous karyotype; medium-sized chromosome; the other characters similar to Type K; and represented by *C. rosea*.

Type N. 2n = 44; gradual, low homogeneous and low symmetric karyotype; medium-sized chromosome; large secondary constriction in one of medium-sized chromosome; the other characters similar to Type K; and represented by *C. succedanea*.

Type O. 2n = 46; karyomorphological features similar to Type N with exception of chromosome number; and represeted by *C. cardioglossa*, and *C. hirsuta*.

II. Cytotaxonomical investigation in *Calanthe*

Lindley (1845) first studied the systematic classification of *Calanthe*, and divided this genus into two sections. Schlechter (1912) studied New Guinean species of *Calanthe* and classified this genus into seven sections and two subgenera. Saigusa and Nagano (1975) revised *Calanthe* taxonomy divided the genus into five subgenera. Among them Schlechter's system has been strongly supported by numerous workers.

A few taxa in *Calanthe* were placed in *Phaius* or *Cephalantheropsis* due to certain distinct characteristics such as the lip without a claw and base of lip shortly adnating to base of column (Holtt. 1947, Hu 1974, Lin 1976, Valmayor 1984). However, the *Calanthe* classification has been still insufficient.

Since *Calanthe* is known to have high variation in morphology and ecology, it is necessary to clarify taxonomical treatment and relationships between *Calanthe* and its allied genera.

The karyomorphological relationships among the 33 taxa in four sections followed Schlechter's system were discussed as follow:

1. Subgenus Eu-Calanthe

(1) Section Calothyrsus

Among 19 taxa, 16 showed the chromosome numbers of 2n=40 and the other three taxa showed the chromosome numbers of 2n=38, 2n=45 and 2n=46, respectively. The chromosomes at resting stage shown in all taxa were of the complex chromocentric karyotype, while the chromosomes at mitotic metaphase showed a gradual and homogeneous karyotype due to the chromosome lengths and a symmetric kayotype due to the arm ratios with an exception of a partially heterogeneous karyotype displayed in *C. reflexa*.

Since section Calothyrsus had karyomorphologically different taxa, it is necessary to clarify whether or not these taxa should be placed within a section.

(2) Section Styloglossum

All of the four taxa in section Styloglossum showed the chromosome number of 2n=40. Their chromosomes at resting stage performed the complex chromocentric karyotype, and they chromosmoes at mitotic metaphase showed a gradual, homogeneous and symmetric karyotype. Three taxa, *C. clavata, C. formosana*, and *C. lyroglossa* were similar to each other with respect to chromosome length, arm ratio, and especially high frequency (85–90%) of chromosomes with centromeres at the median regions. Thus, these three taxa could be quite close resembled to each others.

(3) Section Aceratochilus

All of the two taxa in section Aceratochilus had the chromosome number of 2n = 40. They showed the complex chromocentric karyotype at resting stage and a gradual, homogeneous and symmetric karyotype at mitotic metaphase. Among the 22 taxa which have the chromosome number of 2n = 40, these two taxa displayed the longest moderate-chromosome length of 4.2 μm or more.

2. Subgenus Preptanthe

(1) Section Eu-Preptanthe

Eight taxa studied showed the chromosome numbers of 2n=42, 44 and 46. Three taxa with the chromosome number of 2n=42 showed a bimodal, heterogeneous and symmetric karyotype. Among the three taxa with the chromosome number of 2n=44, two, *C. elmeri* and *C. rosea*, showed a bimodal, heterogeneous and symmetric karyotype and one, *C. succedanea*, showed a gradual, homogeneous and symmetric karyotype. The other two taxa with the chromosome number of 2n=46 showed a gradual, homogeneous and symmetric karyotype. No taxa in this section showed the chromosome number of 2n=40. The taxa in this section exhibited strongly condesed chromocentric aggregations at resting stage and gradual and bimodal karyotypes mixed.

Since this section includes the taxa with karyomorphological differences, it is necessary to clarify biosystematically whether or not these taxa must be placed within the single section.

Summary

1. The chromosome numbers of the 33 taxa in *Calanthe*, were clearly documented and their karyomorphologies at resting stage, mitotic prophase and metaphase were well described with the microphotographs and measurements of somatic metaphase chromosomes.

2. The chromosome numbers of the 33 taxa showed an aneuploid series; 2n=38 in one taxon, 2n=40 in 22 taxa, 2n=42 in three taxa, 2n=44 in three taxa, 2n=45 in one taxon and 2n=46 in three taxa.

3. The chromosome numbers of ten taxa were reported here for the first time; 2n=45 for *C. argenteo-striata*, 2n=40 for *C. conspicua*, 2n=46 for *C. cremeo-viridis*, 2n=40 for *C. hancockii*, 2n=40 for *C. kooshunensis*, 2n=44 for *C. elmeri*, 2n=42 for *C. hennisii*, 2n=46 for *C. hirsuta*, 2n=44 for *C. rosea*, and 2n=44 for *C. succedanea*. The chromosome numbers of three taxa, 2n=38 of *C. caudatilabella*, 2n=46 of *C. cardioglossa*, and 2n=42 of *C. vestita*, reported here were different from the previous counts. The chromosome numbers of the other 20 taxa confirmed the previous reports.

4. All of the 33 taxa studied showed the chromosomes of the complex chromocenter type at resting stage. According to degree of chromocentric aggregation at resting stage, three groups were categorized; the first group was characterized by loose degree of chromocentric aggregation found in two taxa, the second group was characterized by the strong aggregation found in 12 taxa and the third group characterized by the moderate aggregation found in 19 taxa.

5. The chromosomes at mitotic prophase in all of the 33 taxa formed early condensed segments in the proximal and interstitial regions of both chromosome arms.

6. Among the 33 taxa, 28 showed homogeneous and gradual karyotypes. According to degree of homogeneity at mitotic metaphase, three groups were categorized; the first group was characterized by high degree of homogeneity found in ten taxa, the second group was characterized by low homogeneity found in four taxa and the third group was characterized by average degree of homogeneity found in 14 taxa. The other five taxa, *C. elmeri, C. hennisii, C. rosea, C. rubens* and *C. vestita,* had the heterogeneous and bimodal karyotypes.

7. All of the 33 taxa studied indicated symmetric karyotype. According to degree of symmetry, three groups were categorized as follows; the first group was characterized by high degree of symmetry found in 11 taxa, the second group was characterized by low symmetry found in eight taxa and the third group was characterized by average symmetry found in 14 taxa.

8. The average chromosome length in all of taxa at mitotic metaphase was 3.8 μm. The longest one of the average chromosome lengths was 5.8 μm in *C. elmeri*, while the shortest one was 2.8 μm in *C. sieboldii.*

9. The 33 taxa studied could be grouped into 15 types described as follows:

Type A. 2n = 38; the complex chromocenter type at resting stage, loosely aggregated chromocentric karyotype; gradual, moderately homogeneous and moderately symmetric karyotype; large-sized chromosome; and represented by *C. caudatilabella.*

Type B. 2n = 40; moderately homogeneous and highly symmetric karyotype; medium-sized chromosome; large secondary constriction in a pair of small chromosomes and one medium-sized chromosome with the centromere at the subterminal region; the other characters similar to Type A; and represented by *C. reflexa.*

Type C. 2n = 40; the complex chromocenter type at resting stage, karyotype with moderately aggregated chromocenters; gradual, moderately homogeneous and moderately symmetric karyotype; small-sized chromosome; and represented by *C. arisanensis, C. aristulifera, C. graciliflora, C. hamata, C. hancockii, C. mannii, C. matsudai, C. plantaginea, C. sieboldii,* and *C. tricarinata.*

Type D. 2n = 40; highly homogeneous and highly symmetric karyotype; medium-sized chromosome; the other characters similar to Type C; and represented by *C. conspicua, C. herbacea, C. masuca,* and *C. triplicata.*

Type E. 2n = 46; karyomorphological features similar to Type D with exception of chromosome number and small-sized chromosome; and represented by *C. cremeo-viridis.*

Type F. 2n = 44; gradual, moderately homogeneous karyotype; small-sized chromosome; the other characters similar to Type D; and represented by *C. argenteo-striata.*

Type G. 2n = 40; low homogeneous and low symmetric karyotype; large-sized chromosome; the other characters similar to Type D; and represented by *C. sylvatica.*

Type H. 2n = 40; the complex chromocenter type; karyotype with strong aggregation of chromocenters; gradual, highly homogeneous and highly symmetric karyotype; medium-sized chromosome; and represented by *C. clavata, C. formosana*, and *C. lyroglossa*.

Type I. 2n = 40; moderately homogeneous and moderately symmetric karyotype; the other characters similar to Type H; and represented by *C. densiflora*.

Type J. 2n=40; high degree of homogeneity; large-sized chromosome; the other characters similar to Type C; and represented by *C. kooshunensis*, and *C. gracilis*.

Type K. 2n=42; the complex chromocenter type; karyotype with strong aggregation of chromocenters; heterogeneous, bimodal and low symmetric karyotype; large-sized chromosome; and represented by *C. hennisii, C. rubens*, and *C. vestita*.

Type L. 2n = 44; karyomorphological features similar to Type K with exception of chromosome number; and represented by *C. elmeri*.

Type M. 2n=44; gradual, highly homogeneous karyotype; medium-sized chromosome; the other characters similar to Type K; and represented by *C. rosea*.

Type N. 2n = 44; gradual, low homogeneous and low symmetric karyotype; medium-sized chromosome; large secondary constriction in one medium-sized chromosome; the other characters similar to Type K; and represented by *C. succedanea*.

Type O. 2n = 46; karyomorphological features similar to Type N with exception of chromosome number; and represented by *C. cardioglossa*, and *C. hirsuta*.

10. The karyomorphological comparisons in the 15 groups described above supported strongly Schlechter's system. However, his two sections, Calothyrsus included the karyomorphological multi-types of A, B, C, D, E, F and G and Eu-Preptanthe included the karyomorphological multi-types of K, L, M, N and O, are needed for reexamination to justify Schlechter's system.

11. The deciduous species of the genus of Southeast Asia were commonly found to show higher bimodal and less symmetry karyotypes and higher chromosome numbers than the other species. Discussing karyomorphologically these differences, it was concluded and evidently proved here for the first time that the Southeast Asian species of *Calanthe*, especially the deciduous species, could be phylogenetically more advanced than the other species and that *Calanthe* speciation might be occurred in a northen distribution and progressed toward the south in Asia.

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Table 2. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe argenteo-striata*, 2n=45

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	2.0+2.6=4.6	3.4	1.3	m
2	2.0+2.6=4.6	3.4	1.3	m
3	1.8+2.5=4.3	3.1	1.3	m
4	1.8+2.5=4.3	3.1	1.3	m
5	1.8+2.3=4.1	3.0	1.2	m
6	1.8+2.3=4.1	3.0	1.2	m
7	1.7+2.2=3.9	2.8	1.2	m
8	1.7+2.2=3.9	2.8	1.2	m
9	1.5+2.1=3.6	2.6	1.4	m
10	1.5+2.1=3.6	2.6	1.4	m
11	1.4+2.2=3.6	2.6	1.5	m
12	1.4+2.2=3.6	2.6	1.5	m
13	1.3+2.1=3.4	2.5	1.6	m
14	1.3+2.1=3.4	2.5	1.6	m
15	1.3+2.0=3.3	2.4	1.5	m
16	1.3+2.0=3.3	2.4	1.5	m
17	1.1+2.1=3.2	2.3	1.9	sm
18	1.1+2.1=3.2	2.3	1.9	sm
19	1.2+1.9=3.1	2.3	1.5	m
20	1.2+1.9=3.1	2.3	1.5	m
21	1.3+1.6=2.9	2.1	1.2	m
22	1.3+1.6=2.9	2.1	1.2	m
23	1.3+1.6=2.9	2.1	1.2	m
24	1.3+1.6=2.9	2.1	1.2	m
25	1.3+1.5=2.8	2.0	1.1	m
26	1.3+1.5=2.8	2.0	1.1	m
27	0.9+1.9=2.8	2.0	2.1	sm
28	0.9+1.9=2.8	2.0	2.1	sm
29	0.8+1.8=2.6	1.9	2.2	sm
30	0.8+1.8=2.6	1.9	2.2	sm
31	1.0+1.6=2.6	1.9	1.6	m
32	1.0+1.6=2.6	1.9	1.6	m
33	1.0+1.6=2.6	1.9	1.6	m
34	1.0+1.6=2.6	1.9	1.6	m
35	0.7+1.9=2.6	1.9	2.7	sm
36	0.7+1.9=2.6	1.9	2.7	sm
37	0.8+1.7=2.5	1.8	2.1	sm
38	0.8+1.7=2.5	1.8	2.1	sm
39	1.0+1.3=2.3	1.7	1.3	m
40	1.0+1.3=2.3	1.7	1.3	m
41	0.5+1.7=2.2	1.6	3.4	st
42	0.5+1.7=2.2	1.6	3.4	st

Table 2. continued

43	0.7+1.3=2.0	1.5	1.8	sm
44	0.7+1.3=2.0	1.5	1.8	sm
45	0.6+0.6=1.2	0.9	1.0	m

Table 3. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe arisanensis*, 2n=40

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.9+2.3=4.2	3.4	1.2	m
2	1.9+2.3=4.2	3.4	1.2	m
3	1.7+2.3=4.0	3.3	1.3	m
4	1.7+2.3=4.0	3.3	1.3	m
5	1.7+2.2=3.9	3.2	1.2	m
6	1.7+2.2=3.9	3.2	1.2	m
7	1.2+2.5=3.7	3.0	2.0	sm
8	1.2+2.5=3.7	3.0	2.0	sm
9	1.1+2.5=3.6	2.9	2.2	sm
10	1.1+2.5=3.6	2.9	2.2	sm
11	1.3+2.3=3.6	2.9	1.7	m
12	1.3+2.3=3.6	2.9	1.7	m
13	1.7+1.8=3.5	2.9	1.0	m
14	1.7+1.8=3.5	2.9	1.0	m
15	1.6+1.8=3.4	2.8	1.1	m
16	1.6+1.8=3.4	2.8	1.1	m
17	1.3+2.1=3.4	2.8	1.6	m
18	1.3+2.1=3.4	2.8	1.6	m
19	0.9+2.3=3.2	2.6	2.5	sm
20	0.9+2.3=3.2	2.6	2.5	sm
21	1.0+2.1=3.1	2.5	2.1	sm
22	1.0+2.1=3.1	2.5	2.1	sm
23	1.3+1.7=3.0	2.4	1.3	m
24	1.3+1.7=3.0	2.4	1.3	m
25	0.9+2.0=2.9	2.4	2.2	sm
26	0.9+2.0=2.9	2.4	2.2	sm
27	0.7+1.8=2.5	2.0	2.5	sm
28	0.7+1.8=2.5	2.0	2.5	sm
29	0.9+1.6=2.5	2.0	1.7	m
30	0.9+1.6=2.5	2.0	1.7	m
31	1.0+1.4=2.4	2.0	1.4	m
32	1.0+1.4=2.4	2.0	1.4	m
33	0.8+1.4=2.2	1.8	1.7	m
34	0.8+1.4=2.2	1.8	1.7	m
35	0.8+1.4=2.2	1.8	1.7	m
36	0.8+1.4=2.2	1.8	1.7	m
37	0.7+1.3=2.0	1.6	1.8	sm
38	0.7+1.3=2.0	1.6	1.8	sm
39	0.7+1.3=2.0	1.6	1.8	sm
40	0.7+1.3=2.0	1.6	1.8	sm

Table 4. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe arisutlifera*, 2n=40

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.8+2.6=4.4	3.7	1.4	m
2	1.8+2.6=4.4	3.7	1.4	m
3	1.8+2.5=4.3	3.7	1.3	m
4	1.8+2.5=4.3	3.7	1.3	m
5	1.7+2.2=3.9	3.3	1.2	m
6	1.7+2.2=3.9	3.3	1.2	m
7	1.5+2.1=3.6	3.1	1.4	m
8	1.5+2.1=3.6	3.1	1.4	m
9	1.1+2.2=3.3	2.8	2.0	sm
10	1.1+2.2=3.3	2.8	2.0	sm
11	0.9+2.3=3.2	2.7	2.5	sm
12	0.9+2.3=3.2	2.7	2.5	sm
13	1.3+1.8=3.1	2.6	1.3	m
14	1.3+1.8=3.1	2.6	1.3	m
15	0.8+2.3=3.1	2.6	2.8	sm
16	0.8+2.3=3.1	2.6	2.8	sm
17	0.9+2.1=3.0	2.6	2.3	sm
18	0.9+2.1=3.0	2.6	2.3	sm
19	1.0+1.9=2.9	2.5	1.9	sm
20	1.0+1.9=2.9	2.5	1.9	sm
21	0.9+1.9=2.8	2.4	2.1	sm
22	0.9+1.9=2.8	2.4	2.1	sm
23	0.7+2.0=2.7	2.3	2.8	sm
24	0.7+2.0=2.7	2.3	2.8	sm
25	1.1+1.5=2.6	2.2	1.3	m
26	1.1+1.5=2.6	2.2	1.3	m
27	0.9+1.7=2.6	2.2	1.8	sm
28	0.9+1.7=2.6	2.2	1.8	sm
29	0.9+1.7=2.6	2.2	1.8	sm
30	0.9+1.7=2.6	2.2	1.8	sm
31	0.8+1.7=2.5	2.1	2.1	sm
32	0.8+1.7=2.5	2.1	2.1	sm
33	0.9+1.3=2.2	1.9	1.4	m
34	0.9+1.3=2.2	1.9	1.4	m
35	1.0+1.1=2.1	1.8	1.1	m
36	1.0+1.1=2.1	1.8	1.1	m
37	0.8+1.2=2.0	1.7	1.5	m
38	0.7+1.2=1.9	1.6	1.7	m
39	0.7+1.2=1.9	1.6	1.7	m
40	0.7+1.2=1.9	1.6	1.7	m

Table 5. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe caudatilabella*, 2n=38

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	2.7+3.8=6.5	3.6	1.4	m
2	2.7+3.8=6.5	3.6	1.4	m
3	2.3+3.5=5.8	3.2	1.5	m
4	2.3+3.5=5.8	3.2	1.5	m
5	2.3+3.2=5.5	3.0	1.3	m
6	2.3+3.2=5.5	3.0	1.3	m
7	2.2+3.1=5.3	2.9	1.4	m
8	2.2+3.1=5.3	2.9	1.4	m
9	2.5+2.7=5.2	2.9	1.0	m
10	2.5+2.7=5.2	2.9	1.0	m
11	1.5+3.7=5.2	2.9	2.4	sm
12	1.5+3.7=5.2	2.9	2.4	sm
13	1.7+3.5=5.2	2.9	2.0	sm
14	1.7+3.5=5.2	2.9	2.0	sm
15	1.5+3.5=5.0	2.8	2.3	sm
16	1.5+3.5=5.0	2.8	2.3	sm
17	2.0+2.8=4.8	2.7	1.4	m
18	2.0+2.8=4.8	2.7	1.4	m
19	1.6+3.1=4.7	2.6	1.9	sm
20	1.6+3.1=4.7	2.6	1.9	sm
21	1.6+3.1=4.7	2.6	1.9	sm
22	1.6+3.1=4.7	2.6	1.9	sm
23	2.2+2.4=4.6	2.5	1.0	m
24	2.2+2.4=4.6	2.5	1.0	m
25	1.3+3.1=4.4	2.4	2.3	sm
26	1.3+3.1=4.4	2.4	2.3	sm
27	1.3+2.9=4.2	2.3	2.2	sm
28	1.3+2.9=4.2	2.3	2.2	sm
29	1.3+2.8=4.1	2.3	2.1	sm
30	1.3+2.8=4.1	2.3	2.1	sm
31	1.5+2.5=4.0	2.2	1.6	m
32	1.5+2.5=4.0	2.2	1.6	m
33	1.6+2.2=3.8	2.1	1.3	m
34	1.6+2.2=3.8	2.1	1.3	m
35	1.7+2.1=3.8	2.1	1.2	m
36	1.7+2.1=3.8	2.1	1.2	m
37	1.7+2.0=3.7	2.0	1.1	m
38	1.7+2.0=3.7	2.0	1.1	m

Table 6. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe conspicua*, 2n=40

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	2.0+2.5=4.5	3.4	1.2	m
2	2.0+2.5=4.5	3.4	1.2	m
3	1.5+3.0=4.5	3.4	2.0	sm
4	1.5+3.0=4.5	3.4	2.0	sm
5	1.8+2.5=4.3	3.2	1.3	m
6	1.8+2.5=4.3	3.2	1.3	m
7	2.0+2.3=4.3	3.2	1.1	m
8	2.0+2.3=4.3	3.2	1.1	m
9	1.9+2.1=4.0	3.0	1.1	m
10	1.9+2.1=4.0	3.0	1.1	m
11	1.9+1.9=3.8	2.9	1.0	m
12	1.9+1.9=3.8	2.9	1.0	m
13	1.8+2.0=3.8	2.9	1.1	m
14	1.8+2.0=3.8	2.9	1.1	m
15	1.2+2.3=3.5	2.6	1.9	sm
16	1.2+2.3=3.5	2.6	1.9	sm
17	1.1+2.1=3.2	2.4	1.9	sm
18	1.1+2.1=3.2	2.4	1.9	sm
19	1.5+1.7=3.2	2.4	1.1	m
20	1.5+1.7=3.2	2.4	1.1	m
21	1.4+1.8=3.2	2.4	1.2	m
22	1.4+1.8=3.2	2.4	1.2	m
23	1.2+1.8=3.0	2.3	1.5	m
24	1.2+1.8=3.0	2.3	1.5	m
25	0.9+2.1=3.0	2.3	2.3	sm
26	0.9+2.1=3.0	2.3	2.3	sm
27	0.9+2.0=2.9	2.2	2.2	sm
28	0.9+2.0=2.9	2.2	2.2	sm
29	1.1+1.7=2.8	2.1	1.5	m
30	1.1+1.7=2.8	2.1	1.5	m
31	1.3+1.4=2.7	2.0	1.0	m
32	1.3+1.4=2.7	2.0	1.0	m
33	0.7+2.0=2.7	2.0	2.8	sm
34	0.7+2.0=2.7	2.0	2.8	sm
35	0.9+1.7=2.6	2.0	1.8	sm
36	0.9+1.7=2.6	2.0	1.8	sm
37	1.0+1.3=2.3	1.7	1.3	m
38	1.0+1.3=2.3	1.7	1.3	m
39	0.8+1.4=2.2	1.7	1.7	m
40	0.8+1.4=2.2	1.7	1.7	m

Table 7. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe cremeo-viridis*, 2n=46

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.6+2.7=4.3	3.0	1.6	m
2	1.6+2.7=4.3	3.0	1.6	m
3	1.7+2.6=4.3	3.0	1.5	m
4	1.7+2.6=4.3	3.0	1.5	m
5	1.7+2.5=4.2	2.9	1.4	m
6	1.7+2.5=4.2	2.9	1.4	m
7	1.7+2.3=4.0	2.8	1.3	m
8	1.7+2.3=4.0	2.8	1.3	m
9	1.7+2.0=3.7	2.6	1.1	m
10	1.7+2.0=3.7	2.6	1.1	m
11	1.5+2.2=3.7	2.6	1.4	m
12	1.5+2.2=3.7	2.6	1.4	m
13	1.4+2.3=3.7	2.6	1.6	m
14	1.4+2.3=3.7	2.6	1.6	m
15	1.3+2.1=3.4	2.4	1.6	m
16	1.3+2.1=3.4	2.4	1.6	m
17	1.6+1.7=3.3	2.3	1.0	m
18	1.6+1.7=3.3	2.3	1.0	m
19	1.3+1.9=3.2	2.2	1.4	m
20	1.3+1.9=3.2	2.2	1.4	m
21	1.0+2.2=3.2	2.2	2.2	sm
22	1.0+2.2=3.2	2.2	2.2	sm
23	1.0+2.1=3.1	2.2	2.1	sm
24	1.0+2.1=3.1	2.2	2.1	sm
25	1.2+1.7=2.9	2.0	1.4	m
26	1.2+1.7=2.9	2.0	1.4	m
27	1.3+1.5=2.8	2.0	1.1	m
28	1.3+1.5=2.8	2.0	1.1	m
29	0.7+1.9=2.6	1.8	2.7	sm
30	0.7+1.9=2.6	1.8	2.7	sm
31	0.9+1.7=2.6	1.8	1.8	sm
32	0.9+1.7=2.6	1.8	1.8	sm
33	1.1+1.5=2.6	1.8	1.3	m
34	1.1+1.5=2.6	1.8	1.3	m
35	1.0+1.6=2.6	1.8	1.6	m
36	1.0+1.6=2.6	1.8	1.6	m
37	0.9+1.7=2.6	1.8	1.8	sm
38	0.9+1.7=2.6	1.8	1.8	sm
39	0.7+1.8=2.5	1.7	2.5	sm
40	0.6+1.8=2.4	1.7	3.0	sm
41	1.0+1.3=2.3	1.6	1.3	m
42	1.0+1.3=2.3	1.6	1.3	m
43	0.9+1.3=2.2	1.5	1.4	m
44	0.9+1.3=2.2	1.5	1.4	m
45	0.9+1.2=2.1	1.5	1.3	m
46	0.8+1.0=1.8	1.3	1.2	m

Table 8. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe graciliflora*, 2n=40

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	2.0+2.8=4.8	4.0	1.4	m
2	1.8+2.3=4.1	3.4	1.2	m
3	1.0+3.0=4.0	3.3	3.0	sm
4	1.0+3.0=4.0	3.3	3.0	sm
5	1.1+2.6=3.7	3.1	2.3	sm
6	1.1+2.6=3.7	3.1	2.3	sm
7	0.7+3.0=3.7	3.1	4.2	st
8	0.7+3.0=3.7	3.1	4.2	st
9	1.4+2.3=3.7	3.1	1.6	m
10	1.4+2.3=3.7	3.1	1.6	m
11	1.3+2.0=3.3	2.7	1.5	m
12	1.3+2.0=3.3	2.7	1.5	m
13	1.0+2.3=3.3	2.7	2.3	sm
14	1.0+2.3=3.3	2.7	2.3	sm
15	1.0+2.2=3.2	2.7	2.2	sm
16	1.0+2.2=3.2	2.7	2.2	sm
17	1.3+1.8=3.1	2.6	1.3	m
18	1.3+1.8=3.1	2.6	1.3	m
19	1.2+1.8=3.0	2.5	1.5	m
20	1.2+1.8=3.0	2.5	1.5	m
21	0.8+2.2=3.0	2.5	2.7	sm
22	0.8+2.2=3.0	2.5	2.7	sm
23	0.9+2.0=2.9	2.4	2.2	sm
24	0.9+2.0=2.9	2.4	2.2	sm
25	1.0+1.8=2.8	2.3	1.8	sm
26	1.0+1.8=2.8	2.3	1.8	sm
27	0.8+1.8=2.6	2.2	2.2	sm
28	0.8+1.8=2.6	2.2	2.2	sm
29	0.8+1.7=2.5	2.1	2.1	sm
30	0.8+1.7=2.5	2.1	2.1	sm
31	1.1+1.3=2.4	2.0	1.1	m
32	1.1+1.3=2.4	2.0	1.1	m
33	1.0+1.4=2.4	2.0	1.4	m
34	1.0+1.4=2.4	2.0	1.4	m
35	0.7+1.4=2.1	1.7	2.0	sm
36	0.7+1.4=2.1	1.7	2.0	sm
37	0.9+1.2=2.1	1.7	1.3	m
38	0.9+1.2=2.1	1.7	1.3	m
39	0.9+1.1=2.0	1.7	1.2	m
40	0.9+1.1=2.0	1.7	1.2	m

Table 9. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe hamata*, 2n=40

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	2.1+3.5=5.6	3.8	1.6	m
2	2.1+3.2=5.3	3.5	1.5	m
3	1.9+3.3=5.2	3.5	1.7	m
4	1.9+3.3=5.2	3.5	1.7	m
5	1.7+3.2=4.9	3.3	1.8	sm
6	1.7+3.2=4.9	3.3	1.8	sm
7	1.9+2.7=4.6	3.1	1.4	m
8	1.9+2.7=4.6	3.1	1.4	m
9	1.5+2.9=4.4	2.9	1.9	sm
10	1.5+2.9=4.4	2.9	1.9	sm
11	1.2+2.9=4.1	2.7	2.4	sm
12	1.2+2.9=4.1	2.7	2.4	sm
13	0.9+3.0=3.9	2.6	3.3	st
14	0.9+3.0=3.9	2.6	3.3	st
15	0.9+3.0=3.9	2.6	3.3	st
16	0.9+3.0=3.9	2.6	3.3	st
17	1.1+2.7=3.8	2.5	2.4	sm
18	1.1+2.7=3.8	2.5	2.4	sm
19	1.3+2.3=3.6	2.4	1.7	m
20	1.3+2.3=3.6	2.4	1.7	m
21	1.7+1.8=3.5	2.3	1.0	m
22	1.7+1.8=3.5	2.3	1.0	m
23	1.7+1.8=3.5	2.3	1.0	m
24	1.7+1.8=3.5	2.3	1.0	m
25	1.2+2.3=3.5	2.3	1.9	sm
26	1.2+2.3=3.5	2.3	1.9	sm
27	1.0+2.5=3.5	2.3	2.5	sm
28	1.0+2.5=3.5	2.3	2.5	sm
29	1.2+2.3=3.5	2.3	1.9	sm
30	1.2+2.3=3.5	2.3	1.9	sm
31	1.3+2.0=3.3	2.2	1.5	m
32	1.3+2.0=3.3	2.2	1.5	m
33	0.8+2.1=2.9	1.9	2.6	sm
34	0.2+0.8+2.1=3.1*	2.1	2.1	sm
35	1.0+1.5=2.5	1.7	1.5	m
36	0.3+1.0+1.5=2.8*	1.9	1.2	m
37	1.1+1.3=2.4	1.6	1.1	m
38	1.1+1.3=2.4	1.6	1.1	m
39	0.8+1.4=2.2	1.5	1.7	m
40	0.8+1.4=2.2	1.5	1.7	m

* : Chromosome with secondary constriction

Table 10. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe hancockii*, 2n=40

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	2.6+2.7=5.3	4.0	1.0	m
2	2.6+2.7=5.3	4.0	1.0	m
3	2.3+2.9=5.2	3.9	1.2	m
4	2.3+2.9=5.2	3.9	1.2	m
5	1.5+3.0=4.5	3.4	2.0	sm
6	1.5+3.0=4.5	3.4	2.0	sm
7	1.7+2.1=3.8	2.9	1.2	m
8	1.7+2.1=3.8	2.9	1.2	m
9	0.3+1.4+2.3=4.0*	3.0	1.4	m
10	1.4+2.3=3.7	2.8	1.6	m
11	1.3+2.4=3.7	2.8	1.8	sm
12	1.3+2.4=3.7	2.8	1.8	sm
13	1.1+2.3=3.4	2.6	2.0	sm
14	1.1+2.3=3.4	2.6	2.0	sm
15	1.1+2.3=3.4	2.6	2.0	sm
16	1.1+2.3=3.4	2.6	2.0	sm
17	1.0+2.4=3.4	2.6	2.4	sm
18	1.0+2.4=3.4	2.6	2.4	sm
19	1.0+2.2=3.2	2.4	2.2	sm
20	1.0+2.2=3.2	2.4	2.2	sm
21	1.3+1.8=3.1	2.3	1.3	m
22	1.3+1.8=3.1	2.3	1.3	m
23	1.3+1.7=3.0	2.3	1.3	m
24	1.3+1.7=3.0	2.3	1.3	m
25	1.3+1.5=2.8	2.1	1.1	m
26	1.3+1.5=2.8	2.1	1.1	m
27	0.8+2.0=2.8	2.1	2.5	sm
28	0.8+2.0=2.8	2.1	2.5	sm
29	1.3+1.4=2.7	2.0	1.0	m
30	1.3+1.4=2.7	2.0	1.0	m
31	1.0+1.6=2.6	2.0	1.6	m
32	1.0+1.6=2.6	2.0	1.6	m
33	0.9+1.6=2.5	1.9	1.7	m
34	0.9+1.6=2.5	1.9	1.7	m
35	0.8+1.7=2.5	1.9	2.1	sm
36	0.8+1.7=2.5	1.9	2.1	sm
37	1.1+1.2=2.3	1.7	1.0	m
38	1.1+1.2=2.3	1.7	1.0	m
39	1.0+1.3=2.3	1.7	1.3	m
40	1.0+1.3=2.3	1.7	1.3	m

* : Chromosome with secondary constriction

Table 11. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe herbacea*, 2n=40

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	2.1+3.2=5.3	3.5	1.5	m
2	2.1+3.2=5.3	3.5	1.5	m
3	2.2+2.7=4.9	3.3	1.2	m
4	2.2+2.7=4.9	3.3	1.2	m
5	2.1+2.7=4.8	3.2	1.2	m
6	2.1+2.7=4.8	3.2	1.2	m
7	2.0+2.7=4.7	3.1	1.3	m
8	2.0+2.7=4.7	3.1	1.3	m
9	1.8+2.3=4.1	2.7	1.2	m
10	1.8+2.3=4.1	2.7	1.2	m
11	1.9+2.2=4.1	2.7	1.1	m
12	1.9+2.2=4.1	2.7	1.1	m
13	1.7+2.3=4.0	2.7	1.3	m
14	1.7+2.3=4.0	2.7	1.3	m
15	1.5+2.4=3.9	2.6	1.6	m
16	1.5+2.4=3.9	2.6	1.6	m
17	1.5+2.3=3.8	2.5	1.5	m
18	1.5+2.3=3.8	2.5	1.5	m
19	1.3+2.3=3.6	2.4	1.7	m
20	1.3+2.3=3.6	2.4	1.7	m
21	1.3+2.3=3.6	2.4	1.7	m
22	1.3+2.3=3.6	2.4	1.7	m
23	1.7+1.8=3.5	2.3	1.0	m
24	1.7+1.8=3.5	2.3	1.0	m
25	1.4+2.0=3.4	2.3	1.4	m
26	1.3+2.0=3.3	2.2	1.5	m
27	1.7+1.7+0.5=3.9*	2.6	1.2	m
28	1.7+1.7=3.4	2.2	1.0	m
29	0.9+2.4=3.3	2.2	2.6	sm
30	0.9+2.4=3.3	2.2	2.6	sm
31	1.1+2.0=3.1	2.1	1.8	sm
32	1.1+2.0=3.1	2.1	1.8	sm
33	0.9+2.2=3.1	2.1	2.4	sm
34	0.9+2.2=3.1	2.1	2.4	sm
35	0.9+2.1=3.0	2.0	2.3	sm
36	0.9+2.1=3.0	2.0	2.3	sm
37	1.4+1.5=2.9	1.9	1.0	m
38	1.3+1.5=2.8	1.9	1.1	m
39	1.1+1.3=2.4	1.6	1.1	m
40	1.1+1.3=2.4	1.6	1.1	m

* : Chromosome with secondary constriction

Table 12. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe mannii*, 2n=40

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	2.1+2.3=4.4	3.6	1.0	m
2	2.1+2.3=4.4	3.6	1.0	m
3	1.8+2.0=3.8	3.1	1.1	m
4	1.8+2.0=3.8	3.1	1.1	m
5	1.2+2.6=3.8	3.1	2.1	sm
6	1.2+2.6=3.8	3.1	2.1	sm
7	1.0+2.7=3.7	3.0	2.7	sm
8	1.0+2.7=3.7	3.0	2.7	sm
9	1.3+2.3=3.6	3.0	1.7	m
10	1.3+2.3=3.6	3.0	1.7	m
11	0.9+2.5=3.4	2.8	2.7	sm
12	0.9+2.5=3.4	2.8	2.7	sm
13	1.4+1.8=3.2	2.6	1.2	m
14	1.4+1.8=3.2	2.6	1.2	m
15	0.8+2.3=3.1	2.5	2.8	sm
16	0.8+2.3=3.1	2.5	2.8	sm
17	0.7+2.3=3.0	2.5	3.2	st
18	0.7+2.3=3.0	2.5	3.2	st
19	1.4+1.5=2.9	2.4	1.0	m
20	1.4+1.5=2.9	2.4	1.0	m
21	1.2+1.7=2.9	2.4	1.4	m
22	1.2+1.7=2.9	2.4	1.4	m
23	1.0+1.8=2.8	2.3	1.8	sm
24	1.0+1.8=2.8	2.3	1.8	sm
25	1.2+1.6=2.8	2.3	1.3	m
26	1.2+1.6=2.8	2.3	1.3	m
27	1.2+1.6=2.8	2.3	1.3	m
28	1.2+1.6=2.8	2.3	1.3	m
29	0.8+1.9=2.7	2.2	2.3	sm
30	0.8+1.9=2.7	2.2	2.3	sm
31	0.9+1.8=2.7	2.2	2.0	sm
32	0.9+1.8=2.7	2.2	2.0	sm
33	0.9+1.8=2.7	2.2	2.0	sm
34	0.9+1.8=2.7	2.2	2.0	sm
35	0.8+1.8=2.6	2.1	2.2	sm
36	0.8+1.8=2.6	2.1	2.2	sm
37	1.0+1.3=2.3	1.9	1.3	m
38	1.0+1.3=2.3	1.9	1.3	m
39	0.7+1.0=1.7	1.4	1.4	m
40	0.7+1.0=1.7	1.4	1.4	m

Table 13. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe masuca*, 2n=40

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	2.2+2.7=4.9	3.4	1.2	m
2	2.2+2.7=4.9	3.4	1.2	m
3	1.9+2.8=4.7	3.2	1.4	m
4	1.9+2.8=4.7	3.2	1.4	m
5	1.7+2.8=4.5	3.1	1.6	m
6	1.7+2.8=4.5	3.1	1.6	m
7	1.7+2.7=4.4	3.0	1.5	m
8	1.7+2.7=4.4	3.0	1.5	m
9	1.9+2.4=4.3	3.0	1.2	m
10	1.9+2.4=4.3	3.0	1.2	m
11	2.0+2.3=4.3	3.0	1.1	m
12	1.9+2.3=4.2	2.9	1.2	m
13	1.7+2.4=4.1	2.8	1.4	m
14	1.7+2.4=4.1	2.8	1.4	m
15	1.3+2.4=3.7	2.5	1.8	sm
16	1.3+2.4=3.7	2.5	1.8	sm
17	1.3+2.4=3.7	2.5	1.8	sm
18	1.3+2.4=3.7	2.5	1.8	sm
19	1.3+2.4=3.7	2.5	1.8	sm
20	1.3+2.4=3.7	2.5	1.8	sm
21	1.7+1.8=3.5	2.4	1.0	m
22	1.7+1.8=3.5	2.4	1.0	m
23	1.3+1.9=3.2	2.2	1.4	m
24	1.3+1.9=3.2	2.2	1.4	m
25	1.2+2.0=3.2	2.2	1.6	m
26	1.2+2.0=3.2	2.2	1.6	m
27	1.1+2.1=3.2	2.2	1.9	sm
28	1.1+2.1=3.2	2.2	1.9	sm
29	1.1+2.0=3.1	2.1	1.8	sm
30	1.1+2.0=3.1	2.1	1.8	sm
31	0.8+2.3=3.1	2.1	2.8	sm
32	0.8+2.3=3.1	2.1	2.8	sm
33	1.2+1.8=3.0	2.1	1.5	m
34	1.2+1.8=3.0	2.1	1.5	m
35	0.8+2.2=3.0	2.1	2.7	sm
36	0.8+2.2=3.0	2.1	2.7	sm
37	0.9+1.7=2.6	1.8	1.8	sm
38	0.9+1.7=2.6	1.8	1.8	sm
39	1.3+1.3=2.6	1.8	1.0	m
40	1.3+1.3=2.6	1.8	1.0	m

Table 14. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe matsudai*, 2n=40

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	2.3+3.4=5.7	4.0	1.4	m
2	2.3+3.1=5.4	3.7	1.3	m
3	1.9+3.5=5.4	3.7	1.8	sm
4	1.9+3.5=5.4	3.7	1.8	sm
5	1.6+3.1=4.7	3.3	1.9	sm
6	1.2+3.4=4.6	3.2	2.8	sm
7	1.7+2.9=4.6	3.2	1.7	m
8	1.7+2.9=4.6	3.2	1.7	m
9	1.7+2.5=4.2	2.9	1.4	m
10	1.7+2.5=4.2	2.9	1.4	m
11	1.5+2.5=4.0	2.8	1.6	m
12	1.5+2.5=4.0	2.8	1.6	m
13	1.2+2.5=3.7	2.6	2.0	m
14	1.2+2.5=3.7	2.6	2.0	m
15	1.6+2.1=3.7	2.6	1.3	sm
16	1.6+2.1=3.7	2.6	1.3	sm
17	0.7+2.9=3.6	2.5	4.1	st
18	0.7+2.9=3.6	2.5	4.1	st
19	1.0+2.5=3.5	2.4	2.5	sm
20	1.0+2.5=3.5	2.4	2.5	sm
21	1.2+2.2=3.4	2.4	1.8	sm
22	1.2+2.2=3.4	2.4	1.8	sm
23	1.1+2.3=3.4	2.4	2.0	sm
24	1.1+2.3=3.4	2.4	2.0	sm
25	1.0+2.3=3.3	2.3	2.3	sm
26	0.9+2.2=3.1	2.1	2.4	sm
27	1.3+1.7=3.0	2.1	1.3	m
28	1.3+1.7=3.0	2.1	1.3	m
29	1.3+1.7=3.0	2.1	1.3	m
30	1.3+1.7=3.0	2.1	1.3	m
31	1.1+1.7=2.8	1.9	1.5	m
32	1.1+1.7=2.8	1.9	1.5	m
33	0.8+2.0=2.8	1.9	2.5	sm
34	0.8+2.0=2.8	1.9	2.5	sm
35	1.0+1.7=2.7	1.9	1.7	m
36	1.0+1.7=2.7	1.9	1.7	m
37	1.1+1.5=2.6	1.8	1.3	m
38	1.1+1.5=2.6	1.8	1.3	m
39	0.9+1.5=2.4	1.7	1.6	m
40	1.0+1.2=2.2	1.5	1.2	m

Table 15. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe plantaginea*, 2n=40

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.8+2.5=4.3	3.4	1.3	m
2	1.8+2.5=4.3	3.4	1.3	m
3	0.9+3.3=4.2	3.3	3.6	st
4	0.9+3.3=4.2	3.3	3.6	st
5	0.9+3.3=4.2	3.3	3.6	st
6	0.9+3.3=4.2	3.3	3.6	st
7	0.9+2.8=3.7	2.9	3.1	st
8	0.9+2.8=3.7	2.9	3.1	st
9	1.0+2.7=3.7	2.9	2.7	sm
10	1.0+2.7=3.7	2.9	2.7	sm
11	1.7+2.0=3.7	2.9	1.1	m
12	1.7+2.0=3.7	2.9	1.1	m
13	1.5+2.0=3.5	2.7	1.3	m
14	1.5+2.0=3.5	2.7	1.3	m
15	1.0+2.5=3.5	2.7	2.5	sm
16	1.0+2.5=3.5	2.7	2.5	sm
17	0.9+2.5=3.4	2.7	2.7	sm
18	0.9+2.5=3.4	2.7	2.7	sm
19	1.1+2.3=3.4	2.7	2.0	sm
20	1.1+2.3=3.4	2.7	2.0	sm
21	0.8+2.3=3.1	2.4	2.8	sm
22	0.8+2.3=3.1	2.4	2.8	sm
23	1.0+1.9=2.9	2.3	1.9	sm
24	1.0+1.9=2.9	2.3	1.9	sm
25	1.0+1.9=2.9	2.3	1.9	sm
26	1.0+1.9=2.9	2.3	1.9	sm
27	1.3+1.5=2.8	2.2	1.1	m
28	1.3+1.5=2.8	2.2	1.1	m
29	1.0+1.8=2.8	2.2	1.8	sm
30	1.0+1.8=2.8	2.2	1.8	sm
31	0.9+1.8=2.7	2.1	2.0	sm
32	0.9+1.8=2.7	2.1	2.0	sm
33	1.1+1.5=2.6	2.0	1.3	m
34	1.1+1.5=2.6	2.0	1.3	m
35	1.1+1.3=2.4	1.9	1.1	m
36	1.1+1.3=2.4	1.9	1.1	m
37	1.0+1.2=2.2	1.7	1.2	m
38	1.0+1.2=2.2	1.7	1.2	m
39	0.8+1.3=2.1	1.6	1.6	m
40	0.8+1.3=2.1	1.6	1.6	m

Table 16. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe reflexa*, 2n=40

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	2.3+3.3=5.6	3.7	1.4	m
2	2.0+3.3=5.3	3.5	1.6	m
3	2.1+2.8=4.9	3.2	1.3	m
4	2.1+2.8=4.9	3.2	1.3	m
5	1.6+2.9=4.5	2.9	1.8	sm
6	1.6+2.9=4.5	2.9	1.8	sm
7	1.7+2.7=4.4	2.9	1.5	m
8	1.7+2.7=4.4	2.9	1.5	m
9	1.8+2.5=4.3	2.8	1.3	m
10	1.8+2.5=4.3	2.8	1.3	m
11	1.9+2.3=4.2	2.7	1.2	m
12	1.9+2.3=4.2	2.7	1.2	m
13	1.7+2.4=4.1	2.7	1.4	m
14	1.7+2.4=4.1	2.7	1.4	m
15	1.4+2.7=4.1	2.7	1.9	sm
16	1.4+2.7=4.1	2.7	1.9	sm
17	1.9+2.0=3.9	2.6	1.0	m
18	1.9+2.0=3.9	2.6	1.0	m
19	1.7+2.2=3.9	2.6	1.2	m
20	1.7+2.2=3.9	2.6	1.2	m
21	1.6+1.9=3.5	2.3	1.1	m
22	1.6+1.9=3.5	2.3	1.1	m
23	1.3+2.2=3.5	2.3	1.6	m
24	0.5+3.0=3.5	2.3	6.0	st
25	1.6+1.8=3.4	2.2	1.1	m
26	1.6+1.8=3.4	2.2	1.1	m
27	1.6+1.8=3.4	2.2	1.1	m
28	1.6+1.8=3.4	2.2	1.1	m
29	1.4+2.0=3.4	2.2	1.4	m
30	1.4+2.0=3.4	2.2	1.4	m
31	1.6+1.7=3.3	2.2	1.0	m
32	1.6+1.7=3.3	2.2	1.0	m
33	1.5+0.5+1.1=3.1*	2.0	1.0	m
34	1.5+0.5+1.1=3.1*	2.0	1.0	m
35	1.4+1.7=3.1	2.0	1.2	m
36	1.4+1.7=3.1	2.0	1.2	m
37	1.3+1.7=3.0	2.0	1.3	m
38	1.3+1.7=3.0	2.0	1.3	m
39	1.3+1.7=3.0	2.0	1.3	m
40	1.3+1.7=3.0	2.0	1.3	m

* : Chromosome with secondary constriction

Table 17. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe sieboldii*, 2n=40

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	2.0+2.8=4.8	4.3	1.4	m
2	2.0+2.8=4.8	4.3	1.4	m
3	1.7+2.3=4.0	3.6	1.3	m
4	1.7+2.3=4.0	3.6	1.3	m
5	1.2+2.5=3.7	3.3	2.0	sm
6	1.2+2.5=3.7	3.3	2.0	sm
7	1.0+2.2=3.2	2.9	2.2	sm
8	1.0+2.2=3.2	2.9	2.2	sm
9	1.5+1.7=3.2	2.9	1.1	m
10	1.5+1.7=3.2	2.9	1.1	m
11	1.0+2.2=3.2	2.9	2.2	sm
12	1.0+2.2=3.2	2.9	2.2	sm
13	1.3+1.8=3.1	2.8	1.3	m
14	1.3+1.8=3.1	2.8	1.3	m
15	1.3+1.6=2.9	2.6	1.2	m
16	1.3+1.6=2.9	2.6	1.2	m
17	1.0+1.8=2.8	2.5	1.8	sm
18	1.0+1.8=2.8	2.5	1.8	sm
19	1.0+1.8=2.8	2.5	1.8	sm
20	1.0+1.8=2.8	2.5	1.8	sm
21	1.0+1.7=2.7	2.4	1.7	m
22	1.0+1.7=2.7	2.4	1.7	m
23	1.2+1.3=2.5	2.2	1.0	m
24	1.2+1.3=2.5	2.2	1.0	m
25	0.7+1.7=2.4	2.1	2.4	sm
26	0.7+1.7=2.4	2.1	2.4	sm
27	1.0+1.3=2.3	2.1	1.3	m
28	1.0+1.3=2.3	2.1	1.3	m
29	1.0+1.3=2.3	2.1	1.3	m
30	1.0+1.3=2.3	2.1	1.3	m
31	0.7+1.5=2.2	2.0	2.1	sm
32	0.7+1.5=2.2	2.0	2.1	sm
33	0.9+1.3=2.2	2.0	1.4	m
34	0.9+1.3=2.2	2.0	1.4	m
35	0.8+1.3=2.1	1.9	1.6	m
36	0.8+1.3=2.1	1.9	1.6	m
37	0.8+1.2=2.0	1.8	1.5	m
38	0.8+1.2=2.0	1.8	1.5	m
39	0.7+1.0=1.7	1.5	1.4	m
40	0.6+0.9=1.5	1.3	1.5	m

Table 18. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe sylvatica*, 2n=40

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	2.8+5.4=8.2	3.7	1.9	sm
2	2.8+5.4=8.2	3.7	1.9	sm
3	2.5+5.7=8.2	3.7	2.2	sm
4	2.5+5.7=8.2	3.7	2.2	sm
5	2.3+5.0=7.3	3.3	2.1	sm
6	2.0+5.0=7.0	3.2	2.5	sm
7	1.7+5.3=7.0	3.2	3.1	st
8	1.7+5.3=7.0	3.2	3.1	st
9	3.0+3.8=6.8	3.1	1.2	m
10	3.0+3.8=6.8	3.1	1.2	m
11	1.8+4.2=6.0	2.7	2.3	sm
12	1.8+4.2=6.0	2.7	2.3	sm
13	2.8+3.2=6.0	2.7	1.1	m
14	2.6+3.2=5.8	2.6	1.2	m
15	2.1+3.3=5.4	2.4	1.5	m
16	2.1+3.3=5.4	2.4	1.5	m
17	1.8+3.6=5.4	2.4	2.0	sm
18	1.8+3.6=5.4	2.4	2.0	sm
19	2.3+3.0=5.3	2.4	1.3	sm
20	2.3+3.0=5.3	2.4	1.3	sm
21	2.0+3.3=5.3	2.4	1.6	m
22	2.0+3.3=5.3	2.4	1.6	m
23	0.8+4.2=5.0	2.3	5.2	st
24	0.8+4.2=5.0	2.3	5.2	st
25	1.7+3.0=4.7	2.1	1.7	m
26	1.7+3.0=4.7	2.1	1.7	m
27	1.0+3.5=4.5	2.0	3.5	st
28	1.0+3.5=4.5	2.0	3.5	st
29	2.2+2.3=4.5	2.0	1.0	m
30	2.2+2.3=4.5	2.0	1.0	m
31	2.0+2.3=4.3	1.9	1.1	m
32	2.0+2.3=4.3	1.9	1.1	m
33	1.8+2.5=4.3	1.9	1.3	m
34	1.8+2.5=4.3	1.9	1.3	m
35	1.8+2.5=4.3	1.9	1.3	m
36	1.8+2.5=4.3	1.9	1.3	m
37	1.2+3.0=4.2	1.9	2.5	sm
38	1.2+3.0=4.2	1.9	2.5	sm
39	1.2+2.7=3.9	1.8	2.2	sm
40	1.2+2.7=3.9	1.8	2.2	sm

Table 19. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe tricarinata*, 2n=40

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	2.3+3.3=5.6	3.4	1.4	m
2	2.3+3.3=5.6	3.4	1.4	m
3	2.3+3.2=5.5	3.3	1.3	m
4	2.3+3.2=5.5	3.3	1.3	m
5	2.3+2.7=5.0	3.0	1.1	m
6	2.3+2.7=5.0	3.0	1.1	m
7	1.9+2.7=4.6	2.8	1.4	m
8	1.9+2.7=4.6	2.8	1.4	m
9	1.5+3.0=4.5	2.7	2.0	sm
10	1.5+3.0=4.5	2.7	2.0	sm
11	1.7+2.7=4.4	2.7	1.5	m
12	1.7+2.7=4.4	2.7	1.5	m
13	2.0+2.3=4.3	2.6	1.1	m
14	2.0+2.3=4.3	2.6	1.1	m
15	1.3+3.0=4.3	2.6	2.3	sm
16	1.3+3.0=4.3	2.6	2.3	sm
17	1.7+2.6=4.3	2.6	1.5	m
18	1.7+2.6=4.3	2.6	1.5	m
19	1.3+2.8=4.1	2.5	2.1	sm
20	1.3+2.8=4.1	2.5	2.1	sm
21	1.5+2.6=4.1	2.5	1.7	m
22	1.5+2.6=4.1	2.5	1.7	m
23	1.4+2.5=3.9	2.4	1.7	m
24	1.4+2.5=3.9	2.4	1.7	m
25	1.7+2.1=3.8	2.3	1.2	m
26	1.7+2.1=3.8	2.3	1.2	m
27	1.3+2.5=3.8	2.3	1.9	sm
28	1.3+2.5=3.8	2.3	1.9	sm
29	1.3+2.5=3.8	2.3	1.9	sm
30	1.3+2.5=3.8	2.3	1.9	sm
31	0.9+2.8=3.7	2.2	3.1	st
32	0.9+2.8=3.7	2.2	3.1	st
33	1.4+2.3=3.7	2.2	1.6	m
34	1.4+2.3=3.7	2.2	1.6	m
35	1.1+2.3=3.4	2.1	2.0	sm
36	1.1+2.3=3.4	2.1	2.0	sm
37	1.5+1.7=3.2	1.9	1.1	m
38	1.5+1.7=3.2	1.9	1.1	m
39	1.3+1.4=2.7	1.6	1.0	m
40	1.3+1.4=2.7	1.6	1.0	m

Table 20. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe triplicata*, 2n=40

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.8+2.2=4.0	3.3	1.2	m
2	1.8+2.2=4.0	3.3	1.2	m
3	1.8+2.0=3.8	3.2	1.1	m
4	1.8+2.0=3.8	3.2	1.1	m
5	1.7+2.1=3.8	3.2	1.2	m
6	1.7+2.1=3.8	3.2	1.2	m
7	1.6+2.2=3.8	3.2	1.3	m
8	1.6+2.2=3.8	3.2	1.3	m
9	1.6+1.9=3.5	2.9	1.1	m
10	1.6+1.9=3.5	2.9	1.1	m
11	1.7+1.8=3.5	2.9	1.0	m
12	1.7+1.8=3.5	2.9	1.0	m
13	1.7+1.7=3.4	2.8	1.0	m
14	1.7+1.7=3.4	2.8	1.0	m
15	1.2+2.2=3.4	2.8	1.8	sm
16	1.1+2.1=3.2	2.7	1.9	sm
17	1.6+1.7=3.3	2.8	1.0	m
18	1.6+1.7=3.3	2.8	1.0	m
19	1.5+1.6=3.1	2.8	1.0	m
20	1.5+1.6=3.1	2.8	1.0	m
21	1.4+1.5=2.9	2.4	1.0	m
22	1.4+1.5=2.9	2.4	1.0	m
23	1.2+1.6=2.8	2.3	1.3	m
24	1.2+1.6=2.8	2.3	1.3	m
25	0.9+1.7=2.6	2.2	1.8	sm
26	0.9+1.7=2.6	2.2	1.8	sm
27	0.8+1.7=2.5	2.1	2.1	sm
28	0.8+1.7=2.5	2.1	2.1	sm
29	1.2+1.3=2.5	2.1	1.0	m
30	1.2+1.3=2.5	2.1	1.0	m
31	1.2+1.3=2.5	2.1	1.0	m
32	1.2+1.3=2.5	2.1	1.0	m
33	1.0+1.3=2.3	1.9	1.3	m
34	1.0+1.3=2.3	1.9	1.3	m
35	0.8+1.5=2.3	1.9	1.8	sm
36	0.8+1.5=2.3	1.9	1.8	sm
37	1.0+1.1=2.1	1.8	1.1	m
38	1.0+1.1=2.1	1.8	1.1	m
39	0.7+1.3=2.0	1.7	1.8	sm
40	0.7+1.3=2.0	1.7	1.8	sm

Table 21. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe clavata*, 2n=40

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	2.0+2.5=4.5	3.5	1.2	m
2	2.0+2.5=4.5	3.5	1.2	m
3	1.7+2.3=4.0	3.1	1.3	m
4	1.7+2.3=4.0	3.1	1.3	m
5	1.7+2.1=3.8	3.0	1.2	m
6	1.7+2.1=3.8	3.0	1.2	m
7	1.3+2.3=3.6	2.8	1.7	m
8	1.3+2.3=3.6	2.8	1.7	m
9	1.1+2.3=3.4	2.7	2.0	sm
10	1.1+2.3=3.4	2.7	2.0	sm
11	1.5+1.9=3.4	2.7	1.2	m
12	1.5+1.9=3.4	2.7	1.2	m
13	1.6+1.7=3.3	2.6	1.0	m
14	1.6+1.7=3.3	2.6	1.0	m
15	1.3+1.9=3.2	2.5	1.4	m
16	1.3+1.9=3.2	2.5	1.4	m
17	1.3+1.9=3.2	2.5	1.4	m
18	1.3+1.9=3.2	2.5	1.4	m
19	1.5+1.7=3.2	2.5	1.1	m
20	1.5+1.7=3.2	2.5	1.1	m
21	1.3+1.8=3.1	2.4	1.3	m
22	1.3+1.8=3.1	2.4	1.3	m
23	1.3+1.7=3.0	2.4	1.3	m
24	1.3+1.7=3.0	2.4	1.3	m
25	1.3+1.7=3.0	2.4	1.3	m
26	1.3+1.7=3.0	2.4	1.3	m
27	1.3+1.7=3.0	2.4	1.3	m
28	1.3+1.7=3.0	2.4	1.3	m
29	1.3+1.7=3.0	2.4	1.3	m
30	1.3+1.7=3.0	2.4	1.3	m
31	1.3+1.5=2.8	2.2	1.1	m
32	1.3+1.5=2.8	2.2	1.1	m
33	1.0+1.6=2.6	2.0	1.6	m
34	1.0+1.6=2.6	2.0	1.6	m
35	0.9+1.7=2.6	2.0	1.8	sm
36	0.9+1.7=2.6	2.0	1.8	sm
37	1.0+1.4=2.4	1.9	1.4	m
38	1.0+1.4=2.4	1.9	1.4	m
39	0.9+1.5=2.4	1.9	1.6	m
40	0.9+1.5=2.4	1.9	1.6	m

Table 22. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe densiflora*, 2n=40

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	2.0+2.5=4.5	3.5	1.2	m
2	2.0+2.5=4.5	3.5	1.2	m
3	1.7+2.3=4.0	3.1	1.3	m
4	1.7+2.3=4.0	3.1	1.3	m
5	1.7+2.1=3.8	3.0	1.2	m
6	1.7+2.1=3.8	3.0	1.2	m
7	1.3+2.3=3.6	2.8	1.7	m
8	1.3+2.3=3.6	2.8	1.7	m
9	1.1+2.3=3.4	2.7	2.0	sm
10	1.1+2.3=3.4	2.7	2.0	sm
11	1.5+1.9=3.4	2.7	1.2	m
12	1.5+1.9=3.4	2.7	1.2	m
13	1.6+1.7=3.3	2.6	1.0	m
14	1.6+1.7=3.3	2.6	1.0	m
15	1.3+1.9=3.2	2.5	1.4	m
16	1.3+1.9=3.2	2.5	1.4	m
17	1.3+1.9=3.2	2.5	1.4	m
18	1.3+1.9=3.2	2.5	1.4	m
19	1.5+1.7=3.2	2.5	1.1	m
20	1.5+1.7=3.2	2.5	1.1	m
21	1.3+1.8=3.1	2.4	1.3	m
22	1.3+1.8=3.1	2.4	1.3	m
23	1.3+1.7=3.0	2.4	1.3	m
24	1.3+1.7=3.0	2.4	1.3	m
25	1.3+1.7=3.0	2.4	1.3	m
26	1.3+1.7=3.0	2.4	1.3	m
27	1.3+1.7=3.0	2.4	1.3	m
28	1.3+1.7=3.0	2.4	1.3	m
29	1.3+1.7=3.0	2.4	1.3	m
30	1.3+1.7=3.0	2.4	1.3	m
31	1.3+1.5=2.8	2.2	1.1	m
32	1.3+1.5=2.8	2.2	1.1	m
33	1.0+1.6=2.6	2.0	1.6	m
34	1.0+1.6=2.6	2.0	1.6	m
35	0.9+1.7=2.6	2.0	1.8	sm
36	0.9+1.7=2.6	2.0	1.8	sm
37	1.0+1.4=2.4	1.9	1.4	m
38	1.0+1.4=2.4	1.9	1.4	m
39	0.9+1.5=2.4	1.9	1.6	m
40	0.9+1.5=2.4	1.9	1.6	m

Table 23. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe formosana*, 2n=40

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.8+2.3=4.1	3.3	1.2	m
2	1.7+2.3=4.0	3.2	1.3	m
3	1.3+2.3=3.6	2.9	1.7	m
4	1.3+2.3=3.6	2.9	1.7	m
5	1.2+2.3=3.5	2.8	1.9	sm
6	1.2+2.3=3.5	2.8	1.9	sm
7	1.4+2.0=3.4	2.7	1.4	m
8	1.4+2.0=3.4	2.7	1.4	m
9	1.4+1.9=3.3	2.7	1.3	m
10	1.4+1.9=3.3	2.7	1.3	m
11	1.3+2.0=3.3	2.7	1.5	m
12	1.3+2.0=3.3	2.7	1.5	m
13	1.1+2.2=3.3	2.7	2.0	sm
14	1.1+2.2=3.3	2.7	2.0	sm
15	1.5+1.7=3.2	2.6	1.1	m
16	1.5+1.7=3.2	2.6	1.1	m
17	1.4+1.7=3.1	2.5	1.2	m
18	1.4+1.7=3.1	2.5	1.2	m
19	1.4+1.7=3.1	2.5	1.2	m
20	1.4+1.7=3.1	2.5	1.2	m
21	1.3+1.8=3.1	2.5	1.3	m
22	1.3+1.8=3.1	2.5	1.3	m
23	1.3+1.7=3.0	2.4	1.3	m
24	1.3+1.7=3.0	2.4	1.3	m
25	1.3+1.7=3.0	2.4	1.3	m
26	1.3+1.7=3.0	2.4	1.3	m
27	1.4+1.5=2.9	2.3	1.0	m
28	1.4+1.5=2.9	2.3	1.0	m
29	1.3+1.6=2.9	2.3	1.2	m
30	1.3+1.6=2.9	2.3	1.2	m
31	1.2+1.7=2.9	2.3	1.4	m
32	1.2+1.7=2.9	2.3	1.4	m
33	1.3+1.5=2.8	2.3	1.1	m
34	1.3+1.5=2.8	2.3	1.1	m
35	1.0+1.7=2.7	2.2	1.7	m
36	1.0+1.7=2.7	2.2	1.7	m
37	0.8+1.7=2.5	2.0	2.1	sm
38	0.8+1.7=2.5	2.0	2.1	sm
39	0.9+1.5=2.4	1.9	1.6	m
40	0.9+1.5=2.4	1.9	1.6	m

Table 24. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe lyroglossa*, 2n=40

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	2.0+2.3=4.3	3.4	1.1	m
2	2.0+2.3=4.3	3.4	1.1	m
3	1.9+1.9=3.8	3.0	1.0	m
4	1.9+1.9=3.8	3.0	1.0	m
5	1.7+2.0=3.7	2.9	1.1	m
6	1.7+2.0=3.7	2.9	1.1	m
7	1.7+2.0=3.7	2.9	1.1	m
8	1.7+2.0=3.7	2.9	1.1	m
9	1.2+2.5=3.7	2.9	2.0	sm
10	1.2+2.5=3.7	2.9	2.0	sm
11	1.7+1.8=3.5	2.7	1.0	m
12	1.7+1.8=3.5	2.7	1.0	m
13	1.7+1.8=3.5	2.7	1.0	m
14	1.7+1.8=3.5	2.7	1.0	m
15	1.7+1.8=3.5	2.7	1.0	m
16	1.7+1.8=3.5	2.7	1.0	m
17	1.6+1.7=3.3	2.6	1.0	m
18	1.6+1.7=3.3	2.6	1.0	m
19	1.6+1.7=3.3	2.6	1.0	m
20	1.6+1.7=3.3	2.6	1.0	m
21	1.5+1.7=3.2	2.5	1.1	m
22	1.5+1.7=3.2	2.5	1.1	m
23	1.3+1.8=3.1	2.4	1.3	m
24	1.3+1.8=3.1	2.4	1.3	m
25	1.2+1.8=3.0	2.4	1.5	m
26	1.2+1.8=3.0	2.4	1.5	m
27	1.3+1.6=2.9	2.3	1.2	m
28	1.3+1.6=2.9	2.3	1.2	m
29	1.1+1.8=2.9	2.3	1.6	m
30	1.1+1.8=2.9	2.3	1.6	m
31	1.3+1.5=2.8	2.2	1.1	m
32	1.3+1.5=2.8	2.2	1.1	m
33	1.3+1.5=2.8	2.2	1.1	m
34	1.3+1.5=2.8	2.2	1.1	m
35	0.9+1.7=2.6	2.0	1.8	sm
36	0.9+1.7=2.6	2.0	1.8	sm
37	0.9+1.2=2.1	1.6	1.3	m
38	0.9+1.2=2.1	1.6	1.3	m
39	0.9+1.1=2.0	1.6	1.2	m
40	0.9+1.1=2.0	1.6	1.2	m

Table 25. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe kooshunensis*, 2n=40

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	2.7+2.9=5.6	3.3	1.0	m
2	2.7+2.9=5.6	3.3	1.0	m
3	1.6+4.0=5.6	3.3	2.5	sm
4	1.6+3.7=5.3	3.1	2.3	sm
5	1.5+3.6=5.1	3.0	2.4	sm
6	1.5+3.6=5.1	3.0	2.4	sm
7	2.5+2.5=5.0	3.0	1.0	m
8	2.3+2.5=4.8	2.8	1.0	m
9	2.3+2.3=4.6	2.7	1.0	m
10	2.3+2.3=4.6	2.7	1.0	m
11	2.0+2.5=4.5	2.7	1.2	m
12	2.0+2.5=4.5	2.7	1.2	m
13	1.3+3.2=4.5	2.7	2.4	sm
14	1.3+3.2=4.5	2.7	2.4	sm
15	0.9+3.5=4.4	2.6	3.8	st
16	0.9+3.5=4.4	2.6	3.8	st
17	1.0+3.3=4.3	2.6	3.3	st
18	1.0+3.3=4.3	2.6	3.3	st
19	1.8−2.3=4.1	2.4	1.2	m
20	1.8−2.3=4.1	2.4	1.2	m
21	1.2−2.8=4.0	2.4	2.3	sm
22	1.2−2.8=4.0	2.4	2.3	sm
23	1.2−2.7=3.9	2.3	2.2	sm
24	1.2+2.7=3.9	2.3	2.2	sm
25	1.7+2.2=3.9	2.3	1.2	m
26	1.7+2.2=3.9	2.3	1.2	m
27	1.2+2.7=3.9	2.3	2.2	sm
28	1.2+2.7=3.9	2.3	2.2	sm
29	1.2+2.7=3.9	2.3	2.2	sm
30	1.2+2.7=3.9	2.3	2.2	sm
31	1.5+2.3=3.8	2.3	1.5	m
32	1.5+2.3=3.8	2.3	1.5	m
33	1.4+2.1=3.5	2.1	1.5	m
34	1.4+2.1=3.5	2.1	1.5	m
35	1.0+2.5=3.5	2.1	2.5	sm
36	1.0+2.5=3.5	2.1	2.5	sm
37	1.3+1.9=3.2	1.9	1.4	m
38	1.3+1.9=3.2	1.9	1.4	m
39	1.1+2.1=3.2	1.9	1.9	sm
40	1.1+2.1=3.2	1.9	1.9	sm

Table 26. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe gracilis*, 2n=40

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	2.0+2.3=4.3	3.1	1.1	m
2	2.0+2.3=4.3	3.1	1.1	m
3	2.0+2.2=4.2	3.0	1.1	m
4	2.0+2.2=4.2	3.0	1.1	m
5	1.5+2.7=4.2	3.0	1.8	sm
6	1.5+2.7=4.2	3.0	1.8	sm
7	1.2+3.0=4.2	3.0	2.5	sm
8	1.2+3.0=4.2	3.0	2.5	sm
9	1.3+2.8=4.1	2.9	2.1	sm
10	1.3+2.8=4.1	2.9	2.1	sm
11	1.6+2.5=4.1	2.9	1.5	m
12	1.6+2.5=4.1	2.9	1.5	m
13	1.5+2.6=4.1	2.9	1.7	m
14	1.5+2.6=4.1	2.9	1.7	m
15	1.3+2.7=4.0	2.8	2.0	sm
16	1.3+2.7=4.0	2.8	2.0	sm
17	1.7+2.3=4.0	2.8	1.3	m
18	1.7+2.3=4.0	2.8	1.3	m
19	1.7+2.1=3.8	2.7	1.2	m
20	1.7+2.1=3.8	2.7	1.2	m
21	1.1+2.5=3.6	2.6	2.2	sm
22	1.1+2.5=3.6	2.6	2.2	sm
23	1.5+1.7=3.2	2.3	1.1	m
24	1.5+1.7=3.2	2.3	1.1	m
25	1.2+2.0=3.2	2.3	1.6	m
26	1.2+2.0=3.2	2.3	1.6	m
27	1.0+2.1=3.1	2.2	2.1	sm
28	1.0+2.1=3.1	2.2	2.1	sm
29	1.0+2.1=3.1	2.2	2.1	sm
30	1.0+2.1=3.1	2.2	2.1	sm
31	1.0+1.9=2.9	2.1	1.9	sm
32	1.0+1.9=2.9	2.1	1.9	sm
33	1.1+1.7=2.8	2.0	1.5	m
34	1.1+1.7=2.8	2.0	1.5	m
35	1.1+1.7=2.8	2.0	1.5	m
36	1.0+1.7=2.7	1.9	1.7	m
37	0.9+1.8=2.7	1.9	2.0	sm
38	0.9+1.7=2.6	1.8	1.8	sm
39	0.9+1.2=2.1	1.5	1.3	m
40	0.9+1.2=2.1	1.5	1.3	m

Table 27. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe cardioglossa*, 2n=46

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.6+3.3=4.9	3.0	2.0	sm
2	1.6+3.3=4.9	3.0	2.0	sm
3	1.9+2.7=4.6	2.9	1.4	m
4	1.9+2.7=4.6	2.9	1.4	m
5	1.3+3.3=4.6	2.9	2.5	sm
6	1.3+3.3=4.6	2.9	2.5	sm
7	1.5+3.0=4.5	2.8	2.0	sm
8	1.5+3.0=4.5	2.8	2.0	sm
9	1.3+3.0=4.3	2.7	2.3	sm
10	1.3+3.0=4.3	2.7	2.3	sm
11	1.3+3.0=4.3	2.7	2.3	sm
12	1.3+3.0=4.3	2.7	2.3	sm
13	1.0+3.1=4.1	2.5	3.1	st
14	1.0+3.1=4.1	2.5	3.1	st
15	1.2+2.8=4.0	2.5	2.3	sm
16	1.2+2.8=4.0	2.5	2.3	sm
17	1.0+3.0=4.0	2.5	3.0	sm
18	1.0+3.0=4.0	2.5	3.0	sm
19	1.8+2.0=3.8	2.4	1.1	m
20	1.8+2.0=3.8	2.4	1.1	m
21	1.7+2.1=3.8	2.4	1.2	m
22	1.7+2.1=3.8	2.4	1.2	m
23	0.8+2.8=3.6	2.2	3.5	st
24	0.8+2.8=3.6	2.2	3.5	st
25	0.7+2.7=3.4	2.1	3.8	st
26	0.7+2.7=3.4	2.1	3.8	st
27	1.1+2.3=3.4	2.1	2.0	sm
28	1.1+2.3=3.4	2.1	2.0	sm
29	1.3+2.1=3.4	2.1	1.6	m
30	1.3+2.1=3.4	2.1	1.6	m
31	0.7+2.2=2.9	1.8	3.1	st
32	0.7+2.2=2.9	1.8	3.1	st
33	1.2+2.0=3.2	2.0	1.6	m
34	1.2+2.0=3.2	2.0	1.6	m
35	1.3+1.6=2.9	1.8	1.2	m
36	1.3+1.6=2.9	1.8	1.2	m
37	0.8+1.8=2.6	1.6	2.2	sm
38	0.8+1.8=2.6	1.6	2.2	sm
39	1.0+1.2=2.2	1.4	1.2	m
40	1.0+1.2=2.2	1.4	1.2	m
41	0.9+1.2=2.1	1.3	1.3	m
42	0.9+1.2=2.1	1.3	1.3	m

Table 27. continued

43	0.9+1.1=2.0	1.2	1.2	m
44	0.9+1.1=2.0	1.2	1.2	m
45	0.9+1.0=1.9	1.2	1.1	m
46	0.9+1.0=1.9	1.2	1.1	m

Table 28. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe elmeri*, 2n=44

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	2.0+6.2=8.2	3.2	3.1	st
2	2.0+6.2=8.2	3.2	3.1	st
3	2.3+5.3=7.6	3.0	2.3	sm
4	2.3+5.3=7.6	3.0	2.3	sm
5	2.0+5.3=7.3	2.9	2.6	sm
6	2.0+5.3=7.3	2.9	2.6	sm
7	2.5+4.8=7.3	2.9	1.9	sm
8	2.5+4.8=7.3	2.9	1.9	sm
9	2.2+5.0=7.2	2.8	2.2	sm
10	2.2+5.0=7.2	2.8	2.2	sm
11	3.3+3.8=7.1	2.8	1.1	m
12	3.3+3.8=7.1	2.8	1.1	m
13	1.8+5.3=7.1	2.8	2.9	sm
14	1.8+5.3=7.1	2.8	2.9	sm
15	2.0+5.0=7.0	2.7	2.5	sm
16	2.0+5.0=7.0	2.7	2.5	sm
17	1.9+5.0=6.9	2.7	2.6	sm
18	1.7+5.1=6.8	2.7	3.0	sm
19	1.9+4.6=6.5	2.5	2.4	sm
20	1.9+4.6=6.5	2.5	2.4	sm
21	3.2+3.3=6.5	2.5	1.0	m
22	2.9+3.3=6.2	2.4	1.1	m
23	1.9+4.3=6.2	2.4	2.2	sm
24	1.9+4.3=6.2	2.4	2.2	sm
25	1.4+4.8=6.2	2.4	3.4	st
26	1.4+4.8=6.2	2.4	3.4	st
27	2.0+4.0=6.0	2.3	2.0	sm
28	2.0+4.0=6.0	2.3	2.0	sm
29	2.7+3.0=5.7	2.2	1.1	m
30	2.7+3.0=5.7	2.2	1.1	m
31	1.7+3.7=5.4	2.1	2.1	sm
32	1.7+3.7=5.4	2.1	2.1	sm
33	2.0+2.7=4.7	1.8	1.3	m
34	2.0+2.7=4.7	1.8	1.3	m
35	1.4+3.2=4.6	1.8	2.2	sm
36	1.4+3.2=4.6	1.8	2.2	sm
37	0.7+2.6=3.3	1.3	3.7	st
38	0.7+2.6=3.3	1.3	3.7	st
39	1.0+1.8=2.8	1.1	1.8	sm
40	1.0+1.8=2.8	1.1	1.8	sm
41	0.9+1.8=2.7	1.1	2.0	sm
42	0.9+1.8=2.7	1.1	2.0	sm

Table 28. continued

43	0.5+1.4=1.9	0.7	2.8	sm
44	0.5+1.4=1.9	0.7	2.8	sm

Table 29. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe hennisii*, 2n=42

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.5+3.5=5.0	3.1	2.3	sm
2	1.5+3.5=5.0	3.1	2.3	sm
3	1.7+3.1=4.8	3.0	1.8	sm
4	1.7+3.1=4.8	3.0	1.8	sm
5	1.7+2.9=4.6	2.8	1.7	m
6	1.7+2.9=4.6	2.8	1.7	m
7	1.4+3.1=4.5	2.8	2.2	sm
8	1.4+3.1=4.5	2.8	2.2	sm
9	1.3+3.1=4.5	2.8	2.4	sm
10	1.3+3.1=4.5	2.8	2.4	sm
11	2.1+2.3=4.4	2.7	1.0	m
12	2.1+2.3=4.4	2.7	1.0	m
13	1.5+2.9=4.4	2.7	1.9	sm
14	1.5+2.9=4.4	2.7	1.9	sm
15	1.4+3.0=4.4	2.7	2.1	sm
16	1.4+3.0=4.4	2.7	2.1	sm
17	1.4+3.0=4.4	2.7	2.1	sm
18	1.4+3.0=4.4	2.7	2.1	sm
19	1.4+3.0=4.4	2.7	2.1	sm
20	1.4+3.0=4.4	2.7	2.1	sm
21	1.2+3.1=4.3	2.7	2.5	sm
22	1.2+3.1=4.3	2.7	2.5	sm
23	1.1+3.2=4.3	2.7	2.9	sm
24	1.1+3.2=4.3	2.7	2.9	sm
25	1.9+2.0=3.9	2.4	1.0	m
26	1.9+2.0=3.9	2.4	1.0	m
27	1.2+2.3=3.5	2.2	1.9	sm
28	1.2+2.3=3.5	2.2	1.9	sm
29	1.2+2.3=3.5	2.2	1.9	sm
30	1.2+2.3=3.5	2.2	1.9	sm
31	1.3+2.2=3.5	2.2	1.6	m
32	1.3+2.2=3.5	2.2	1.6	m
33	1.5+2.0=3.5	2.2	1.3	m
34	1.5+2.0=3.5	2.2	1.3	m
35	1.0+2.0=3.0	1.9	2.0	sm
36	1.0+2.0=3.0	1.9	2.0	sm
37	0.7+1.4=2.1	1.3	2.0	sm
38	0.7+1.4=2.1	1.3	2.0	sm
39	0.7+1.3=2.0	1.2	1.8	sm
40	0.7+1.3=2.0	1.2	1.8	sm
41	0.3+1.7=2.0	1.2	5.6	st
42	0.3+1.7=2.0	1.2	5.6	st

Table 30. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe hirsuta*, 2n=46

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	2.2+4.5=6.7	2.9	2.0	sm
2	2.2+4.5=6.7	2.9	2.0	sm
3	1.9+4.7=6.6	2.9	2.4	sm
4	1.9+4.7=6.6	2.9	2.4	sm
5	2.2+4.2=6.4	2.8	1.9	sm
6	2.2+4.2=6.4	2.8	1.9	sm
7	2.8+3.3=6.1	2.7	1.1	m
8	2.8+3.3=6.1	2.7	1.1	m
9	2.1+4.0=6.1	2.7	1.9	sm
10	2.1+4.0=6.1	2.7	1.9	sm
11	1.7+4.3=6.0	2.6	2.5	sm
12	1.7+4.3=6.0	2.6	2.5	sm
13	1.2+4.8=6.0	2.6	4.0	s t
14	1.2+4.8=6.0	2.6	4.0	s t
15	1.4+4.3=5.7	2.5	3.0	sm
16	1.4+4.3=5.7	2.5	3.0	sm
17	1.9+3.7=5.6	2.4	1.9	sm
18	1.9+3.7=5.6	2.4	1.9	sm
19	1.5+4.0=5.5	2.4	2.6	sm
20	1.5+4.0=5.5	2.4	2.6	sm
21	2.0+3.5=5.5	2.4	1.7	m
22	2.0+3.5=5.5	2.4	1.7	m
23	2.5+2.8=5.3	2.3	1.1	m
24	2.5+2.8=5.3	2.3	1.1	m
25	2.3+2.7=5.0	2.2	1.1	m
26	2.3+2.7=5.0	2.2	1.1	m
27	2.0+3.0=5.0	2.2	1.5	m
28	2.0+3.0=5.0	2.2	1.5	m
29	1.7+3.3=5.0	2.2	1.9	sm
30	1.7+3.3=5.0	2.2	1.9	sm
31	1.7+2.7=4.4	1.9	1.5	m
32	1.7+2.7=4.4	1.9	1.5	m
33	1.3+3.0=4.3	1.9	2.3	sm
34	1.3+3.0=4.3	1.9	2.3	sm
35	1.0+3.0=4.0	1.7	3.0	sm
36	1.0+3.0=4.0	1.7	3.0	sm
37	1.2+2.7=3.9	1.7	2.2	sm
38	1.2+2.7=3.9	1.7	2.2	sm
39	1.1+2.2=3.3	1.4	2.0	sm
40	1.1+2.2=3.3	1.4	2.0	sm
41	1.0+2.0=3.0	1.3	2.0	sm
42	1.0+2.0=3.0	1.3	2.0	sm
43	1.1+1.8=2.9	1.3	1.6	m
44	1.1+1.8=2.9	1.3	1.6	m
45	1.3+1.3=2.6	1.1	1.0	m
46	1.3+1.3=2.6	1.1	1.0	m

Table 30. continued

Table 31. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe rosea*, 2n=44

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	2.5+2.7=5.2	3.0	1.0	m
2	2.5+2.7=5.2	3.0	1.0	m
3	2.5+2.7=5.2	3.0	1.0	m
4	2.5+2.7=5.2	3.0	1.0	m
5	2.0+2.7=4.7	2.7	1.3	m
6	2.0+2.7=4.7	2.7	1.3	m
7	1.3+3.3=4.6	2.6	2.5	sm
8	1.3+3.3=4.6	2.6	2.5	sm
9	2.0+2.5=4.5	2.6	1.2	m
10	2.0+2.5=4.5	2.6	1.2	m
11	1.8+2.7=4.5	2.6	1.5	m
12	1.8+2.7=4.5	2.6	1.5	m
13	2.2+2.3=4.5	2.6	1.0	m
14	2.2+2.3=4.5	2.6	1.0	m
15	2.0+2.3=4.3	2.5	1.1	m
16	2.0+2.3=4.3	2.5	1.1	m
17	2.0+2.3=4.3	2.5	1.1	m
18	2.0+2.3=4.3	2.5	1.1	m
19	1.0+3.3=4.3	2.5	3.3	st
20	1.0+3.3=4.3	2.5	3.3	st
21	1.8+2.3=4.1	2.4	1.2	m
22	1.8+2.3=4.1	2.4	1.2	m
23	1.2+2.8=4.0	2.3	2.3	sm
24	1.2+2.8=4.0	2.3	2.3	sm
25	1.9+2.0=3.9	2.2	1.0	m
26	1.9+2.0=3.9	2.2	1.0	m
27	1.8+2.0=3.8	2.2	1.0	m
28	1.8+2.0=3.8	2.2	1.0	m
29	1.8+2.0=3.8	2.2	1.0	m
30	1.8+2.0=3.8	2.2	1.0	m
31	1.5+2.1=3.6	2.1	1.4	m
32	1.5+2.1=3.6	2.1	1.4	m
33	1.4+2.2=3.6	2.1	1.5	m
34	1.4+2.2=3.6	2.1	1.5	m
35	1.0+2.4=3.4	2.0	2.4	sm
36	1.0+2.4=3.4	2.0	2.4	sm
37	1.2+1.8=3.0	1.7	1.5	m
38	1.2+1.7=2.9	1.7	1.4	m
39	0.9+2.0=2.9	1.7	2.2	sm
40	0.9+2.0=2.9	1.7	2.2	sm
41	1.0+1.5=2.5	1.4	1.5	m
42	1.0+1.5=2.5	1.4	1.5	m

Table 31. continued

43	1.0+1.3=2.3	1.3	1.3	m
44	0.9+1.2=2.1	1.2	1.3	m

Table 32. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe rubens*, 2n=42

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.7+4.0=5.7	3.0	2.3	sm
2	1.7+4.0=5.7	3.0	2.3	sm
3	1.8+3.7=5.5	2.9	2.0	sm
4	1.8+3.7=5.5	2.9	2.0	sm
5	1.7+3.8=5.5	2.9	2.2	sm
6	1.7+3.8=5.5	2.9	2.2	sm
7	1.7+3.7=5.4	2.8	2.1	sm
8	1.7+3.7=5.4	2.8	2.1	sm
9	1.9+3.5=5.4	2.8	1.8	sm
10	1.9+3.5=5.4	2.8	1.8	sm
11	2.3+3.1=5.4	2.8	1.3	m
12	2.3+3.1=5.4	2.8	1.3	m
13	1.7+3.6=5.3	2.8	2.1	sm
14	1.7+3.6=5.3	2.8	2.1	sm
15	1.7+3.6=5.3	2.8	2.1	sm
16	1.7+3.6=5.3	2.8	2.1	sm
17	1.7+3.5=5.2	2.7	2.0	sm
18	1.7+3.5=5.2	2.7	2.0	sm
19	2.1+2.8=4.9	2.6	1.3	m
20	2.1+2.8=4.9	2.6	1.3	m
21	1.6+3.3=4.9	2.6	2.0	sm
22	1.6+3.3=4.9	2.6	2.0	sm
23	1.6+3.2=4.8	2.5	2.0	sm
24	1.6+3.2=4.8	2.5	2.0	sm
25	1.3+3.2=4.5	2.4	2.4	sm
26	1.3+3.2=4.5	2.4	2.4	sm
27	1.7+2.8=4.5	2.4	1.6	m
28	1.7+2.8=4.5	2.4	1.6	m
29	1.3+2.8=4.1	2.1	2.1	sm
30	1.3+2.8=4.1	2.1	2.1	sm
31	1.3+2.7=4.0	2.1	2.0	sm
32	1.3+2.7=4.0	2.1	2.0	sm
33	1.5+2.5=4.0	2.1	1.6	m
34	1.5+2.3=3.8	2.0	1.5	m
35	1.4+2.4=3.8	2.0	1.7	m
36	1.3+2.2=3.5	1.8	1.6	m
37	1.1+1.7=2.8	1.5	1.5	m
38	1.1+1.7=2.8	1.5	1.5	m
39	1.0+1.5=2.5	1.3	1.5	m
40	0.9+1.5=2.4	1.3	1.6	m
41	0.3+2.0=2.3	1.2	6.6	st
42	0.3+2.0=2.3	1.2	6.6	st

Table 33. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe succedanea*, 2n=44

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.7+3.7=5.4	3.3	2.1	sm
2	1.7+3.7=5.4	3.3	2.1	sm
3	2.2+3.0=5.2	3.2	1.3	m
4	2.2+2.8=5.0	3.1	1.2	m
5	1.3+3.7=5.0	3.1	2.8	sm
6	1.3+3.7=5.0	3.1	2.8	sm
7	1.0+3.8=4.8	3.0	3.8	st
8	1.0+3.8=4.8	3.0	3.8	st
9	1.5+3.2=4.7	2.9	2.1	sm
10	1.5+3.2=4.7	2.9	2.1	sm
11	1.2+3.3=4.5	2.8	2.7	sm
12	1.2+3.3=4.5	2.8	2.7	sm
13	2.2+2.3=4.5	2.8	1.0	m
14	2.2+2.3=4.5	2.8	1.0	m
15	1.3+3.0=4.3	2.7	2.3	sm
16	1.3+3.0=4.3	2.7	2.3	sm
17	1.4+2.7=4.1	2.5	1.9	sm
18	1.4+2.7=4.1	2.5	1.9	sm
19	1.0+3.1=4.1	2.5	3.1	st
20	1.0+3.1=4.1	2.5	3.1	st
21	1.2+2.6=3.8	2.4	2.1	sm
22	1.2+2.6=3.8	2.4	2.1	sm
23	1.5+0.8+1.3=3.7*	2.2	1.4	m
24	1.5+0.8+1.3=3.7*	2.2	1.4	m
25	1.5+1.8=3.3	2.0	1.2	m
26	1.5+1.8=3.3	2.0	1.2	m
27	1.1+2.2=3.3	2.0	2.0	sm
28	1.0+2.2=3.2	2.0	2.2	sm
29	1.0+1.9=2.9	1.8	1.9	sm
30	1.0+1.9=2.9	1.8	1.9	sm
31	0.6+2.3=2.9	1.8	3.8	st
32	0.6+2.3=2.9	1.8	3.8	st
33	0.7+2.0=2.7	1.7	2.8	sm
34	0.7+2.0=2.7	1.7	2.8	sm
35	1.3+1.4=2.7	1.7	1.0	m
36	1.3+1.4=2.7	1.7	1.0	m
37	1.0+1.7=2.7	1.7	1.7	m
38	1.0+1.7=2.7	1.7	1.7	m
39	0.8+1.5=2.3	1.4	1.8	sm
40	0.8+1.5=2.3	1.4	1.8	sm
41	0.9+1.2=2.1	1.3	1.3	m
42	0.9+1.2=2.1	1.3	1.3	m

Table 33. continued

43	0.8+1.3=2.1	1.3	1.6	m
44	0.8+1.3=2.1	1.3	1.6	m

＊ : Chromosome with secondary constriction

Table 34. Measurements of somatic chromosomes at mitotic metaphase in *Calanthe vestita*, 2n=42

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.5+4.2=5.7	3.0	2.8	sm
2	1.5+4.2=5.7	3.0	2.8	sm
3	1.8+3.7=5.5	2.9	2.0	sm
4	1.8+3.7=5.5	2.9	2.0	sm
5	2.0+3.3=5.3	2.8	1.6	m
6	2.0+3.3=5.3	2.8	1.6	m
7	1.3+4.0=5.3	2.8	3.0	sm
8	1.3+4.0=5.3	2.8	3.0	sm
9	1.6+3.7=5.3	2.8	2.3	sm
10	1.6+3.7=5.3	2.8	2.3	sm
11	2.5+2.7=5.2	2.8	1.0	m
12	2.5+2.7=5.2	2.8	1.0	m
13	1.7+3.4=5.1	2.7	2.0	sm
14	1.7+3.4=5.1	2.7	2.0	sm
15	1.6+3.5=5.1	2.7	2.1	sm
16	1.6+3.5=5.1	2.7	2.1	sm
17	1.3+3.7=5.0	2.7	2.8	sm
18	1.3+3.7=5.0	2.7	2.8	sm
19	2.0+2.8=4.8	2.6	1.4	m
20	2.0+2.8=4.8	2.6	1.4	m
21	1.5+3.3=4.8	2.6	2.2	sm
22	1.5+3.3=4.8	2.6	2.2	sm
23	1.3+3.3=4.6	2.5	2.5	sm
24	1.3+3.3=4.6	2.5	2.5	sm
25	1.3+3.2=4.5	2.4	2.4	sm
26	1.3+3.2=4.5	2.4	2.4	sm
27	1.7+2.8=4.5	2.4	1.6	m
28	1.7+2.8=4.5	2.4	1.6	m
29	2.0+2.3=4.3	2.3	1.1	m
30	2.0+2.3=4.3	2.3	1.1	m
31	1.5+2.8=4.3	2.3	1.8	sm
32	1.3+2.8=4.1	2.2	2.1	sm
33	1.3+2.7=4.0	2.1	2.0	sm
34	1.3+2.7=4.0	2.1	2.0	sm
35	1.2+2.5=3.7	2.0	2.0	sm
36	1.2+2.5=3.7	2.0	2.0	sm
37	0.8+1.6=2.4	1.3	2.0	sm
38	0.8+1.6=2.4	1.3	2.0	sm
39	0.8+1.4=2.2	1.2	1.7	m
40	0.8+1.4=2.2	1.2	1.7	m
41	0.3+1.8=2.1	1.1	6.0	st
42	0.3+1.8=2.1	1.1	6.0	st

Karyomorphological Studies on *Goodyera* and its Allied Genera in Orchidaceae*

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ラン科シュスラン属およびその近縁属の核形態学的研究*

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Introduction

The genus *Goodyera*, the Orchidaceae, consists of approximately 40 species which are mainly terrestrial and rarely epiphytic, and is widely distributed from the subarctic area of the Northern Hemisphere to the tropical Asia (*e.g.*, Satomi 1982). Approximately 13 species of *Goodyera* are reported in Japan (Satomi 1982).

Goodyera and its allied about 36 genera were placed all together in a common group by Dressler (1981). Since this group includes many rare species which would not supply enough complete herbarium specimen masses, taxonomical treatments of the genera and the species could be highly imperfect and confused (Schlechter 1926, Holttum 1964, Brieger 1974-1975, Dressler 1981 etc.). Dressler and Dodson (1960), Maekawa (1971, 1978), Seidenfaden (1978), and so on suggested that more examinations must be necessary to clarify these taxonomic treatments.

On the other hand, most of the taxa of this group grow in primary forests with high humidity and are often associated with dominant forest-trees. Thus, speciation of *Goodyera* might be correlated with certain associated forest-trees (Tanaka 1965a). These facts suggest that the interrelationships among the *Goodyera* species and their allied genera could be further complicated.

Chromosomes of *Goodyera* and its allied genera have been observed by many authors (Miduno 1939, Tanaka 1965b, 1976, Mehra and Bawa 1970, and so on). These reports documented chromosome numbers but lack of any chromosome morphology.

In the present paper, 27 taxa of *Goodyera* and its allied seven genera are dealt with the karyomorphological studies to speculate their speciation and interrelationships.

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Materials and Methods

Localities and source and number of plants studied were listed in Table 1. Taxonomical treatments of the materials followed mostly Ohwi and Kitagawa (1983) and some Garay and Sweet (1974), Hatusima (1975), Luer (1975) and Seidenfaden (1978). The voucher specimens and the cytological data of the plants studied were deposited in the Herbarium of the Hiroshima Botanical Garden.

Somatic chromosomes were stained and observed by the aceto-orcein squash method as follows: Growing root tips were cut into small pieces 1 − 2 mm long and immersed in 0.002M 8-hydroxyquinoline for four hours at 16℃. Then, they were fixed in 45% acetic acid for 15 minutes at 5℃ and were macerated in a mixture of one part of 45% acetic acid and two parts of 1N hydrochloric acid for 20 seconds at 60℃ before they were stained with 1% aceto-orcein for about 15 minutes and squashed softly.

Growing shoot apices in *Hetaeria sikokiana*, two taxa of *Myrmechis* and *Vexillabium yakushimense*, which did not have any usual root, were cut into small pieces 2−3 mm long and were pretreated in 0.002M 8-hydroxyquinoline for four hours at 16℃. Then, they were first fixed in a modified Carnoy's solution (99% ethanol : chloroform : glacial acetic acid = 2 : 1 : 1) for two hours at 5℃ and transferred to 45% acetic acid for five minutes at 5℃, before they were stained with 1% aceto-orcein, squashed and observed.

Chromosomes at resting stage were studied morphologically by their condensed features and shapes and numbers of chromatin blocks. At mitotic prophase, localities of early condensed segments and their features of successional differentiation to late condensed segments were recorded. Chromosomes at mitotic metaphase were measured by length of their long and short arms. Arm ratio and average chromosome length were calculated by long arm length / short arm length and total chromosome length / chromosome number (2n), res pectively. Arm ratios were expressed by the value of arm ratio from 1.0 to 1.7 as "median" (m), 1.8 to 3.0 as "submedian" (sm), 3.1 to 7.0 as "subterminal" (st) and over 7.1 as "terminal" (t) according to Levan *et al.* (1964). Variation of chromosome length in a chromosome set was studied. The results of the observations in the resting nuclei and somatic prophase chromosomes and the karyotype formulas at mitotic metaphase were described and classified according to Tanaka (1980). The chromosomes were basically aligned in descending order from the longest to the shortest chromosomes and were given numbers 1, 2, 3,... respectively.

Observations

The results of observations in 27 taxa were described as follows.

Table 1. Locality and source, chromosome number and number of plants studied

Species	Locality and source	Somatic chromosome number (2n)	No. of plants
Anoectochilus formosanus Hayata	Mt. Omotoyama, Ishigaki C. Okinawa Pref.	40	1
Goodyera foliosa (Lindl.) Benth. var. *commelinoides* (Fukuyama) F. Maekawa	Yaku-cho, Yakushima Isl. Kagoshima Pref.	56	2
		56+2B	2
	Mt. Omotoyama, Ishigaki C. Okinawa Pref.	56	1
G. foliosa (Lindl.) Benth. var. *laevis* Finet	Nopporo, Sapporo C., Hokkaido Dist.	28	2
	Mt. Hayasemori, Owani-cho, Aomori Pref.	28	2
	Mt. Iwatesan, Morioka C., Iwate Pref.	28	1
	Mt. Tateyama, Toyama Pref.	28	1
	Mt. Togakushiyama, Nagano Pref.	28	3
	Ishiyama, Otsu C., Shiga Pref.	56	2
	Mt. Mikawayama, Kazumi-cho, Hyogo Pref.	56	1
	Mt. Oginosen, Onsen-cho, Hyogo Pref.	28	3
	Hongu-cho, Wakayama Pref.	56	1
	Kozagawa-cho, Wakayama Pref.	56	1
	Ashizu, Chizu-cho, Tottori Pref.	28	3
	Mt. Daisen, Tottori Pref.	28	5
	Mt. Kamihirusen, Yatsuka-mura, Okayama Pref.	28	3
	Mt. Sanbesan, Oda C., Shimane Pref.	56	9
	Mt. Tateeboshiyama, Saijo-cho, Hiroshima Pref.	28	14
	Mt. Oyorogiyama, Takano-cho, Hiroshima Pref.	28	7
	Mt. Garyuzan, Geihoku-cho, Hiroshima Pref.	56	3
	Mt. Jipposan, Yoshiwa-mura, Hiroshima Pref.	56	4
	Mt. Kanmuriyama, Yoshiwa-mura, Hiroshima Pref.	56	12
	Ugakyo, Asa-cho, Hiroshima Pref.	56	5
	Mt. Togosan, Yuki-cho, Hiroshima Pref.	56	4
	Nukui, Kake-cho, Hiroshima Pref.	56	5
	Nebutani, Tsutsuga-mura, Hiroshima Pref.	56	1
	Tanoshiri, Tsutsuga-mura, Hiroshima Pref.	56	3
	Mt. Jakuchisan, Nishiki-cho, Yamaguchi Pref.	56	2
	Deai, Tokuji-cho, Yamaguchi Pref.	56	5
	Rokkenjaya, Yamaguchi C. Yamaguchi Pref.	56	4

Table 1. continued

	Otoshi, Niihama C., Ehime Pref.	56	4
	Mt. Yokogurayama, Ochi-cho, Kochi Pref.	56	2
	Shimonanokawa, Agawa-mura Kochi Pref.	56	2
G. hachijoensis Yatabe var. *hachijoensis*	Hachijojima Isl., Tokyo, Metrop.	28	1
G. hachijoensis Yatabe var. *leuconeura* (F. Maekawa) Ohwi	Yaku-cho, Yakushima Isl., Kagoshima Pref.	28	4
G. hachijoensis Yatabe var. *matsumurana* (Schltr.) Ohwi	Okinoerabujima Isl., Kagoshima Pref.	28	1
	Iriomotejima Isl., Okinawa Pref.	28	1
G. hachijoensis Yatabe var. *yakushimensis* (Nakai) Ohwi	Kamikoshikijima Isl. Kagoshima Pref.	28	1
	Yaku-cho, Yakushima Isl., Kagoshima Pref.	28	7
G. macrantha Maxim.	Mt.Takagoyama Kimitsu C., Chiba Pref.	28	1
		28+1B	3
		28+2B	2
		28+3B	3
		28+4B	1
	Kozagawa-cho, Wakayama Pref.	28+3B	1
	Yamano, Fukuyama C., Hiroshima Pref.	28	1
		28+1B	7
		28+2B	7
		28+3B	1
		28+4B	1
	Mt. Koshosan, Kaho-cho, Fukuoka Pref.	28+2B	2
	Sotaro, Ume-cho, Oita Pref.	28	3
		28+2B	1
	Mt. Osuzuyama, Tsuno-cho, Miyazaki Pref.	28+2B	1
		28+5B	1
G. oblongifolia Raf.	North America (commercial source)	30	2
G. pendula Maxim.	Sandankyo, Togochi-cho, Hiroshima Pref.	30	1
	Mt. Inugadake, Tsuiki-cho, Fukuoka Pref.	30	1
	Yaku-cho, Yakushima Isl., Kagoshima Pref.	30	3
G. procera (Ker-Gawl.) Hook.	Mt. Komidake, Iriomote Isl. Okinawa Pref.	42	2
G. pubescens (Willd.) R.Br.	North America, (commercial source)	26	2
G. repens (Linn.) R.Br.	Mt. Fuji, Narusawa-mura, Yamanashi Pref.	30	2

Table 1. continued

G. schlechtendaliana Reichb.f.	Mt. Hayasemori, Owani-cho, Aomori Pref.	30	1
	Mt. Kiyosumiyama, Amatsuko-minato-cho, Chiba Pref.	30	1
	Mt. Fuji, Narusawa-mura, Yamanashi Pref.	30	2
	Mt. Hieizan, Otsu C., Shiga Pref.	30	1
	Mt. Mikawayama, Kazumi-cho, Hyogo Pref.	30	1
	Oto-mura, Wakayama Pref.	30	1
		60	1
	Yodo, Saji-mura, Tottori Pref.	30	2
	Chizu-cho, Tottori Pref.	30	1
	Mt. Daisen, Tottori Pref.	30	1
	Mt. Sanbesan, Oda. C., Shimane Pref.	30	2
	Yamano, Fukuyama C., Hiroshima Pref.	30	1
	Sandankyo, Togochi-cho, Hiroshima Pref.	30	1
	Asaminami-ku, Hiroshima C., Hiroshima Pref.	30	1
	Mt. Arataniyama, Hiroshima C., Hiroshima Pref.	60	2
	Mt. Kanmuriyama, Yoshiwa-mura, Hiroshima Pref.	30	1
	Miyajima Isl., Hiroshima Pref.	30	1
	Shuho-cho, Yamaguchi Pref.	30	2
	Nomura-cho, Ehime Pref.	60	1
	Umaji-mura, Kochi Pref.	30	1
	Tagawa-cho, Fukuoka Pref.	30	2
	Mt. Koshosan, Kaho-cho, Fukuoka Pref.	60	1
	Izuhara-cho, Tsushima Isl., Nagasaki Pref.	30	1
	Sotome-cho, Nagasaki Pref.	30	1
	Kamikoshikijima Isl., Kagoshima Pref.	30	2
	Kamiyaku-cho, Yakushima Isl. Kagoshima Pref.	30	1
G. velutina Maxim.	Mt. Kiyosumiyama, Amatsuko-minato-cho, Chiba Pref.	28	1
	Mt. Kasugayama, Nara C., Nara Pref.	56	1
	Sukumo C., Kochi Pref.	28	2
		56	1
	Mt. Inugadake, Tsuiki-cho, Fukuoka Pref.	28	3
	Mt. Koshosan, Kaho-cho, Fukuoka Pref.	56	3
	Mt. Taterayama, Tsushima Isl., Nagasaki Pref.	56	2
	Yaku-cho, Yakushima Isl., Kagoshima Pref.	28	2
G. viridiflora (Bl.) Bl.	Kamiyaku-cho, Yakushima Isl., Kagoshima Pref.	22	1

Table 1. continued

	Yaku-cho, Yakushima Isl., Kagoshima Pref.	22	3
Hetaeria rubens (Lindl.) Benth.	Commercial source	24	1
H. sikokiana (Makino et F. Maekawa) Tuyama	Sandankyo, Togochi-cho, Hiroshima Pref.	42	2
H. yakusimensis Masamune	Kamiyaku-cho, Yakushima Isl., Kagoshima Pref.	42	3
	Yaku-cho, Yakushima Isl., Kagoshima Pref.	42	1
Macodes petola (Bl.) Lindl.	Mt. Gozadake, Iriomote-jima Isl., Okinawa Pref.	42	2
Myrmechis japonica (Reichb.f.) Rolfe	Mt. Kurohimeyama, Shinano-cho, Nagano Pref	56	1
	Mt. Fuji, Narusawa-mura, Yamanashi Pref.	56	1
M. tsukusiana Masamune	Mt. Kuromidake, Yakushima Isl., Kagoshima Pref.	28	2
Odontochilus inabai Hayata	Mt. Marun, Taichun Pref., Taiwan, China	28	1
Vexillabium yakushimense (Yamamoto) F. Maekawa	Yaku-cho, Yakushima Isl., Kagoshima Pref.	26	4
Zeuxine agyokuana Fukuyama	Kamiyaku-cho, Yakushima Isl., Kagoshima Pref.	20	2
	Yaku-cho, Yakushima Isl., Kagoshima Pref.	20	2
Z. leucochila Schltr.	Yaku-cho, Yakushima Isl., Kagoshima Sref.	20	2
Z. odorata Fukuyama	Mitsuishi, Kubera, Yonaguni, Okinawa Pref.	40	1

I. *Anoectochilus*

1. *Anoectochilus formosanus* Hayata, 2n=40, Japanese Name: Kibana-shusu-ran, Tables 1 and 2, Fig. 1.

Observations were made in a plant collected in Okinawa Prefecture, Japan. Morphological features of leaves, shoots, rhizomes and flowers of the plant were similar to those of this species described by Hatusima (1975).

The chromosome number of the plant was 2n=40 at mitotic prophase and metaphase which confirmed the previous report on this taxon treated previously as *Anoectochilus tetsuoi* (Tanaka 1965b) but was different from the previous count of n=12 reported by Hsu (1971).

The chromosomes at resting stage were observed as numerous chromomeric granules, fibrous threads scattered throughout the nucleus and conspicuous chromatin blocks. The chromatin blocks varied in diameter of the long axis from 0.5−3.0 μm and round-, rod- and string-shaped with smooth or rough surface. The chromatin blocks showed a slight variability in size, shape and number among the nuclei. The most common type of the nucleus showed about 20 chromocentric bodies. Thus, the chromosome feature at resting stage was of the chromocenter type in a large sense and were regarded as the intermediate type between the simple chromocenter type and the complex chromocenter type according to the definition proposed by Tanaka (1971). At mitotic prophase, among the 40 chromosomes of

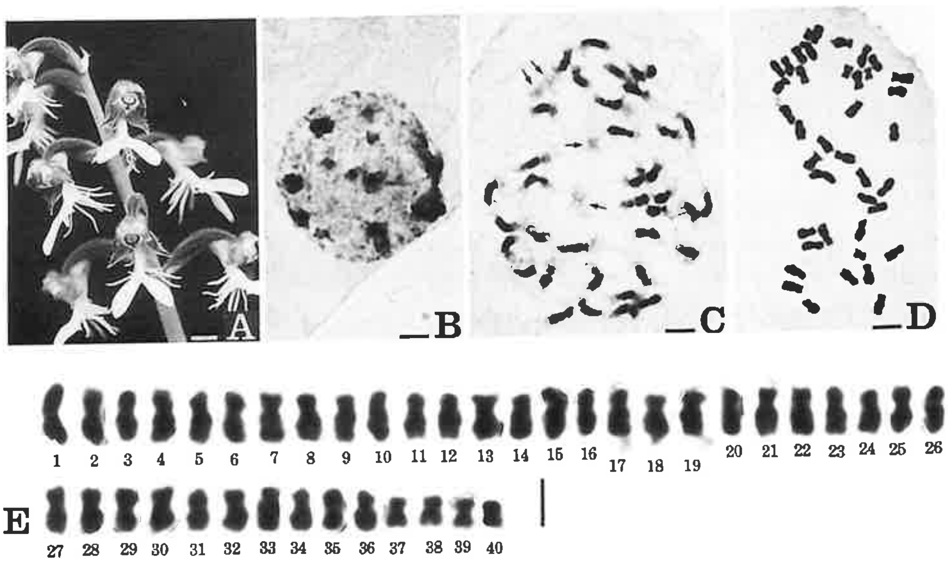

Fig. 1. *Anoectochilus formosanus*, 2n=40. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Arrows indicate the deheterochromatinized chromosomes. Bars indicate 4 mm in A and 2.0μm in B-E.

the complement, 36 chromosomes had early condensed segments in the proximal regions of both arms and differentiated clearly to late condensed segments. The other four chromosomes were slightly shorter than the former 36 chromosomes and had no early condensed segments (Fig. 1. C).

The 2n=40 chromosome set at mitotic metaphase consisted of 36 chromosomes which showed a degradation in length from the longest (2.4 μm) to the shortest (1.4 μm) chromosomes in length and four slightly smaller chromosomes which varied in length from 1.1−1.0 μm. These small chromosomes seemed to correspond to those without early condensed segments at prophase and were known to be morphologically identical to the deheterochromatinized chromosomes in *Spiranthes sinensis* reported by Tanaka (1969). The average chromosome length was 1.7 μm. Among the 40 chromosomes of the complement, 13 were median centromeric with arm ratios varying between 1.0 and 1.5. The other 27 chromosomes were submedian centromeric with arm ratios between 1.8 and 2.6. Three chromosomes (Nos. 17, 18, 19) had lightly stained satellites at the terminal regions of their long arms.

The 2n=40 chromosome complement at mitotic metaphase showed a gradual karyotype due to the gradual decrease of the chromosome length from the longest to the shortest chromosomes and a symmetric karyotype due to arm ratio.

II. *Goodyera*

1. *Goodyera foliosa* (Lindl.) Benth. var. *commelinoides* (Fukuyama) F. Maekawa, 2n=56 and 2n=56+2B, Japanese Name: Tsuyukusa-shusu-ran, Tables 1, 3 and 4, Figs. 2 and 3.

Observations were made in four plants collected in Kagoshima Prefecture and a plant collected in Okinawa Prefecture, Japan. Morphological features of leaves, shoots, rhizomes and flowers of the plants were similar to those of this variety described by Ohwi and Kitagawa (1983).

The chromosome numbers observed at mitotic prophase and metaphase were 2n=56 in two plants from Kagoshima Prefecture and one from Okinawa and 2n=58 in the other two from Kagoshima Prefecture. These chromosome numbers were determined here for this variety for the first time.

(1) The plants with 2n=56 chromosomes. Tables 1 and 3, Fig. 2.

The chromosomes at resting stage were observed as numerous chromomeric granules, fibrous threads scattered throughout the nucleus and conspicuous chromatin blocks. The chromatin blocks varied in diameter of the long axis from 0.5−1.5 μm and round- and rod-shaped with smooth surface. The chromatin blocks showed slight variability in size, shape and number among the nuclei. The most common type of the nucleus showed about 50 prochromosomal bodies. Thus, the chromosome feature at resting stage was of the prochromosome type according to the definition proposed by Tanaka (1971).

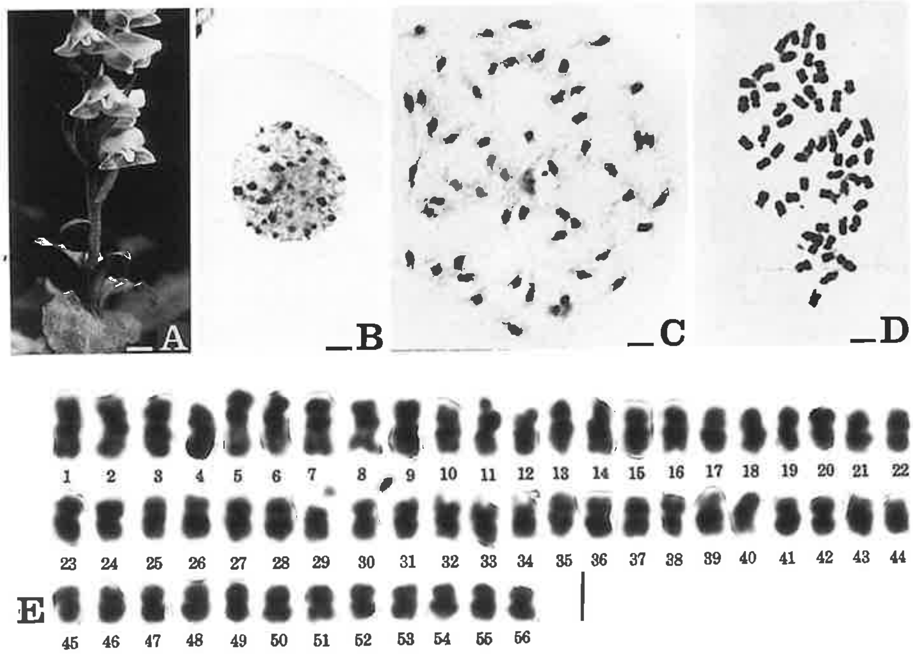

Fig. 2. *Goodyera foliosa* var. *commelinoides*, 2n=56. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 5 mm in A and 2 μm in B-E.

At mitotic prophase, all of the 56 chromosomes had early condensed segments. The early condensed segments were located in the proximal regions and differentiated clearly to late condensed segments.

The 2n=56 chromosome set at mitotic metaphase showed a gradual decrease in length from the longest (2.4 μm) to the shortest (1.1 μm) chromosomes. The average chromosome length was 1.5 μm. Among the 56 chromosomes of the complement, 39 were median centromeric with arm ratios varying between 1.0 and 1.7 and 15 were submedian centromeric with arm ratios between 1.8 and 2.8. The other two chromosomes were subterminal centromeric with the arm ratios of 3.2 and 4.0. Four chromosomes (Nos. 5, 6, 7, 8) had secondary constrictions at the interstitial regions of their long arms and another four (Nos. 11, 12, 29, 30) had satellites at the terminal regions of their short arms, respectively.

Thus, the 2n=56 chromosome complement at mitotic metaphase formed a gradual and symmetric karyotype.

(2) The plants with 2n=58 chromosomes. Tables 1 and 4, Fig. 3.

The chromosome morphology at resting stage and mitotic prophase were similar to those of the 2n=56 plants. Two out of the 58 chromosomes at prophase morphologically similar to one another were condensed earlier than the others and were seemed to be made

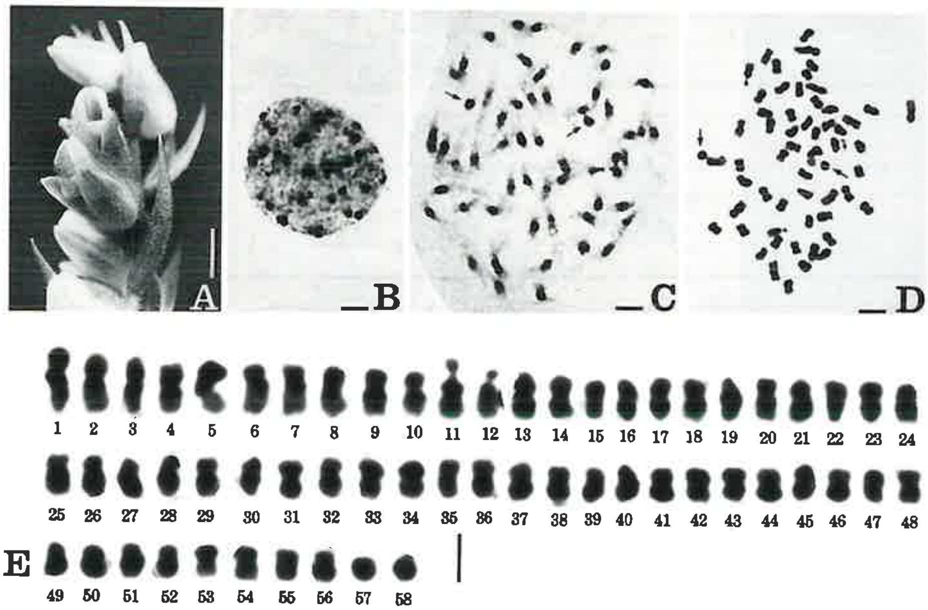

Fig. 3. *Goodyera foliosa* var. *commelinoides*, 2n = 56 + 2B. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Arrows indicate B-chromosomes. Bars indicate 4 mm in A and 2μm in B-E.

of heterochromatin.

The 2n=58 chromosome complement at mitotic metaphase exhibited a gradual decrease in length from the longest (2.3 μm) to the shortest (0.9 μm) chromosomes. The average chromosome length was 1.4 μm. Among the 2n=58 chromosomes of the complement, 37 were median centromeric with arm ratios varying between 1.0 and 1.6, and 18 were submedian centromeric with arm ratios between 1.8 and 2.8. The other one was subterminal centromeric with the arm ratio of 3.2. Two chromosomes (Nos. 57 and 58) were smaller than the other 56 chromosomes and had no constriction. Two small chromosomes observed in these plants could be regarded as B-chromosome based on their morphology at mitotic prophase and metaphase. Four chromosomes (Nos. 5, 6, 7, 8) had secondary constrictions at the interstitial regions of their long arms, and another two (Nos. 11 and 12) had satellites at the terminal regions of their short arms. Thus, the 2n=58 chromosome complement at mitotic metaphase showed a gradual and symmetric karyotype.

2. *Goodyera foliosa* (Lindl.) Benth. var. *laevis* Finet, 2n = 28 and 2n = 56, Japanese Name: Akebono-shusu-ran, Tables 1, 5 and 6, Figs. 4 and 5.

Observations were made in 114 plants collected in Hokkaido and other 29 localities in Japan. Morphological features of leaves, shoots, rhizomes and flowers of the plants were similar to those of this variety described by Ohwi and Kitagawa (1983).

The chromosome numbers observed at mitotic prophase and metaphase were 2n=28 in 44 plants from 11 localities and 2n=56 in 70 plants from 19 localities. This result confirmed the previous reports in this taxon treated previously as *G. maximowicziana* Makino (Mutsuura 1959, Mutsuura and Nakahira 1959, Tanaka 1965a), but was different from the previous count of 2n=42 reported by Miduno (1939).

(1) The plants with 2n=28 chromosomes. Tables 1 and 5, Fig. 4.

The chromosome morphology at resting stage and mitotic prophase were similar to those of *G. foliosa* var. *commelinoides* (2n=56).

The 2n = 28 chromosome complement at mitotic metaphase performed a gradual decrease in length from the longest (3.1 μm) to the shortest (1.5 μm) chromosomes. The average chromosome length was 2.1 μm. Among the 28 chromosomes in the complement, 18 were median centromeric with arm ratios varying between 1.0 and 1.6, while the other ten were submedian centromeric with arm ratios between 1.8 and 2.7. Two chromosomes (Nos. 1 and 2) had secondary constrictions at the interstitial regions of their long arms and two (Nos. 5 and 6) had satellites at the terminal regions of their short arms.

Thus, the 2n=28 chromosome complement at mitotic metaphase showed a gradual and symmetric karyotype.

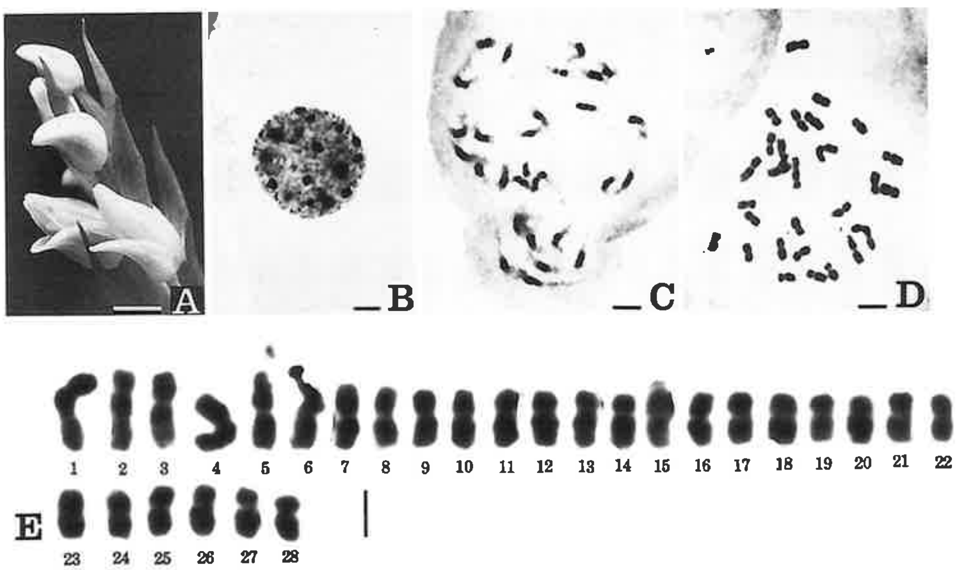

Fig. 4. *Goodyera foliosa* var. *laevis*, 2n=28. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 4 mm in A and 2 μm in B-E.

(2) The plants with 2n=56 chromosomes. Tables 1 and 6, Fig. 5.

The chromosome morphology at resting stage and mitotic prophase were similar to those of the 2n = 28 plants. The 2n = 56 chromosome complement at mitotic metaphase showed a gradual decrease in length from the longest (2.3 μm) to the shortest (1.1 μm) chromosomes. The average chromosome length was 2.1 μm. Among the 56 chromosomes in the complement, 40 were median centromeric with arm ratios varying between 1.0 and 1.7, while 16 were submedian centromeric with arm ratios between 1.8 and 3.0. Four chromosomes (Nos. 1, 2, 3, 4) had secondary constrictions at the interstitial regions of their long arms and another four (Nos, 13, 14, 15, 16) had satellites at the terminal regions of their short arms.

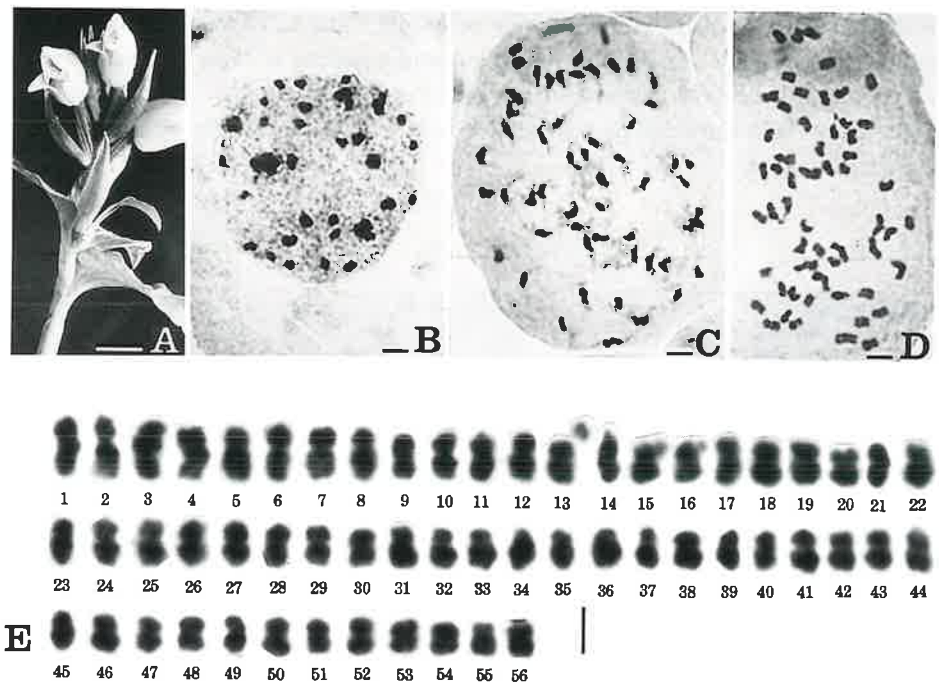

Fig. 5. *Goodyera foliosa* var. *laevis*, 2n=56. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 7 mm in A and 2 μm in B-E.

Thus, the 2n=56 chromosome complement at mitotic metaphase formed a gradual and symmetric karyotype.

3. *Goodyera hachijoensis* Yatabe var. *hachijoensis*, 2n = 28, Japanese Name: Hachijo-shusu-ran, Tables 1 and 7, Fig. 6.

Observations were made in a plant collected in Tokyo, Japan. Morphological features of leaves, shoots, rhizomes and flowers of the plant were similar to those of this type variety described by Ohwi and Kitagawa (1983).

The chromosome number of the plant was 2n = 28 at mitotic prophase and metaphase which confirmed the previous reports (Miduno 1939, Tanaka 1965b).

The chromosomes at resting stage were quite similar in morphology to those of *G. foliosa* var. *commelinoides* (2n = 56) excepting this taxon showed numerous small chromatin blocks and darkly stained chromomeric granules and fibrous threads.

The chromosome morphology at mitotic prophase was quite similar to those of *G. foliosa* var. *commelinoides* (2n = 56) excepting early condensed segments were observed at the proximal and terminal regions of several chromosomes in the complement in this taxon.

The 2n = 28 chromosome complement at mitotic metaphase showed a gradual decrease in length from the longest (3.1 μm) to the shortest (1.5 μm) chromosomes. The average chromosome length was 2.1 μm. Among the 28 chromosomes of the complement, 21 were median centromeric with arm ratios between 1.0 and 1.7, six were submedian centromeric with arm ratios between 1.8 and 2.8, and the other one was subterminal centromeric with the arm ratio of 3.2. Two chromosomes (Nos. 1 and 2) had secondary constrictions at the

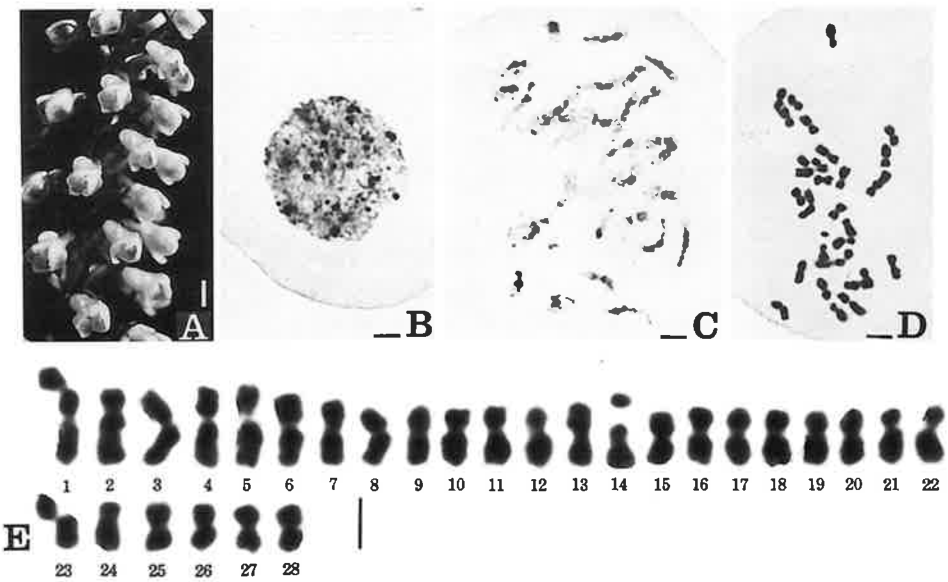

Fig. 6. *Goodyera hachijoensis* var. *hachijoensis*, 2n=28. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 7 mm in A and 2 μm in B-E.

interstitial regions of their long arms, while two chromosomes (Nos. 13 and 14) had satellites at the terminal regions of their short arms.

Thus, the 2n=28 chromosome complement at mitotic metaphase formed a gradual and symmetric karyotype.

4. *Goodyera hachijoensis* Yatabe var. *leuconeura* (F. Maekawa) Ohwi, 2n=28, Japanese Name: Shiraito-shusu-ran, Tables 1 and 8, Fig. 7.

Observations were made in four plants collected in Kagoshima Prefecture, Japan. Morphological features of leaves, shoots, rhizomes and flowers of the plants were similar to those of this variety described by Ohwi and Kitagawa (1983).

The chromosome number of the plants was 2n=28 at mitotic prophase and metaphase which confirmed Tanaka (1965b).

The chromosome morphology at resting stage and mitotic prophase were similar to those of the type variety of this species described above.

The 2n=28 chromosome complement at mitotic metaphase displayed a gradual decrease in length from the longest (3.5 μm) to the shortest (1.6 μm) chromosomes. The average chromosome length was 2.2 μm. Among the 28 chromosomes of the complement, 20 were median centromeric with arm ratios between 1.0 and 1.7 and the other eight were submedian centromeric with arm ratios between 2.0 and 2.5. Two chromosomes (Nos. 1 and 2) had secondary constrictions at the interstitial regions of their long arms, while another two

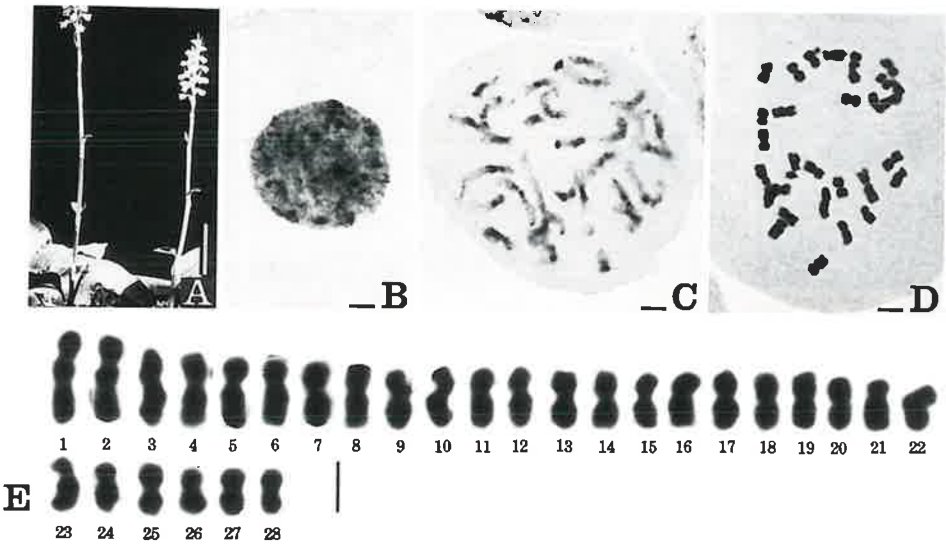

Fig. 7. *Goodyera hachijoensis* var. *leuconeura*, 2n=28. A, plants. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 30 mm in A and 2 μm in B-E.

(Nos. 9 and 10) had satellites at the terminal regions of their short arms.

Thus, the 2n = 28 chromosome complement at mitotic metaphase formed a gradual and symmetric karyotype.

5. *Goodyera hachijoensis* Yatabe var. *matsumurana* (Schltr.) Ohwi, 2n = 28, Japanese Name: Kagome-ran, Tables 1 and 9, Fig. 8.

Observations were made in two plants collected in Kagoshima and Okinawa Prefectures, Japan. Morphological features of leaves, shoots, rhizomes and flowers of these plants were similar to those of this variety described by Ohwi and Kitagawa (1983).

The chromosome number of these plants was 2n = 28 which confirmed previous reports on this taxon treated previously as *G. matsumurana* Schltr. (Miduno 1939, Tanaka 1965b).

The chromosome morphology at resting stage and mitotic metaphase were similar to those of the type variety of this species described above.

The 2n = 28 chromosome complement at mitotic metaphase performed a gradual decrease in length from the longest (2.9 μm) to the shortest (1.4 μm) chromosomes. The average chromosome length was 2.0 μm. Among the 28 chromosomes of the complement, 21 were median centromeric with arm ratios between 1.0 and 1.7, six were submedian centromeric with arm ratios between 1.8 and 3.0 and the other one was subterminal centromeric with the arm ratio of 3.1. Two chromosomes (Nos. 1 and 2) had secondary constrictions at the interstitial regions of their long arms while another two (Nos. 11 and 12) had satellites at the terminal regions of their short arms.

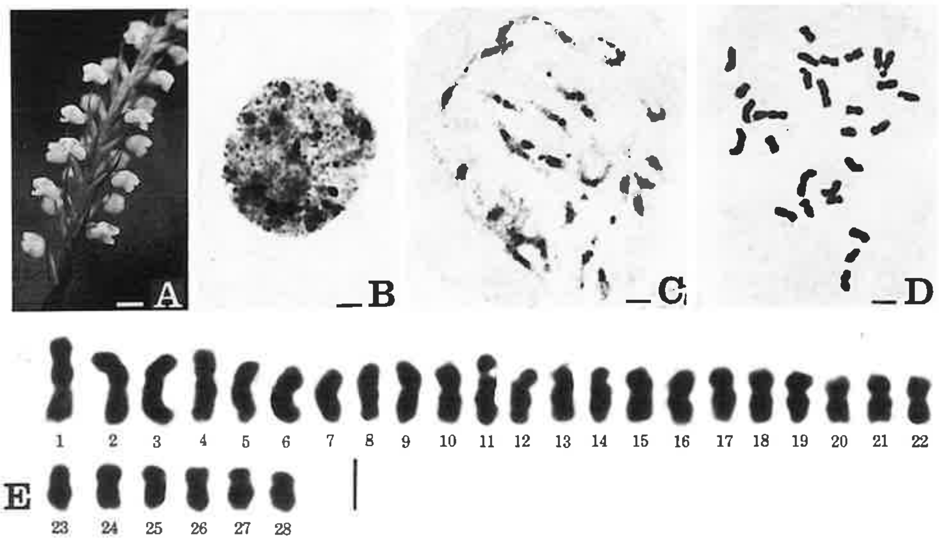

Fig. 8. *Goodyera hachijoensis* var. *matsumurana*, 2n=28. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 6 mm in A and 2 μm in B-E.

Thus, the 2n=28 chromosome complement at mitotic metaphase showed a gradual and symmetric karyotype.

6. *Goodyera hachijoensis* Yatabe var. *yakushimensis* (Nakai) Ohwi, 2n = 28, Japanese Name: Yakushima-shusu-ran, Tables 1 and 10, Fig. 9.

Observations were made in eight plants collected in Kagoshima Prefecture, Japan. Morphological features of leaves, shoots, rhizomes and flowers of the plants were similar to those of this variety described by Ohwi and Kitagawa (1983).

The chromosome number of these plants was 2n=28 at mitotic prophase and metaphase which confirmed Tanaka (1965b).

The chromosome morphology at resting stage and mitotic prophase were similar to those of the type variety of this species described above.

The 2n=28 chromosome complement at mitotic metaphase showed a gradual decrease in length from the longest (3.8 μm) to the shortest (1.6 μm) chromosomes. The average chromosome length was 2.4 μm. Among the 28 chromosomes of the complement, 20 were median centromeric with arm ratios between 1.0 and 1.6, seven were submedian centromeric with arm ratios between 1.8 and 3.0 and the other one was subterminal centromeric with the arm ratio of 3.2.

Two chromosomes (Nos. 1 and 2) had secondary constrictions at the interstitial regions

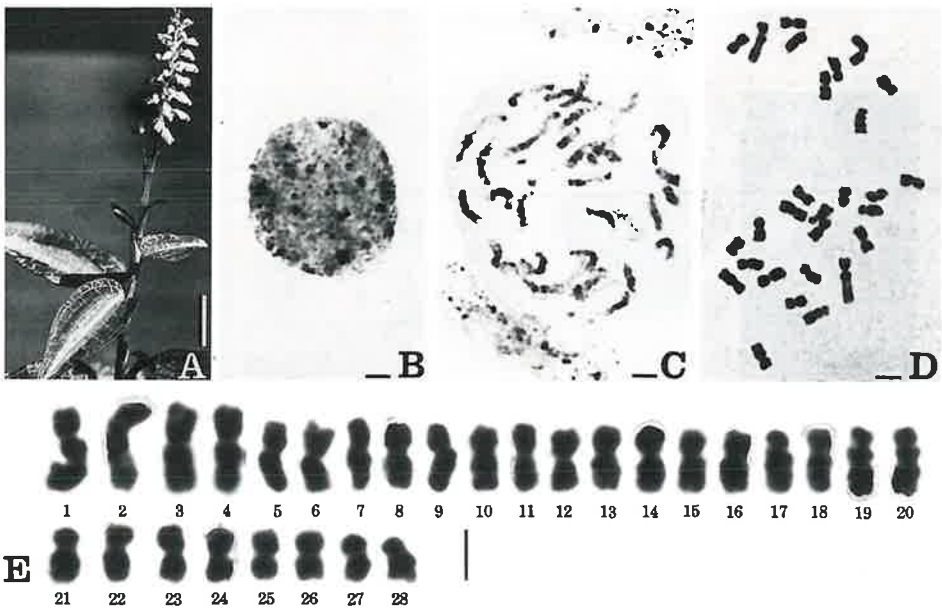

Fig. 9. *Goodyera hachijoensis* var. *yakushimensis*, 2n=28. A, plant. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 13 mm in A and 2 μm in B-E.

of their long arms and another two (Nos. 19 and 20) had satellites at the terminal regions of their short arms.

Thus, the 2n=28 chromosome complement at mitotic metaphase formed a gradual and symmetric karyotype.

7. *Goodyera macrantha* Maxim., 2n = 28 + (0-5B), Japanese Name: Beni-shusu-ran, Tables 1 and 11, Figs. 10 and 11.

Observations were made in 36 plants collected in a locality in Chiba Prefecture and five localities in Prefectures other than Chiba Prefecture. Morphological features of leaves, shoots, rhizomes and flowers of the plants were similar to those of this species described by Ohwi and Kitagawa (1983).

The chromosome numbers observed at mitotic prophase and metaphase were 2n=28 in five plants from three localities, 2n=29 in ten plants from two localities, 2n=30 in 13 plants from five localities, 2n=31 in five plants from three localities, 2n=32 in two plants from two localities and 2n=33 in a plant from a locality. Among these chromosome numbers 2n=30 supported the previous reports (Miduno 1939, Mutsuura and Nakahira 1958, Tanaka 1965b), but the other chromosome numbers were reported here for the first time.

(1) The plants with 2n=28 chromosomes. Tables 1 and 11, Fig. 10.

The chromosome morphology at resting stage and mitotic prophase were similar to those of *G. foliosa* var. *commelinoides* (2n=56).

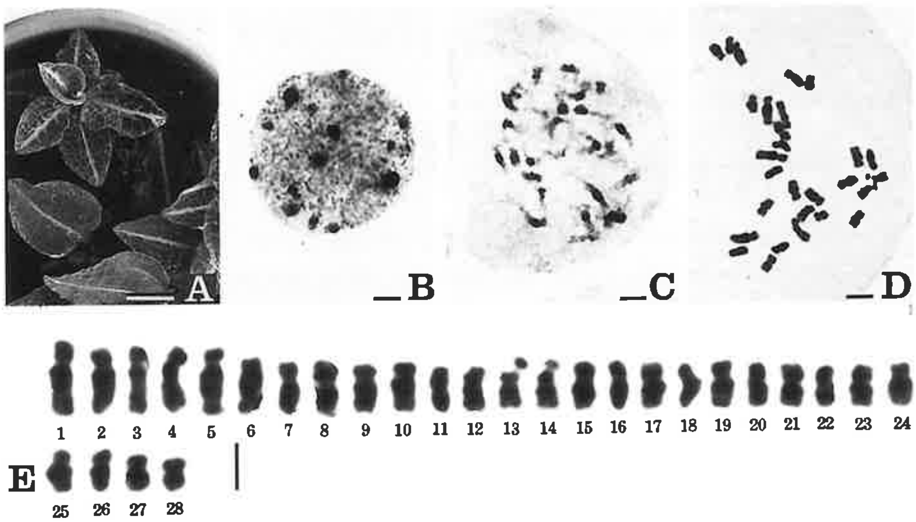

Fig. 10. *Goodyera macrantha*, 2n=28. A, plants. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 15 mm in A and 2 μm in B-E.

The 2n=28 chromosome complement at mitotic metaphase showed a gradual decrease in length from the longest (2.9 μm) to the shortest (1.4 μm) chromosomes. The average chromosome length was 1.9 μm. Among the 28 chromosomes of the complement, 14 were median centromeric with arm ratios between 1.0 and 1.7, 13 were submedian centromeric with arm ratios between 1.8 and 2.8 and the other one was subterminal centromeric with the arm ratio of 3.6. Four chromosomes (Nos. 1, 2, 3, 4) had secondary constrictions at the interstitial regions of their long arms and another two (Nos. 13 and 14) had satellites at the terminal regions of their short arms.

Thus, the 2n=28 chromosome set at mitotic metaphase performed a gradual and symmetric karyotype.

(2) The plants with 2n=29, 30, 31, 32, 33 chromosomes. Table 1, Fig. 11.

The chromosomes at resting stage were similar in morphology to those of *G. foliosa* var. *commelinoides* (2n=56) and the chromatin blocks seemed to get larger in proportion to the increase of chromosome numbers (Fig. 11., A, D, G, J, M).

At mitotic prophase the 28 chromosomes of the complement had early condensed segments at the proximal regions. One chromosome in the 2n=29 plants (2n=28+1), two chromosomes in the 2n=30 plants (2n=28+2), three chromosomes in the 2n=31 plants (2n=28+3), four chromosomes in the 2n=32 plants (2n=28+4) and five chromosomes in the 2n=33 plant (2n=28+5) got condensed earlier, respectively (Fig. 11. B, E, H, K, N). These chromosomes were similar in morphology to B-chromosomes in *Tainia laxiflora* reported by Tanaka and Matsuda (1972) and Matsuda and Tanaka (1977). Therefore, the formula of the chromosome number of this species was regarded as 2n=28+ (0-5B).

8. *Goodyera oblongifolia* Raf., 2n=30, Tables 1 and 12, Fig. 12.

This species is distributed in North America.

Observations were made in two plants propagated commercially. Morphological features of leaves, shoots, rhizomes of the plants were similar to those of this species described by Luer (1975).

The chromosome number of the plants was 2n=30 which confirmed Kallunki (1981) and supported n=15 reported by Taylor and Mulligan (1968) and Pojar (1973), but differed from the previous count of 2n=22 reported by Löve and Simon (1968).

The chromosome morphology at resting stage and mitotic prophase were similar to those of *G. foliosa* var. *commelinoides* (2n=56).

The 2n=30 chromosome complement at mitotic metaphase exhibited a gradual decrease in length from the longest (2.9 μm) to the shortest (1.4 μm) chromosomes. The average chromosome length was 2.1 μm. Among the 30 chromosomes of the mitotic metaphase complement, 11 were median centromeric with arm ratios between 1.0 and 1.6, 18 were submedian centromeric with arm ratios between 1.8 and 2.8 and the other one was subterminal centromeric with the arm ratio of 3.6. Two chromosomes (Nos. 1 and 2) had secondary constrictions at the interstitial regions of their long arms.

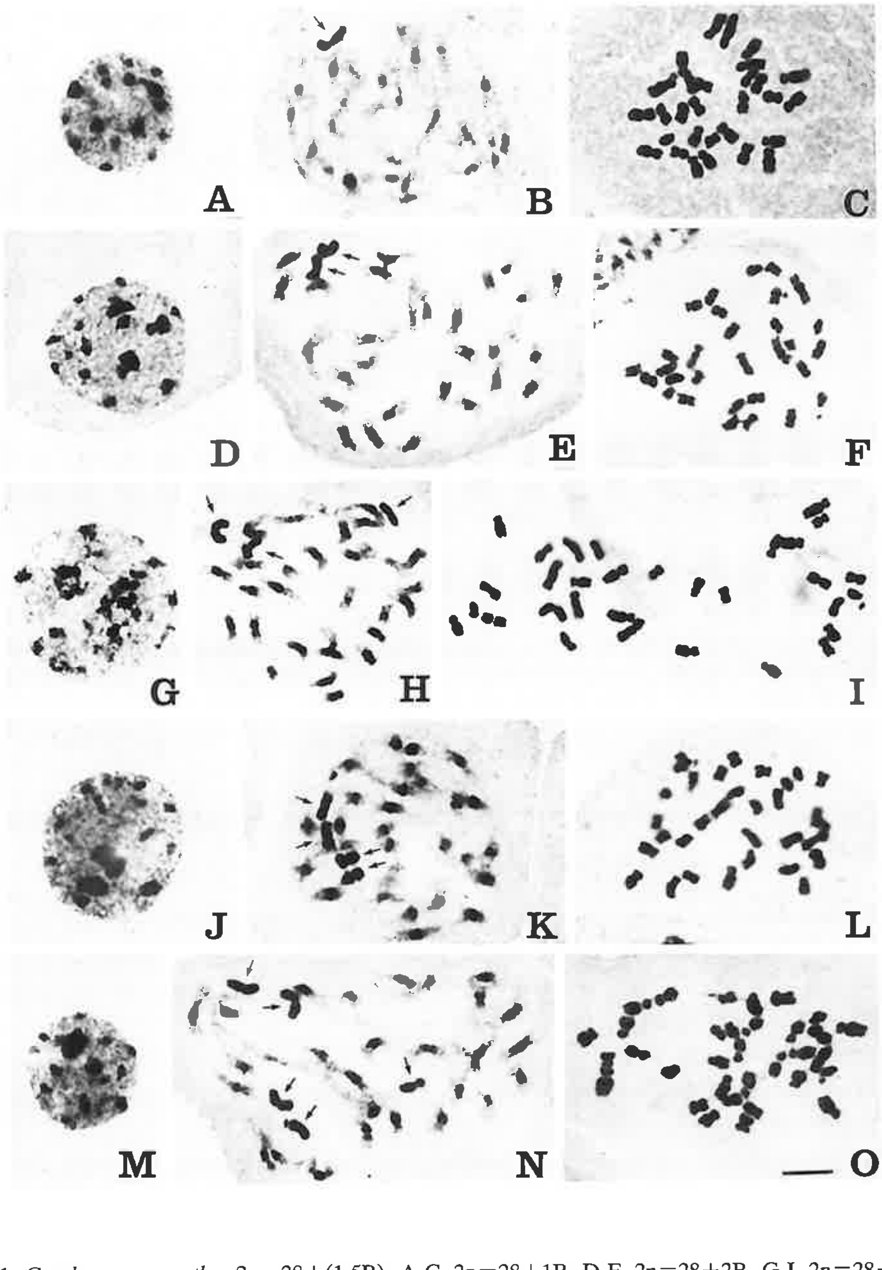

Fig. 11. *Goodyera macrantha*, 2n=28+(1-5B). A-C, 2n=28+1B. D-F, 2n=28+2B. G-I, 2n=28+3B. J-L, 2n=28+4B. M-O, 2n=28+5B. A,D,G,J,M; chromosomes at resting stage. B,E,H,K,N; chromosomes at mitotic prophase. C,F,I,L,O; chromosomes at mitotic metaphase. Arrows indicate B-chromosomes. Bar indicates 2 μm.

Thus, the 2n=30 chromosome complement at mitotic metaphase showed a gradual and symmetric karyotype.

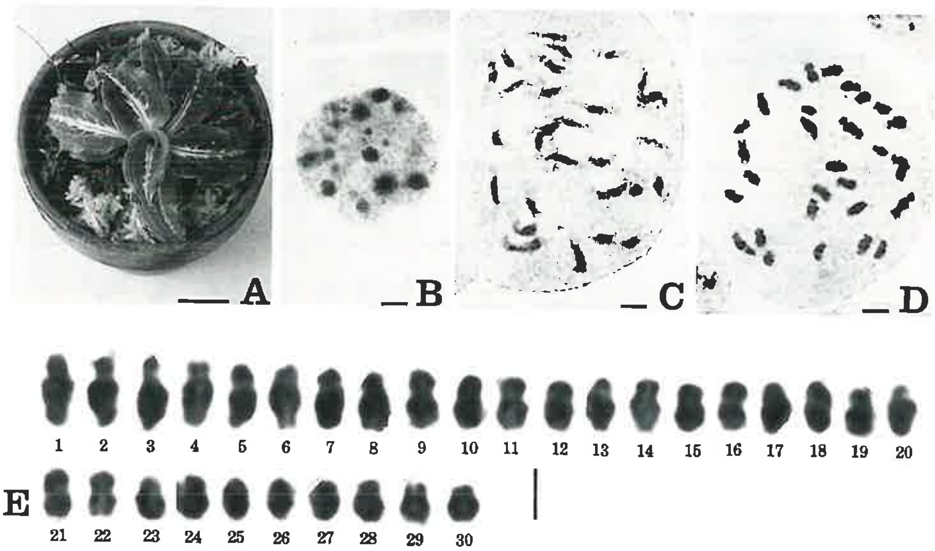

Fig. 12. *Goodyera oblongifolia*, 2n=30. A, plant. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 25 mm in A and 2 μm in B-E.

9. *Goodyera pendula* Maxim., 2n = 30, Japanese Name: Tsuri-shusu-ran, Tables 1 and 13, Fig. 13.

Observations were made in five plants collected in Hiroshima Prefecture and two localities from Prefectures other than Hiroshima Prefecture in Japan. Morphological features of leaves, shoots, rhizomes and flowers of the plants were similar to those of this species described by Ohwi and Kitagawa (1983).

The chromosome number of these plants was 2n=30 which confirmed the previous report (Tanaka 1965b), but differed from the previous count of 2n=28 reported by Mutsuura and Nakahira (1960).

The chromosome morphology at resting stage and mitotic prophase were similar to those of *G. foliosa* var. *commelinoides* (2n=56).

The 2n = 30 chromosome complement at mitotic metaphase exhibited a bimodality in length with a group of the chromosomes between 4.1 and 4.0 μm and the other group between 3.4 and 1.3 μm. The average chromosome length was 2.1 μm. Among the 30 chromosomes of the mitotic metaphase complement, 21 were median centromeric with arm ratios between 1.0 and 1.7, seven were submedian centromeric with arm ratios between 1.8 and 3.0 and the other two were subterminal centromeric with the arm ratios of 4.0 and 4.1. Two chromosomes (Nos. 1 and 2) had secondary constrictions at the interstitial regions of their

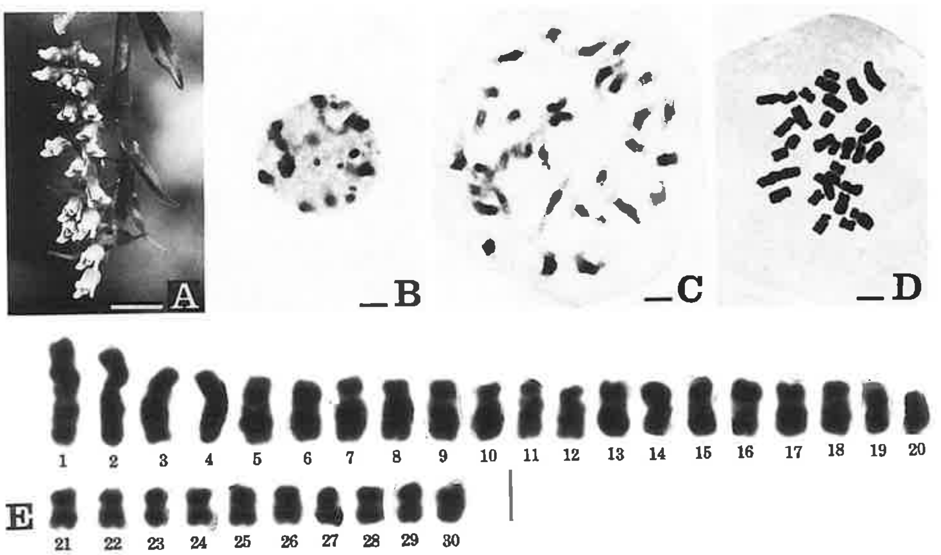

Fig. 13. *Goodyera pendula*, 2n=30. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 6 mm in A and 2 μm in B-E.

long arms, while another two chromosomes (Nos. 11 and 12) had satellites at the terminal regions of their short arms.

Thus, the 2n=30 chromosome complement at mitotic metaphase showed a bimodal and symmetric karyotype.

10. ***Goodyera procera*** **(Ker-Gawl.) Hook., 2n=42, Japanese Name: Kingin-so, Tables 1 and 14, Fig. 14.**

Observations were made in two plants collected in Okinawa Prefecture, Japan. Morphological features of leaves, shoots, rhizomes and flowers of the plants were similar to those of this species described by Ohwi and Kitagawa (1983).

The chromosome number of the plants was 2n=42 at mitotic prophase and metaphase which confirmed Miduno (1939) and Tanaka (1965b) but was different from the previous count of n=11 reported by Afzelius (1943).

The chromosome morphology at resting stage and mitotic prophase were similar to those of *G. hachijoensis* var. *hachijoensis*.

The 2n=42 chromosome complement at mitotic metaphase showed a gradual decrease in length from the longest (2.1 μm) to the shortest (1.0 μm) chromosomes. The average chromosome length was 1.5 μm. Among the 42 chromosomes of the metaphase complement, 23 were median centromeric with arm ratios between 1.1 and 1.7, 18 were submedian centromeric with arm ratios between 1.8 and 3.0 and the other one was subterminal centromeric with the arm ratio of 3.2.

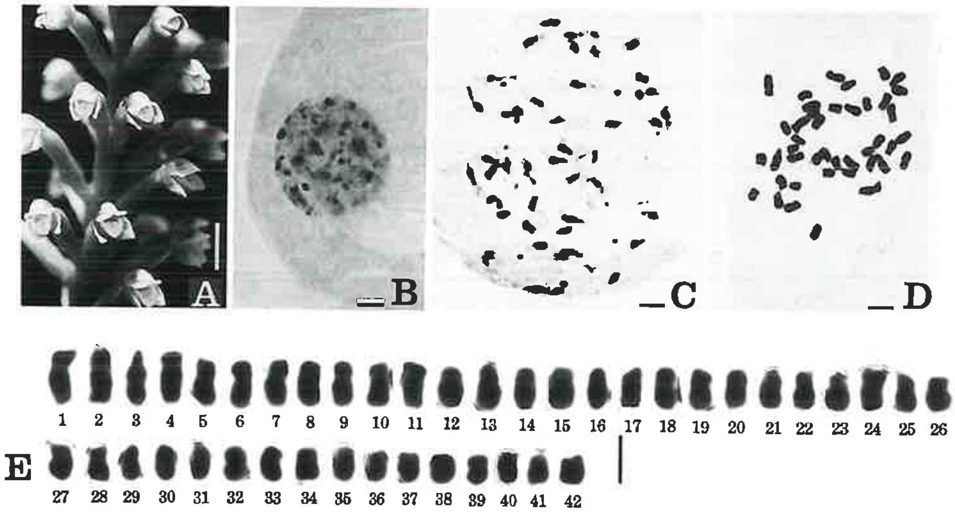

Fig. 14. *Goodyera procera*, 2n=42. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 4 mm in A and 2 μm in B-E.

Thus, the 2n=42 chromosome complement at mitotic metaphase showed a gradual and symmetric karyotype.

11. *Goodyera pubescens* (Willd.) R. Br., 2n=26, Tables 1 and 15, Fig. 15.

This species is distributed in North America.

Observations were made in two plants propagated commercially. Morphological features of leaves, shoots and rhizomes of the plants were similar to those of this species described by Luer (1975).

The chromosome number of the plants was 2n=26 which confirmed Kallunki (1981) and supported the previous count of n=13 reported by Bostick (1965).

The chromosome morphology at resting stage and mitotic prophase were similar to those of *G. foliosa* var. *commelinoides* (2n=56).

The 2n=26 chromosome complement at mitotic metaphase exhibited a gradual decrease in length from the longest (3.1 μm) to the shortest (1.5 μm) chromosomes. The average chromosome length was 2.3 μm. Among the 26 chromosomes of the metaphase complement, 17 were median centromeric with arm ratios between 1.0 and 1.7, eight were submedian centromeric with arm ratios between 1.8 and 2.4 and the other one was subterminal centromeric with the arm ratio of 3.1. Four chromosomes (Nos. 1, 2, 7, 8) had secondary constrictions at the interstitial regions of their long arms and two (Nos. 17 and 18) had satellites at the terminal regions of their long arms.

Thus, the 2n=26 chromosome complement at mitotic metaphase showed a gradual and symmetric karyotype.

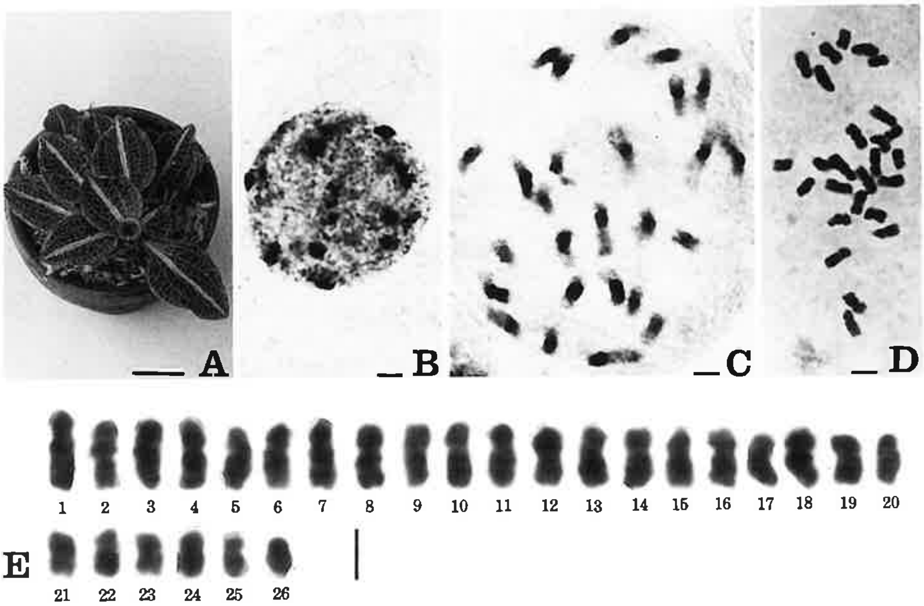

Fig. 15. *Goodyera pubescens*, 2n=26. A, plant. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 25 mm in A and 2 μm in B-E.

12. ***Goodyera repens*** **(Linn.) R. Br., 2n = 30, Japanese Name: Hime-miyama-uzura, Tables 1 and 16, Fig. 16.**

Observations were made in two plants collected in Yamanashi Prefecture, Japan. Morphological features of leaves, shoots, rhizomes and flowers of the plants were similar to those of this species described by Ohwi and Kitagawa (1983).

The chromosome number of the plants was 2n=30 at mitotic prophase and metaphase which confirmed Richardson (1935), Löve and Löve (1944, 1954), Mutsuura and Nakahira (1959), Gadella and Kliphuis (1963), Kliphuis (1963), Vij and Gupta (1975), Mehra and Pandita (1979) and Vij *et al.* (1981) and which supported the previous count of n=15 reported by Richardson (1935), Kliphuis (1963), Mehra and Bawa (1970) and Vij and Gupta (1975), but which was different from the previous counts of 2n=28 and 2n=32 reported by Eftimiu-Heim (1941) and 2n=32 by Tanaka (1965b), Mehra and Bawa (1970) and Schotsman (1970).

The chromosome morphology at resting stage of this species was similar to that of *G. hachijoensis* var. *hachijoensis*.

The chromosomes at mitotic prophase were similar in morphology to those of *G. foliosa* var. *commelinoides* (2n=56).

The 2n=30 chromosome complement at mitotic metaphase performed bimodality with a group of the chromosomes which varied in length from 4.6 to 4.5 μm and the other group

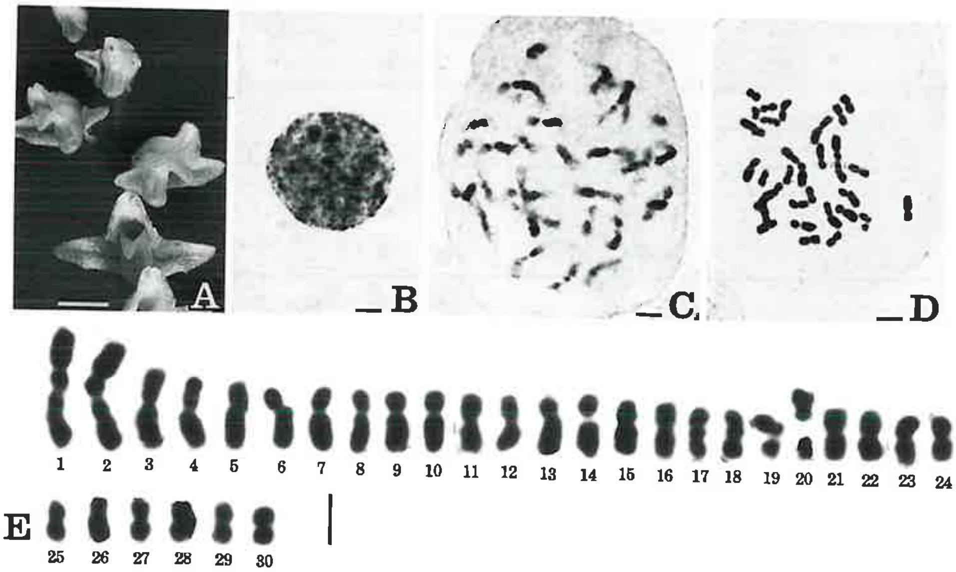

Fig. 16. *Goodyera repens*, 2n=30. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 4 mm in A and 2 μm in B-E.

of the chromosomes which varied in length from 3.1 to 1.5 μm. The average chromosome length was 2.2 μm. Among the 30 chromosomes of the metaphase complement, 22 were median centromeric with arm ratios between 1.0 and 1.7 and eight were submedian centromeric with arm ratios between 1.8 and 2.2. Two chromosomes (Nos. 1 and 2) had secondary constrictions at the interstitial regions of their long arms, while another two (Nos. 19 and 20) had satellited secondary constrictions in their long arms.

Thus, the 2n=30 chromosome complement at mitotic metaphase formed a bimodal and symmetric karyotype.

13. *Goodyera schlechtendaliana* Reichb. f., 2n = 30 and 2n = 60, Japanese Name: Miyama-uzura, Tables 1, 17 and 18, Figs. 17 and 18.

Observations were made in 33 plants collected in Aomori Prefecture and 24 localities in other than Aomori Prefecture, Japan. Morphological features of leaves, shoots, rhizomes and flowers of the plants were similar to those of this species described by Ohwi and Kitagawa (1983).

The chromosome numbers observed at mitotic prophase and metaphase were 2n=30 in 28 plants from 22 localities and 2n=60 in five plants from four localities. While the former chromosome number of 2n = 30 confirmed the previous reports (Mutsuura and Nakahira 1958, Shoji 1963, Tanaka 1965b), the latter chromosome number of 2n=60 was reported here for the first time. Thus, the intraspecific polyploidy was found in this species for the first time.

(1) The plants with 2n=30 chromosomes. Tables 1 and 17, Fig. 17.

The chromosome morphology at resting stage and mitotic prophase were quite similar to those of *G. foliosa* var. *commelinoides* (2n = 56) excepting the chromomeric granules and fibrous threads at resting stage were more darkly stained.

The 2n=30 chromosome complement at mitotic metaphase displayed a gradual decrease in length from the longest (3.8 μm) to the shortest (1.6 μm) chromosomes. The average chromosome length was 2.4 μm. Among the 30 chromosomes of the metaphase complement, 21 were median centromeric with arm ratios between 1.0 and 1.6, six were submedian centromeric with arm ratios between 1.8 and 2.8 and the other three were subterminal with arm ratios between 3.2 and 3.6. Two chromosomes (Nos. 1 and 2) had secondary constrictions at the interstitial regions of their long arms and two (Nos. 15 and 16) had lightly stained satellites at the terminal regions of their short arms.

Thus, the 2n=30 chromosome complement at mitotic metaphase showed a gradual and symmetric karyotype.

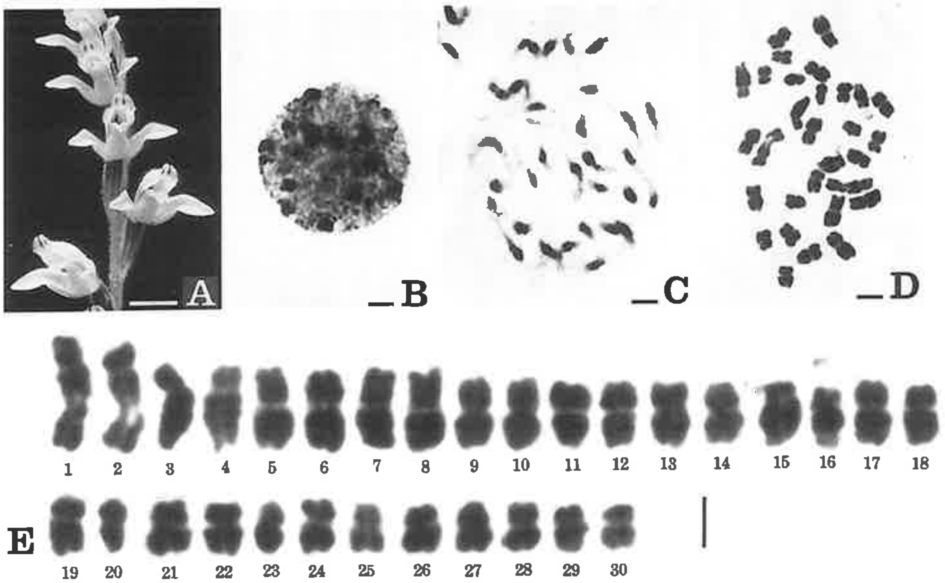

Fig. 17. *Goodyera schlechtendaliana*, 2n=30. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 6 mm in A and 2 μm in B-E.

(2) The plants with 2n=60 chromosomes. Tables 1 and 18, Fig.18.

The reticulate variegation on the leaves were vague and the leaves were thicker than those of the 2n = 30 plants. The chromosome morphology at resting stage and mitotic

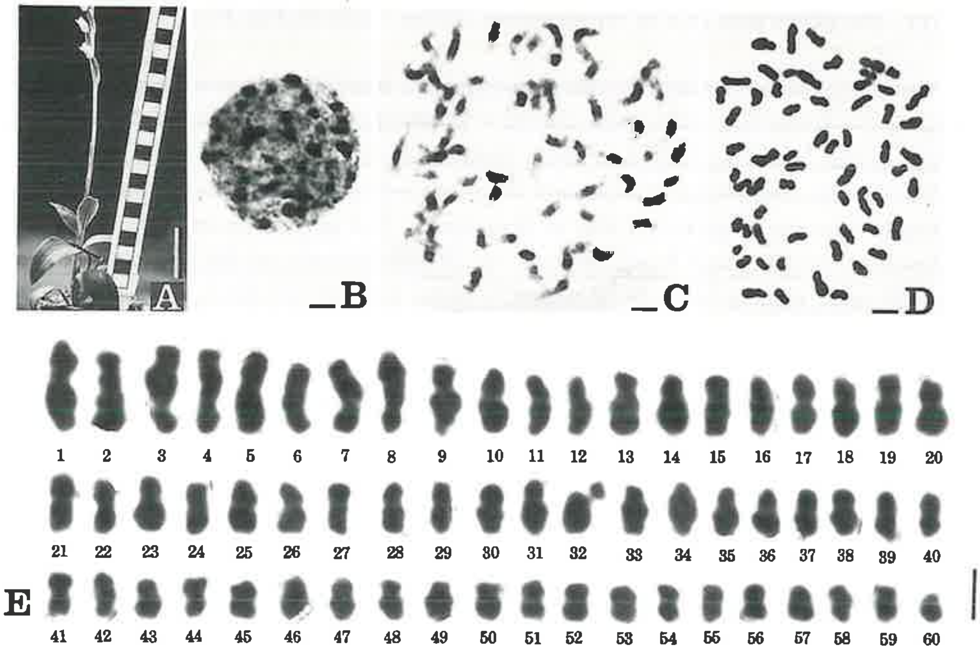

Fig. 18. *Goodyera schlechtendaliana*, 2n=60. A, plant. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 35 mm in A and 2 μm in B-E.

prophase were similar to those of the 2n=30 plants. The 2n=60 chromosome complement at mitotic metaphase performed a gradual decrease in length from the longest (3.4 μm) to the shortest (1.0 μm) chromosomes. The average chromosome length was 1.9 μm. Among the 60 chromosomes of the metaphase complement, 35 were median centromeric with arm ratios between 1.0 and 1.7, 19 were submedian centromeric with arm ratios between 1.8 and 2.8 and six were subterminal with arm ratios between 3.1 and 5.3. Four chromosomes (Nos. 3, 4, 7, 8) had secondary constrictions at the interstitial regions of their long arms.

Thus, the 2n=60 chromosome complement at mitotic metaphase showed a gradual and symmetric karyotype.

The 2n=60 plants seemed to be an autopolyploid of the 2n=30 plants according to the morphology of chromosomes at mitotic metaphase described above.

14. *Goodyera velutina* Maxim., 2n=28 and 2n=56, Japanese Name: Shusu-ran, Tables 1, 19 and 20, Figs. 19 and 20.

Observations were made in 15 plants collected in Chiba Prefecture and another seven localities in Japan. Morphological features of leaves, shoots, rhizomes and flowers of the plants were similar to those of this species described by Ohwi and Kitagawa (1983).

The chromosome numbers observed at mitotic prophase and metaphase were 2n=28 in eight plants from four localities and 2n = 56 in seven plants from four localities. The chromosome number of 2n=28 counted here confirmed the previous reports (Miduno 1939, Mutsuura and Nakahira 1960, Tanaka 1965b), while the chromosome number of 2n=56 counted here confirmed the previous observation in the plants from Nagasaki Prefecture (Yokota personal communication). It was revealed that the intraspecific polyploidy in this species was observed in various districts in Japan.

(1) The plants with 2n=28 chromosomes. Tables 1 and 19, Fig. 19.

The chromosome morphology at resting stage and mitotic prophase were similar to those of *G. foliosa* var. *commelinoides* (2n=56).

The 2n=28 chromosome complement at mitotic metaphase displayed a gradual decrease in length from the longest (2.2 μm) to the shortest (1.1 μm) chromosomes. The average chromosome length was 1.6 μm. Among the 28 chromosomes of the metaphase complement, 24 were median centromeric with arm ratios between 1.1 and 1.7 and the other four were submedian with arm ratios between 1.8 and 2.6. Two chromosomes (Nos. 1 and 2) had secondary constrictions at the interstitial regions of their long arms and two (Nos. 5 and 6) had satellites at the terminal regions of their short arms.

Thus, the 2n=28 chromosome complement at mitotic metaphase formed a gradual and symmetric karyotype.

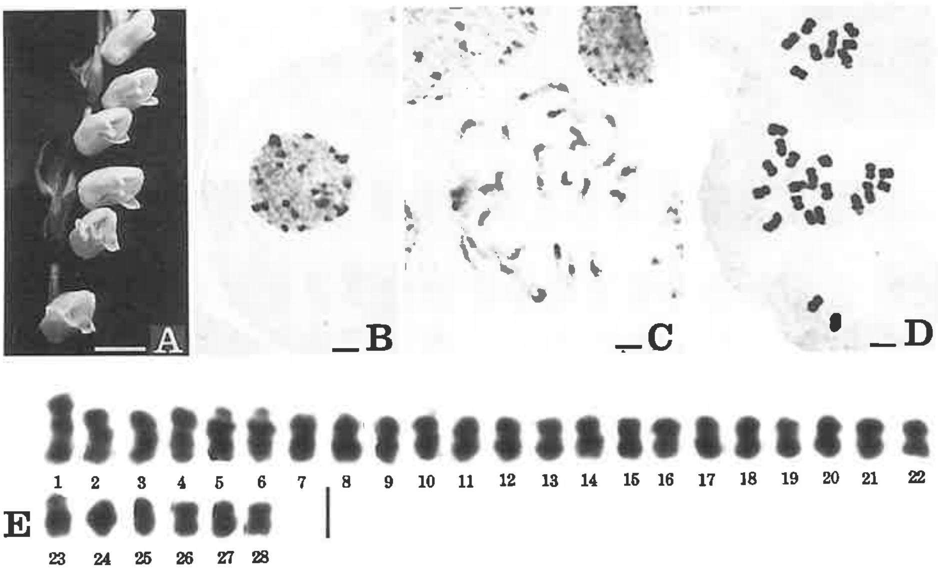

Fig. 19. *Goodyera velutina*, 2n=28. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 10 mm in A and 2 μm in B-E.

(2) The plants with 2n=56 chromosomes. Tables 1 and 20, Fig. 20.

The chromosome morphology at resting stage and mitotic prophase were similar to those of 2n=28 plants.

The 2n=56 chromosome complement at mitotic metaphase displayed a gradual decrease in length from the longest (2.3 μm) to the shortest (1.1 μm) chromosomes. The average chromosome length was 1.6 μm. Among the 56 chromosomes of the metaphase complement, 42 were median centromeric with arm ratios between 1.0 and 1.7, 12 were submedian centromeric with arm ratios between 1.8 and 2.7 and the rest two were subterminal centromeric with the arm ratio of 3.2. Four chromosomes (Nos. 7, 8, 9, 10) had secondary constrictions at the interstitial regions of their long arms and two (Nos. 11 and 12) had satellites at terminal regions of their short arms.

Thus, the 2n=56 chromosome complement at mitotic metaphase showed a gradual and symmetric karyotype.

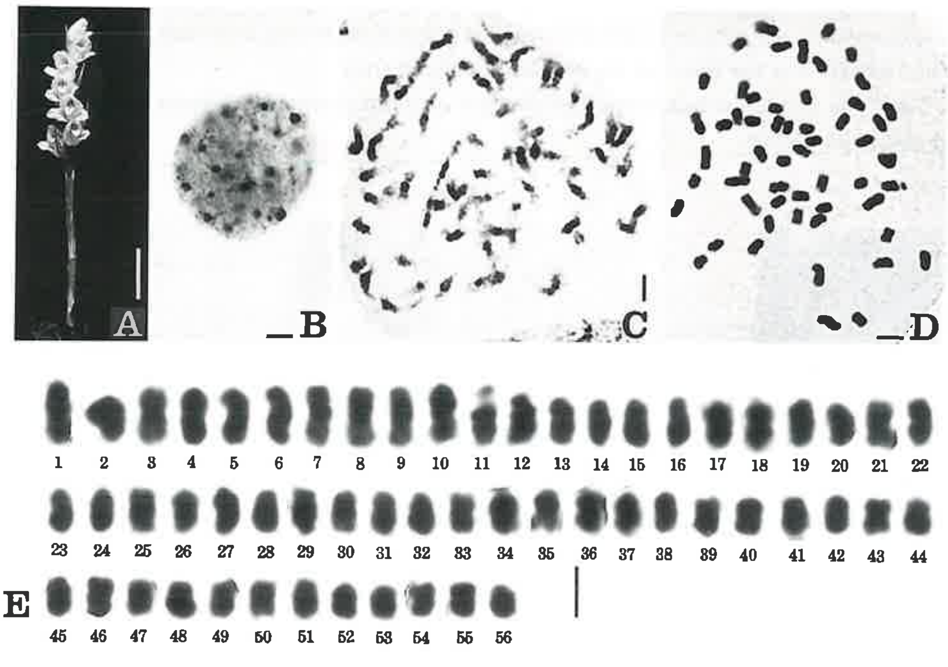

Fig. 20. *Goodyera velutina*, 2n=56. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 15 mm in A and 2 μm in B-E.

The 2n=56 plants seemed to be an autopolyploid of the 2n=28 plants according to the morphology of chromosomes at mitotic metaphase described above.

15. *Goodyera viridiflora* (Bl.) Bl., 2n = 22, Japanese Name: Shima-shusu-ran, Tables 1 and 21, Fig. 21.

Observations were made in four plants collected in Kagoshima Prefecture, Japan. Morphological features of leaves, shoots, rhizomes and flowers of the plants were similar to those of this species described by Ohwi and Kitagawa (1983).

The chromosome number of the plants was 2n = 22 at mitotic prophase and metaphase which confirmed the previous report on the species treated previously as *G. ogatai* Yamamoto (Tanaka 1965b).

The chromosome morphology at resting stage and mitotic prophase were quite similar to those of *G. foliosa* var. *commelinoides* (2n = 56) excepting most of the large chromatin blocks at resting stage and the early condensed segments at prophase were rod-shaped.

The 2n = 22 chromosome set at mitotic metaphase exhibited a gradual decrease in length from the longest (2.4 μm) to the shortest (1.4 μm) chromosomes. The average chromosome length was 1.9 μm. Among the 22 chromosomes of the metaphase complement, seven were median centromeric with arm ratios between 1.1 and 1.6, nine were submedian centromeric with arm ratios between 1.8 and 2.6 and six were subterminal with arm ratios between 3.3 and 3.6. Four chromosomes (Nos. 3, 4, 5, 6) had secondary constrictions at the interstitial regions of their long arms and two (Nos. 19 and 20) had lightly stained satellites at the terminal regions of their short arms.

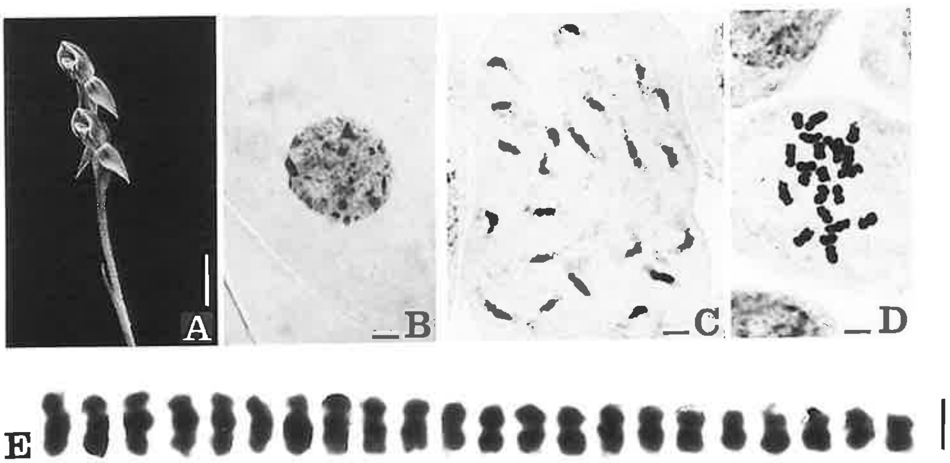

Fig. 21. *Goodyera viridiflora*, 2n = 22. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 10 mm in A and 2 μm in B-E.

Thus, the 2n = 22 chromosome complement at mitotic metaphase showed a gradual and symmetric karyotype.

III. *Hetaeria*

1. *Hetaeria rubens* (Lindl.) Benth., 2n=24, Tables 1 and 22, Fig. 22.

This species is distributed in tropical Asia from the Himalayas to Indochina.

Observations were made in a plant propagated commercially. Morphological features of leaves, shoots, rhizomes and flowers of the plant were similar to those of this species described by Seidenfaden (1978).

The chromosome number of the plant was 2n=24 at mitotic prophase and metaphase which was different from the previous count of 2n=22 (Mehra and Sehgal 1974, Mehra 1982) and n=21 (Mehra and Bawa 1970, Mehra et al. 1972).

The chromosomes at resting stage were observed as numerous chromomeric granules and fibrous threads scattered more or less unevenly in the nucleus and conspicuous chromatin blocks. The chromatin blocks varied in diameter of the long axis from 0.5−3.0 μm and in morphology from round- to rod-shaped with smooth or rough surface. While the chromatin blocks varied slightly in size, shape and number among the nuclei, about 35 chromocentric bodies were constantly counted in every nucleus. Thus, the chromosome feature at resting stage was of the complex chromocenter type according to the definition proposed by Tanaka (1971).

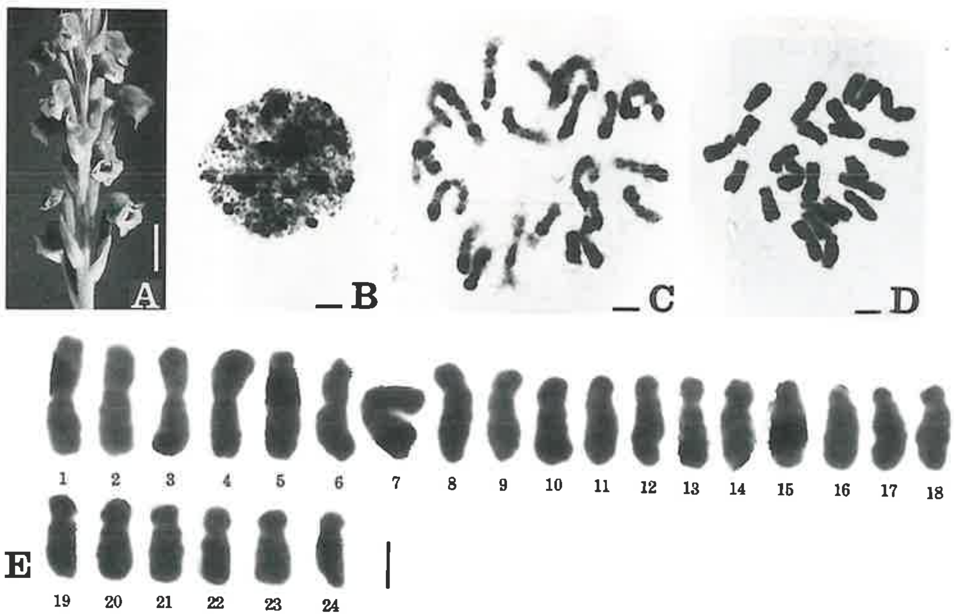

Fig. 22. *Hetaeria rubens*, 2n=24. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 6 mm in A and 2 μm in B-E.

At mitotic prophase, all of the 2n=24 chromosomes in the complement had early condensed segments located at the proximal, the interstitial and the terminal regions and less clearing differentiated slightly clearly to late condensed segments.

The 2n = 24 chromosome set at mitotic metaphase performed a gradual decrease in length from the longest (4.6 μm) to the shortest (2.8 μm) chromosomes. The average chromosome length was 3.6 μm. Among the 24 chromosomes of the mitotic metaphase complement, six were median centromeric with arm ratios between 1.0 and 1.4, 12 were submedian centromeric with arm ratios between 2.0 and 3.0 and the other six were subterminal with arm ratios between 3.2 and 5.8.

Thus, the 2n=24 chromosome complement at mitotic metaphase showed a gradual and symmetric karyotype.

2. *Hetaeria sikokiana* (Makino et F. Maekawa) Tuyama, 2n=42, Japanese Name: Hime-no-yagara, Tables 1 and 23, Fig. 23.

Observations were made in two plants collected in Hiroshima Prefecture, Japan. Morphological features of shoots, rhizomes and flowers of the plants were similar to those of this species described by Ohwi and Kitagawa (1983).

The chromosome number of the plants was 2n=42 at mitotic prophase and metaphase

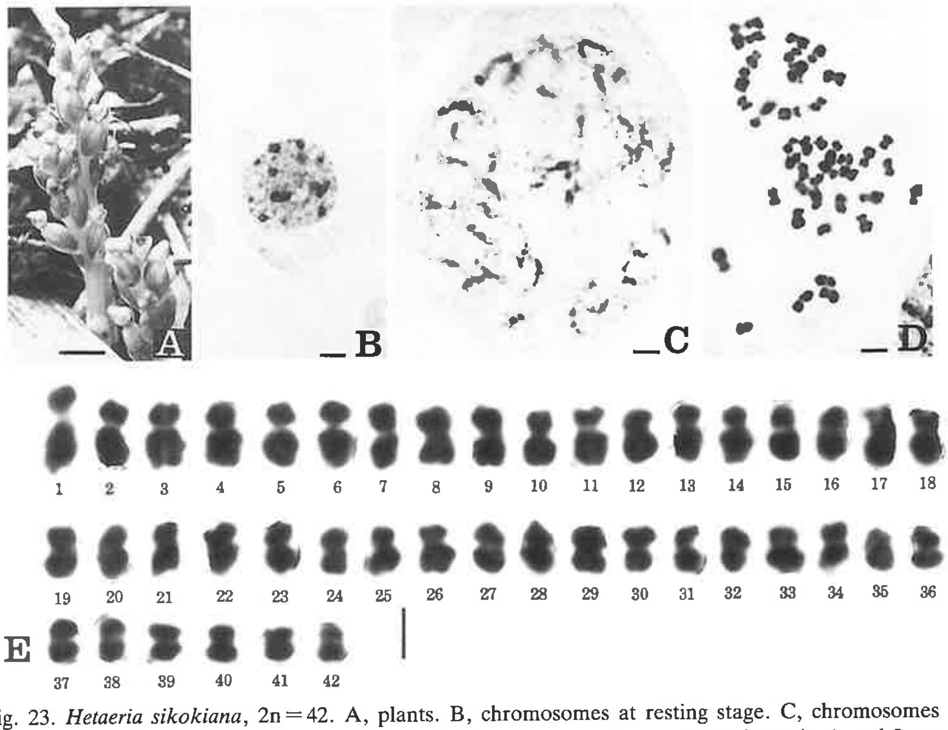

Fig. 23. *Hetaeria sikokiana*, 2n=42. A, plants. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 6 mm in A and 2 μm in B-E.

which were determined here for the first time.

The chromosome morphology at resting stage was similar to that of *Anoectochilus formosanus*.

The chromosomes at mitotic prophase were similar in morphology to those of *Goodyera hachijoensis* var. *hachijoensis*.

The 2n=42 chromosome set at mitotic metaphase displayed a gradual decrease in length from the longest (2.6 μm) to the shortest (1.1 μm) chromosomes. The average chromosome length was 1.8 μm. Among the 42 chromosomes of the mitotic metaphase complement, 32 were median centromeric with arm ratios between 1.0 and 1.7 and the other ten were submedian centromeric with arm ratios between 1.8 and 2.2. Two chromosomes (Nos. 17 and 18) had satellites at the terminal regions of their short arms.

Thus, the 2n=42 chromosome complement at mitotic metaphase showed a gradual and symmetric karyotype.

3. *Hetaeria yakusimensis* Masamune, 2n = 42, Japanese Name: Yakushima-aka-shusuran, Tables 1 and 24, Fig. 24.

Observations were made in four plants collected in Kagoshima Prefecture, Japan. Morphological features of leaves, shoots, rhizomes and flowers of the plants were similar to those of this species described by Ohwi and Kitagawa (1983).

The chromosome number of the plants was 2n=42 at mitotic prophase and metaphase

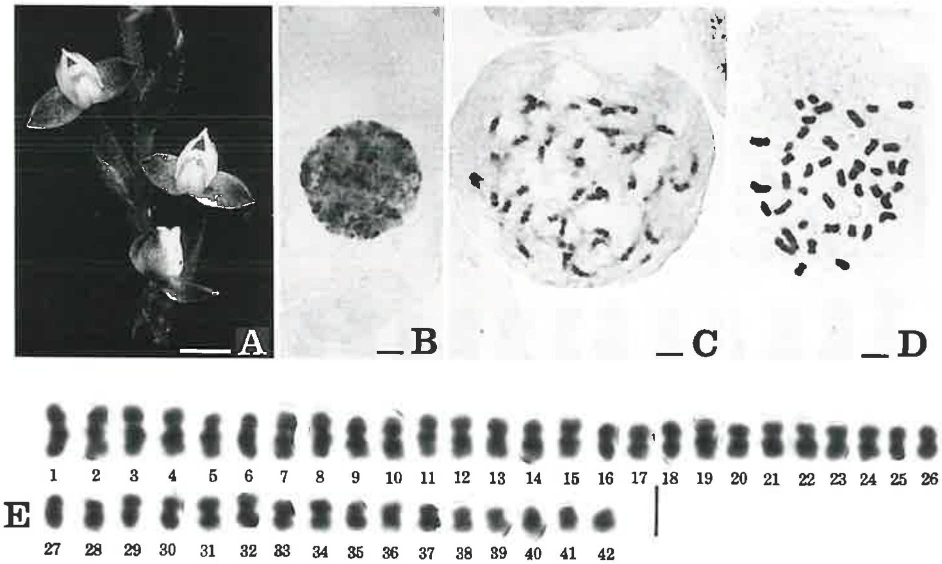

Fig. 24. *Hetaeria yakusimensis*, 2n=42. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 3 mm in A and 2 μm in B-E.

which confirmed Tanaka (1965b).

The chromosome morphology at resting stage and mitotic prophase were similar to those of *Goodyera hachijoensis* var. *hachijoensis*.

The 2n=42 chromosome complement at mitotic metaphase exhibited a gradual decrease in length from the longest (2.0 μm) to the shortest (0.7 μm) chromosomes. The average chromosome length was 1.3 μm. Among the 42 chromosomes of the mitotic metaphase complement, 33 were median centromeric with arm ratios between 1.0 and 1.7 and the other nine were submedian centromeric with arm ratios between 1.8 and 2.2. Two chromosomes (Nos. 1 and 2) had secondary constrictions at the interstitial regions of their long arms.

Thus, the 2n=42 chromosome set at mitotic metaphase showed a gradual and symmetric karyotype.

IV. *Macodes*

1. *Macodes petola* (Bl.) Lindl., 2n=42, Japanese Name: Nanban-kagome-ran, Tables 1 and 25, Fig. 25.

Observations were made in two plants collected in Okinawa Prefecture, Japan. Morphological features of leaves, shoots, rhizomes and flowers of the plants were similar to those of this species described by Holttum (1964).

The chromosome number of the plants was 2n=42 at mitotic prophase and metaphase which was determined here for the first time.

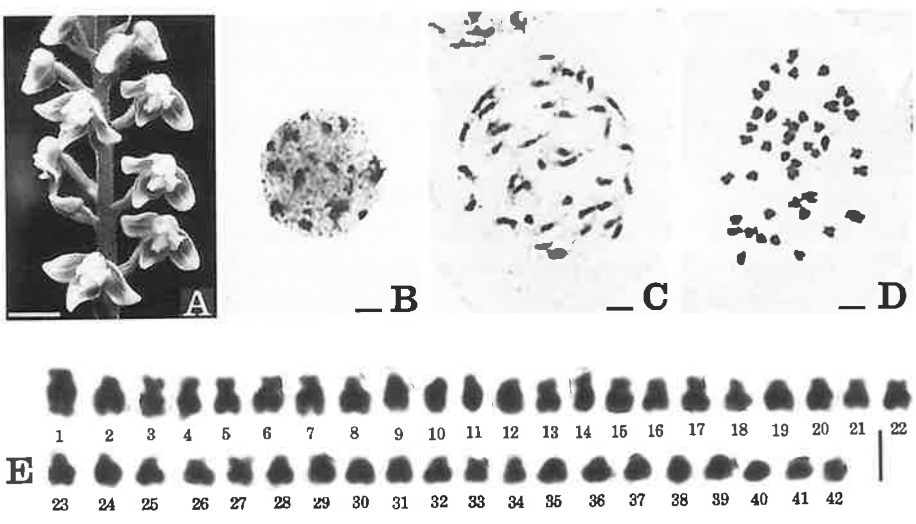

Fig. 25. *Macodes petola*, 2n=42. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 10 mm in A and 2 μm in B-E.

The chromosome at resting stage were observed as numerous chromomeric granules, fibrous threads scattered throughout the nucleus and conspicuous chromatin blocks. The chromatin blocks varied in diameter of the long axis from 0.5−2.5 μm and in morphology from round-, rod- to string-shaped with smooth or rough surface. While the chromatin blocks varied in size, shape and number among the nuclei, about 20 chromocentric bodies were counted constatly in every nucleus. Thus, the chromosome feature at resting stage was of the intermediate type between simple and complex chromocenter types according to the definition proposed by Tanaka (1971).

At mitotic prophase, early condesed segments located at the proximal regions of all the 2n=42 chromosomes were rod-shaped and were shifted clearly to late condensed segments.

The 2n=42 chromosome complement at mitotic metaphase exhibited a gradual decrease in length from the longest (1.8 μm) to the shortest (0.6 μm) chromosomes. The average chromosome length was 1.1 μm. Among the 42 chromosomes of the mitotic metaphase complement, four were median centromeric with arm ratios between 2.0 and 2.6 ten were subterminal centrometic with arm ratios between 3.5 and 7.0 and the other six were terminal centrometic with arm ratios between 8.0 and 9.0.

Thus, the 2n=42 chromosome complement at mitotic metaphase showed a gradual and symmetric karyotype.

V. *Myrmechis*

1. *Myrmechis japonica* (Reichb. f.) Rolfe, 2n=56, Japanese Name: Aridoshi-ran, Tables 1 and 26, Fig. 26.

Observations were made in two plants collected in Nagano and Yamanashi Prefectures, Japan. Morphological features of leaves, shoots, rhizomes and flowers of the plants were similar to those of this species described by Ohwi and Kitagawa (1983).

The chromosome number of the plants was 2n=56 at mitotic prorhase and metaphase which confirmed Tanaka and Sera (1981).

The chromosomes at resting stage were observed as numerous chromomeric granules, fibrous threads scattered throughout the nucleus and conspicuous chromatin blocks. The chromatin blocks varied in diameter of the long axis from 0.5−1.5 μm and in morphology from round- to rod-shaped with smooth or rough surface. While the chromatin blocks varied slightly in size, shape and number among the nuclei, about 40 prochromosomal bodies were counted constantly in every nucleus. Thus, the chromosome feature at resting stage was of the prochromosome type according to the definition proposed by Tanaka (1971) and it was similar to that of *Goodyera hachijoensis* var. *hachijoensis*.

At mitotic prophase, early condensed segments were located at the proximal regions of all of the 56 chromosomes of the mitotic metaphase complement and at the terminal regions of several chromosomes.

The 2n=56 chromosome complement at mitotic metaphase exhibited a gradual decrease in length from the longest (2.0 μm) to the shortest (1.4 μm) chromosomes. The average

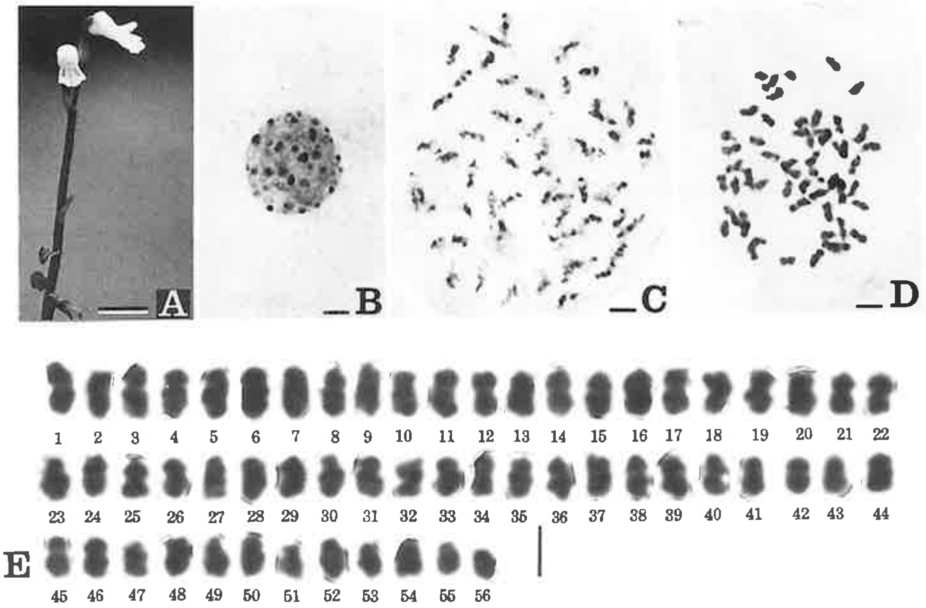

Fig. 26. *Myrmechis japonica*, 2n=56. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 10 mm in A and 2μm in B-E.

chromosome length was 1.5 μm. Among the 56 chromosomes of the mitotic metaphase complement, 30 were median centromeric with arm ratios between 1.0 and 1.7 and the other 26 were submedian with arm ratios between 1.8 and 2.3

Thus, the 2n=56 chromosome complement at mitotic metaphase showed a gradual and symmetric karyotype.

2. *Myrmechis tsukusiana* Masamune, 2n = 28, Japanese Name: Tsukushi-aridoshi-ran, Tables 1 and 27, Fig. 27.

Observations were made in two plants collected in Kagoshima Prefecture, Japan. Morphological features of leaves, shoots, rhizomes and flowers of the plants were similar to those of this species described by Ohwi and Kitagawa (1983).

The chromosome number of the plants was 2n=28 at mitotic prophase and metaphase which confirmed the previous report (Tanaka and Sera 1981).

The chromosome morphology at resting stage and mitotic prophase were similar to those of *Goodyera hachijoensis* var. *hachijoensis*.

The 2n=28 chromosome complement at mitotic metaphase displayed a gradual decrease in length from the longest (2.2 μm) to the shortest (1.3 μm) chromosomes. The average chromosome length was 1.7 μm. Among the 28 chromosomes of the mitotic metaphase complement, 22 were median centromeric with arm ratios between 1.0 and 1.6 and the

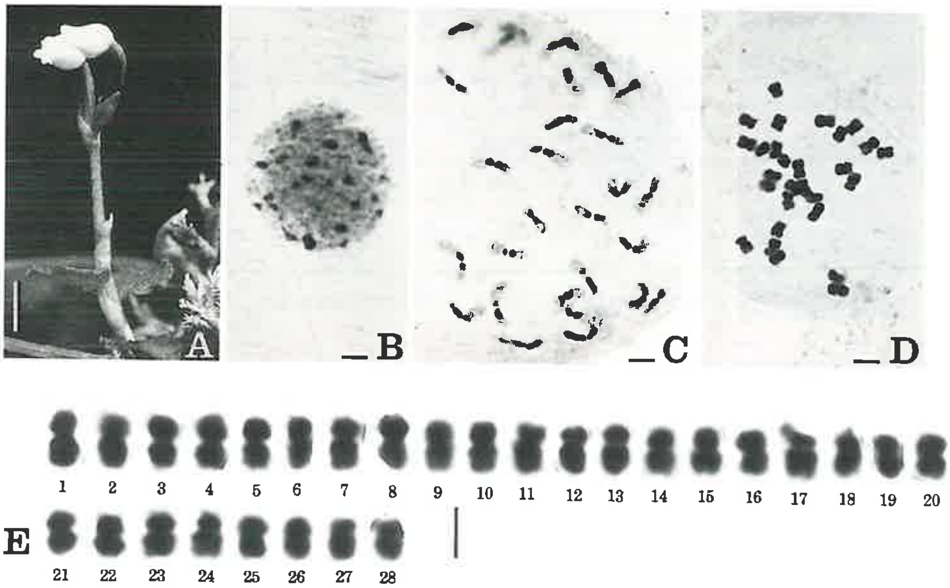

Fig. 27. *Myrmechis tsukusiana*, 2n=28. A, plant. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 5 mm in A and 2μm in B-E.

other six were submedian centromeric with arm ratios between 2.0 and 2.2. Two chromosomes (Nos. 17 and 18) had lightly stained satellites at the terminal regions of their short arms.

Thus, the 2n=28 chromosome complement at mitotic metaphase showed a gradual and symmetric karyotype.

VI. *Odontochilus*

1. *Odontochilus inabai* Hayata, 2n=28, Japanese Name: Inaba-ran, Tables 1 and 28, Fig. 28.

Observations were made in a plant collected in Taichun Prefecture, Taiwan, China. Morphological features of leaves, shoots, rhizomes and flowers of the plant were similar to those of this species described by Ohwi and Kitagawa (1983).

The chromosome number of the plant was 2n=28 at mitotic prophase and metaphase which was determined here for the first time.

The chromosomes at resting stage were observed as numerous chromomeric granules, fibrous threads scattered throughout the nucleus and conspicuous chromatin blocks. The chromatin blocks varied in diameter of the long axis from 0.5−2.0 μm and in morphology from round- to rod-shaped with smooth to rough surface. While the chromatin blocks

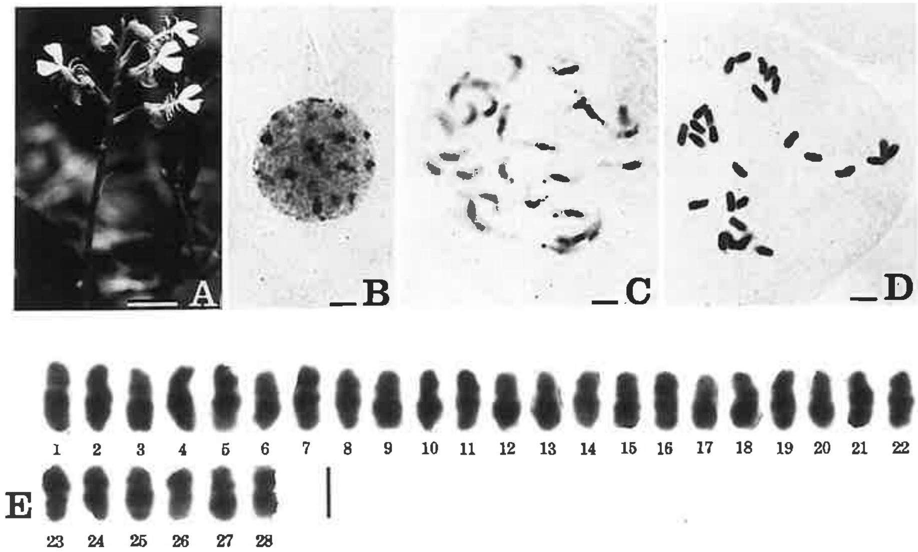

Fig. 28. *Odontochilus inabai*, 2n=28. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 22 mm in A and 2μm in B-E.

varied in size, shape and number among the nuclei, about 25 prochromosomal bodies were counted constantly in every nucleus. Thus, the chromosome feature at resting stage was of the prochromosome type according to the definition proposed by Tanaka (1971) and it was similar to that of *Goodyera foliosa* var. *commelinoides* (2n=56).

At mitotic prophase, early condensed segments were observed at the proximal regions of all of the 28 chromosomes of the complement and at the terminal regions of several chromosomes and were shifted clearly to late condensed segments.

The 2n=28 chromosome complement at mitotic metaphase exhibited a gradual decrease in length from the longest (2.7 μm) to the shortest (1.9 μm) chromosomes. The average chromosome length was 2.3 μm. Among the 28 chromosomes of the mitotic metaphase complement, 22 were median centromeric with arm ratios between 1.0 and 1.7 and the other six were submedian centromeric with arm ratios between 1.8 and 2.1.

Thus, the 2n=28 chromosome complement at mitotic metaphase showed a gradual and symmetric karyotype.

VII. *Vexillabium*

1. *Vexillabium yakushimense* (Yamamoto) F. Maekawa, 2n=26, Japanese Name: Yakushima-hime-aridoshi-ran, Tables 1 and 29, Fig. 29.

Observations were made in four plants collected in Kagoshima Prefecture, Japan. Mor-

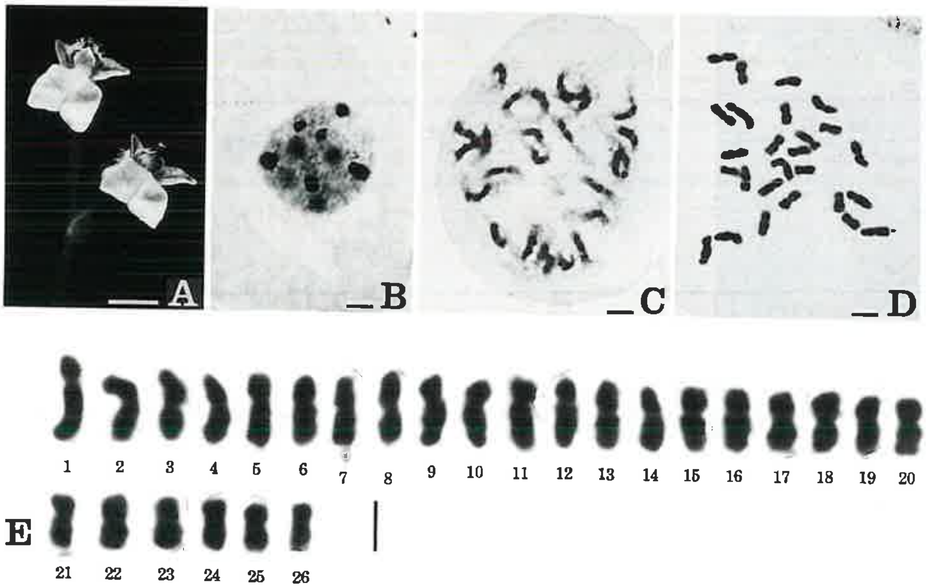

Fig. 29. *Vexillabium yakushimense*, 2n=26 A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 5 mm in A and 2μm in B-E.

phological features of leaves, shoots, rhizomes and flowers of the plants were similar to those of this species described by Ohwi and Kitagawa (1983).

The chromosome number of the plants was 2n=26 at mitotic prophase and metaphase which confirmed Tanaka (1965b).

The chromosomes at resting stage were observed as numerous chromomeric granules, fibrous threads scattered throughout the nucleus and conspicuous chromatin blocks. The chromatin blocks varied in diameter of the long axis from 0.5−2.0 μm and in morphology from round- to rod-shaped with smooth surface. While the chromatin blocks varied in size, shape and number among the nuclei, about 10 chromocentric bodies were counted constantly in every nucleus. Thus, the chromosome feature at resting stage was of the intermediate type between the simple and complex chromocenter types according to the definition proposed by Tanaka (1971) and it was similar to that of *Anoectochilus formosanus*.

At mitotic prophase, early condensed segments were observed at the proximal regions of all of the 28 chromosomes of complement and the terminal regions of several chromosomes and were shifted clearly to late condensed segments.

The 2n=26 chromosome complement at mitotic metaphase showed a gradual decrease in length from the longest (3.4 μm) to the shortest (1.7 μm) chromosomes. The average chromosome length was 2.5 μm. Among the 26 chromosomes of the mitotic metaphase complement, 19 were median centromeric with arm ratios between 1.0 and 1.7, five were submedian centromeric with arm ratios between 1.8 and 2.3 and the other two were subterminal centromeric with the arm ratios of 3.2 and 3.1. Two chromosomes (Nos. 7 and 8) had lightly stained satellites at the terminal regions of their long arms.

Thus, the 2n=26 chromosome complement at mitotic metaphase showed a gradual and symmetric karyotype.

VIII. *Zeuxine*

1. *Zeuxine agyokuana* Fukuyama, 2n=20, Japanese Name: Kagero-ran, Tables 1 and 30, Fig. 30.

Observations were made in four plants collected in Kagoshima Prefecture, Japan. Morphological features of leaves, shoots, rhizomes and flowers of the plants were similar to those of this species described by Garay and Sweet (1974).

The chromosome number of the plants was 2n=20 at mitotic prophase and metaphase which confirmed the previous report (Tanaka 1965b) on this species treated previously as *Hetaeria xenantha*.

The chromosomes at resting stage were observed as numerous chromomeric granules, fibrous theads scattered throughout the nucleus and conspicuous chromatin blocks. The chromatin blocks varied in diameter of the long axis from 0.5−1.5 μm and in morphology

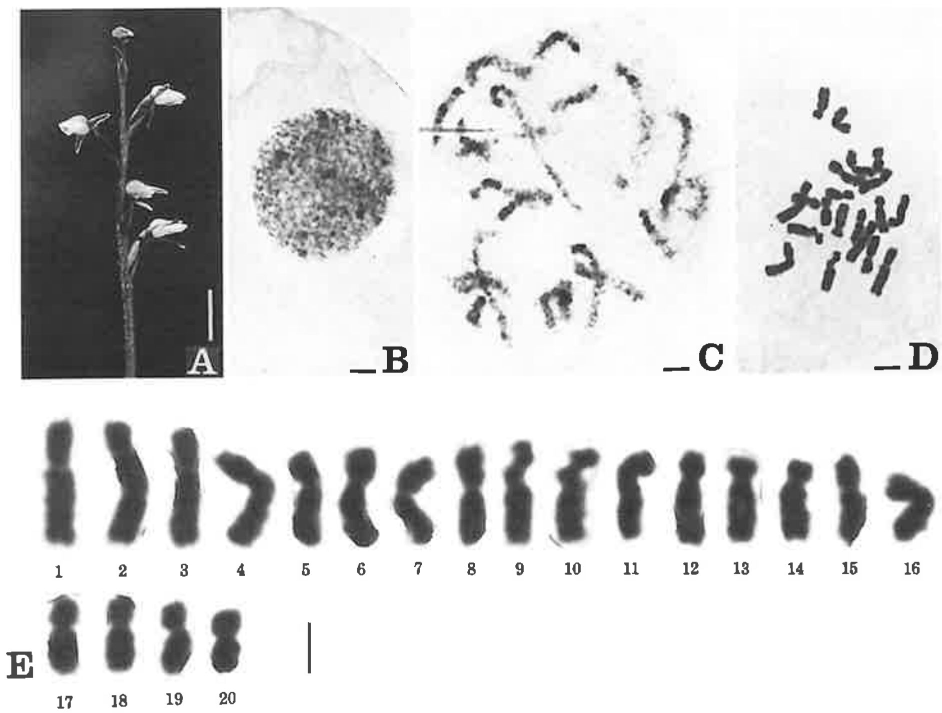

Fig. 30. *Zeuxine agyokuana*, 2n=20. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 10 mm in A and 2μm in B-E.

from round- to rod-shaped with smooth to rough surface. While the chromatin blocks varied in size, shape and number among the nuclei, about five chromocentric bodies were counted constantly in every nucleus. Thus, the chromosome feature at resting stage was of the simple chromocenter type according to the definition proposed by Tanaka (1971).

At mitotic prophase, early condensed segment were observed at the proximal regions of all of the 2n=20 chromosomes and the terminal regions beside the interstitial regions of several chromosomes and were shifted more or less gradually to late condensed segments.

The 2n=20 chromosome complement at mitotic metaphase showed a gradual decrease in legth from the longest (4.9 μm) to the shortest (2.4 μm) chromosomes. The average chromosome length was 3.6 μm. Among the 20 chromosomes of the mitotic metaphase complement, seven were median centromeric with arm ratios between 1.2 and 1.7, 12 were submedian centromeric with arm ratios between 1.8 and 3.0 and the other one was subterminal centromeric with the arm ratio of 3.1. Two chromosomes (Nos. 9 and 10) had satellites at the terminal regions of their short arms.

Thus, the 2n=20 chromosome complement at mitotic metaphase showed a gradual and symmetric karyotype.

2. *Zeuxine leucochila* Schltr., 2n=20, Japanese Name: Ishigaki-kinu-ran, Tables 1 and 31, Fig. 31.

Observations were made in two plants collected in Kagoshima Prefecture, Japan. Mor-

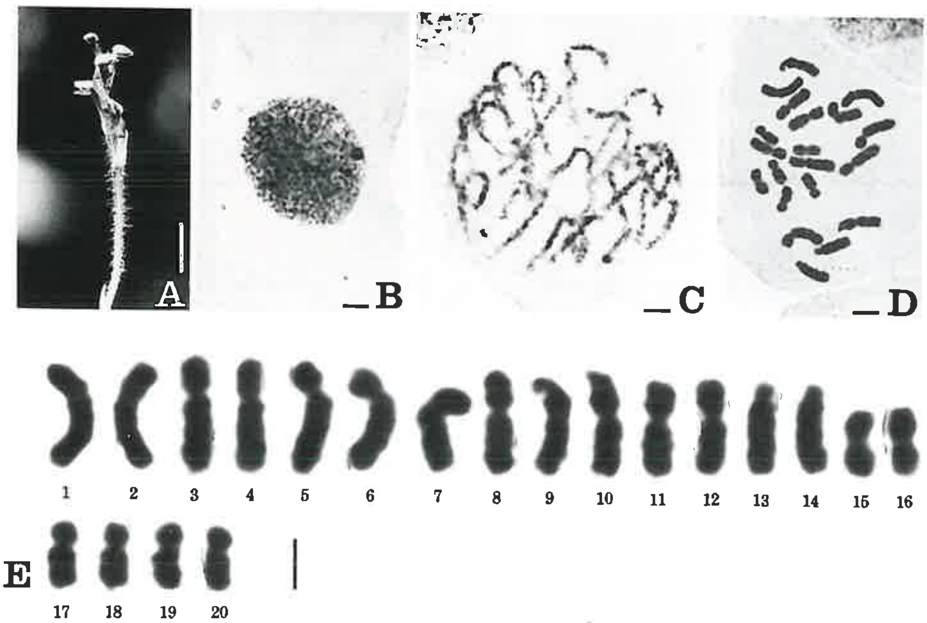

Fig. 31. *Zeuxine leucochila*, 2n=20. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bars indicate 8 mm in A and 2 μm in B-E.

phological features of leaves, shoots and rhizomes of the plants were similar to those of this species described by Garay and Sweet (1974). However, their flowers were not typical because the apical parts of the lips were not clearly reniform.

The chromosome number of the plants was 2n = 20 at mitotic prophase and metaphase which was documented here for the first time.

The chromosome morphology at resting stage and mitotic prophase were similar to those of *Z. agyokuana*.

The 2n = 20 chromosomes in the complement at mitotic metaphase formed a bimodality in the chromosome alignment in length with a group of chromosomes ranging from 4.9−3.6 μm and with the other group of chromosomes ranging from 2.7 − 2.5 μm. The average chromosome length was 3.7 μm. Among the 20 chromosomes of the mitotic metaphase complement, eight were median centromeric with arm ratios between 1.0 and 1.7, 10 were submedian centromeric with arm ratios between 2.0 and 3.0 and the other two were subterminal centromeric with the arm ratios of 6.2 and 6.4. Two chromosomes (Nos. 9 and 10) had satellites at the terminal regions of their short arms.

Thus, the 2n = 20 chromosome complement at mitotic metaphase showed a bimodal and symmetric karyotype.

3. *Zeuxine odorata* Fukuyama, 2n = 40, Japanese Name: Jako-kinu-ran, Table 1 and 32, Fig. 32.

Observations were made in a plant collected in Okinawa Prefecture, Japan. Morpholo-

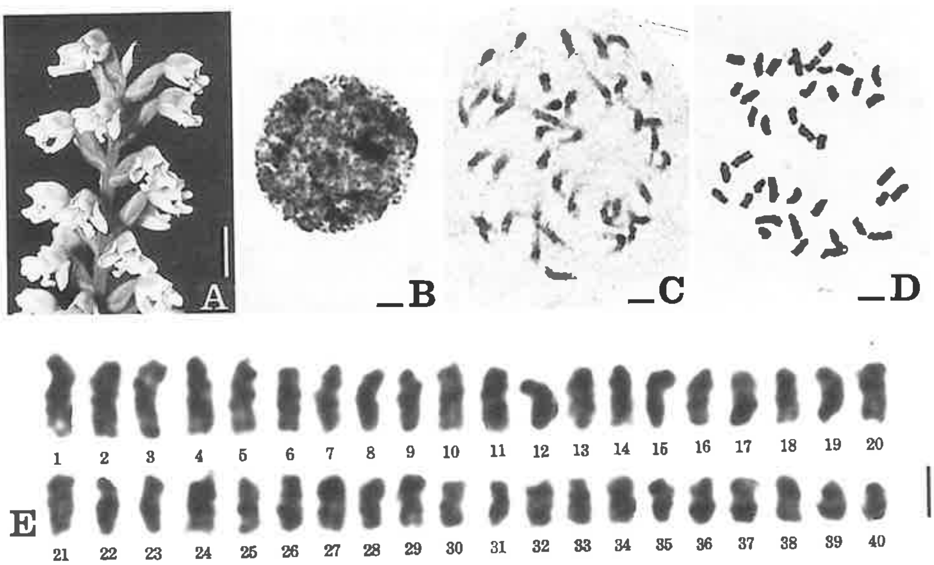

Fig. 32. *Zeuxine odorata*, 2n = 40. A, flowers. B, chromosomes at resting stage. C. chromosomes at mitotic prophase. D. and E, chromosomes at mitotic metaphase. Bars indicate 10 mm in A and 2 μm in B-E.

gical features of leaves, shoots, rhizomes and flowers of the plant were similar to those of this species described by Hatusima (1975).

The chromosome number of the plant was 2n = 40 at mitotic prophase and metaphase which was determined here for the first time.

The chromosome morphology at resting stage and mitotic prophase were similar to those of *Hetaeria rubens* excepting the chromocentric bodies were slightly unclear and fewer than those of *H. rubens*.

The 2n = 40 chromosome complement at mitotic metaphase performed a gradual decrease in length from the longest (3.4 μm) to the shortest (1.4 μm) chromosomes. The average chromosome length was 3.7 μm. Among the 40 chromosomes of the complement, 24 were median centromeric with arm ratios between 1.0 and 1.7, 15 were submedian with arm ratios between 1.8 and 2.8 and the other one was subterminal centromeric with the arm ratio of 3.3.

The 2n = 40 chromosome complement at mitotic metaphase showed a gradual and symmetric karyotype.

Discussion

I. Karyomorphological characteristics

1. Chromosome number

The chromosome numbers of 27 taxa investigated were listed in Table 1. The chromosome numbers of 2n = 20, 22, 26, 28, 30, 32, 40, 42, 44 and 56 have previously been reported in *Goodyera* and its certain closely related genera (Tanaka and Kamemoto 1984). Thus, the chromosome numbers of 2n = 24 counted in *Hetaeria rubens*, 2n = 28 + (0-5B) counted in *Goodyera macrantha*, 2n = 56 + 2B counted in G. *foliosa* var. *commelinoides* and 2n = 60 counted in *G. schlechtendaliana* were newly added to the aneuploid series of this group.

Intraspecific polyploidy was observed in three taxa, *Goodyera foliosa* var. *laevis*, *G. schlechtendaliana* and *G. velutina*. The results of the observations in *G. foliosa* var. *laevis* confirmed the previous report (Tanaka 1965a) in correlationships between speciation and natural habitats and between speciation and distributions of certain orchids, while those in *Goodyera schlechtendaliana* and *G. velutina* did not. The polyploids of *G. schlechtendaliana* were localized rather in the southwestern part of their distribution in Japan as seen in *G. foliosa* var. *laevis*.

B-chromosomes have been reported in *Goodyera biflora* (n = 16 + 2B) (Mehra and Kashyap 1979) and *G. secundiflora* n = 15 + (0-1B) (Mehra 1982) among the group members. Thus, B-chromosomes of 2n = 56 + 2B and 2n = 28 + (0-5B) were observed here for the first time in *G. foliosa* var. *commelinoides* and *G. macrantha* , respectively, regarding chromosome morphology and behavior at mitotic prophase and metaphase.

2. Chromosome morphology at resting stage

Each taxon showed distinct features of the chromosome condensation and the shape and the number of chromatin blocks at resting stage. Thus, the resting nuclei could be morphologically grouped into four types according to Tanaka (1971) as follows:

(Ⅰ) The prochromosome type was observed in all taxa of *Goodyera*, *Hetaeria yakusimensis*, *Myrmechis japonica*, *Myr. tsukusiana* and *Odontochilus inabai* . The resting nuclei of the prochromosome type in *G. hachijoensis sensu lato*,*G. procera*, *G. repens*, *H. yakusimensis*, *Myr. japonica* and *Myr. tsukusiana* had rather darkly stained chromomeric granules and many small chromatin blocks. Most of the chromatin blocks in the resting nuclei of *G. viridiflora* were rod-shaped.

(Ⅱ) The simple chromocenter type was observed in *Zeuxine agyokuana* and *Z. leucochila*.

(Ⅲ) The complex chromocenter type was observed in *Hetaeria rubens* and *Zeuxine odorata*. The resting nucleus of *Z. odorata* showed the chromosomes condensed more loosely than that of *H. rubens*.

(Ⅳ) The intermediate type between the simple and the complex chromocenter types, characterized by the chromocentric bodies of which number was 1/2～1/3 the number of chromosomes with early condensed segments at mitotic prophase. This type was observed in *Anoectochilus formosanus*, *Hetaeria sikokiana*, *Macodes petola* and *Vexillabium yakushimense*. The chromocentric bodies in *H. sikokiana* and *V. yakushimense* showed nearly prochromosome features with smooth surface.

3. Chromosome morphology at mitotic prophase

Early condensed segments were observed in all of the chromosomes in the mitotic prophase complements of the 26 taxa except for *Anoectochilus formosanus*. *A. formosanus* exhibited no early condensed segment in four of the 40 chromosomes at mitotic prophase. The early condensed segments were located at the proximal, interstitial and terminal regions of all of the chromosomes at mitotic prophase in *Hetaeria rubens*, most of the chromosomes at mitotic prophase in *Zeuxine odorata* and several chromosomes at mitotic prophase in *Z. agyokuana* and *Z. leucochila*. Thus, the other chromosomes in *Z. odorata*, *Z. agyokuana* and *Z. leucochila* and all chromosomes in the other 23 taxa were basically belonged to the proximal type of the chromosome morphology at mitotic prophase (Tanaka 1980). On the other hand, the early condensed segments were observed not only at the proximal regions but at the terminal regions of several chromosomes in the mitotic prophase complements of *Goodyera hachijoensis sensu lato*, *G. procera*, *Hetaeria sikokiana*, *H. yakusimensis, Myrmechis japonica, Myr. tsukusiana, Odontochilus inabai* and *Vexillabium yakushimense*.

4. Chromosome morphology at mitotic metaphase

The length of the chromosome of the 27 taxa investigated at mitotic metaphase ranged

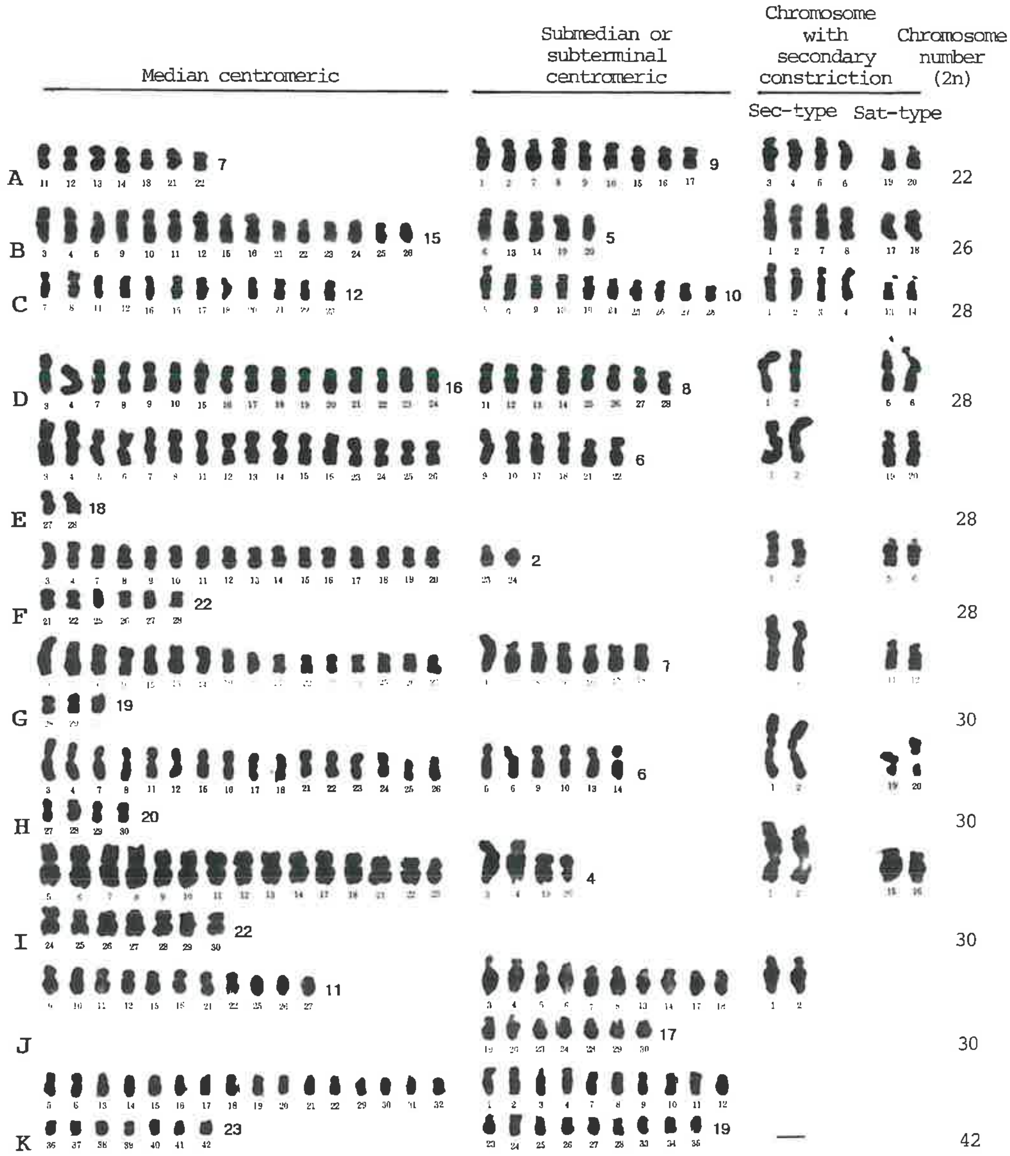

Fig. 33. Photomicrographs of chromosomes at mitotic metaphase in 11 species of *Goodyera*. A, *G. viridiflora*. B, *G. pubescens*. C, *G. macrantha*. D, *G. foliosa* var. *laevis*. E, *G. hachijoensis* var. *yakushimensis*. F, *G. velutina*. G, *G. pendula*. H, *G. repens*. I, *G. schlechtendaliana*. J, *G. oblongifolia*. K, *G. procera*. Bar idicates 2 μm. The Sec-type and the Sat-type are of the marker chromosomes described in the text. The number just below each chromosome is the identification number. The bold-faced number on the right of the chromosome alignment is number of chromosomes belonged to each centromeric type.

Fig. 34. Photomicrographs of chromosomes at mitotic metaphase in 12 species of seven genera allied to *Goodyera*. A, *Zeuxine agyokuana*. B, *Z. leucochila*. C, *Myrmechis tsukusiana*. D, *Hetaeria sikokiana*. E, *H. yakusimensis*. F, *Vexillabium yakushimense*. G, *Anoectochilus formosanus*. H, *H. rubens*. I, *Odontochilus inabai*. J, *Z. odorata*. K, *Macodes petola*. L, *Myr. japonica*. Bar indicates 2 µm."SIM", "PRO", "INT", and "COM" designate simple chromocenter type, prochromosome type, intermediate type between simple and complex chromocenter types, and complex chromocenter type, respectively. Chromosomes with secondary constriction of A,B,C,E,F are Sat-type and those of D are Sec-type. See Fig. 33 for the other explanation.

between 4.9 and 0.6 µm. The mean chromosome lengths in the mitotic metaphase complements of the taxa varied from 3.7 µm in *Zeuxine leucochila* to 1.1 µm in*Macodes petola*. The chromosome complements of the 27 taxa at mitotic metaphase could be divided into two types on the basis of the chromosome length; the large type with the average chromosome lengths of 3.7 or 3.6 µm (three taxa) and the small type with the average chromosome lengths varied from 2.5 -1.1 µm (24 taxa).

The chromosome lengths of the mitotic metaphase complements in 24 taxa showed commonly gradual decrease from the longest to the shortest chromosomes, while those in the other three taxa, *Goodyera pendula*, *G. repens* and *Zeuxine leucochila* showed bimodality of their chromosome lengths.

The 27 taxa showed symmetric karyotype with respect to their arm ratios. Appearance frequencies of the chromosomes with median centromeres in the mitotic metaphase complements in the taxa varied between 86 (*Goodyera velutina*) and 10% (*Macodes petola*).

Figs. 33 and 34 show the chromosome alignments at mitotic metaphase of 11 species of *Goodyera* and 12 species of seven genera allied to *Goodyera*. These figures display that the majority of these 23 species has two or four chromosomes with the secondary constrictions. These chromosomes could be classified into two types regarding their size and the position of the secondary constrictions. One is called "Sec-type", abbreviation of "secondary constriction type". This type is of the large chromosomes with the secondary constrictions at the interstitial regions of their long arms in respective complement. The other one is called "Sat-type", abbreviation of "satellite type". This type is of mostly medium and rarely large chromosomes with satellited secondary constrictions in respective complement. Based on these two types of the chromosomes as the marker chromosomes, the 23 species could be divided into five groups as follows:

A) It is characterized by four chromosomes of the "Sec-type" and two chromosomes of the "Sat-type" and includes *Goodyera viridiflora* (2n=22), *G. pubescens* (2n=26) and *G. macrantha* (2n=28).

B) It is characterized by two chromosomes of the "Sec-type" and two chromosomes of the "Sat-type" and includes *Goodyera foliosa* var. *laevis* (2n=28), *G. hachijoensis sensu lato* (2n=28), *G. velutina* (2n=28), *G. pendula* (2n=30), *G. repens* (2n=30) and *G. schlechtendaliana* (2n=30).

C) It is characterized by two chromosomes of the "Sec-type" and includes *Goodyera oblongifolia* (2n=30) and *Hetaeria yakusimensis* (2n=42).

D) It is characterized by two chromosomes of the "Sat-type" and includes *Zeuxine agyokuana* (2n = 20), *Z. leucochila* (2n = 20), *Vexillabium yakushimense* (2n = 26), *Myrmechis tsukusiana* (2n=28), *Anoectochilus formosanus* (2n=40) and *Hetaeria sikokiana* (2n =42).

E) It is characterized by the absence of any marker chromosomes and includes *Hetaeria rubens* (2n = 24), *Odontochilus inabai* (2n = 28), *Zeuxine odorata* (2n = 40), *Goodyera procera* (2n=42), *Macodes petola* (2n=42) and *Myrmechis japonica* (2n=56).

The chromosomes of "Sat-type" in *Vexillabium yakushimense* and *Anoectochilus formosanus* had slightly stained satellites at their long arms, which were not observed in the other species (Fig. 34 F and G).

II. Relationships among the taxa

1. The genus *Goodyera*

It was confirmed that intraspecific polyploidy with 2n=28 and 2n=56 was observed in *Goodyera foliosa* var. *laevis* and that the tetraploids (2n=56) were distributed more south than the diploids (2n = 28). Furthermore, *G. foliosa* var. *commelinoides* containing the chromosome number of 2n=56 occurred more south than *G. foliosa* var. *laevis* (Ohwi and Kitagawa 1983). These facts suggested that *G. foliosa* var. *commelinoides* might be derived from a tetraploid of *G. foliosa* var. *laevis*. It is speculated that this species might have been diversified and differentiated by polyploidization to progress and expand its distribution more south in East Asia.

It was found karyomorphologically that all of the 11 species were very much closely related with each other regarding the common resting stage of the prochromosome type and the small mitotic metaphase chromosomes exhibiting the symmetric karyotypes. However, these species showed different chromosome numbers of 2n=22, 26, 28, 30 and 42 for the aneuploid series. Tanaka (1976) hypothesized that this aneuploid series might be caused by polyploidization of the basic number x = 7 followed by aneuploidization. In contrast, Maekawa (1978) speculated that the aneuploid series might be caused by polyploidization of the basic number x=5 followed by aneuploidization.

The present observation of four chromosomes of "Sec-type" and two chromosomes of "Sat-type" in *Goodyera viridiflora* (2n=22), *G. pubescens* (2n=26), and *G. macrantha* (2n =28) (Fig. 33) made it possible to hypothesize that the chromosome numbers of 2n=22, 26 and 28 might be in the tetraploid level and those of 2n=22 and 2n=26 might be derived from 2n=28 by elimination of certain chromosomes without any secondary constriction. On the other hand, two of the four chromosomes of the "Sec-type" might have lost the secondary constrictions in the chromosome complement of 2n = 28 (*G. foliosa* var. *laevis*, *G. hachijoensis sensu lato*, and *G. velutina*). Moreover, the 2n=30 chromosomes complements in *G. pendula*, *G. repens* and *G. schlechtendaliana* might have been occurred by addition and increase of the median chromosomes and loss of the secondary constrictions.

Goodyera procera (2n=42) did not show any marker chromosome but showed shorter chromosomes and more gradual decrease in chromosome length than those of the other species of *Goodyera*. These karyomorphological characteristics seemed to indicate that *G. procera* could be distantly related to the other species of the genus.

As mentioned above, the results given here supported Tanaka's hypothesis (1976) that explained evolution of the chromosome numbers in *Goodyera*. Moreover, the results made it possible to make another hypothesis that speciation in *Goodyera* has been taken place firstly by polyploidization of the basic genome and secondly by elimination of certain chromosomes without any secondary constriction and disappearance of the secondary constrictions followed by addition of the chromosomes.

2. The genera allied to *Goodyera*

Zeuxine leucochila (2n=20) was very similar to *Z. agyokuana* (2n=20) with respect to the morphology of the mitotic metaphase chromosomes. However, the former species possessed a pair of medium-sized subterminal chromosomes of which arm ratios were higher than those of the latter species (Fig. 31, E. Nos. 13 and 14) and performed bimodality of the chromosome lengths which was not observed in the latter species. Thus, these observations suggested that *Z. leucochila* coud be closely related to *Z. agyokuana* which might be later differentiated by terminalization of centromeres of a pair of chromosomes in a complement.

Zeuxine agyokuana Fukuyama has been treated taxonomically as *Hetaeria agyokuana* (Fukuyama) K. Nackejima by Nackejima (1971), supported by Hatusima (1975). On the other hand, *Z. agyokuana* was distinct from *Hetaeria yakusimensis* (2n=42) regarding the chromosome number, the chromosome size, the marker chromosomes and the chromosomes of the simple chromocenter type at resting stage. Therefore, the taxonomical treatment of *Z. agyokuana* which was placed in the group separated from *H. yakusimensis* could be supported by the present karyomorphological evidences.

Among the three species of *Zeuxine*, *Z. odorata* Fukuyama did not have any marker chromosome, while the other two species had a pair of chromosomes of the "Sat-type". Moreover, *Z. odorata* was different from the two species since it exhibited the chromosomes of the complex chromocenter type at resting stage while the latter two species did not. Hashimoto (1986) changed taxonomically the generic combination of *Z. odorata* into *Hetaerozeuxine* Hashimoto and completely separated it from *Z. agyokuana* and *Z. leucochila*. Thus, the result given here supported the taxonomical treatment that *Z. odorata* was belonged to the group distinct from that of the other two species.

Vexillabium yakushimense and *Anoectochilus formosanus* are considered to be closely related to each other, since they showed commonly the intermediate type between the simple and the complex chromocenter types at resting stage. Moreover, they possessed singular chromosomes of the "Sat-type" which carried lightly stained satellites on the terminal regions of their long arms, which were not observed in the other species.

Odontochilus inabai Hayata (*e. g.*, Lin 1976, Lin and Hsu 1976, Ohwi and Kitagawa 1983) has been sometimes treated as *Anoectochilus inabai* Hayata (*e. g.*, Garay and Sweet 1974, Maekawa 1978) or a synonym of *Pristiglottis tashiroi* (Maxim.) Crez *et* J.J.Sm (Hatusima 1975). In this study, *O. inabai* showed no chromosome of the "Sat-type"as seen in *A. formosanus*. Moreover, *O. inabai* showed the chromosomes of the prochromosome type at resting stage while *A. formosanus* showed the chromosomes of the intermediate typc between the simple and the complex chromocenter types. These results supported the taxonomical treatment that *O. inabai* was placed in the taxonomic group different from that of *A. formosanus*.

Myrmechis tsukusiana (2n=28) and *Hetaeria yakusimensis* (2n=42) had the marker chromosomes of the "Sat-type" similar to those observed in *Goodyera*, and showed the prochromosome type at resting stage as seen in *Goodyera*. Therefore, it is speculated that these two species might be closely related to *Goodyera* and originated from the progress of speciation by the polyploidization with the basic chromosome number of x=7 as similarly speculated in *Goodyera*.

Similarly, the marker chromosomes of the "Sat-type" were observed in *Zeuxine agyokuana* (2n = 20), *Z. leucochila* (2n = 20) and *Hetaeria sikokiana* (2n = 42). However, these three species showed the chromosomes of the simple chromocenter type or the intermediate type between the simple and the complex chromocenter types at resting stage, which were different from those of certain species of *Goodyera*. The similarity of the chromosome sizes at mitotic metaphase indicates a close relationship of *Z. agyokuana*, *Z. leucochila* and *Hetaeria rubens* (2n = 24). On the other hand, *H. rubens* was similar to *Odontochilus inabai* (2n = 28), *Z. odorata* (2n = 40), *Goodyera procera* (2n = 42), *Macodes petola* (2n = 42) and *Myrmechis japonica* (2n = 56) with respect to lack of the marker chromosomes. However, these species showed the different types of the chromosomes at resting stage and the arm ratios of the mitotic metaphase chromosomes (Figs. 33 and 34). Thus, it suggested that the species without any marker chromosome might be distantly related to each other and might have certain relationships with respective taxon with the marker chromosomes. Further karyomorphological examination in many more species is necessary to clarify the relationships among those species.

Goodyera and its allied genera were divided into two groups according to the number of stigmas by Schlechter (1926, 1927), Brieger (1974-1975), Dressler (1981), and so on; *Goodyera* and *Macodes* were placed in Haplostigmata, and the other six genera were placed in Diplostigmata. However, these two groups could not be separated clearly by the chromosome morphology as discussed above. Thus, the results indicates that two taxonomic groups divided on the basis of the number of stigmas are not supported by the karyomorphological relationships among these genera or species.

Summary

1. The morphological observations in somatic chromosomes at resting, mitotic prophase and metaphase stages were made in 27 taxa of *Goodyera* and its seven allied genera.

2. The chromosome numbers counted in the 27 taxa were listed as follows: 2n = 20 (two taxa), 2n = 22 (one taxon), 2n = 24 (one taxon), 2n = 26 (two taxa), 2n = 28 (six taxa), 2n = 28 + (0-5B) (one taxon), 2n = 28 and 2n = 56 (two taxa), 2n = 30 (three taxa), 2n = 30 and 2n = 60 (one taxon), 2n = 40 (two taxa), 2n = 42 (four taxa), 2n = 56 (one taxon), 2n = 56 and 2n = 56 + 2B (one taxon).

3. The chromosome numbers of six taxa were determined in this study for the first time; 2n = 56 and 2n = 56 + 2B of *Goodyera foliosa* var. *commelinoides*, 2n = 42 of *Hetaeria sikokiana*, 2n = 42 of *Macodes petola*, 2n = 28 of *Odontochilus inabai*, 2n = 20 of *Zeuxine leucochila*, and 2n = 40 of *Z. odoata*. The chromosome numbers in three taxa were different from the previous counts; 2n = 28 + (0-5B) in *G. macrantha* (previously 2n = 30), 2n = 30 and 60 in *G. schlechtendaliana* (previously 2n = 30), and 2n = 24 in *Hetaeria rubens* (previously 2n = 22).

4. Intraspecific polyploidy with 2n=30 and 2n=60 was found in *Goodyera schlechtendaliana* for the first time. On the other hand, it was newly reported that intraspecific polyploidy with 2n=28 and 2n=56 was observed in *G. velutina* in various localities throughout in Japan. B-chromosomes were observed for the first time in *G. foliosa* var. *commelinoides* (2n=56+2B) and in *G. macrantha* 2n=28+(0-5B).

5. The chromosome morphology at resting stage given in the taxa studied were classified into four types; the prochromosome type in 19 taxa, the simple chromocenter type in two taxa, the complex chromocenter type in two taxa and the intermediate type between the simple and the complex chromocenter types in four taxa.

6. Early condensed segments found at mitotic prophase were located in the proximal regions of the chromosomes in most of the taxa studied, excepting in some cases they were located either in the proximal regions or in the proximal, the interstitial and the terminal regions in some taxa.

7. Among the species studied *Zeuxine leucochila* (2n=20) showed the longest chromosomes at mitotic metaphase varying from 4.9−2.5 μm with mean length of 3.7 μm. In contrast, *Macodes petola* (2n = 42) showed the shortest chromosomes at mitotic metaphase varying from 1.8−0.6 μm with mean length of 1.1 μm. On the basis of the lengths of the mitotic metaphase chromosomes, the 27 taxa were classified into the "large" and the "small" types. The large type had the average chromosome lengths of 3.6 or 3.7 μm while the small type had the average chromosome lengths varying from 1.1 to 2.5 μm.

8. According to the arm ratios of the chromosomes at mitotic metaphase, the 27 taxa showed the symmetric karyotype although appearance frequencies of the median chromosomes in their complements varied between 86 and 10%.

9. Twenty-four out of the 27 taxa studied showed the gradual karyotype and three taxa showed the bimodal karyotype in chromosome length at mitotic metaphase.

10. Twenty-three species representing the 27 taxa studied exhibited two types of the marker chromosomes at mitotic metaphase as follows: One was the "Sec-type" which was characterized by the secondary constriction at the interstitial region of the long arm and the other one was the "Sat-type" which was characterized by the satellited secondary constriction. Based on these marker chromosomes,the 23 species were divided into the following five groups (A~E):

A group: Characterized by four chromosomes of the "Sec-type" and two chromosomes of the "Sat-type"; represented by *Goodyera viridiflora* (2n=22), *G. pubescens* (2n=26) and *G. macrantha* (2n=28). The same number of marker chromosomes with the three different chromosome numbers indicated that these chromosome numbers could be in tetraploid level and that the chromosome numbers of 2n=22 and 2n=26 might be derived from 2n=

28 by chromosome elimination.

B group: Characterized by two chromosomes of the "Sec-type" and two chromosomes of the "Sat-type"; represented by *Goodyera foliosa* var. *laevis* (2n=28), *G. hachijoensis sensu lato* (2n=28), *G. velutina* (2n=28), *G. pendula* (2n=30), *G. repens* (2n=30) and *G. schlechtendaliana* (2n=30). It is speculated that the chromosome number of 2n=28 might be occurred from 2n=28 of the group A by disappearance of the secondary constrictions in the two chromosomes of the Sec-type and that the chromosome number of 2n=30 might be occurred by increase of median chromosomes following disappearance of the secondary constrictions.

C group: Characterized by two chromosomes of the "Sec-type"; represented by *Goodyera oblongifolia* (2n=30) and *Hetaeria yakusimensis* (2n=42). It is speculated that the chromosome number of 2n=30 might be derived from 2n=30 of the group B by disappearance of the secondary constrictions of the chromosomes of the Sat-type and asymmetrization of the chromosomes.

D group: Characterized by two chromosomes of the "Sat-type"; represented by *Zeuxine agyokuana* (2n=20), *Z. leucochila* (2n=20), *Vexillabium yakushimense* (2n=26), *Myrmechis tsukusiana* (2n=28), *Anoectochilus formosanus* (2n=40) and *Hetaeria sikokiana* (2n=42).

E group: Characterized by no marker chromosome; represented by *Hetaeria rubens* (2n=24), *Odontochilus inabai* (2n=28), *Zeuxine odorata* (2n=40), *Goodyera procera* (2n=42), *Macodes petola* (2n=42) and *Myrmechis japonica* (2n=56).

11. Certain cytotaxonomic and karyomorphological evidences supplied some informations to clarify the interrelationships and the taxonomical treatments among the species and the genera as follows:

1) *Goodyera foliosa* var. *laevis* had the intraspecific polyploidy with 2n=28 and 2n=56. *G. foliosa* var. *commelinoides* distributed more south than the former variety showed the chromosome number 2n=56. These coincidences suggested that *G. foliosa* var. *commelinoides* might be derived from a polyploid of *G. foliosa* var. *laevis* which could be differentiated to expand the distribution toward southwards in East Asia.

2) *Goodyera procera* (2n=42) was different from the other species of the genus since it had no marker chromosome and small-sized chromosomes.

3) The above tenth category of the summary supported that the basic chromosome number of *Goodyera* was x=7 (Tanaka 1976). Thus, it was speculated that the chromosome numbers of 2n=22, 26, 28 and 30 in *Goodyera* might be secondarily derived from 2n=28 or a tetraploid plant with x=7. These different chromosome numbers might be accomplished and accumulated by elimination, addition, asymmetrization of certain chromosomes without any secondary constriction and disappearance of the secondary constrictions.

4) The mitotic metaphase chromosomes of *Zeuxine leucochila* (2n = 20) and *Z.*

agyokuana (2n=20) were karyomorphologically similar to each other excepting the former species had a pair of singular subterminal chromosomes. This result suggested that *Z. leucochila* (2n=20) could be closely related to *Z. agyokuana* (2n=20) and might be later differentiated by terminalization of centromeres.

5) *Zeuxine agyokuana* (2n=20) was different from *Hetaeria yakusimensis* (2n=42) on account of the chromosome number and of the chromosome morphology at resting and mitotic metaphase. This result did not support the taxonomical treatment of these species by Nackejima (1971) and Hatusima (1975).

6) Among three species of *Zeuxine*, *Z. odorata* (2n=40) was distinguished from the other two species by the chromosome morphology of the complex chromocenter type at resting stage and lack of the marker chromosomes of the "Sat-type". This result supported the taxonomical treatment of these species by Hashimoto (1986).

7) It was suggested that *Anoectochilus formosanus* (2n = 40) and *Vexillabium yakushimense* (2n=26) could be closely related with each other because they had commonly the chromosome morphology of the intermediate type between the simple and the complex chromocenter types at resting stage and the marker chromosomes morphologically similar to each other.

8) *Odontochilus inabai* (2n=28) was distinct from *Anoectochilus formosanus* (2n=40) since it had the chromosome morphology of the prochromosome type at resting stage and lack of the marker chromosomes of the "Sat-type". This result supported the taxonomical treatment of these species by Lin (1976) and Ohwi and Kitagawa (1983).

9) *Hetaeria yakusimensis* (2n=42) and *Myrmechis tsukusiana* (2n=28) were similar to the species of *Goodyera* with respect to the type of the marker chromosomes and the chromosome morphology of the prochromosome type at resting stage. Therefore, these two species seemed to be closely related to *Goodyera* and might be differentiated by the similar process as in *Goodyera*.

10) *Goodyera* and *Macodes* which had single stigma, were not karyomorphologically distinct from *Anoectochilus*, *Hetaeria*, *Myrmechis*, *Odontochilus*, *Vexillabium* and *Zeuxine* which had two stigmas. Thus, this phenomenon indicated that the taxonomical treatment based on the number of stigmas and made by Schlechter (1926), Brieger (1974-1975), Dressler (1981) and so on was not supported by the karyomorphological investigation.

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Table 2. Measurements of somatic chromosomes of *Anoectochilus formosanus* at mitotic metaphase, 2n=40

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.1+1.3=2.4	3.6	1.1	m
2	0.9+1.1=2.0	3.0	1.2	m
3	0.7+1.3=2.0	3.0	1.8	sm
4	0.7+1.3=2.0	3.0	1.8	sm
5	0.6+1.4=2.0	3.0	2.3	sm
6	0.7+1.3=2.0	3.0	1.8	sm
7	0.6+1.3=1.9	2.8	2.1	sm
8	0.6+1.3=1.9	2.8	2.1	sm
9	0.6+1.3=1.9	2.8	2.1	sm
10	0.6+1.3=1.9	2.8	2.1	sm
11	0.5+1.3=1.8	2.7	2.6	sm
12	0.5+1.3=1.8	2.7	2.6	sm
13	0.5+1.3=1.8	2.7	2.6	sm
14	0.5+1.3=1.8	2.7	2.6	sm
15	0.5+1.3=1.8	2.7	2.6	sm
16	0.6+1.1=1.7	2.5	1.8	sm
17	0.6+1.1+d=1.7*	2.5	1.8	sm
18	0.5+1.1+d=1.6*	2.4	2.2	sm
19	0.5+1.1+d=1.6*	2.4	2.2	sm
20	0.6+1.1=1.7	2.5	1.8	sm
21	0.6+1.1=1.7	2.5	1.8	sm
22	0.5+1.1=1.6	2.4	2.2	sm
23	0.6+1.1=1.7	2.5	1.8	sm
24	0.6+1.1=1.7	2.5	1.8	sm
25	0.6+1.1=1.7	2.5	1.8	sm
26	0.6+1.1=1.7	2.5	1.8	sm
27	0.7+1.0=1.7	2.5	1.4	m
28	0.7+1.0=1.7	2.5	1.4	m
29	0.8+0.9=1.7	2.5	1.1	m
30	0.7+0.9=1.6	2.4	1.2	m
31	0.7+0.9=1.6	2.4	1.2	m
32	0.6+0.9=1.5	2.2	1.5	m
33	0.5+1.0=1.5	2.2	2.0	sm
34	0.5+1.0=1.5	2.2	2.0	sm
35	0.7+0.8=1.5	2.2	1.1	m
36	0.5+0.9=1.4	2.1	1.8	sm
37	0.5+0.6=1.1	1.6	1.2	m
38	0.5+0.6=1.1	1.6	1.2	m
39	0.5+0.5=1.0	1.5	1.0	m
40	0.5+0.5=1.0	1.5	1.0	m

d : lightly stained satellite
*: chromosome with secondary constriction
m: median sm: submedian

Table 3. Measurements of somatic chromosomes of *Goodyera foliosa* var. *commelinoides* at mitotic metaphase, 2n=56

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	0.9+1.5=2.4	2.8	1.6	m
2	0.8+1.5=2.3	2.7	1.8	sm
3	0.9+1.4=2.3	2.7	1.5	m
4	0.8+1.4=2.2	2.6	1.7	m
5	0.6+0.7+1.0=2.3*	2.7	2.8	sm
6	0.5+0.6+1.0=2.1*	2.4	3.2	st
7	0.6+0.6+0.8=2.0*	2.3	2.3	sm
8	0.4+0.6+1.0=2.0*	2.3	4.0	st
9	0.8+1.3=2.1	2.4	1.6	m
10	0.8+1.1=1.9	2.2	1.3	m
11	0.4+0.6+1.0=2.0*	2.3	1.0	m
12	0.4+0.4+1.1=1.9*	2.2	1.3	m
13	0.8+1.0=1.8	2.1	1.2	sm
14	0.7+1.1=1.8	2.1	1.5	m
15	0.6+1.0=1.6	1.9	1.6	m
16	0.6+1.0=1.6	1.9	1.6	m
17	0.7+0.9=1.6	1.9	1.2	m
18	0.7+0.9=1.6	1.9	1.2	m
19	0.6+1.0=1.6	1.9	1.6	m
20	0.7+0.8=1.5	1.7	1.1	m
21	0.7+0.8=1.5	1.7	1.1	m
22	0.7+0.8=1.5	1.7	1.1	sm
23	0.7+0.8=1.5	1.7	1.1	sm
24	0.6+0.9=1.5	1.7	1.5	m
25	0.6+0.9=1.5	1.7	1.5	m
26	0.6+0.9=1.5	1.7	1.5	m
27	0.6+0.8=1.4	1.6	1.3	m
28	0.7+0.7=1.4	1.6	1.0	m
29	0.2+0.4+0.9=1.5*	1.7	1.5	m
30	0.2+0.3+0.8=1.3*	1.5	1.6	m
31	0.4+1.0=1.4	1.6	2.5	sm
32	0.5+0.9=1.4	1.6	1.8	sm
33	0.4+0.9=1.3	1.5	2.2	sm
34	0.4+0.8=1.2	1.4	2.0	sm
35	0.4+0.8=1.2	1.4	2.0	sm
36	0.6+0.7=1.3	1.5	1.1	m
37	0.5+0.8=1.3	1.5	1.6	m
38	0.5+0.8=1.3	1.5	1.6	m
39	0.6+0.8=1.4	1.6	1.3	m
40	0.5+0.8=1.3	1.5	1.6	m

Table 3. continued

41	0.5+0.8=1.3	1.5	1.6	m
42	0.6+0.7=1.3	1.5	1.1	m
43	0.4+0.9=1.3	1.5	2.2	sm
44	0.4+0.9=1.3	1.5	2.2	sm
45	0.4+0.8=1.2	1.4	2.0	sm
46	0.3+0.8=1.1	1.3	2.6	sm
47	0.6+0.7=1.3	1.5	1.1	m
48	0.6+0.7=1.3	1.5	1.1	m
49	0.6+0.7=1.3	1.5	1.1	m
50	0.6+0.7=1.3	1.5	1.1	m
51	0.6+0.6=1.2	1.4	1.0	m
52	0.5+0.7=1.2	1.4	1.4	m
53	0.5+0.7=1.2	1.4	1.4	m
54	0.5+0.7=1.2	1.4	1.4	m
55	0.5+0.7=1.2	1.4	1.4	m
56	0.5+0.6=1.1	1.3	1.2	m

st: subterminal
See Table 2. for explanation of the other symbols.

Table 4. Measurements of somatic chromosomes of *Goodyera foliosa* var. *commelinoides* at mitotic metaphase, 2n=58

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	0.9+1.4=2.3	2.8	1.5	m
2	0.8+1.3=2.1	2.6	1.6	m
3	0.8+1.1=1.9	2.3	1.3	m
4	0.8+1.1=1.9	2.3	1.3	m
5	0.6+0.6+0.9=2.1*	2.6	2.5	sm
6	0.5+0.6+0.8=1.9*	2.3	2.8	sm
7	0.4+0.5+0.8=1.7*	2.1	3.2	st
8	0.6+0.5+0.6=1.2*	2.1	1.8	sm
9	0.7+1.0=1.7	2.1	1.4	m
10	0.7+0.9=1.6	2.0	1.2	m
11	0.3+0.5+1.1=1.9*	2.3	1.3	m
12	0.3+0.4+0.9=1.6*	2.0	1.2	m
13	0.6+0.9=1.5	1.8	1.5	m
14	0.7+0.8=1.5	1.8	1.1	m
15	0.7+0.8=1.5	1.8	1.1	m
16	0.7+0.8=1.5	1.8	1.1	m
17	0.7+0.8=1.5	1.8	1.1	m
18	0.7+0.8=1.5	1.8	1.1	m
19	0.5+1.0=1.5	1.8	2.0	sm
20	0.5+1.0=1.5	1.8	2.0	sm
21	0.5+1.0=1.5	1.8	2.0	sm
22	0.5+1.0=1.5	1.8	2.0	sm
23	0.6+0.9=1.5	1.8	1.5	m
24	0.6+0.8=1.4	1.7	1.3	m
25	0.4+1.0=1.4	1.7	2.5	sm
26	0.5+0.9=1.4	1.7	1.8	sm
27	0.5+0.9=1.4	1.7	1.8	sm
28	0.5+0.9=1.4	1.7	1.8	sm
29	0.5+0.9=1.4	1.7	1.8	sm
30	0.5+0.9=1.4	1.7	1.8	sm
31	0.6+0.8=1.4	1.7	1.3	m
32	0.6+0.8=1.4	1.7	1.3	m
33	0.6+0.8=1.4	1.7	1.3	m
34	0.7+0.7=1.4	1.7	1.0	m
35	0.6+0.7=1.3	1.6	1.1	m
36	0.5+0.8=1.3	1.6	1.6	m
37	0.6+0.7=1.3	1.6	1.1	m
38	0.6+0.7=1.3	1.6	1.1	m
39	0.5+0.7=1.2	1.5	1.4	m
40	0.5+0.7=1.2	1.5	1.4	m

Table 4. continued

41	0.5+0.7=1.2	1.5	1.4	m
42	0.6+0.6=1.2	1.5	1.0	m
43	0.5+0.7=1.2	1.5	1.4	m
44	0.5+0.7=1.2	1.5	1.4	m
45	0.4+0.8=1.2	1.5	2.0	sm
46	0.4+0.8=1.2	1.5	2.0	sm
47	0.4+0.8=1.2	1.5	2.0	sm
48	0.5+0.6=1.1	1.3	1.2	m
49	0.5+0.6=1.1	1.3	1.2	m
50	0.5+0.6=1.1	1.3	1.2	m
51	0.5+0.6=1.1	1.3	1.2	m
52	0.4+0.7=1.1	1.3	1.7	m
53	0.5+0.6=1.1	1.3	1.2	m
54	0.5+0.5=1.0	1.2	1.0	m
55	0.3+0.7=1.0	1.2	2.3	sm
56	0.3+0.7=1.0	1.2	2.3	sm
57	−+0.9=0.9	1.1	−	−
58	−+0.9=0.9	1.1	−	−

See Table 3. for explanation of symbols.

Table 5. Measurements of somatic chromosomes of *Goodyera foliosa* var. *laevis* at mitotic metaphase, 2n=28

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	0.9+0.9+1.3=3.1*	5.2	2.4	sm
2	0.9+0.9+1.3=3.1*	5.1	2.7	sm
3	1.1+1.8=2.9	4.9	1.6	m
4	1.1+1.8=2.9	4.9	1.6	m
5	0.5+0.7+1.5=2.7*	4.6	1.2	m
6	0.4+0.6+1.5=2.5*	4.2	1.5	m
7	1.3+1.4=2.7	4.6	1.0	m
8	1.1+1.3=2.4	4.0	1.1	m
9	0.9+1.4=2.3	3.9	1.5	m
10	0.9+1.3=2.2	3.7	1.4	m
11	0.7+1.4=2.1	3.5	2.0	sm
12	0.7+1.4=2.1	3.5	2.0	sm
13	0.7+1.4=2.1	3.5	2.0	sm
14	0.7+1.3=2.0	3.4	1.8	sm
15	1.0+1.1=2.1	3.5	1.1	m
16	0.9+1.1=2.0	3.4	1.2	m
17	0.9+1.0=1.9	3.2	1.1	m
18	0.8+1.0=1.8	3.0	1.2	m
19	0.7+1.0=1.7	2.9	1.4	m
20	0.6+1.0=1.6	2.7	1.6	m
21	0.8+0.9=1.7	2.9	1.1	m
22	0.8+0.9=1.7	2.9	1.1	m
23	0.8+0.9=1.7	2.9	1.1	m
24	0.8+0.9=1.7	2.9	1.1	m
25	0.6+1.1=1.7	2.9	1.8	sm
26	0.6+1.1=1.7	2.9	1.8	sm
27	0.5+1.0=1.5	2.5	2.0	sm
28	0.5+1.0=1.5	2.5	2.0	sm

See Table 2. for explanation of symbols.

Table 6. Measurements of somatic chromosomes of *Goodyera foliosa* var. *laevis* at mitotic metaphase, 2n=56

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	0.8+0.6+0.9=2.3*	2.7	1.8	sm
2	0.7+0.7+0.7=2.1*	2.5	2.0	sm
3	0.7+0.7+0.7=2.1*	2.5	2.0	sm
4	0.5+0.7+0.8=2.0*	2.4	3.0	sm
5	0.8+1.2=2.0	2.4	1.5	m
6	0.8+1.1=1.9	2.2	1.3	m
7	0.6+1.1=1.7	2.0	1.8	sm
8	0.6+1.1=1.7	2.0	1.8	sm
9	0.7+1.1=1.8	2.1	1.5	m
10	0.7+1.1=1.8	2.1	1.5	m
11	0.8+0.9=1.7	2.0	1.1	m
12	0.8+0.8=1.6	1.9	1.0	m
13	0.2+0.6+0.9=1.7*	2.0	1.1	m
14	0.2+0.6+0.9=1.7*	2.0	1.1	m
15	0.2+0.5+1.0=1.7*	2.0	1.4	m
16	0.2+0.5+0.9=1.6*	1.9	1.2	m
17	0.6+1.0=1.6	1.9	1.6	m
18	0.6+1.0=1.6	1.9	1.6	m
19	0.6+1.0=1.6	1.9	1.6	m
20	0.5 1.0 1.5	1.8	2.0	sm
21	0.6+0.9=1.5	1.8	1.5	m
22	0.6+0.9=1.5	1.8	1.5	m
23	0.6+0.9=1.5	1.8	1.5	m
24	0.6+0.9=1.5	1.8	1.5	m
25	0.6+0.9=1.5	1.8	1.5	m
26	0.7+0.8=1.5	1.8	1.1	m
27	0.6+0.9=1.5	1.8	1.5	m
28	0.7+0.7=1.4	1.6	1.0	m
29	0.7+0.7=1.4	1.6	1.0	m
30	0.6+1.8=1.4	1.6	1.3	m
31	0.7+0.7=1.4	1.6	1.0	m
32	0.7+0.7=1.4	1.6	1.0	m
33	0.5+1.0=1.5	1.8	2.0	sm
34	0.5+1.0=1.5	1.8	2.0	sm
35	0.6+0.9=1.5	1.8	1.5	m
36	0.5+0.8=1.3	1.5	1.6	m
37	0.5+0.8=1.3	1.5	1.6	m
38	0.5+1.0=1.5	1.8	2.0	sm
39	0.5+0.9=1.4	1.6	1.8	sm
40	0.5+0.9=1.4	1.6	1.8	sm

Table 6. continued

41	0.6+0.7=1.3	1.5	1.1	m
42	0.6+0.7=1.3	1.5	1.1	m
43	0.5+0.8=1.3	1.5	1.6	m
44	0.5+0.8=1.3	1.5	1.6	m
45	0.5+0.9=1.4	1.6	1.8	sm
46	0.5+1.9=1.4	1.6	1.8	sm
47	0.5+1.9=1.4	1.6	1.8	sm
48	0.4+0.9=1.3	1.5	2.2	sm
49	0.6+0.7=1.3	1.5	1.1	m
50	0.6+0.7=1.3	1.5	1.1	m
51	0.6+0.7=1.3	1.5	1.1	m
52	0.6+0.7=1.3	1.5	1.1	m
53	0.5+0.7=1.2	1.4	1.4	m
54	0.5+0.7=1.2	1.4	1.4	m
55	0.5+1.6=1.1	1.3	1.2	m
56	0.1+0.7=1.1	1.3	1.7	m

See Table 3. for explanation of symbols.

Table 7. Measurements of somatic chromosomes of *Goodyera hachijoensis* var. *hachijoensis* at mitotic metaphase, 2n=28

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	0.8+0.9+1.4=3.1*	5.2	2.8	sm
2	0.7+0.9+1.4=3.0*	5.1	3.2	st
3	1.3+1.8=3.1	5.2	1.3	m
4	1.1+1.7=2.8	4.7	1.5	m
5	0.9+1.7=2.6	4.4	1.8	sm
6	0.9+1.6=2.5	4.2	1.7	m
7	1.0+1.4=2.4	4.0	1.4	m
8	0.9+1.4=2.3	3.9	1.5	m
9	0.9+1.3=2.2	3.7	1.4	m
10	0.8+1.3=2.1	3.5	1.6	m
11	0.8+1.3=2.1	3.5	1.6	m
12	0.8+1.3=2.1	3.5	1.6	m
13	0.5+0.5+1.0=2.0*	3.4	1.0	m
14	0.5+0.5+1.0=2.0*	3.4	1.0	m
15	0.9+1.1=2.0	3.4	1.2	m
16	0.9+1.0=1.9	3.2	1.1	m
17	0.8+1.1=1.9	3.2	1.3	m
18	0.8+1.1=1.9	3.2	1.3	m
19	0.8+1.1=1.9	3.2	1.3	m
20	0.7+1.0=1.7	2.9	1.4	m
21	0.5+1.4=1.9	3.2	2.8	sm
22	0.5+1.4=1.9	3.2	2.8	sm
23	0.6+1.3=1.9	3.2	2.1	sm
24	0.5+1.3=1.8	3.0	2.6	sm
25	0.8+0.8=1.6	2.7	1.0	m
26	0.8+0.8=1.6	2.7	1.0	m
27	0.7+0.8=1.5	2.5	1.1	m
28	0.7+0.8=1.5	2.5	1.1	m

See Table 3. for explanation of symbols.

Table 8. Measurements of somatic chromosomes of *Goodyera hachijoensis* var. *leuconeura* at mitotic metaphase, 2n=28

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.0+1.0+1.5=3.5*	5.6	2.5	sm
2	0.9+0.9+1.4=3.2*	5.1	2.5	sm
3	1.1+1.9=3.0	4.8	1.7	m
4	1.1+1.7=2.8	4.5	1.5	m
5	0.9+1.8=2.7	4.3	2.0	sm
6	0.8+1.7=2.5	4.0	2.1	sm
7	1.0+1.4=2.4	3.8	1.4	m
8	1.0+1.4=2.4	3.8	1.4	m
9	0.5+0.5+1.3=2.3*	3.7	1.3	m
10	0.4+0.6+1.3=2.3*	3.7	1.3	m
11	0.9+1.4=2.3	3.7	1.5	m
12	0.8+1.4=2.2	3.5	1.7	m
13	0.9+1.3=2.2	3.5	1.4	m
14	0.9+1.3=2.2	3.5	1.4	m
15	0.8+1.3=2.1	3.3	1.6	m
16	0.8+1.3=2.1	3.3	1.6	m
17	0.9+1.1=2.0	3.2	1.2	m
18	0.9+1.1=2.0	3.2	1.2	m
19	1.0+1.0=2.0	3.2	1.0	m
20	0.9+0.9=1.8	2.9	1.0	m
21	0.6+1.5=2.1	3.3	2.5	sm
22	0.6+1.4=2.0	3.2	2.3	sm
23	0.3+1.4=2.0	3.2	2.3	sm
24	0.6+0.3=1.9	3.0	2.1	sm
25	0.9+0.9=1.8	2,9	1.0	m
26	0.8+0.9=1.7	2.7	1.1	m
27	0.8+0.8=1.6	2.6	1.0	m
28	0.8+0.8=1.6	2.6	1.0	m

See Table 2. for explanation of symbols.

Table 9. Measurements of somatic chromosomes of *Goodyera hachijoensis* var. *matsumurana* at mitotic metaphase, 2n=28

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	0.7+0.9+1.3=2.9*	5.1	3.1	st
2	0.7+0.8+1.2=2.7*	4.8	2.8	sm
3	1.3+1.8=3.1	5.5	1.3	m
4	1.0+1.7=2.7	1.8	1.7	m
5	0.9+1.5=2.4	4.2	1.6	m
6	0.8+1.5=2.3	4.1	1.8	sm
7	0.9+1.4=2.3	4.1	1.5	m
8	0.9+1.3=2.2	3.9	1.4	m
9	1.0+1.3=2.3	4.1	1.3	m
10	0.9+1.1=2.0	3.5	1.2	m
11	0.5+0.5+1.1=2.1*	3.7	1.1	m
12	0.5.+0.4+1.1=2.0*	3.5	1.2	m
13	0.6+1.4=2.0	3.5	2.3	sm
14	0.5+1.5=2.0	3.5	3.0	sm
15	0.6+1.1=2.0	3.5	1.2	m
16	0.9+1.0=1.9	3.4	1.1	m
17	0.8+1.1=1.9	3.4	1.3	m
18	0.8+1.1=1.9	3.4	1.3	m
19	0.7+1.1=1.8	3.2	1.5	m
20	0.7+1.0=1.7	3.0	1.4	m
21	0.7+1.0=1.7	3.0	1.4	m
22	0.8+0.8=1.6	2.8	1.0	m
23	0.6+1.0=1.6	2.8	1.6	m
24	0.7+0.9=1.6	2.8	1.2	m
25	0.7+0.9=1.6	2.8	1.2	m
26	0.7+0.8=1.5	2.6	1.1	m
27	0.5+1.0=1.5	2.6	2.0	sm
28	0.4+1.0=1.4	2.5	2.5	sm

See Table 3. for explanation of symbols.

Table 10. Measurements of somatic chromosomes of *Goodyera hachijoensis* var. *yakushimensis* at mitotic metaphase, 2n=28

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	0.9+0.8+2.1=3.8*	5.6	3.2	st
2	0.9+0.9+1.8=3.6*	5.3	3.0	sm
3	1.4+2.0=3.4	5.0	1.4	m
4	1.4+1.9=3.3	4.8	1.3	m
5	1.3+1.7=3.0	4.4	1.3	m
6	1.3+1.5=2.8	4.1	1.1	m
7	1.1+1.6=2.7	4.0	1.4	m
8	1.1+1.5=2.6	3.8	1.3	m
9	0.9+1.7=2.6	3.8	1.8	sm
10	0.8+1.6=2.4	3.5	2.0	sm
11	1.1+1.3=2.4	3.5	1.1	m
12	1.1+1.3=2.4	3.5	1.1	m
13	0.9+1.5=2.4	3.5	1.6	m
14	0.9+1.5=2.4	3.5	1.6	m
15	1.1+1.3=2.4	3.5	1.1	m
16	1.0+1.3=2.3	3.4	1.3	m
17	0.6+1.8=2.4	3.5	3.0	sm
18	0.6+1.4=2.3	3.4	2.8	sm
19	0.4+0.6+1.1=2.1*	3.1	1.1	m
20	0.5+0.5+1.1=2.1*	3.1	1.1	m
21	0.6+1.5=2.1	3.1	2.5	sm
22	0.6+1.5=2.1	3.1	2.5	sm
23	1.0+1.0=2.0	2.9	1.0	m
24	0.9+1.0=1.9	2.8	1.1	m
25	0.8+0.9=0.7	2.5	1.1	m
26	0.8+0.9=1.7	2.5	1.1	m
27	0.6+1.0=1.6	2.3	1.6	m
28	0.6+1.0=1.6	2.3	1.6	m

See Table 3. for explanation of symbols.

Table 11. Measurements of somatic chromosomes of *Goodyera macrantha* at mitotic metaphase, 2n=28

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	0.8+1.0+1.1=2.9*	5.4	2.6	sm
2	0.7+1.0+1.0=2.7*	5.0	2.8	sm
3	0.7+1.0+1.0=2.7*	5.0	2.8	sm
4	0.7+1.0+1.0=2.7*	5.0	2.8	sm
5	0.7+1.9=2.6	4.8	2.7	sm
6	0.5+1.8=2.3	4.3	3.6	st
7	0.8+1.3=2.1	3.9	1.6	m
8	0.7+1.2=1.9	3.5	1.7	m
9	0.6+1.3=1.9	3.5	2.1	sm
10	0.6+1.3=1.9	3.5	2.1	sm
11	0.9+0.9=1.8	3.3	1.0	m
12	0.8+1.0=1.8	3.3	1.2	m
13	0.4+0.4+1.0=1.8*	3.3	1.2	m
14	0.4+0.4+1.0=1.8*	3.3	1.2	m
15	0.7+1.1=1.8	3.3	1.5	m
16	0.7+1.1=1.8	3.3	1.5	m
17	0.7+1.1=1.8	3.3	1.5	m
18	0.7+1.1=1.8	3.3	1.5	m
19	0.6+1.2=1.8	3.3	2.0	sm
20	0.7+1.0=1.7	3.1	1.4	m
21	0.7+1.0=1.7	3.1	1.4	m
22	0.8+0.8=1.6	3.0	1.0	m
23	0.3+1.0=1.6	3.0	1.6	m
24	0.5+1.1=1.6	3.0	2.2	sm
25	0.5+1.1=1.6	3.0	2.2	sm
26	0.5+1.0=1.5	2.8	2.0	sm
27	0.5+0.9=1.4	2.6	1.8	sm
28	0.5+0.9=1.4	2.6	1.8	sm

See Table 3. for explanation of symbols.

Table 12. Measurements of somatic chromosomes of *Goodyera oblongifolia* at mitotic metaphase, 2n=30

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	0.8+1.3+0.8=2.9*	4.6	2.6	sm
2	0.8+1.4+0.6=2.8*	4.4	2.5	sm
3	0.8+2.1=2.9	4.6	2.6	sm
4	0.7+2.0=2.7	4.2	2.8	sm
5	0.8+1.8=2.6	4.1	2.2	sm
6	0.6+1.9=2.5	3.9	3.1	st
7	0.8+1.6=2.4	3.8	2.0	sm
8	0.8+1.6=2.4	3.8	2.0	sm
9	0.9+1.4=2.3	3.6	1.5	m
10	0.9+1.3=2.2	3.5	1.4	m
11	0.9+1.3=2.2	3.5	1.4	m
12	0.8+1.3=2.1	3.3	1.6	m
13	0.7+1.4=2.1	3.3	2.0	sm
14	0.6+1.5=2.1	3.3	2.5	sm
15	0.8+1.2=2.0	3.1	1.5	m
16	0.8+1.2=2.0	3.1	1.5	m
17	0.7+1.3=2.0	3.1	1.8	sm
18	0.7+1.3=2.0	3.1	1.8	sm
19	0.7+1.3=2.0	3.1	1.8	sm
20	0.5+1.0=2.0	3.1	3.0	sm
21	0.9+0.9=1.8	2.8	1.0	m
22	0.7+1.1=1.8	2.8	1.5	m
23	0.6+1.2=1.8	2.8	2.0	sm
24	0.6+1.2=1.8	2.8	2.0	sm
25	0.8+0.9=1.7	2.7	1.1	m
26	0.8+1.9=1.7	2.7	1.1	m
27	0.7+1.0=1.7	2.7	1.4	m
28	0.3+1.1=1.7	2.7	1.9	sm
29	0.6+1.1=1.7	2.7	1.8	sm
30	0.5+0.9=1.4	2.2	1.8	sm

See Table 3. for explanation of symbols.

Table 13. Measurements of somatic chromosomes of *Goodyera pendula* at mitotic metaphase, 2n=30

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	0.8+0.8+2.5=4.1*	6.5	4.1	st
2	0.8+0.9+2.3=4.0*	6.3	4.0	st
3	1.3+2.1=3.4	5.4	1.6	m
4	1.1+2.0=3.1	4.9	1.8	sm
5	1.1+1.5=2.6	4.1	1.3	m
6	1.1+1.4=2.5	4.0	1.2	m
7	0.7+1.7=2.4	3.8	2.4	sm
8	0.6+1.8=2.4	3.8	3.0	sm
9	0.7+1.6=2.3	3.6	2.2	sm
10	0.6+1.7=2.3	3.6	2.8	sm
11	0.4+0.5+1.4=2.3*	3.6	1.5	m
12	0.4+0.4+1.3=2.1*	3.3	1.6	m
13	0.8+1.4=2.2	3.5	1.4	m
14	0.9+1.3=2.2	3.5	1.4	m
15	0.8+1.3=2.1	3.3	1.6	m
16	0.9+1.1=2.0	3.2	1.2	m
17	0.7+1.4=2.1	3.3	2.0	sm
18	0.7+1.3=2.0	3.2	1.8	sm
19	0.7+0.9=1.6	2.5	1.2	m
20	0.7+0.9=1.6	2.5	1.2	m
21	0.7+0.8=1.5	2.4	1.1	m
22	0.7+0.8=1.5	2.4	1.1	m
23	0.7+0.7=1.4	2.2	1.0	m
24	0.7+0.7=1.4	2.2	1.0	m
25	0.6+0.8=1.4	2.2	1.3	m
26	0.6+0.8=1.4	2.2	1.3	m
27	0.6+0.7=1.3	2.1	1.1	m
28	0.6+0.7=1.3	2.1	1.1	m
29	0.6+0.7=1.3	2.0	1.1	m
30	0.6+0.7=1.3	2.1	1.1	m

See Table 3. for explanation of symbols.

Table 14. Measurements of somatic chromosomes of *Goodyera procera* at mitotic metaphase, 2n=42

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	0.6+1.5=2.1	3.4	2.5	sm
2	0.6+1.5=2.1	3.4	2.5	sm
3	0.5+1.6=2.1	3.4	3.2	st
4	0.5+1.5=2.0	3.2	3.0	sm
5	0.7+1.0=1.7	2.7	1.4	m
6	0.7+1.0=1.7	2.7	1.4	m
7	0.6+1.3=1.9	3.1	2.1	sm
8	0.5+1.3=1.8	2.9	2.6	sm
9	0.6+1.1=1.7	2.7	1.8	sm
10	0.5+1.1=1.6	2.6	2.2	sm
11	0.5+1.1=1.6	2.6	2.2	sm
12	0.5+1.0=1.5	2.4	2.0	sm
13	0.6+1.0=1.6	2.6	1.6	m
14	0.6+1.0=1.6	2.6	1.6	m
15	0.6+1.0=1.6	2.6	1.6	m
16	0.6+1.0=1.6	2.6	1.6	m
17	0.6+1.0=1.6	2.6	1.6	m
18	0.6+1.0=1.6	2.6	1.6	m
19	0.7+0.9=1.6	2.6	1.2	m
20	0.6+0.9=1.5	2.4	1.5	m
21	0.5+0.8=1.3	2.1	1.6	m
22	0.5+0.8=1.3	2.1	1.6	m
23	0.4+1.0=1.4	2.3	2.5	sm
24	0.4+1.0=1.4	2.3	2.5	sm
25	0.5+0.9=1.4	2.3	1.8	sm
26	0.5+0.9=1.4	2.3	1.8	sm
27	0.5+0.9=1.4	2.3	1.8	sm
28	0.4+0.8=1.2	1.9	2.0	sm
29	0.6+0.8=1.4	2.3	1.3	m
30	0.6+0.8=1.4	2.3	1.3	m
31	0.6+0.8=1.4	2.3	1.3	m
32	0.6+0.7=1.3	2.1	1.1	m
33	0.4+0.9=1.3	2.1	2.2	sm
34	0.4+0.8=1.2	1.9	2.0	sm
35	0.4+0.8=1.2	1.9	2.0	sm
36	0.4+0.7=1.1	1.8	1.7	m
37	0.4+0.7=1.1	1.8	1.7	m
38	0.4+0.7=1.1	1.8	1.7	m
39	0.5+0.6=1.1	1.8	1.2	m
40	0.4+0.6=1.0	1.6	1.5	m
41	0.4+0.6=1.0	1.6	1.5	m
42	0.4+0.6=1.0	1.6	1.5	m

See Table 3. for explanation of symbols.

Table 15. Measurements of somatic chromosomes of *Goodyera pubescens* at mitotic metaphase, 2n=26

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	0.9+1.1+1.1=3.1*	5.3	2.4	sm
2	0.7+1.1+1.1=2.9*	4.9	3.1	st
3	1.0+1.7=2.7	4.6	1.7	m
4	1.0+1.6=2.6	4.4	1.6	m
5	1.0+1.6=2.6	4.4	1.6	m
6	0.9+1.7=2.6	4.4	1.8	sm
7	0.9+0.8+0.9=2.6*	4.4	1.8	sm
8	1.0+0.7+0.8=2.5*	4.3	1.5	m
9	1.0+1.5=2.5	4.3	1.5	m
10	0.9+1.6=2.5	4.3	1.7	m
11	0.9+1.5=2.4	4.1	1.6	m
12	1.0+1.3=2.3	3.9	1.3	m
13	0.8+1.5=2.3	3.9	1.8	sm
14	0.8+1.5=2.3	3.9	1.8	sm
15	0.8+1.4=2.2	3.8	1.7	m
16	0.8+1.4=2.2	3.8	1.7	m
17	0.8+1.0+0.3=2.1*	3.6	1.6	m
18	0.7+1.0+0.4=2.1*	3.6	2.0	sm
19	0.7+1.3=2.0	3.4	1.8	sm
20	0.7+1.3=2.0	3.4	1.8	sm
21	0.9+0.9=1.8	3.1	1.0	m
22	0.7+1.1=1.8	3.1	1.5	m
23	0.8+0.9=1.7	2.9	1.1	m
24	0.7+1.0=1.7	2.9	1.4	m
25	0.6+1.0=1.6	2.7	1.6	m
26	0.6+0.9=1.5	2.6	1.5	m

See Table 3. for explanation of symbols.

Table 16. Measurements of somatic chromosomes of *Goodyera repens* at mitotic metaphase, 2n=30

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.6+0.7+2.3=4.6*	6.9	1.8	sm
2	1.5+0.7+2.3=4.5*	6.8	2.0	sm
3	1.4+1.7=3.1	4.7	1.2	m
4	1.3+1.6=2.9	4.4	1.2	m
5	0.9+1.7=2.6	3.9	1.8	sm
6	0.9+1.7=2.6	3.9	1.8	sm
7	0.9+1.6=2.5	3.8	1.7	m
8	0.9+1.5=2.4	3.6	1.6	m
9	0.8+1.5=2.3	3.5	1.8	sm
10	0.8+1.5=2.3	3.5	1.8	sm
11	1.0+1.3=2.3	3.5	1.3	m
12	0.7+1.6=2.3	3.5	2.2	sm
13	0.7+1.4=2.1	3.2	2.0	sm
14	0.9+1.3=2.2	3.3	1.4	m
15	0.8+1.3=2.1	3.2	1.6	m
16	0.9+1.1=2.0	3.0	1.2	m
17	0.7+1.2=1.9	2.9	1.7	m
18	0.7+1.1=1.8	2.7	1.5	m
19	0.7+0.5+0.6=1.8*	2.7	1.5	m
20	0.8+0.5+0.6=1.9*	2.9	1.3	m
21	0.9+1.0=1.9	2.9	1.1	m
22	0.9+0.9=1.8	2.7	1.0	m
23	0.9+0.9=1.8	2.7	1.0	m
24	0.8+0.9=1.7	2.6	1.1	m
25	0.7+1.0=1.7	2.6	1.4	m
26	0.7+0.8=1.5	2.3	1.1	m
27	0.7+0.8=1.5	2.3	1.1	m
28	0.7+0.8=1.5	2.3	1.1	m
29	0.7+0.8=1.5	2.3	1.1	m
30	0.7+0.8=1.5	2.3	1.1	m

See Table 2. for explanation of symbols.

Table 17. Measurements of somatic chromosomes of *Goodyera schlechtendaliana* at mitotic metaphase, 2n=30

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	0.9+1.3+1.6=3.8*	5.2	3.2	st
2	0.8+1.4+1.4=3.6*	4.9	3.5	st
3	1.0+2.3=3.3	4.5	2.3	sm
4	0.9+2.1=3.0	4.1	2.3	sm
5	1.4+1.7=3.1	4.3	1.2	m
6	1.4+1.4=3.1	4.3	1.2	m
7	1.5+1.6=3.1	4.3	1.0	m
8	1.5+1.5=3.0	4.1	1.0	m
9	1.3+1.4=2.7	3.7	1.0	m
10	1.3+1.4=2.7	3.7	1.0	m
11	1.1+1.4=2.5	3.4	1.2	m
12	1.1+1.4=2.5	3.4	1.2	m
13	1.0+1.5=2.5	3.4	1.5	m
14	1.1+1.3=2.4	3.3	1.1	m
15	d+0.5+1.8=2.3*	3.2	3.6	st
16	d+0.5+1.6=2.1*	2.9	3.2	st
17	0.9+1.4=2.3	3.2	1.5	m
18	0.8+1.1=1.9	2.6	1.3	m
19	0.8+1.5=2.3	3.2	1.8	sm
20	0.7+1.3=2.0	2.7	1.8	sm
21	0.8+1.3=2.1	2.9	1.6	m
22	0.8+1.1=1.9	2.6	1.3	m
23	0.9+1.4=2.3	3.2	1.5	m
24	0.9+1.0=1.9	2.6	1.1	m
25	0.8+1.0=1.8	2.5	1.2	m
26	0.8+1.0=1.8	2.5	1.2	m
27	0.9+0.9=1.8	2.5	1.0	m
28	0.7+1.0=1.7	2.3	1.4	m
29	0.6+1.1=1.7	2.3	1.8	sm
30	0.6+1.0=1.6	2.2	1.6	m

See Table 3. for explanation of symbols.

Table 18. Measurements of somatic chromosomes of *Goodyera schlechtendaliana* at mitotic metaphase, 2n=60

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.4+2.0=3.4	2.9	1.4	m
2	1.5+1.9=3.4	2.9	1.2	m
3	0.8+1.5+1.0=3.3*	2.8	3.1	st
4	0.7+1.4+1.1=3.1*	2.7	3.4	st
5	1.3+1.9=3.2	2.8	1.4	m
6	1.0+1.9=2.9	2.5	1.9	sm
7	0.6+1.1+1.3=3.0*	2.6	4.0	st
8	0.8+1.0+0.9=2.7*	2.3	2.3	sm
9	0.8+1.4=2.2	1.9	1.7	m
10	1.0+1.4=2.4	2.1	1.4	m
11	1.0+1.4=2.4	2.1	1.4	m
12	1.0+1.4=2.4	2.1	1.4	m
13	0.6+1.7=2.3	2.0	2.8	sm
14	0.6+1.6=2.2	1.9	2.6	sm
15	0.8+1.5=2.3	2.0	1.8	sm
16	0.8+1.4=2.2	1.9	1.7	m
17	0.9+1.3=2.2	1.9	1.4	m
18	0.9+1.3=2.2	1.9	1.4	m
19	1.0+1.1=2.1	1.8	1.1	m
20	0.8+1.3=2.1	1.8	1.6	m
21	0.6+1.5=2.1	1.8	2.5	sm
22	0.8+1.3=2.1	1.8	1.6	m
23	0.9+1.1=2.0	1.7	1.2	m
24	0.9+1.0=1.9	1.6	1.1	m
25	0.8+1.0=1.8	1.5	1.2	m
26	0.8+1.0=1.8	1.5	1.2	m
27	0.6+1.3=1.9	1.6	2.1	sm
28	0.6+1.3=1.6	1.6	2.1	sm
29	0.7+1.1=1.8	1.5	1.5	m
30	0.7+1.1=1.8	1.5	1.5	m
31	0.6+1.5=2.1	1.8	2.5	sm
32	0.4+1.5=1.9	1.6	3.7	st
33	0.3+1.5=1.8	1.5	5.0	st
34	0.3+1.6=1.9	1.6	5.3	st
35	0.8+1.0=1.8	1.5	1.2	m
36	0.8+1.0=1.8	1.5	1.2	m
37	0.6+1.1=1.7	1.5	1.8	sm
38	0.8+0.9=1.7	1.5	1.1	m
39	0.8+0.9=1.7	1.5	1.1	m
40	0.7+0.8=1.5	1.3	1.1	m

Table 18. continued

41	0.6+1.1=1.7	1.5	1.8	sm
42	0.6+1.0=1.6	1.4	1.6	m
43	0.7+0.8=1.5	1.3	1.1	m
44	0.7+0.8=1.5	1.3	1.1	m
45	0.6+0.8=1.4	1.2	1.3	m
46	0.6+0.8=1.4	1.2	1.3	m
47	0.6+0.8=1.4	1.2	1.3	m
48	0.6+0.8=1.4	1.2	1.3	m
49	0.5+1.0=1.5	1.3	2.0	sm
50	0.5+0.9=1.4	1.2	1.8	sm
51	0.5+0.9=1.4	1.2	1.8	sm
52	0.4+1.0=1.4	1.2	2.5	sm
53	0.4+1.0=1.4	1.2	2.5	sm
54	0.4+0.9=1.3	1.1	2.2	sm
55	0.5+0.8=1.3	1.1	1.6	m
56	0.5+0.7=1.2	1.0	1.4	m
57	0.6+0.6=1.2	1.0	1.0	m
58	0.5+0.6=1.1	0.9	1.2	m
59	0.4+0.8=1.2	1.0	2.0	sm
60	0.3+0.7=1.0	0.9	2.3	sm

See Table 3. for explanation of symbols.

Table 19. Measurements of somatic chromosomes of *Goodyera velutina* at mitotic metaphase, 2n=28

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	0.6+0.8+0.8=2.2*	4.9	2.6	sm
2	0.6+0.7+0.7=2.0*	4.5	2.3	sm
3	0.8+1.3=2.1	4.7	1.6	m
4	0.8+1.3=2.1	4.7	1.6	m
5	0.3+0.5+1.0=1.8*	4.0	1.2	m
6	0.3+0.4+1.0=1.7*	3.8	1.4	m
7	0.8+1.0=1.8	4.0	1.2	m
8	0.8+1.0=1.8	4.0	1.2	m
9	0.7+1.0=1.7	3.8	1.4	m
10	0.7+1.0=1.7	3.8	1.4	m
11	0.8+0.9=1.7	3.8	1.1	m
12	0.8+0.9=1.7	3.8	1.1	m
13	0.7+0.9=1.6	3.6	1.2	m
14	0.6+1.0=1.6	3.6	1.6	m
15	0.7+0.8=1.5	3.3	1.1	m
16	0.7+0.8=1.5	3.3	1.1	m
17	0.7+0.8=1.5	3.3	1.1	m
18	0.7+0.8=1.5	3.3	1.1	m
19	0.7+0.8=1.5	3.3	1.1	m
20	0.6+0.8=1.4	3.1	1.3	m
21	0.6+0.8=1.4	3.1	1.3	m
22	0.6+0.8=1.4	3.1	1.3	m
23	0.5+0.9=1.4	3.1	1.8	sm
24	0.4+0.9=1.3	2.9	2.3	sm
25	0.6+0.7=1.3	2.9	1.1	m
26	0.6+0.7=1.3	2.9	1.1	m
27	0.5+0.8=1.3	2.9	1.6	m
28	0.4+0.7=1.1	2.4	1.7	m

See Table 2. for explanation of symbols.

Table 20. Measurements of somatic chromosomes of *Goodyera velutina* at mitotic metaphase, 2n=56

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	0.9+1.4=2.3	2.6	1.5	m
2	0.9+1.4=2.3	2.6	1.5	m
3	1.0+1.3=2.3	2.6	1.3	m
4	0.9+1.3=2.2	2.5	1.4	m
5	0.8+1.4=2.2	2.5	1.7	m
6	0.8+1.4=2.2	2.5	1.7	m
7	0.7+0.7+0.8=2.2*	2.5	2.1	sm
8	0.6+0.7+0.8=2.1*	2.4	2.5	sm
9	0.5+0.8+0.8=2.1*	2.4	3.2	st
10	0.5+0.8+0.8=2.1*	2.4	3.2	st
11	0.3+0.4+1.1=1.8*	2.0	1.5	m
12	0.4+0.4+0.9=1.7*	1.9	1.1	m
13	0.6+1.1=1.7	1.9	1.8	sm
14	0.6+1.1=1.7	1.9	1.8	sm
15	0.8+0.9=1.7	1.9	1.1	m
16	0.8+0.9=1.7	1.9	1.1	m
17	0.7+0.9=1.6	1.8	1.2	m
18	0.7+0.9=1.6	1.8	1.2	m
19	0.6+1.0=1.6	1.8	1.6	m
20	0.6+1.0=1.6	1.8	1.6	m
21	0.6+1.0=1.6	1.8	1.6	m
22	0.6+1.0=1.6	1.8	1.6	m
23	0.8+0.8=1.6	1.8	1.0	m
24	0.7+0.9=1.6	1.8	1.2	m
25	0.8+0.8=1.6	1.8	1.0	m
26	0.8+0.8=1.6	1.8	1.0	m
27	0.6+0.9=1.5	1.7	1.5	m
28	0.5+1.1=1.6	1.8	2.2	sm
29	0.4+1.1=1.5	1.7	2.7	sm
30	0.5+0.9=1.4	1.6	1.8	sm
31	0.7+0.8=1.5	1.7	1.1	m
32	0.7+0.8=1.5	1.7	1.1	m
33	0.7+0.8=1.5	1.7	1.1	m
34	0.7+0.8=1.5	1.7	1.1	m
35	0.7+0.7=1.4	1.6	1.0	m
36	0.5+0.9=1.4	1.6	1.8	sm
37	0.5+0.9=1.4	1.6	1.8	sm
38	0.5+0.9=1.4	1.6	1.8	sm
39	0.6+0.8=1.4	1.6	1.3	m
40	0.6+0.8=1.4	1.6	1.3	m

Table 20. continued

41	0.5+0.9=1.4	1.6	1.8	sm
42	0.6+0.8=1.4	1.6	1.3	m
43	0.6+0.8=1.4	1.6	1.3	m
44	0.6+0.8=1.4	1.6	1.3	m
45	0.6+0.8=1.4	1.6	1.3	m
46	0.6+0.7=1.3	1.5	1.1	m
47	0.6+0.7=1.3	1.5	1.1	m
48	0.6+0.7=1.3	1.5	1.1	m
49	0.6+0.7=1.3	1.5	1.1	m
50	0.5+0.7=1.2	1.3	1.4	m
51	0.6+0.6=1.2	1.3	1.0	m
52	0.6+0.6=1.2	1.3	1.0	m
53	0.5+0.7=1.2	1.3	1.4	m
54	0.5+0.7=1.2	1.3	1.4	m
55	0.4+0.8=1.2	1.3	2.0	sm
56	0.4+0.7=1.1	1.2	1.7	m

See Table 3. for explanation of symbols.

Table 21. Measurements of somatic chromosomes of *Goodyera viridiflora* at mitotic metaphase, 2n=22

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	0.7+1.7=2.4	5.8	2.4	sm
2	0.7+1.7=2.4	5.8	2.4	sm
3	0.6+0.9+0.8=2.4*	5.8	3.0	sm
4	0.5+1.0+0.8=2.3*	5.5	3.6	st
5	0.5+0.9+0.9=2.3*	5.5	3.6	st
6	0.5+0.9+0.9=2.3*	5.5	3.6	st
7	0.5+1.8=2.3	5.5	3.6	st
8	0.5+1.7=2.2	5.3	3.4	st
9	0.6+1.6=2.2	5.3	2.6	sm
10	0.6+1.4=2.0	4.8	2.3	sm
11	0.8+1.0=1.8	4.3	1.2	m
12	0.8+0.9=1.7	4.1	1.1	m
13	0.7+1.0=1.7	4.1	1.4	m
14	0.6+1.0=1.6	3.9	1.6	m
15	0.5+1.1=1.6	3.9	2.2	sm
16	0.5+1.1=1.6	3.9	2.2	sm
17	0.5+1.0=1.5	3.6	2.0	sm
18	0.7+0.8=1.5	3.6	1.1	m
19	d+0.5+1.0=1.5*	3.6	2.0	sm
20	d+0.5+0.9=1.4*	3.4	1.8	sm
21	0.6+0.8=1.4	3.4	1.3	m
22	0.6+0.8=1.4	3.4	1.3	m

See Table 3. for explanation of symbols.

Table 22. Measurements of somatic chromosomes of *Hetaeria rubens* at mitotic metaphase, 2n=24

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	2.3+2.3=4.6	5.4	1.0	m
2	1.8+2.6=4.4	5.1	1.4	m
3	1.9+2.5=4.4	5.1	1.3	m
4	2.1+2.2=4.3	5.0	1.0	m
5	2.0+2.2=4.2	4.9	1.1	m
6	1.7+2.3=4.0	4.7	1.3	m
7	1.3+2.7=4.0	4.7	2.0	sm
8	1.0+2.9=3.9	4.5	2.9	sm
9	1.0+2.7=3.7	4.3	2.7	sm
10	1.0+2.4=3.4	4.0	2.4	sm
11	0.8+2.7=3.5	4.1	3.3	st
12	0.8+2.6=3.4	4.0	3.2	st
13	0.9+2.5=3.4	4.0	2.7	sm
14	0.9+2.4=3.3	3.8	2.6	sm
15	0.6+2.9=3.5	4.1	4.8	st
16	0.5+2.9=3.4	4.0	5.8	st
17	0.6+2.8=3.4	4.0	4.6	st
18	0.7+2.5=3.2	3.7	3.5	st
19	0.8+2.4=3.2	3.7	3.0	sm
20	0.8+2.3=3.1	3.6	2.8	sm
21	0.8+2.3=3.1	3.6	2.8	sm
22	0.8+2.0=2.8	3.3	2.5	sm
23	0.8+2.0=2.8	3.3	2.5	sm
24	0.7+2.1=2.8	3.3	3.0	sm

See Table 3. for explanation of symbols.

Table 23. Measurements of somatic chromosomes of *Hetaeria sikokiana* at mitotic metaphase, 2n=42

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	0.8+1.8=2.6	3.5	2.2	sm
2	0.8+1.7=2.5	3.4	2.1	sm
3	0.8+1.6=2.4	3.2	2.0	sm
4	0.9+1.5=2.4	3.2	1.6	m
5	0.8+1.4=2.2	3.0	1.7	m
6	0.8+1.4=2.2	3.0	1.7	m
7	1.0+1.1=2.1	2.8	1.1	m
8	1.0+1.1=2.1	2.8	1.1	m
9	0.9+1.1=2.0	2.7	1.2	m
10	0.8+1.1=1.9	2.6	1.3	m
11	0.7+1.3=2.0	2.7	1.8	sm
12	0.7+1.3=2.0	2.7	1.8	sm
13	0.7+1.4=2.1	2.8	2.0	sm
14	0.7+1.3=2.0	2.7	1.8	sm
15	0.8+1.1=1.9	2.6	1.3	m
16	0.8+1.1=1.9	2.6	1.3	m
17	0.2+0.4+1.3=1.9*	2.6	2.1	sm
18	0.2+0.5+1.1=1.8*	2.4	1.5	m
19	0.7+1.1=1.8	2.4	1.5	m
20	0.7+1.1=1.8	2.4	1.5	m
21	0.7+1.1=1.8	2.4	1.5	m
22	0.7+1.0=1.7	2.3	1.4	m
23	0.7+1.0=1.7	2.3	1.4	m
24	0.7+1.0=1.7	2.3	1.4	m
25	0.6+1.1=1.7	2.3	1.8	sm
26	0.5+1.1=1.6	2.2	2.2	sm
27	0.7+0.9=1.6	2.2	1.2	m
28	0.7+0.9=1.6	2.2	1.2	m
29	0.8+0.8=1.6	2.2	1.0	m
30	0.7+0.8=1.5	2.0	1.1	m
31	0.7+0.9=1.6	2.2	1.2	m
32	0.7+0.8=1.5	2.0	1.1	m
33	0.5+1.0=1.5	2.0	2.0	sm
34	0.6+0.8=1.4	1.9	1.3	m
35	0.6+0.8=1.4	1.9	1.3	m
36	0.6+0.8=1.4	1.9	1.3	m
37	0.6+0.7=1.3	1.8	1.1	m
38	0.6+0.7=1.3	1.8	1.1	m
39	0.5+0.7=1.2	1.6	1.4	m
40	0.5+0.7=1.2	1.6	1.4	m
41	0.5+0.7=1.2	1.6	1.4	m
42	0.5+0.6=1.1	1.5	1.2	m

See Table 2. for explanation of symbols.

Table 24. Measurements of somatic chromosomes of *Hetaeria yakusimensis* at mitotic metaphase, 2n=42

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	0.8+0.7+0.5=2.0*	3.8	1.5	m
2	0.6+0.6+0.6=1.8*	3.4	2.0	sm
3	0.6+1.1=1.7	3.2	1.8	sm
4	0.6+1.0=1.6	3.0	1.6	m
5	0.5+1.0=1.5	2.9	2.0	sm
6	0.5+1.0=1.5	2.9	2.0	sm
7	0.7+0.9=1.6	3.0	1.2	m
8	0.7+0.9=1.6	3.0	1.2	m
9	0.8+0.8=1.6	3.0	1.0	m
10	0.8+0.8=1.6	3.0	1.0	m
11	0.6+0.9=1.5	2.9	1.5	m
12	0.5+0.9=1.4	2.7	1.8	sm
13	0.5+0.9=1.4	2.7	1.8	sm
14	0.5+0.9=1.4	2.7	1.8	sm
15	0.6+0.8=1.4	2.7	1.3	m
16	0.6+0.8=1.4	2.7	1.3	m
17	0.7+0.7=1.4	2.7	1.0	m
18	0.7+0.7=1.4	2.7	1.0	m
19	0.4+0.9=1.3	2.5	2.2	sm
20	0.4+0.8=1.2	2.3	2.0	sm
21	0.5+0.8=1.3	2.5	1.6	m
22	0.5+0.8=1.3	2.5	1.6	m
23	0.5+0.8=1.3	2.5	1.6	m
24	0.5+0.7=1.2	2.3	1.4	m
25	0.6+0.6=1.2	2.3	1.0	m
26	0.6+0.6=1.2	2.3	1.0	m
27	0.4+0.7=1.1	2.1	1.7	m
28	0.4+0.7=1.1	2.1	1.7	m
29	0.5+0.6=1.1	2.1	1.2	m
30	0.5+0.6=1.1	2.1	1.2	m
31	0.5+0.6=1.1	2.1	1.2	m
32	0.5+0.5=1.0	1.9	1.0	m
33	0.5+0.5=1.0	1.9	1.0	m
34	0.5+0.5=1.0	1.9	1.0	m
35	0.4+0.5=0.9	1.7	1.2	m
36	0.3+0.5=0.8	1.5	1.6	m
37	0.3+0.5=0.8	1.5	1.6	m
38	0.4+0.4=0.8	1.5	1.0	m
39	0.4+0.4=0.8	1.5	1.0	m
40	0.3+0.4=0.7	1.3	1.3	m
41	0.3+0.4=0.7	1.3	1.3	m
42	0.3+0.4=0.7	1.3	1.3	m

See Table 2. for explanation of symbols.

Table 25. Measurements of somatic chromosomes of *Macodes petola* at mitotic metaphase, 2n=42

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	0.4+1.4=1.8	3.8	3.5	st
2	0.3+1.3=1.6	3.4	4.3	st
3	0.5+1.0=1.5	3.1	2.0	sm
4	0.5+1.0=1.5	3.1	2.0	sm
5	0.5+1.0=1.5	3.1	2.0	sm
6	0.5+1.0=1.5	3.1	2.0	sm
7	0.3+1.1=1.4	2.9	3.6	st
8	0.4+1.0=1.4	2.9	2.5	sm
9	0.4+1.0=1.4	2.9	2.5	sm
10	0.4+1.0=1.4	2.9	2.5	sm
11	0.4+0.9=1.3	2.7	2.2	sm
12	0.4+0.9=1.3	2.7	2.2	sm
13	0.4+0.8=1.2	2.5	2.0	sm
14	0.4+0.8=1.2	2.5	2.0	sm
15	0.4+0.8=1.2	2.5	2.0	sm
16	0.4+0.8=1.2	2.5	2.0	sm
17	0.5+0.8=1.3	2.7	1.6	m
18	0.4+0.6=1.0	2.1	1.5	m
19	0.3+0.9=1.2	2.5	3.0	sm
20	0.3+0.9=1.2	2.5	3.0	sm
21	0.3+0.8=1.1	2.3	2.6	sm
22	0.3+0.8=1.1	2.3	2.6	sm
23	0.3+0.8=1.1	2.3	2.6	sm
24	0.3+0.8=1.1	2.3	2.6	sm
25	0.3+0.7=1.0	2.1	2.3	sm
26	0.3+0.7=1.0	2.1	2.3	sm
27	0.4+0.7=1.1	2.3	1.7	m
28	0.4+0.6=1.0	2.1	1.5	m
29	0.1+0.9=1.0	2.1	9.0	t
30	0.1+0.9=1.0	2.1	9.0	t
31	0.2+0.8=1.0	2.1	4.0	st
32	0.2+0.7=0.9	1.9	3.5	st
33	0.2+0.7=0.9	1.9	3.5	st
34	0.3+0.6=0.9	1.9	2.0	sm
35	0.1+0.8=0.9	1.9	8.0	t
36	0.1+0.8=0.9	1.9	8.0	t
37	0.1+0.8=0.9	1.9	8.0	t
38	0.1+0.8=0.9	1.9	8.0	t
39	0.1+0.7=0.8	1.7	7.0	st
40	0.1+0.7=0.8	1.7	7.0	st
41	0.1+0.5=0.6	1.3	5.0	st
42	0.1+0.5=0.6	1.3	5.0	st

t: terminal
See Table 3. for explanation of symbols.

Table 26. Measurements of somatic chromosomes of *Myrmechis japonica* at mitotic metaphase, 2n=56

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.0+1.0=2.0	2.4	1.0	m
2	0.9+0.9=1.8	2.2	1.0	m
3	0.7+1.3=2.0	2.4	1.8	sm
4	0.7+1.3=2.0	2.4	1.8	sm
5	0.7+1.3=2.0	2.4	1.8	sm
6	0.6+1.4=2.0	2.4	2.3	sm
7	0.6+1.3=1.9	2.3	2.1	sm
8	0.6+1.3=1.9	2.3	2.1	sm
9	0.6+1.1=1.7	2.0	1.8	sm
10	0.6+1.1=1.7	2.0	1.8	sm
11	0.6+1.0=1.6	1.8	1.6	m
12	0.7+0.9=1.6	1.9	1.2	m
13	0.6+0.9=1.5	1.8	1.5	m
14	0.7+0.8=1.5	1.8	1.1	m
15	0.6+0.9=1.5	1.8	1.5	m
16	0.6+0.9=1.5	1.8	1.5	m
17	0.6+0.9=1.5	1.8	1.5	m
18	0.7+0.8=1.5	1.8	1.1	m
19	0.6+0.9=1.5	1.8	1.5	m
20	0.6+0.9=1.5	1.8	1.5	m
21	0.7+0.8=1.5	1.8	1.1	m
22	0.6+0.9=1.5	1.8	1.5	m
23	0.6+0.9=1.5	1.8	1.5	m
24	0.6+0.9=1.5	1.8	1.5	m
25	0.7+0.8=1.5	1.8	1.1	m
26	0.7+0.8=1.5	1.8	1.1	m
27	0.5+1.0=1.5	1.8	2.0	sm
28	0.5+1.0=1.5	1.8	2.0	sm
29	0.5+1.0=1.5	1.8	2.0	sm
30	0.5+1.0=1.5	1.8	2.0	sm
31	0.5+1.0=1.5	1.8	2.0	sm
32	0.5+1.0=1.5	1.8	2.0	sm
33	0.5+0.9=1.4	1.7	1.8	sm
34	0.5+0.9=1.4	1.7	1.8	sm
35	0.5+0.9=1.4	1.7	1.8	sm
36	0.5+0.9=1.4	1.7	1.8	sm
37	0.6+0.8=1.4	1.7	1.3	m
38	0.6+0.8=1.4	1.7	1.3	m
39	0.6+0.8=1.4	1.7	1.3	m
40	0.6+0.8=1.4	1.7	1.3	m

Table 26. continued

41	0.5+0.8=1.3	1.6	1.6	m
42	0.5+0.8=1.3	1.6	1.6	m
43	0.5+0.8=1.3	1.6	1.6	m
44	0.5+0.8=1.3	1.6	1.6	m
45	0.5+0.8=1.3	1.6	1.6	m
46	0.5+0.8=1.3	1.6	1.6	m
47	0.4+0.9=1.3	1.6	2.2	sm
48	0.4+0.9=1.3	1.6	2.2	sm
49	0.4+0.9=1.3	1.6	2.2	sm
50	0.4+0.9=1.3	1.6	2.2	sm
51	0.4+0.8=1.2	1.4	2.0	sm
52	0.4+0.8=1.2	1.4	2.0	sm
53	0.4+0.8=1.2	1.4	2.0	sm
54	0.4+0.7=1.1	1.3	1.7	sm
55	0.3+0.7=1.0	1.2	2.6	sm
56	0.3+0.7=1.0	1.3	2.3	sm

See Table 2. for explanation of symbols.

Table 27. Measurements of somatic chromosomes of *Myrmechis tsukusiana* at mitotic metaphase, 2n=28

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	0.9+1.3=2.2	4.5	1.4	m
2	0.9+1.3=2.2	4.5	1.4	m
3	1.0+1.0=2.0	4.1	1.0	m
4	1.0+1.0=2.0	4.1	1.0	m
5	0.9+1.0=1.9	3.9	1.1	m
6	0.8+1.1=1.9	3.9	1.3	m
7	0.8+1.1=1.9	3.9	1.3	m
8	0.8+1.1=1.9	3.9	1.3	m
9	0.8+1.0=1.8	3.7	1.2	m
10	0.8+1.0=1.8	3.7	1.2	m
11	0.6+1.3=1.9	3.9	2.1	sm
12	0.6+1.3=1.9	3.9	2.1	sm
13	0.7+1.1=1.8	3.7	1.5	m
14	0.8+0.9=1.7	3.5	1.1	m
15	0.8+0.9=1.7	3.5	1.1	m
16	0.7+1.0=1.7	3.5	1.4	m
17	d+0.5+1.1=1.6*	3.3	2.2	sm
18	d+0.5+1.1=1.6*	3.3	2.2	sm
19	0.6+1.0=1.6	3.3	1.6	m
20	0.7+0.9=1.6	3.3	1.2	m
21	0.8+0.8=1.6	3.3	1.0	m
22	0.8+0.8=1.6	3.3	1.0	m
23	0.6+0.9=1.5	3.1	1.5	m
24	0.6+0.9=1.5	3.1	1.5	m
25	0.6+0.9=1.5	3.1	1.5	m
26	0.7+0.8=1.5	3.1	1.1	m
27	0.5+1.0=1.5	3.1	2.0	sm
28	0.4+0.9=1.3	2.7	2.2	sm

See Table 2. for explanation of symbols.

Table 28. Measurements of somatic chromosomes of *Odontochilus inabai* at mitotic metaphase, 2n=28

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.0+1.7=2.7	4.3	1.7	m
2	0.9+1.7=2.6	4.1	1.8	sm
3	1.0+1.5=2.5	4.0	1.5	m
4	0.9+1.3=2.5	4.0	1.7	m
5	0.9+1.6=2.5	4.0	1.7	m
6	1.0+1.4=2.4	3.8	1.4	m
7	0.9+1.5=2.4	3.8	1.6	m
8	0.8+1.6=2.4	3.8	2.0	sm
9	1.0+1.3=2.3	3.7	1.3	m
10	1.0+1.3=2.3	3.7	1.3	m
11	1.0+1.3=2.3	3.7	1.3	m
12	0.9+1.4=2.3	3.7	1.5	m
13	0.9+1.4=2.3	3.7	1.5	m
14	0.9+1.4=2.3	3.7	1.5	m
15	1.1+1.1=2.2	3.5	1.0	m
16	0.9+1.3=2.2	3.5	1.4	m
17	0.9+1.3=2.2	3.5	1.4	m
18	0.9+1.3=2.2	3.5	1.4	m
19	1.0+1.1=2.1	3.3	1.1	m
20	0.8+1.4=2.2	3.5	1.7	m
21	0.7+1.5=2.2	3.5	2.1	sm
22	0.7+1.5=2.2	3.5	2.1	sm
23	1.0+1.0=2.0	3.2	1.0	m
24	0.8+1.1=1.9	3.0	1.3	m
25	0.7+1.3=2.0	3.2	1.8	sm
26	0.7+1.3=2.0	3.2	1.8	sm
27	0.8+1.1=1.9	3.0	1.3	m
28	0.7+1.2=1.9	3.0	1.7	m

See Table 2. for explanation of symbols.

Table 29. Measurements of somatic chromosomes of *Vexillabium yakushimense* at mitotic metaphase, 2n=26

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	0.8+2.6=3.4	5.3	3.2	st
2	0.8+2.5=3.3	5.1	3.1	st
3	1.4+1.5=2.9	4.5	1.0	m
4	1.3+1.6=2.9	4.5	1.2	m
5	1.0+1.8=2.8	4.3	1.8	sm
6	1.0+1.7=2.7	4.2	1.7	m
7	1.3+1.5+d=2.8*	4.3	1.1	m
8	1.3+1.5+d=2.8*	4.3	1.1	m
9	0.9+1.9=2.8	4.3	2.1	sm
10	0.8+1.9=2.7	4.2	2.3	sm
11	0.9+1.8=2.7	4.2	2.0	sm
12	0.9+1.8=2.7	4.2	2.0	sm
13	1.1+1.6=2.7	4.2	1.4	m
14	1.0+1.5=2.5	3.9	1.5	m
15	0.9+1.6=2.5	3.9	1.7	m
16	0.9+1.5=2.4	3.9	1.6	m
17	0.9+1.3=2.2	3.4	1.4	m
18	1.0+1.1=2.1	3.3	1.1	m
19	1.0+1.1=2.1	3.3	1.1	m
20	0.9+1.2=2.1	3.3	1.3	m
21	0.8+1.3=2.1	3.3	1.6	m
22	0.9+1.1=2.0	3.1	1.2	m
23	0.9+1.0=1.9	3.0	1.1	m
24	0.9+1.0=1.9	3.0	1.1	m
25	0.7+1.0=1.7	2.6	1.4	m
26	0.7+1.0=1.7	2.6	1.4	m

See Table 2. for explanation of symbols.

Table 30. Measurements of somatic chromosomes of *Zeuxine agyokuana* at mitotic metaphase, 2n=20

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.8+3.1=4.9	6.7	1.7	m
2	1.7+3.1=4.8	3.3	1.8	sm
3	1.6+3.1=4.7	6.4	1.9	sm
4	1.5+3.1=4.6	6.3	2.0	sm
5	1.4+2.6=4.0	5.5	1.8	sm
6	1.4+2.6=4.0	5.5	1.8	sm
7	1.7+2.3=4.0	5.5	1.3	m
8	1.7+2.2=3.9	5.3	1.2	m
9	0.6+0,8+2.4=3.8*	5.2	1.7	m
10	0.6+0.8+2.3=3.7*	5.1	1.6	m
11	1.0+2.6=3.6	4.9	2.6	sm
12	1.0+2.6=3.6	4.9	2.6	sm
13	0.8+2.5=3.3	4.5	3.1	st
14	0.8+2.4=3.2	4.4	3.0	sm
15	1.1+2.1=3.2	4.4	1.9	sm
16	1.1+2.1=3.2	4.4	1.9	sm
17	1.1+1.8=2.9	4.0	1.6	m
18	0.9+1.8=2.7	3.7	2.0	sm
19	0.9+1.8=2.7	3.7	2.0	sm
20	0.9+1.8=2.4	3.3	1.6	m

See Table 3. for explanation of symbols.

Table 31. Measurements of somatic chromosomes of *Zeuxine leucochila* at mitotic metaphase, 2n=20

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.6+3.3=4.9	6.6	2.0	sm
2	1.6+3.2=4.8	6.5	2.0	sm
3	1.5+3.2=4.7	6.4	2.1	sm
4	1.5+3.1=4.6	6.2	2.0	sm
5	1.1+3.4=4.5	6.1	3.0	sm
6	1.1+3.3=4.4	6.0	3.0	sm
7	1.5+2.6=4.1	5.6	1.7	m
8	1.5+2.5=4.0	5.4	1.6	m
9	0.4+0.4+2.3=3.8*	5.1	1.5	m
10	0.4+1.1+2.3=3.8*	5.1	1.5	m
11	1.4+2.3=3.7	5.0	1.6	m
12	1.4+2.3=3.7	5.0	1.6	m
13	0.5+3.2=3.7	5.0	6.4	st
14	0.5+3.1=3.6	4.9	6.2	st
15	1.3+1.4=2.7	3.7	1.0	m
16	1.3+1.3=2.6	3.5	1.0	m
17	0.8+1.9=2.7	3.7	2.3	sm
18	0.8+1.7=2.5	3.4	2.1	sm
19	0.8+1.7=2.5	3.4	2.1	sm
20	0.8+1.7=2.5	3.4	2.1	sm

See Table 3. for explanation of symbols.

Table 32. Measurements of somatic chromosomes of *Zeuxine odorata* at mitotic metaphase, 2n=40

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.1+2.3=3.4	3.7	2.0	sm
2	1.2+2.0=3.2	3.5	1.6	m
3	0.9+2.3=3.2	3.5	2.5	sm
4	0.8+2.3=3.1	3.4	2.8	sm
5	0.7+2.1=2.8	3.1	3.0	sm
6	0.7+2.0=2.7	3.0	2.8	sm
7	1.0+1.6=2.6	2.9	1.6	m
8	0.9+1.7=2.6	2.9	1.8	sm
9	0.8+1.8=2.6	2.9	2.2	sm
10	0.6+2.0=2.6	2.9	3.3	st
11	1.1+1.4=2.5	2.7	1.2	m
12	0.9+1.6=2.5	2.7	1.7	m
13	1.1+1.3=2.4	2.6	1.1	m
14	1.0+1.4=2.4	2.6	1.4	m
15	1.0+1.4=2.4	2.6	1.4	m
16	1.0+1.3=2.3	2.5	1.3	m
17	1.0+1.3=2.3	2.5	1.3	m
18	0.8+1.5=2.3	2.5	1.8	sm
19	0.7+1.7=2.4	2.6	2.4	sm
20	0.6+1.7=2.3	2.5	2.8	sm
21	0.7+1.6=2.3	2.5	2.2	sm
22	0.7+1.6=2.3	2.5	2.2	sm
23	0.7+1.5=2.2	2.4	2.1	sm
24	0.8+1.3=2.1	2.3	1.6	m
25	0.8+1.3=2.1	2.3	1.6	m
26	1.0+1.0=2.0	2.2	1.0	m
27	1.0+1.0=2.0	2.2	1.0	m
28	0.9+1.1=2.0	2.2	1.2	m
29	0.7+1.3=2.0	2.2	1.8	sm
30	0.9+1.0=1.9	2.1	1.1	m
31	0.8+1.1=1.9	2.1	1.3	m
32	0.7+1.2=1.9	2.1	1.7	m
33	0.6+1.3=1.9	2.1	2.1	sm
34	0.8+1.0=1.8	2.0	1.2	m
35	0.8+1.0=1.8	2.0	1.2	m
36	0.8+1.0=1.8	2.0	1.2	m
37	0.8+1.0=1.8	2.0	1.2	m
38	0.8+0.9=1.7	1.9	1.1	m
39	0.8+0.8=1.6	1.8	1.0	m
40	0.6+1.8=1.4	1.5	1.3	m

See Table 3. for explanation of symbols.

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