Karyomorphological Studies in *Paphiopedilum*, Orchidaceae*

Kohji Karasawa

Introduction

Paphiopedilum is an interesting genus for the study of process of species differentiation, since it includes approximately 60 species with high variability in external morphology and in geographical distribution and is cultivated in the floricultural world differentiating into many horticultural cultivars.

The chromosome numbers of *Paphiopedilum* are known to be highly variable, 2n=26, 28, 30, 32, 34, 36, 38, 40, 41, 42 (Mehlquist 1947, Duncan 1947, Duncan & MacLeod 1948, 1949, 1950, Kamemoto *et al.* 1963, Tanaka 1964, Sasa & Torikata 1967, Tanaka & Aoyama 1974, cf. Tanaka & Kamemoto 1972 and 1974) . It was speculated that the variation of the chromosome numbers of the genus might be occurred mainly by centric fission in metacentric chromosomes (Duncan & MacLeod 1949, 1950, Kamemoto *et al.* 1963, Tanaka & Aoyama 1974) .

In the present investigation the morphology of chromosomes is studied in about 60 taxa in order to elucidate the process of karyotypical change and species differentiation in *Paphiopedilum.*

Materials and Methods

Materials, sources and the numbers of clones were listed in Table 1. The photographs of flowers of the taxa studied were shown in certain places of this paper. Validating specimens of the clones studied were deposited in the Herbarium of The Hiroshima Botanical Garden. Taxonomic treatment followed mainly Fowlie (1966 - 1977) and partly Brieger (1971) and Wood (1975-1977) .

Observation of somatic chromosomes was made with the aceto-orcein technique developed by Tanaka & Kamemoto (1960) : Active root tips were immersed in 0.002M 8-hydroxyquinoline for 4 - 5 hours at 18°C. They were then transferred to 45% acetic acid for 5 minutes at 5°C, hydrolyzed in 1N HCl at 60°C for 15 seconds, and finally stained and squashed in 1% aceto-orcein.

The metaphase chromosomes of the species with the chromosome numbers of 2n=26 and 28 and 2n=30-42 were aligned in descending order of length. The metaphase chromosomes of the species with the chromosome numbers of 2n=30 - 42 were divided into two

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* The disseratation submitted in partial fulfilment of the requirements for the degree of D. Sc. of the Hiroshima University.

Bulletin of The Hiroshima Botanical Garden, No. 2: 1- 149 , 1979.

Table 1. Sources, numbers of clone and chromosome number of the species of *Paphiopedilum* studied

Species	Source	No. of clone	Chromosome number (2n)
Subgenus BRACHYPETALUM			
bellatulum	Thailand	4	26
niveum	Thailand	4	26
concolor	Thailand	3	26
leucochilum	Thailand	1	26**
godefroyae	Thailand	2	26
ang-thong	Thailand	3	26**
delenatii	Lecoufle*	2	26
Subgenus POLYANTHA			
Section MASTIGOPETALUM			
stonei	Borneo	3	26
rothschildianum	Ahuri Noen*	1	26
glanduliferum	Rands Orchid*	1	26**
praestans	New Guinea	3	26***
bodegomii	New Guinea	1	26**
philippinense	Philippine	5	26
laevigatum	Philippine	1	26**
roebbelenii	Philippine	2	26**
randsii	Philippine	2	26**
Section MYSTROPETALUM			
parishii	Thailand	3	26
Section PARDALOPETALUM			
lowii	Borneo	2	26
haynaldianum	Philippine	2	26
Section COCHLOPETALUM			
victoria-regina			
ssp. *liemianum*	Sumatra	2	32**
ssp. *primulinum*	Sumatra	2	32
ssp. *primulinum*			
f. *purpurascens*	Sumatra	2	32
ssp. *chamberlainianum*	Sumatra	1	34***
ssp. *glaucophyllum*	Java	5	36, 37**
ssp. *glaucophyllum*			
v. *moquetteanum*	Java	2	34**
ssp.	Sumatra	3	33**, 35**, 36**
Subgenus PAPHIOPEDILUM			
Section STICTOPETALUM			
esquirolei	Thailand	3	26**
hirsutissimum	India	3	26
Section NEUROPETALUM			

Table 1. (continued)

exul	Thailand	2	26
insigne	India	5	26, 39
charlesworthii	Burma	2	26
villosum	Thailand	2	26
boxalli	Ahuri Noen*	1	26
Section CYMATOPETALUM			
spicerianum	India	3	30
Section THIOPETALUM			
druryi	India	1	30***
Subgenus BARBATA			
Section CERATOPETALUM			
fairieanum	India	3	26
Section SIGMATOPETALUM			
hookerae	Borneo	4	28**
appletonianum	Thailand, Sunda Is.	6	38**
bullenianum	Borneo	2	40**
celebesense	Celebes	2	42**
Section BLEPHAROPETALUM			
tonsum	Sumatra	6	32***
dayanum	Borneo	2	36***
mastersianum	Borneo	3	36***
javanicum	Java	3	38***
violascens	New Guinea	4	38**
wentworthianum	Bougainville	1	40**
bougainvilleanum	Bougainville	2	40**
sukhakulii	Thailand	3	40
purpuratum	Hong Kong	2	40***
virens	Borneo	4	40**
Section BARBATA			
callosum	Thailand	7	32
ciliolare	Philippine	2	32**
acmodontum	Philippine	2	36**
lawrenceanum	Yamato Noen*	1	36
hennisianum	Philippine	2	36**
curtisii	Sumatra	2	36
superbiens	Sumatra	3	38
barbatum	Malaya	2	38
argus	Philippine	2	38
venustum	India	5	40, 41

* cultured
** first time record
*** differ from previous record

groups: one consisted of two-armed (metacentric to subtelocentric) chromosomes and the other consisted of one-armed (telocentric) chromosomes.

Numbers (1, 2, 3, ...) were given to the chromosomes aligned in descending order. Each chromosome was measured by the length of both long and short arms. Arm ratio was estimated by (length of long arm) / (length of short arm), and expressed by the value of arm ratio 1.0 to 1.7 as "median", 1.8 to 3.0 as "submedian", 3.1 to 7.0 as "subterminal" and over 7.1 as "terminal" according to Levan et al. (1964).

Acknowledgements

This work has been carried out under the direction of Professor Dr. Ryuso Tanaka of Hiroshima University, to whom the author wishes to express his sincerest gratitude. I wish to thank Dr. Katsumi Ueda of Nara Woman University and Dr. Katsuhiko Kondo of Hiroshima University, for their kind and valuable criticism during the preparation of this manuscript. My special thanks are also due to members of the Botanical Garden of the University of Tokyo, Mr. Takao Abe, Mr. Chuyo Fukui, Mr. Hiroyuki Gauda, Mr. Kengo Fujio, Mr. Sigeaki Ichijo, Mr. Hiromichi Miyahara, Mr. Issaku Nagata, Mr.Yoshitoshi Hattori, Mr. Toshimichi Soda, Mr. Fumimasa Sugiyama, Mr. Yoshio Udagawa and Mr. Neville Hawcroft for supplying the materials.

Observations

Morphological changes of chromosomes in mitotic cell cycle were studied in root tip cells of *Paphiopedilum insigne* (2n=26) (Fig. 1). The interphase nuclei (Fig. 1A-C) were categoried to be the complex chromocenter type which has many darkly stained chromocenters according to the Tanaka's classification of resting nuclei (Tanaka 1971). The chromocenters varied in shapes ranging from about 1 to 3 μm in size and its edges were not clear. In early mitotic phase chromosomes changed to fibrous thread stained almost homogeneously. The chromosomes at mitotic prometaphase were uniformly stained.

I. BRACHYPETALUM

1) *Paphiopedilum bellatulum* (Rchb. f.) Pfitz., 2n=26
Validated specimen No. 1090, 1132, 1134, 1248.

This species grows in Burma and in Thailand. External morphological characteristics of this species are as follows: Leaves are thick and deep green, mottled on the upper surface with pale green. The peduncle is short, and bears single flower. The dorsal sepal,

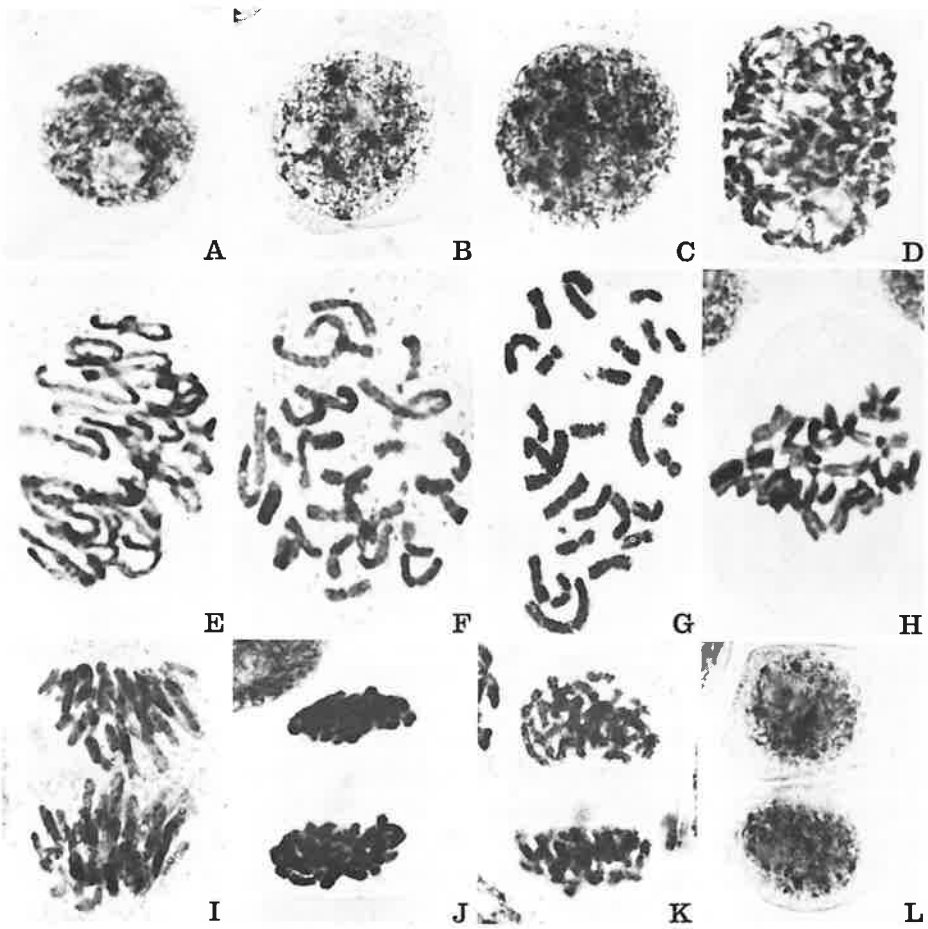


Fig. 1. Chromosomes in mitotic cell cycle in root-tip cells of *Paphiopedilum insigne*, 2n=26. A-C, interphase. D and E, prophase. F and G, prometaphase. H, metaphase. I and J, anaphase. K, telophase. L, early interphase of daughter cells. ×1000.

which is white, spotted with purple in color, is round and broad. The lip is white, spotted with purple in color, and its edge curve toward the inside (Fig. 2A) .

The chromosome number of 2n=26 in this species was previously reported by Duncan (1947) , Mehlquist (1947) , Duncan & MacLeod (1948) and Kamemoto *et al.* (1963) . In the present investigation, the number of chromosomes was reexamined to be 2n=26. The chromosomes at resting stage and mitotic phase were shown in Fig. 2. The results of the measurement of chromosome length and centromere position were shown in Table 2.

Among the 26 chromosomes four longest chromosomes (Nos. 1-4) were distinguished. They ranged from 10.6 to 9.3 μm in length. Their arm ratios varied from 1.1 to 1.2 and the centromeres were situated in median. The other 22 chromosomes (Nos. 5-26) ranged from 7.5 to 3.4 μm in length, and decreased gradually in size from the longest to the

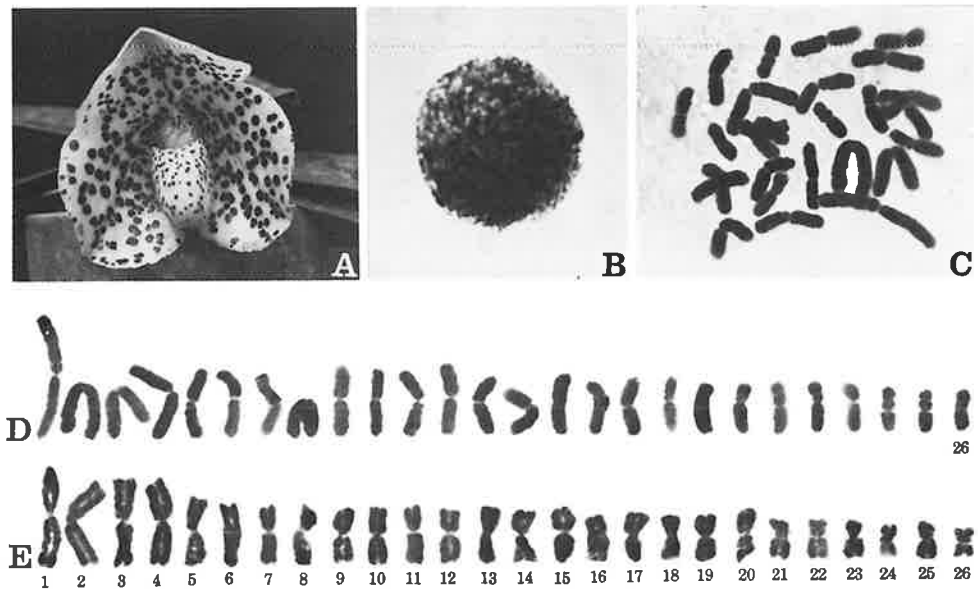


Fig. 2. *Paphiopedilum bellatulum*, 2n=26. A, flower. B, interphase nucleus. C and D, somatic prometaphase chromosomes. E, somatic metaphase chromosomes. A, × 0.5. B-E, ×1200.

shortest chromosomes. Their arm ratios varied from 1.0 to 1.3 and the positions of centromeres were median. Six chromosomes (Nos. 21-26) had the obvious small constrictions on the middle parts of short arms, respectively, at prometaphase. At midmetaphase, these small constrictions had been obscured into slight constrictions.

As mentioned above, the chromosomes which consisted of morphologically 13 pairs of matched chromosomes can be divided mainly into two quantitative groups constructing a bimodal karyotype. One group consisted of two matched large chromosomes and the other group consisted of 11 matched small chromosomes.

2) *Paphiopedilum niveum* (Rchb. f.) Pfitz., 2n=26
Validated specimen No. 1166, 1168, 1169.

This species is native to Langkwai Islands, Penang and Tambelan Islands.

This species is morphologically chracterized as follows: The upper surface of the leves is deep green with grayish-green spots and the reverse is deep purple. Each peduncle bears generally single flower. The dorsal sepal and petals are roundish and white with fine purple dots toward the base. The lip is white with small dots and its margin curve toward the inside (Fig. 3A) .

The chromosome number of 2n=26 in this species was previously reported by Duncan (1947) , Mehlquist (1947) , Duncan & MacLeod (1948) and Kamemoto *et al.* (1963) . In the present investigation the number of chromosomes was reexamined to be 2n=26.

The chromosomes at mitotic phase were shown in Fig. 3. The results of the measurement of chromosome length and centromere position were shown in Table 3.

Among the 26 chromosomes four longest chromosomes (Nos. 1-4) , which were distinguished, ranged from 10.4 to 9.0 μm in length. Their arm ratios varied from 1.0 to 1.1 and the positions of centromeres were median. The other 22 chromosomes (Nos. 5-26) ranged from 7.8 to 3.8 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Their arm ratios varied from 1.0 to 1.6 and the positions of centromeres were median.

The karyotype of *Paphiopedilum niveum* was similar to that of *P. bellatulum* except for higher arm ratios.

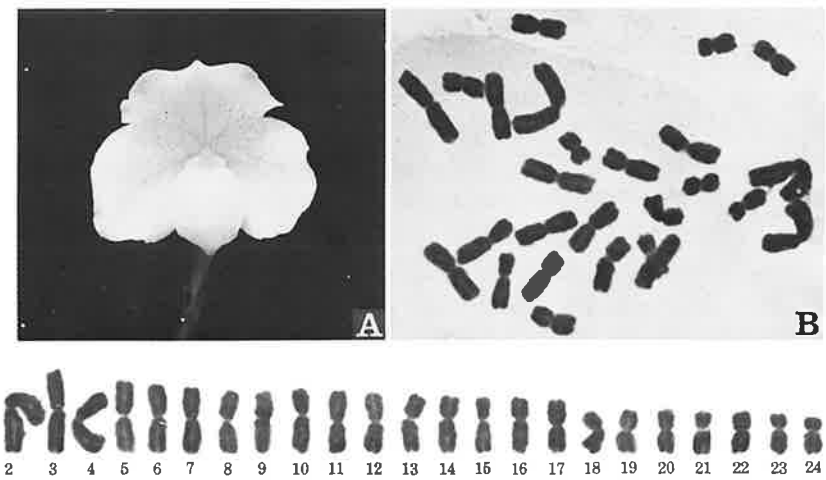


Fig. 3. *Paphiopedilum niveum*, 2n=26. A, flower. B and C, somatic metaphase chromosomes. A, × 0.7. B and C, × 1200.

3) *Paphiopedilum concolor* (Par. & Batem.) Pfitz., 2n=26
Validated specimen No. 1087, 1222, 1216.

Two types of *P. concolor*, which were introduced to the horticultural field from two different sources, Thailand and Viet Nam, were comparatively described as follows:

Type 1.

(Fig. 4, Table 4).

In the present investigation the specimen from Thailand is dealt with. This specimen has the following distinct morphological characteristics: Color of the leaves is deep green with grayish green mottling. The peduncle bears one to two flowers. The dorsal sepal and petals are roundish and creamy yellow with small purple dots. The lip is creamy yellow, spotted with purple color, and its edge curve toward the inside (Fig. 4A).

The chromosome number of 2n=26 in *P. concolor* was previously reported by Duncan

(1947), Duncan & MacLeod (1948) and Kamemoto *et al.* (1963). In the present investigation the number of chromosomes was reexamined to be 2n=26. The chromosomes at mitotic phase were shown in Fig. 4. The results of the measurement of chromosome length and centromere position were shown in Table 4.

Among the 26 chromosomes four longest chromosomes (Nos. 1-4) were distinguished. They ranged from 10.5 to 9.3 μm in length. Their arm ratios varied from 1.0 to 1.1 and the positions of centromeres were median. The other 22 chromosomes (Nos. 5-26) ranged from 7.4 to 3.9 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of 14 (Nos. 5-18) out of the 22 chromosomes varied from 1.0 to 1.5 and the positions of centromeres were median. Two (Nos. 19, 20) of these 22 chromosomes had satellites on their short arms. The short arms of them were 2.4 μm (0.5+1.9 μm) and 2.0 μm (0.2+1.8 μm) in length and their long arm were 3.0 μm and 2.8 μm respectively in length. Thus, their arm ratios were 1.3 and 1.4. The positions of centromeres of the satellited chromosomes were median. Arm ratios of the leftover six chromosomes (Nos. 21-26) varied from 1.1 to 1.7 and the positions of centromeres were median. Especially, arm ratios of two chromosomes (Nos. 23, 24) were both 1.7 which was the highest value in the 26 chromosomes.

According to the morphology of chromosome complement this species was clearly different from *P. bellatulum.* The 19th and the 20th chromosomes of this species had satellites on their short arms and arm ratios of the 23rd and the 24th chromosomes were highly both 1.7 respectively.

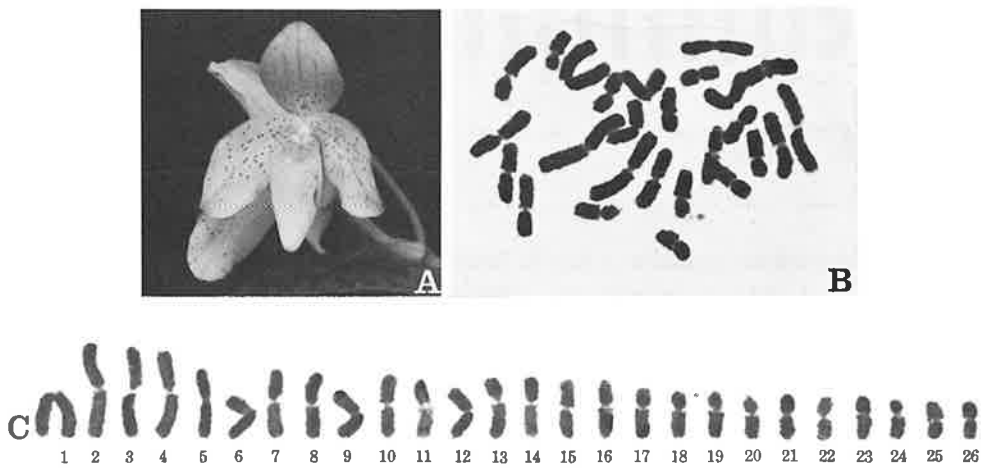


Fig. 4. *Paphiopedilum concolor,* Type 1 2n=26. A, flower. B and C, somatic metaphase chromosomes. A, × 0.7. B and C, × 1200.

Type 2.

(Fig. 5, Table 5).

The specimen investigated which had been imported from the Rands Orchids was the unflowered clone (Fig. 5A). Rands (1975) charactrized this species as follows: "From

Laos region, the flower is virtually circular in form, softer lime-yellow in color, very lightly spotted, with a much larger stem system. Bi-flowers are the rule, rather than the exception".

The clone investigated showed 2n=26 chromosomes. The chromosomes at mitotic phase were shown in Fig. 5.

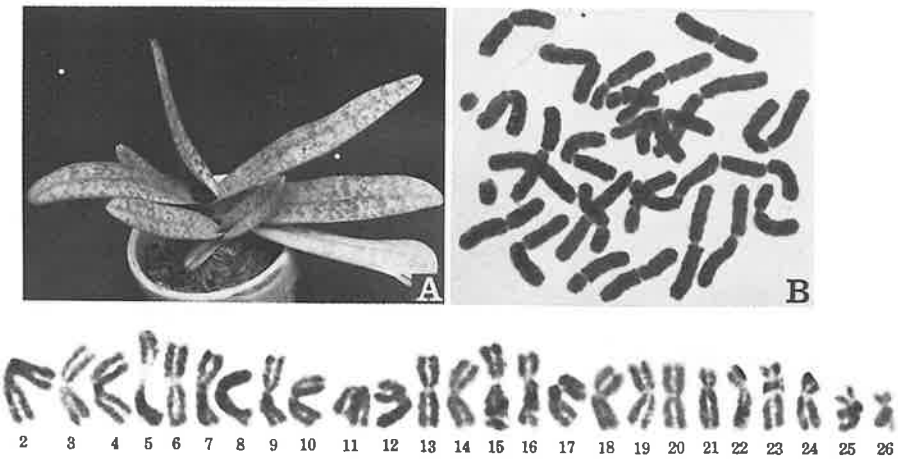


Fig. 5. *Paphiopedilum concolor*, Type 2 2n=26. A, seedling. B, somatic prometaphase chromosomes. C, somatic metaphase chromosomes. A, ×0.4. B and C, ×1200.

The results of the measurement of chromosome length and centromere position were shown in Table 5.

Among the 26 chromosomes four longest chromosomes (Nos. 1-4) were distinguished. They ranged from 11.0 to 9.1 μm in length. Their arm ratios were all 1.0 and the positions of centromeres were median. The other 22 chromosomes (Nos. 5-26) ranged from 8.5 to 4.3 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of ten of the 22 chromosomes (Nos. 5-14) varied from 1.1 to 1.3 and the positions of centromeres were median. In contrast, two of these chromosomes (Nos. 15, 16) had satellites on their long arms. The short arms of them were both 3.0 μm in length and the long arms were both 4.8 μm (3.5+1.3 μm) in length. Thus, their arm ratios were both 1.6. The positions of centromeres of the satellited chromosomes were median. Arm ratios of four chromosomes (Nos. 17-20) were 1.3 and 1.1 respectively and the positions of centromeres were median. Arm ratios of four chromosomes (Nos. 21-24) were all 2.2 and the positions of centromeres were submedian. Arm ratios of the last two chromosomes (Nos. 25, 26) were both 1.7 and the positions of centromeres were median.

According to the morphology of chromosome complement this species was clearly different from *P. concolor* Type 1. It was the characteristics that the 15th and the 16th chromosomes had satellites on their long arms and the positions of centromeres of four chromosomes (Nos. 21-24) were submedian.

4) *Paphiopedilum leucochilum* Fowl., 2n=26
Validated specimen No. 1167.

Paphiopedilum leucochilum, native to Phuket-Krabi Islands, was recently described as a distinct species by Fowlie (1975) after a change of the varietal rank of *P. godefroyae* var. *leucochilum.* In compared with *P. godefroyae,* the staminode of this species is distinctive. Color of the lip is pure white with no purple spot (Fig. 6A).

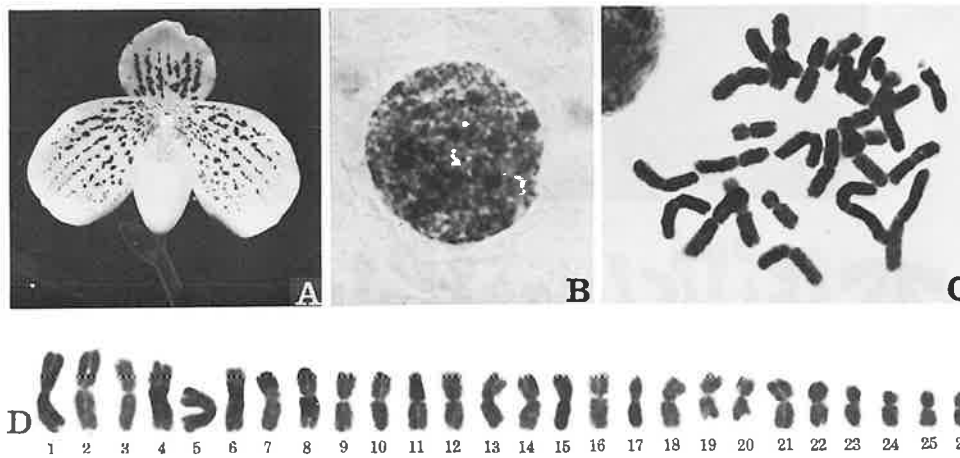


Fig. 6. *Paphiopedilum leucochilum,* 2n=26. A, flower. B, interphase nucleus. C, somatic prometaphase chromosomes. D, somatic metaphase chromosomes. A, × 0.5. B-D, × 1200.

The chromosome number of this species was examined to be 2n=26. The chromosomes at resting stage and mitotic phase were shown in Fig. 6. The results of the measurement of chromosome length and centromere position were shown in Table 6.

Among the 26 chromosomes four longest chromosomes (Nos. 1- 4) were distinguished. They ranged from 9.0 to 8.0 μm in length. Their arm ratios varied from 1.0 to 1.1 and the positions of centromeres were median. The other 22 chromosomes (Nos. 5-26) ranged from 7.3 to 4.0 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of 14 chromosomes (Nos. 5-18) varied from 1.0 to 1.4, and the positions of centromeres were median. Two chromosomes (Nos. 19, 20) had indefinite satellites on their long arms. The short arms were both 2.5 μm in length and the long arms were both 3.2 μm (2.7+0.5 μm) in length. The positions of their centromeres were median. Arm ratios of six chromosomes (Nos. 21-26) varied from 1.0 to 1.4, and the positions of centromeres were median.

According to the morphology of chromosome complement this species was clearly different from *P. bellatulum.* The 19th and 20th chromosomes of this species were the marked chromosomes for the chromosome complement of this species.

5) *Paphiopedilum godefroyae* (Godefr.) Pfitz., 2n=26
Validated specimen No. 1089, 1133.

This species widely distributes in Burma, Thailand, South Viet Nam and has the following distinct morphological characteristics: The surface of the leaf is dark green mottled with pale green. The peduncle bears single flower. The dorsal sepal is roundish and broad, and is white with purple spots. The lip is white with purple spots and its edge curve toward the inside (Fig. 7A).

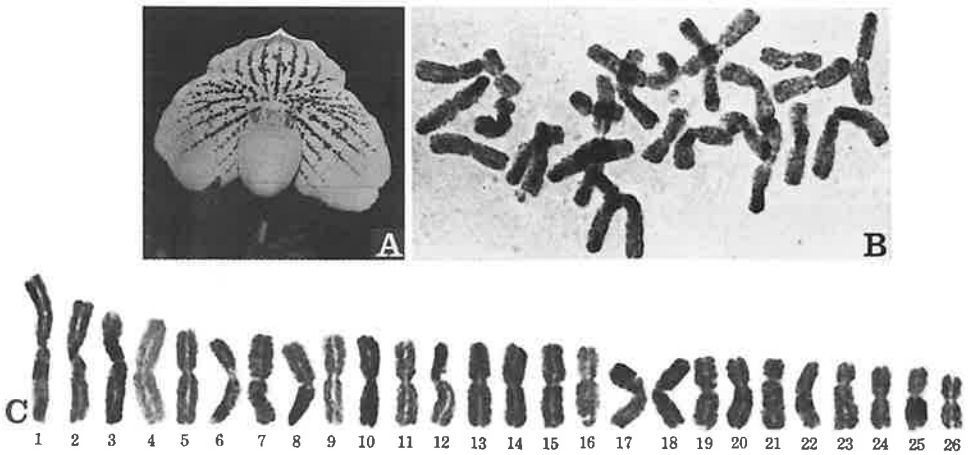


Fig. 7. *Paphiopedilum godefroyae*, 2n=26. A, flower. B, somatic prometaphase chromosomes. C, somatic metaphase chromosomes. A, × 0.5. B and C, ×1200.

The chromosome number of 2n=26 in this species was previously reported by Kamemoto *et al.* (1963) and Tanaka & Aoyama (1974). In the present investigation the number of chromosomes was reexamined to be 2n=26. The chromosomes at mitotic phase were shown in Fig. 7. The results of the measurement of chromosome length and centromere position were shown in Table 7.

Among the 26 chromosomes four longest chromosomes (Nos. 1- 4) were distinguished. They ranged from 16.5 to 11.7 μm in length. Their arm ratios varied from 1.1 to 1.2, and the positions of centromeres were median. The other 22 chromosomes (Nos. 5-26) ranged from 10.4 to 6.4 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of 11 chromosomes (Nos. 5-15) varied from 1.0 to 1.2, and the positions of centromeres were median. The 16th chromosome had a satellite on its long arm. The short arm was 3.5 μm in length and the long arm was 5.5 μm (4.5+1.0 μm). Arm ratios of the chromosome was 1.6, and the position of centromere was median. Arm ratios of four chromosomes (Nos. 17-20) were all 1.1 and the positions of centromeres were median. Arm ratios of two chromosomes (Nos. 21, 23) were highly 2.2, and the positions of centromeres were submedian. Arm ratios of four chromosomes (Nos. 22, 24-26) varied from 1.1 to 1.3, and the positions of centromeres

were median.

According to the morphology of chromosome complement this species was clearly different from *P. bellatulum.* The 16th, 21st and 23rd chromosomes of this species were the marked chromosomes for the chromosome complement of this species.

6) *Paphiopedilum* × *ang-thong* Fowl., 2n=26
Validated specimen No. 1086, 1118, 1258.

This species is found on Phangan Island and Samui Island in the Gulf of Thailand. External morphological characteristics of this species are as follows: The surface of the leaf is deep green, tessllated with grayish-green. The dorsal sepal and petals are roundish and broad, and these are, such as lip, white with purple spots. (Fig. 8A). Fowlie (1977) described this species as a natural hybrid of *P. godefroyae* and *P. niveum.*

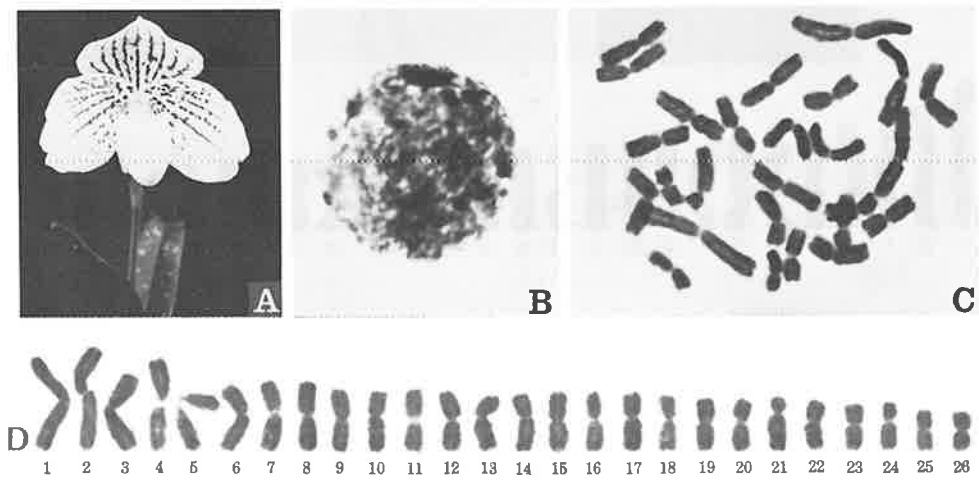


Fig. 8. *Paphiopedilum* × *ang-thong,* 2n=26. A, flower. B, interphase nucleus. C and D, somatic metaphase chromosomes. A, × 0.5. B-D, × 1200.

Two clones investigated showed 2n=26 chromosomes. The chromosomes at resting stage and mitotic phase were shown in Fig. 8. The results of the measurement of chromosome length and centromere position were shown in Table 8.

Among the 26 chromosomes four longest chromosomes (Nos. 1- 4) were distinguished. They ranged from 12.5 to 9.8 μm in length. Their arm ratios were all 1.1 and the positions of centromeres were median. The other 22 chromosomes (Nos. 5-26) ranged from 8.8 to 4.3 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Thus, these 26 chromosomes could be divided mainly into two groups showing a bimodal karyotype. Arm ratios of 16 chromosomes (Nos. 5-20) varied from 1.1 to 1.4, and the positions of centromeres were median. Arm ratio of the 21st chromosome was 2.2, and the position of centromere was submedian. Arm ratios of five chromosomes

(Nos. 22-26) varied from 1.1 to 1.6, and the positions of centromeres were median.

According to the morphology of chromosome complement this species was clearly different from *P. bellatulum.* The 21st chromosome of this species was the marked chromosome for the chromosome complement of this species.

7) *Paphiopedilum delenatii* Guil., 2n=26
Validated specimen No. 1120, 1154.

This species is found in Tonkin and Annan. External morphological characteristics of this species are as follows: The surface of the leaf is dark green with light green spots. The reverse of the leaf is pale green with purplish red spots. The peduncle bears single flower. The dorsal sepal and petals are roundish and wide, and their color is white blushed with rose. The lip is white and pink, and its edge curve toward the inside (Fig. 9A).

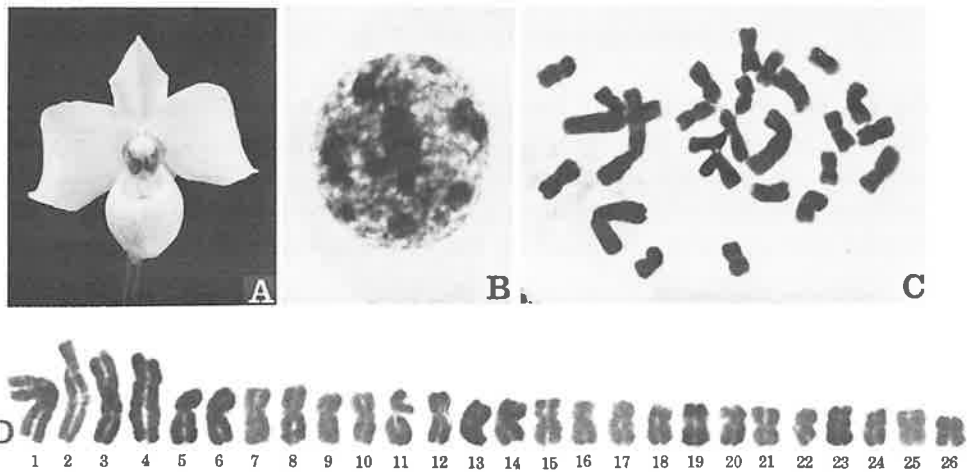


Fig. 9. *Paphiopedilum delenatii,* 2n=26. A, flower. B, interphase nucleus. C and D, somatic metaphase chromosomes. A, × 0.6. B-D, × 1200.

The chromosome number of 2n=26 in this species was previously reported by Mehlquist (1947), Duncan (1947) and Duncan & MacLeod (1948). In the present investigation the number of chromosomes was reexamined to be 2n=26. The chromosomes at resting stage and mitotic phase were shown in Fig. 9. The results of the measurement of chromosome length and centromere position were shown in Table 9.

Among the 26 chromosomes four longest chromosomes (Nos. 1-4) were distinguished. They ranged from 11.9 to 10.1 μm in length. The other 22 chromosomes (Nos. 5-26) ranged from 7.0 to 3.6 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of the first and the third chromosomes were 1.2 and 1.1, the positions of centromeres were median. Arm ratios of the second and the fourth chromosomes were 2.0 and 1.9, the positions of centromeres were submedian.

Arm ratios of the leftover 22 chromosomes (Nos. 5-26) varied from 1.0 to 1.6, and the positions of centromeres were median. the 15th, 16th, 23rd and 24th chromosomes had small constrictions on their short arms.

According to the morphology of chromosome complement this species was clearly different from *P. bellatulum.* The second and the fourth chromosomes of this species were the marked chromosomes for the chromosome complement of this species.

II. POLYANTHA

1. MASTIGOPETALUM

1) *Paphiopedilum stonei* (HK. f.) Pfitz., 2n=26
Validated specimen No. 1021, 1051, 1302.

This species is found in Sarawak, Borneo. This species is morphologically characterized as follows: The leaves are green and strap-shaped. The peduncle bears 3-5 flowers. The dorsal sepal is heart-shaped and tapers to a point. The color is creamy yellow with brownish-black vertical stripes. The elongate petals are spreading for the basal. The color is brownish yellow, shading to red-brown. The yellow portion is spotted with elongate

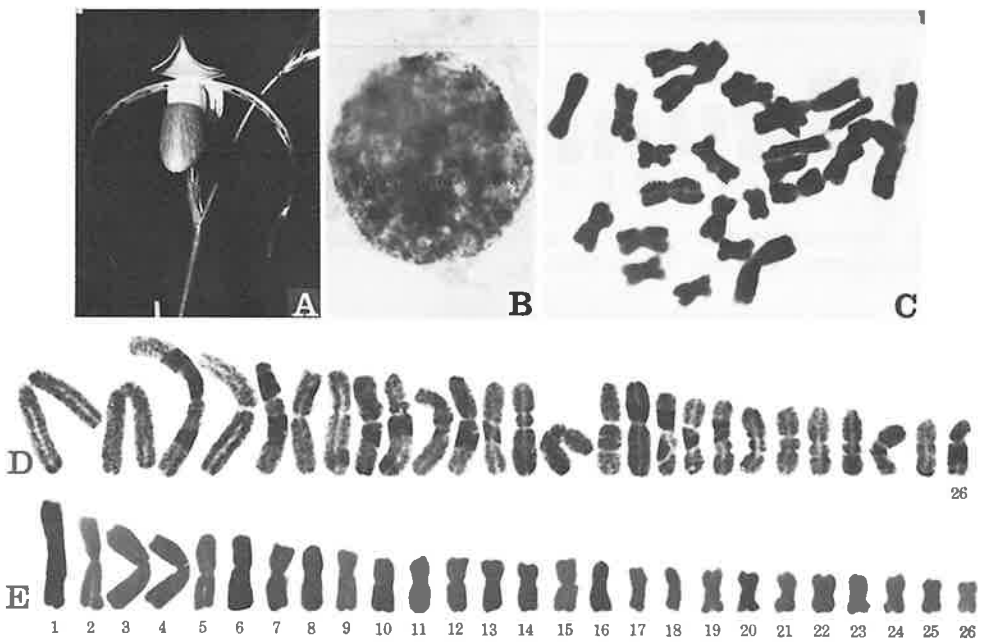


Fig. 10. *Paphiopedilum stonei,* 2n=26. A, flower. B, interphase nucleus. C and E, somatic metaphase chromosomes. D somatic prometaphase chromosomes. A, × 0.3. B-E, × 1200.

patches of reddish brown. The lip is muddy pink to creamy yellow (Fig. 10A).

The chromosome number of 2n=26 in this species was previously reported by Duncan (1947) and Duncan & MacLeod (1949). In the present investigation the number of chromosomes was reexamined to be 2n=26. The chromosomes at resting stage and mitotic phase were shown in Fig. 10. The results of the measurement of metaphase chromosome length and centromere position were shown in Table 10.

Among the 26 chromosomes, four longest chromosomes (Nos. 1- 4) were distinguished. They ranged from 12.0 to 10.3 μm in length. Their arm ratios varied from 1.0 to 1.1, and the positions of centromeres were median. The remaining 22 chrosomes (Nos. 5-26) ranged from 8.0 to 3.8 μm in length. Their arm ratios varied from 1.1 to 1.3, and the positions of centromeres were median.

Fourteen chromosomes (Nos. 1, 2, 9, 10, 13, 14, 17-24) having the small constrictions at prometaphase had the slight constrictions in each corresponded parts at midmetaphase (Fig. 10D, 10E).

As mentioned above, the metaphase chromosomes of this species were consisted of morphologically 13 pairs of matched chromosomes. These 26 chromosomes were found to be heterogeneous which could be divided into two quantitative groups showing a bimodal karyotype: One consisted of four large chromosomes and the other consisted of 22 small chromosomes of which only a gradual decrease in size from the longest to the shortest chromosomes. Arm ratios of these 26 chromosomes varied from 1.0 to 1.3, and the positions of centromeres were median.

2) *Paphiopedilum rothschildianum* (Rchb. f.) Pfitz., 2n=26
Validated specimen No. 1301.

According to Fowlie (1966), this species has been found in North Borneo. External morphological characteristics of this species are as follows: The leaves are green. The peduncle bears generally 3-5 flowers. The dorsal sepal is oval and creamy with many black brown vertical stripes. The petals are nallow and elongate slantly dawnwards. The color of the petals is same as dorsal sepal and with black purple spots on the base. The edges of petals are wavy and have black purple hairs. The lip is pink brown (Fig. 11A).

The chromosome number of 2n=26, 28 in this species was previously reported by Duncan (1947) and Duncan & MacLeod (1949). In the present investigation the number of chromosomes was reexamined to be 2n=26. The chromosomes at mitotic phase were shown in Fig. 11. The results of the measurement of chromosome length and centromere position were shown in Table 11.

Among the 26 chromosomes four longest chromosomes (Nos. 1- 4) were distinguished. They ranged from 13.9 to 11.9 μm in length. Their arm ratios varied from 1.1 to 1.3 and the positions of centromeres were median. The other 22 chromosomes (Nos. 5-26) ranged from 9.8 to 4.7 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of 12 chromosomes (Nos. 5-16) varied from 1.0 to 1.4 and the positions of centromeres were median. Two chromosomes (Nos.

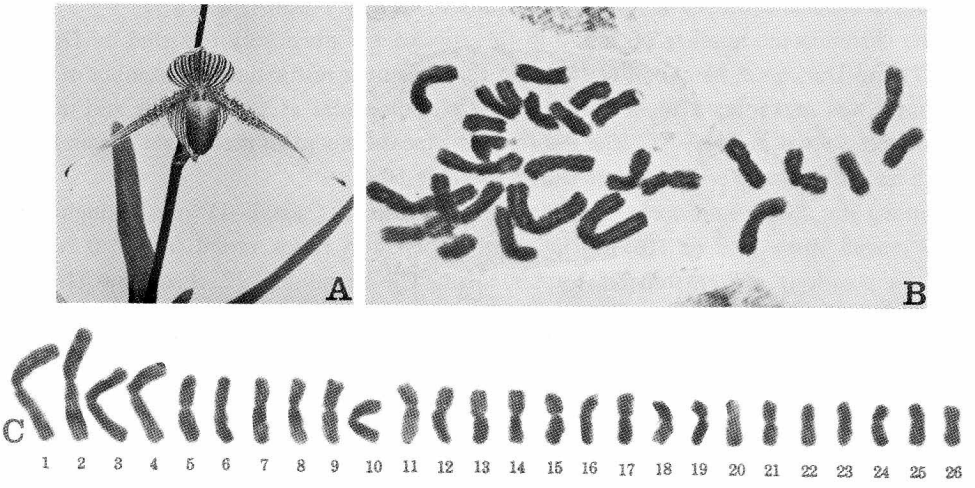


Fig. 11. *Paphiopedilum rothschildianum,* 2n=26. A, flower. B and C, somatic metaphase chromosomes. A, × 0.2. B and C, × 1200.

17, 18) of them had satellites on their short arms. The short arms of them were 3.0 μm (0.6+2.4 μm) and 2.6 μm (0.3+2.3 μm) in length and their long arms were both 3.4 μm in length. Thus, their arm ratios were 1.1 and 1.3. The positions of centromeres of the satellited chromosomes were median. Arm ratios of eight chromosomes (Nos. 19-26) varied from 1.0 to 1.4, and the positions of centromeres were median.

According to the morphology of chromosome complement this species was similar to *P. stonei,* but the 17th and the 18th satellited chromosomes of this species were the distinct characteristics for this species.

3) *Paphiopedilum glanduliferum* (Blume) Pfitz., 2n=26
Validated specimen No. 1218.

This species was found in the small island, northwest of New Guinea. Morphology of this species was extremely similar to *P. praestans,* and thus both species are sometimes considered to be conspecific (Waters & Waters 1973).

The clone investigated showed the somatic chromosome number of 2n=26. The chromosomes at resting stage and mitotic phase were shown in Fig. 12. The results of the measurement of chromosome length and centromere position were shown in Table 12.

Among the 26 chromosomes four longest chromosomes (Nos. 1- 4) were distinguished. They ranged from 11.7 to 10.8 μm in length. Their arm ratios varied from 1.0 to 1.1 and the positions of centromeres were median. The other 22 chromosomes (Nos. 5-26) ranged from 8.7 to 3.4 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of six chromosomes (Nos. 5-10) varied from 1.2 to 1.4, and the positions of centromeres were median. Two chromosomes (Nos.

11, 12) had satellites on their long arms. The short arms were 2.7 μm and 2.8 μm in length and the long arms were 3.6 μm (3.0+0.6 μm) and 3.5 μm (3.0+0.5μm) in length, respectively. Arm ratios of their two chromosomes were both 1.3, and the positions of centromeres were median. Arm ratios of ten chromosomes (Nos. 13-22) varied from 1.0 to 1.3, and the positions of centromeres were median. Arm ratios of two chromosomes (Nos. 23, 24) were 1.8 and 2.0 and the positions of centromeres were submedian. Arm ratios of the leftover two chromosomes (Nos. 25, 26) were 1.3 and 1.4, and the positions of centromeres were median.

According to the morphology of chromosome complement this species was clearly different from *P. stonei.* Two submetacentric chromosomes (Nos. 23, 24) and two satellited chromosomes (Nos. 11, 12) of this species were the marked chromosomes for the chromosome complement of this species.

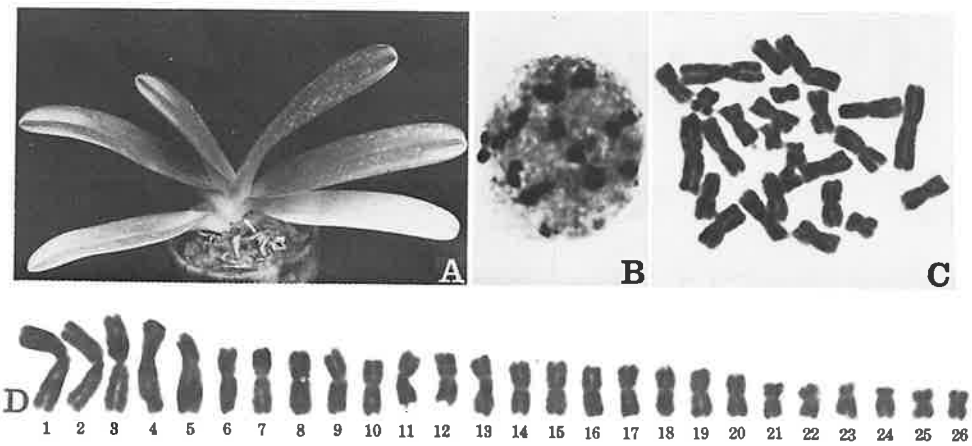


Fig. 12. *Paphiopedilum glanduliferum,* 2n=26. A, seedling. B, interphase nucleus. C and D, somatic metaphase chromosomes. A, ×0.3. B-D, ×1200.

4) *Paphiopedilum praestans* (Rchb. f.) Pfitz., 2n=26
Validated specimen No. 1165, 1239, 1268.

This species has been collected from West Irian. External morphological characteristics of this species are as follows: The leaves are lustrous green. The peduncle bears 1-3 flowers. Flower of this species is, on the whole, alike that of *P. rothschildianum.* The petals twist spirally. Some black hairy warts are found on either petal margin (Fig. 13A).

The chromosome number of 2n=28 in this species was previously reported by Duncan (1947) and Duncan & MacLeod (1949). In the present investigation the author counted 2n=26 using two clones of this species. The chromosomes at mitotic phase were shown in Fig. 13. The results of the mesurement of chromosome length and centromere position were shown in Table 13.

Among the 26 chromosomes four longest chromosomes (Nos. 1-4) were distinguished.

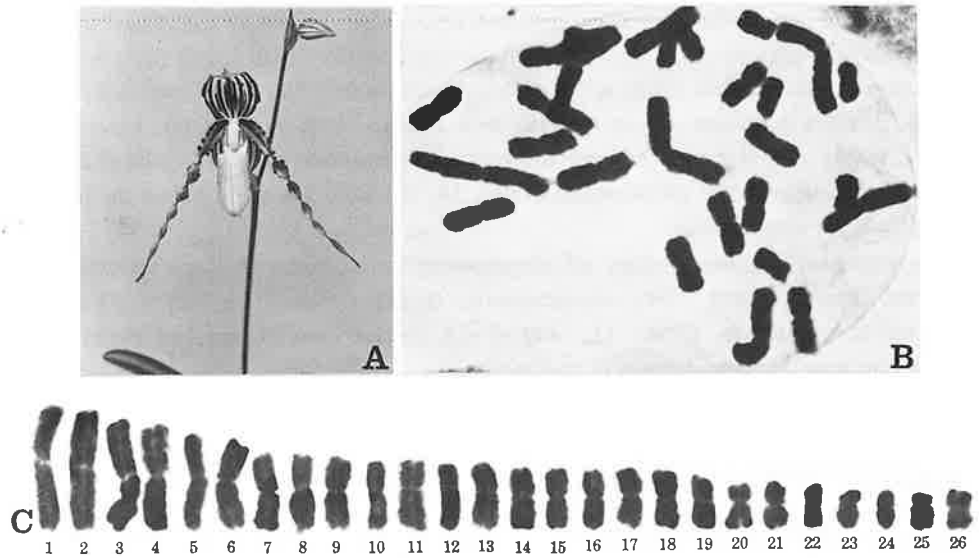


Fig. 13. *Paphiopedilum praestans*, 2n=26. A, flower. B and C, somatic metaphase chromosomes. A, × 0.3. B and C, × 1200.

They ranged from 13.5 to 11.5 μm in length. Their arm ratios varied from 1.1 to 1.3 and the positions of centromeres were median. The other 22 chromosomes (Nos. 5-26) ranged from 10.3 to 4.0 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of them varied from 1.0 to 1.5, and the positions of centromeres were median.

According to the morphology of chromosome complement this species was similar to *P. stonei*, but their arm ratios of this species were slightly higher than those of *P. stonei*.

5) *Paphiopedilum bodegomii* Hort., 2n=26
Validated specimen No. 1303.

This species is native to West Irian. The flower of this species is similar to that of *P. praestans*. The staminode of this species is oblong, hollowed at the base and has horns at the each side of the upper front (Fig. 14A).

The clone investisgated showed 2n=26 chromosomes. The chromosomes at resting stage and mitotic phase were shown in Fig. 14. The results of the measurement of chromosome length and centromere position were shown in Table 14.

Among the 26 chromosomes four longest chromosomes (Nos. 1- 4) were distinguished. They ranged from 13.0 to 11.7 μm in length. Their arm ratios varied from 1.3 to 1.1, and the positions of centromeres were median. The other 22 chromosomes (Nos. 5-26) ranged from 10.6 to 4.0 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of their chromosomes varied from 1.0 to 1.6,

and the positions of centromeres were median. Four chromosomes (Nos. 19-22) of them had the small constictions on their short arms.

According to the morphology of chromosome complement this species was extremely similar to *P. praestans,* except this species and no satellite.

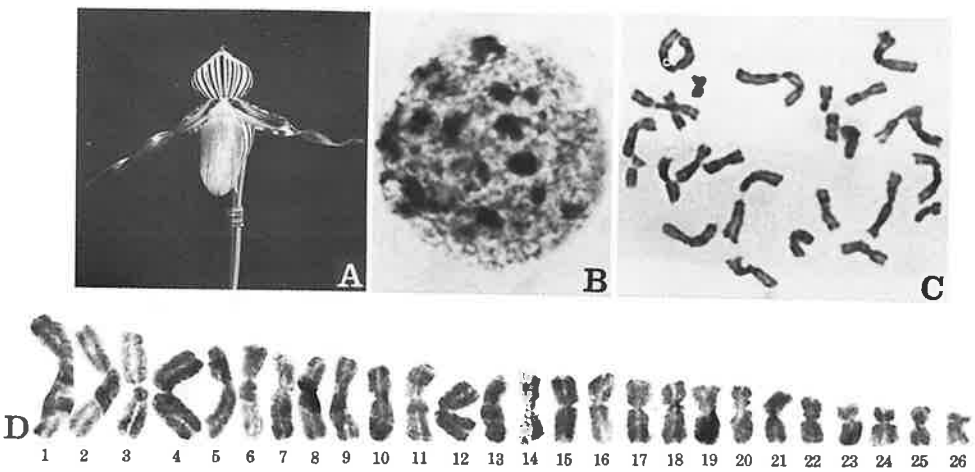


Fig. 14. *Paphiopedilum bodegomii,* 2n=26. A, flower. B, interphase nucleus. C and D, somatic metaphase chromosomes. A, × 0.4. B and D, × 1200. C, × 900.

6) *Paphiopedilum philippinense* (Rchb. f.) Pfitz., 2n=26
Validated specimen No. 1026, 1158, 1256, BG-1, HU-1.

This species grows in Palawan, Mindanao, Negros in the Philippines, and the distinct morphological characteristics of this spcies are as follows: The leaves are green. The peduncle bears generally 3-5 flowers. The dorsal sepal is oval and white with brownish red vertical stripes which length is various. The petals are four times as long as dorsal sepal. They are narrow, twisted and elongate slantly downwards and their margin has hairy warts at the base. The lip is helmet-shaped (Fig. 15A).

The chromosome number of 2n=26 in this species was previously reported by Duncan & MacLeod (1949), Pancho (1965) and Tanaka & Aoyama (1974). In the present investigation the number of chromosomes of five clones were reexamined to be 2n=26. The chromosomes at resting stage and mitotic phase were shown in Fig. 15. The results of the measurement of metaphase chromosome length and centromere position were shown in Table 15.

Among the 26 chromosomes four longest chromosomes (Nos. 1-4) were distinguished. They ranged from 11.8 to 10.0 μm in length. Their arm ratios varied from 1.0 to 1.2 and the positions of centromeres were median. The other 22 chromosomes (Nos. 5-26) ranged from 8.8 to 4.7 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of 12 chromosomes (Nos. 5-16) varied from 1.1 to 1.6 and the positions of centromeres were median. Arm ratios of the 17th and 18th chromosomes were both 1.9 and the positions of centromeres were submedian.

Arm ratios of seven chromosomes (Nos. 19-25) varied from 1.1 to 1.6 and the positions of centromeres were median. Arm ratio of the last 26th chromosome was 1.8 and the position of centromere was submedian. As mentioned above there could not seen any satellited chromosome in the metaphase chromosome. On the other hand, two chromosomed (Nos. 15, 16) had satellites on their short arms at the prometaphase (Fig. 15D). It was considered that these satellites were obscured themselves at the metaphase (Fig. 15E).

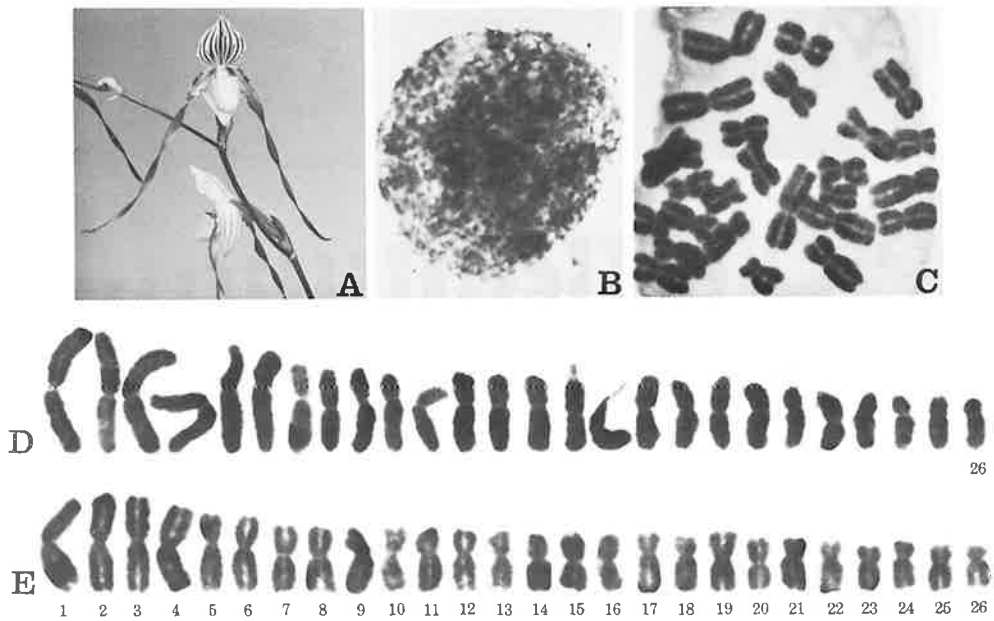


Fig. 15. *Paphiopedilum philippinense,* 2n=26. A, flower. B, interphase nucleus. C and E, somatic metaphase chromosomes. D, somatic prometaphase chromosomes. A, × 0.3. B-E, × 1200.

According to the morphology of chromosome complement this species was clearly different from *P. stonei.* This species had many chromosomes with high arm ratios and the positions of centromeres of the three chromosomes (Nos. 17, 18, 26) were submedian. Furthermore the short arms of certain two chromosomes (Nos. 15, 16) had satellites, respectively, in the prometaphase chromosomes.

7) *Paphiopedilum laevigatum* Bateman, 2n=26
Validated specimen No. 1212.

This dwarf species is closely resemble to *P. philippinense,* and thus *P. laevigatum* is sometimes placed in *P. philippinense* as a synonym (Fowlie 1966, Waters & Waters 1973). The petals of this species twist and stretch horizontally (Fig. 16A).

The clone investigated showed 2n=26 chromosomes. The chromosomes at resting

stage and mitotic phase were shown in Fig. 16. The results of the mesurement of chromosome length and centromere position were shown in Table 16.

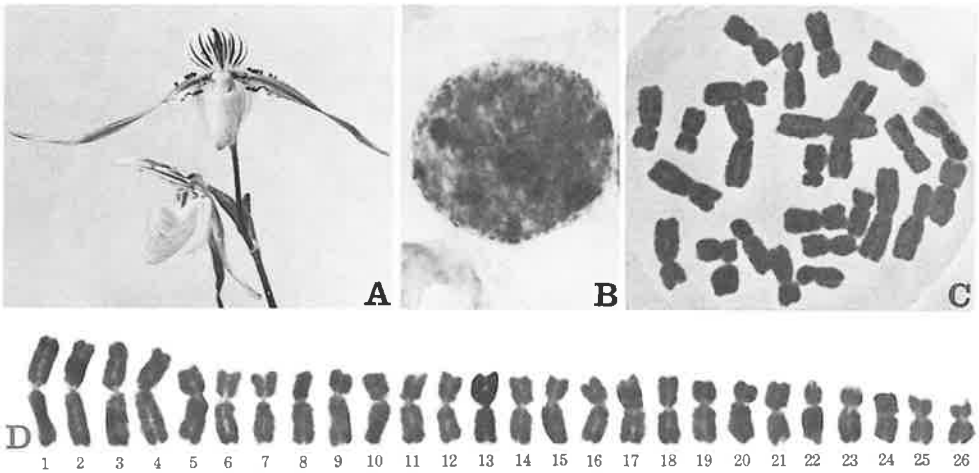


Fig. 16. *Paphiopedilum laevigatum*, 2n=26. A, flower. B, interphase nucleus. C and D, somatic metaphase chromosomes. A, × 0.3. B-D, × 1200.

Among the 26 chromosomes four longest chromosomes (Nos. 1- 4) were distinguished. They ranged from 12.6 to 11.3 μm in length. Their arm ratios varied from 1.1 to 1.2 and the positions of centromeres were median. The other 22 chromosomes (Nos. 5-26) ranged from 8.4 to 5.1 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of four chromosomes (Nos. 5-8) were all 1.5, and the positions of centromeres were median. Arm ratios of two chromosomes (Nos. 9, 10) were 2.1 and 1.8, and the positions of centromeres were submedian. Arm ratios of the remaining 16 chromosomes (Nos. 11-26) varied from 1.1 to 1.7, and the positions of centromeres were median.

According to the morphology of chromosome complement this species was different from *P. stonei* and *P. philippinense.* Arm ratios of this species were generally higher than those of *P. stonei.* Two submetacentric chromosomes (Nos. 9, 10) were characteristics. On the other hand the positions of centromeres of the three chromosomes (Nos. 17, 18 and 25) of *P. philippinense* were submedian and the short arms of the two prometaphase chromosomes (Nos. 15, 16) had satellites while this species had no satellite.

8) *Paphiopedilum roebbelenii* (Rchb. f.) Pfitz., 2n=26
Validated specimen No. 1049, BG-59.

The morphology of this species is extremely similar to that of *P. philippinense.* Their petals and lip are golden yellow (Fig. 17A).

Two clones investigated showed 2n=26 chromosomes. The chromosomes at mitotic

phase were shown in Fig. 17. The results of the measurement of chromosome length and centromere position were shown in Table 17.

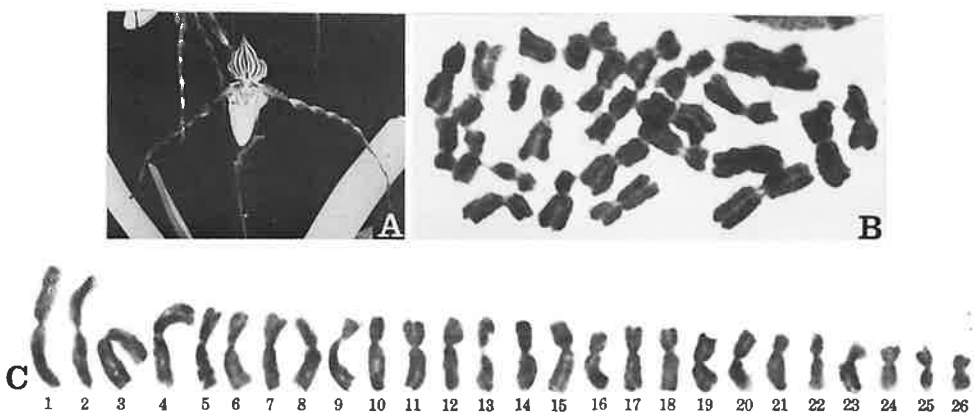


Fig. 17. *Paphiopedilum roebbelenii*, 2n=26. A, flower. B and C, somatic metaphase chromosomes. A, ×0.2. B and C, ×1200.

Among the 26 chromosomes four longest chromosomes (Nos. 1- 4) were distinguished. They ranged from 14.3 to 11.5 μm in length. Their arm ratios varied from 1.0 to 1.1 and the positions of centromeres were median. The other 22 chromosomes (Nos. 5-26) ranged from 9.6 to 4.4 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of the four chromosomes (Nos. 5-8) varied from 1.1 to 1.3, and the positions of centromeres were median. Arm ratios of two chromosomes (Nos. 9, 10) were both 1.8, and the positions of centromeres were submedian. Arm ratios of four chromosomes (Nos. 11-14) were 1.6 and 1.2, and the positions of centromeres were median. Arm ratios of the two chromosomes (Nos. 15, 16) were both 2.0, and the positions of centromeres were submedian. Arm ratios of the leftover ten chromosomes (Nos. 17-26) varied from 1.0 to 1.7, and the positions of centromeres were median.

This species was similar to *P. philippinense* in morphology of the chromosome complement of the karyotype except the positions of centromeres of two chromosomes (Nos. 15, 16) were submedian and arm ratios of two chromosomes (Nos. 25, 26) were 1.2.

9) *Paphiopedilum randsii* Fowl., 2n=26
Validated specimen No. 1204, 1303.

This species was found in Mindanao in the Philippines in 1968 (Fowlie 1970). *Paphiopedilum randsii* is similar to *P. philippinense,* but the petals of *P. randsii* are not twisted and clearly shorter than those of *P. philippinense* (Fig. 18A).

The clone investigated showed 2n=26 chromosomes. The chromosomes at resting

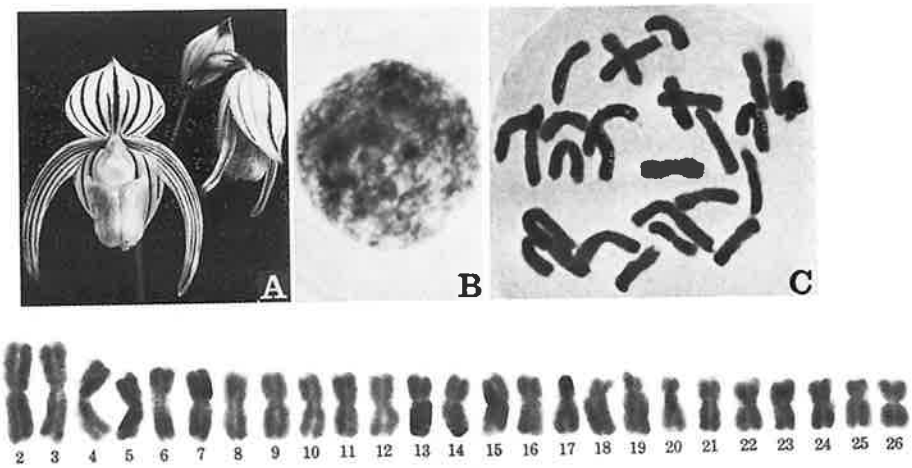


Fig. 18. *Paphiopedilum randsii*, 2n=26. A, flower. B, interphase nucleus. C, somatic prometaphase chromosomes. D, somatic metaphase chromosomes. A, × 0.5. B-D, × 1200.

stage and mitotic phase were shown in Fig. 18. The results of the measurement of chromosome length and centromere position were shown in Table 18.

Among the 26 chromosomes four longest chromosomes (Nos. 1- 4) were distinguished. They ranged from 12.0 to 9.7 μm in length. Their arm ratios varied from 1.0 to 1.1 and the positions of centromeres were median. The other 22 chromosomes (Nos. 5-26) ranged from 7.7 to 5.1 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of 12 chromosomes (Nos. 5-16) varied from 1.0 to 1.4, and the positions of centromeres were median. Arm ratios of four chromosomes (Nos. 17-20) varied from 1.9 to 2.4, and the positions of centromeres were submedian. Arm ratios of the leftover six chromosomes (Nos. 21-26) varied from 1.0 to 1.5, and the positions of centromeres were median.

According to the morphology of chromosome complement this species was clearly different from *P. stonei*. The four submetacentric chromosomes (Nos. 17-20) of this species were the distinct characteristics for the chromosome complement of the karyotype of *P. randsii*.

2. MYSTROPETALUM

1) *Paphiopedilum parishii* (Rchb. f.) Pfitz., 2n=26
Validated specimen No. 1027, 1037, 1117.

This species is found in the Shan States and Moulmein, Burma and in Thailand and Malay Peninsula. External morphological characteristics of this species are as follows: The leaves are large and green. The peduncle bears several flowers. The dorsal sepal rolls its margin backward, and is pale green. The petals are twisted, ribon-like, and are green

with marginal purple-brown warts (Fig. 19A).

The chromosome number of 2n=26 in this species was previously reported by Duncan (1947), Duncan & MacLeod (1949) and Kamemoto *et al.* (1963). In the present investigation the number of chromosomes of the three clones was reexamined to be 2n=26. The chromosomes at resting stage and mitotic phase were shown in Fig. 19. The results of the measurement of chromosome length and centromere position were shown in Table 19.

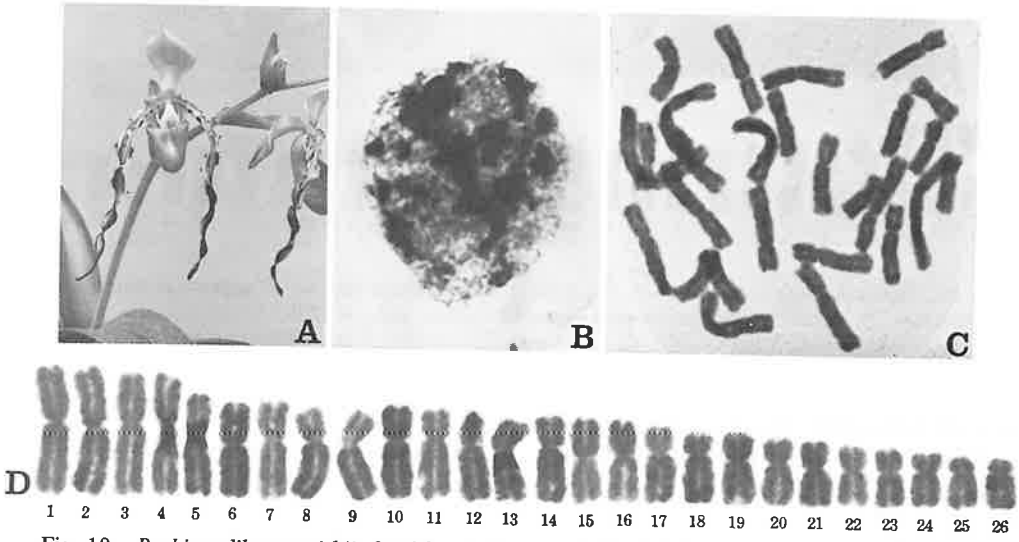


Fig. 19. *Paphiopedilum parishii*, 2n=26. A, flower. B, interphase nucleus. C, somatic prometaphase chromosomes. D, somatic metaphase chromosomes. A, ×0.4. B-D, ×1200.

Among the 26 chromosomes four longest chromosomes (Nos. 1-4) were distinguished. They ranged from 14.5 to 13.7 μm in length. Their arm ratios were 1.2 and 1.4, and the positions of centromeres were median. The other 22 chromosomes (Nos. 5-26) ranged from 11.5 to 6.0 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of six chromosomes (Nos. 5-10) varied from 1.3 to 1.7, and the positions of centromeres were median. Arm ratios of two chromosomes (Nos. 11, 12) were 1.9 and 1.8, and the positions of centromeres were submedian. Arm ratios of four chromosomes (Nos. 13-16) varied from 1.1 to 1.6, and the positions of centromeres were median. The 17th chromosome was 8.6 μm in length, and was clearly longer than the 18th chromosome, which length was 8.0 μm. These two chromosomes did not make a pair. Arm ratios of these two chromosomes were 1.9 and 2.2, and the positions of centromeres were both submedian. Arm ratios of the six chromosomes (Nos. 19-24) varied from 1.5 to 1.7, and the positions of centromeres were median. The 21th chromosome of these six chromosomes was 7.5 μm in length, and was clearly longer than the 22nd chromosome, which length was 6.7 μm. These two chromosomes did not make a pair. Arm ratios of the two chromosomes (Nos. 25, 26) were both 2.2, and the positions of centromeres were submedian.

According to the morphology of chromosome complement this species was clearly

different from *P. stonei.* Arm ratios of this species were generally higher than those of *P. stonei.* The positions of centromeres of six chromosomes (Nos. 11, 12, 17, 18, 25 and 26) were submedian. Furthermore the lengths of two pairs of chromosomes (Nos. 17-18, 21-22) were not equal respectively.

3. PARDALOPETALUM

1) *Paphiopedilum lowii* (Lindl.) Pfitz., 2n=26
Validated specimen No. 1025, 1080.

This species is native to Borneo, Celebes, Java and Sumatra. Morphological characteristics of this species are as follows: The leaves are yellowish green. The peduncle is tall and bears 4 -7 flowers. The dorsal sepal is yellowish green, overlaid from the base upward by a brownish tint. The petals are long and outspread with a slight downward curve. The petal bases are green, marked with brown spots. Distally, the petals widen and are rose in color (Fig. 20A).

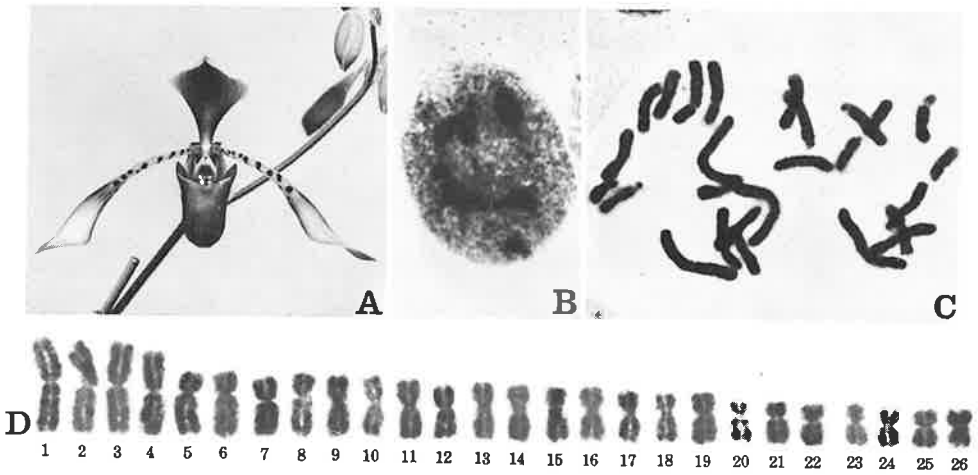


Fig. 20. *Paphiopedilum lowii,* 2n=26. A, flower. B, interphase nucleus. C, somatic prometaphase chromosomes. D, somatic metaphase chromosomes. A, × 0.5. B-D, × 1200.

The chromosome number of 2n=26 in this species was previously reported by Duncan (1947), Duncan & MacLeod (1949) and Tanaka & Aoyama (1974). In the present investigation the number of chromosomes of two clones was reexamined to be 2n=26. The chromosomes at resting stage and mitotic phase were shown in Fig. 20. The results of the measurement of chromosome length and centromere position were shown in Table 20.

Among the 26 chromosomes four longest chromosomes (Nos. 1- 4) were distinguished. They ranged from 10.7 to 9.7 μm in length. Their arm ratios were all 1.1, and the

positions of centromeres were median. The other 22 chromosomes (Nos. 5-26) ranged from 7.3 to 4.2 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of two chromosomes (Nos. 5, 6) were both 2.0, and the positions of centromeres were submedian. Arm ratios of 20 chromosomes (Nos. 7-26) varied from 1.2 to 1.7, and the positions of centromeres were all median. Four chromosomes (Nos. 15, 16, 19 and 20) had the satellites on the long arms at prometaphase. At metaphase, these satellites had been obscured. On six (Nos. 13-18) out of their 26 chromosomes, small constrictions were observed near the bases of their long arms respectively.

According to the morphology of chromosome complement this species was clearly different from *P. stonei.* It was the characteristics that arm ratios of this species were generally higher than those of *P. stonei* and the fifth and the sixth chromosomes were submedian.

2) *Paphiopedilum haynaldianum* (Rchb. f.) Pfitz., 2n=26
Validated specimen No. 1304, HU-2.

This species is found in the Island of Luzon in the Philippines. External morphology of this species is resembling *P. lowii,* except the dorsal sepal of *P. haynaldianum* has lineally brownish purple spots (Fig. 21A).

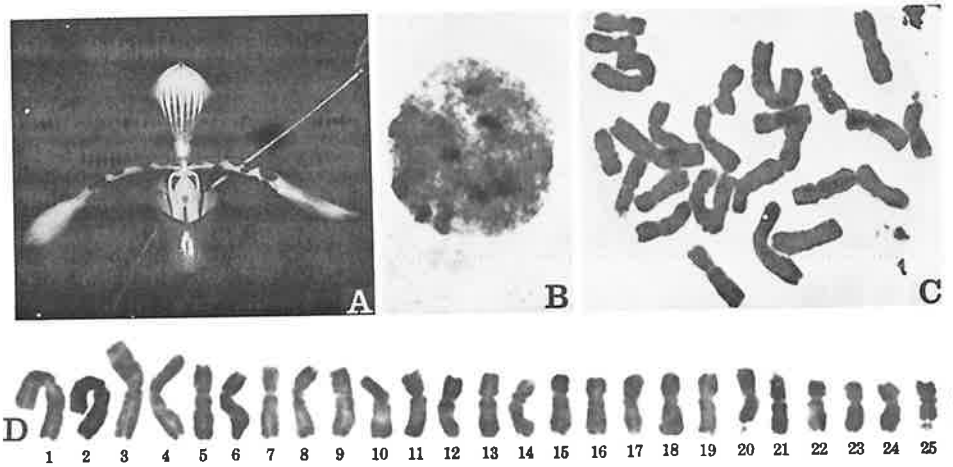


Fig. 21. *Paphiopedilum haynaldianum,* 2n=26. A, flower. B, interphase nucleus. C and D, somatic metaphase chromosomes. A, × 0.3. B-D, ×1200.

The chromosome number of 2n=26 in this species was previously reported by Duncan (1947), Duncan & MacLeod (1949), Pancho (1965) and Tanaka & Aoyama (1974). In the present investigation the number of chromosomes was reexamined to be 2n=26. The chromosomes at resting stage and misotic phase were shown in Fig. 21. The results of the measurement of chromosome length and centromere position were shown in Table 21.

Among the 26 chromosomes four longest chromosomes (Nos. 1-4) were distinguished. They ranged from 12.0 to 10.9 μm in length. Their arm ratios varied from 1.0 to 1.1, and the positions of centromeres were all median. The other 22 chromosomes (Nos. 5-26) ranged from 8.3 to 5.2 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of the 14 chromosomes (Nos. 5-18) varied from 1.4 to 1.7, and the positions of centromeres were median. Among these 14 chromosomes the six chromosomes (Nos. 5, 6, 15-18) had the small constrictions near the bases of long arms and the two chromosomes (Nos. 13, 14) had the small constrictions near the bases of short arms. One of the matched chromosomes (No. 19) was median and the arm ratio was 1.5, the other chromosome (No. 20) had the satellite in the long arm. The short arm was 3.3 μm in length and the long arm was 3.4 μm (2.9+0.5 μm) in length respectively. The position of its centromere was median. Arm ratio of the 21st chromosome was 1.4, and the position of centromere was median. Arm ratio of the 22nd chromosome was 1.8, and the position of centromere was submedian. Arm ratios of the two chromosomes (Nos. 23, 24) were both 1.4, and the positions of centromeres were median. The 25th chromosome had a satellite on the long arm. The short arm was 2.5 μm in length and the long arm was 3.0 μm (2.0+1.0 μm) in length. Arm ratio of the chromosome was 1.2, and the position of centromere was median. Arm ratio of the 26th chromosome was 1.1, and the position of centromere was median.

According to the morphology of chromosome complement, this species was clearly different from *P. stonei*. Generally the arm ratios of the 14 chromosomes of this species varied from 1.5 to 1.8, and the positions of centromeres were closely submedian. The 22nd chromosome was submedian. Two satellited chromosomes (Nos. 20, 25) did not matched with each other.

4. COCHLOPETALUM

1) *Paphiopedilum victoria-regina* (Sander) Wood subsp. *liemianum* (Fowl.) Wood, 2n=32

Validated specimen No. 1103, BG-61.

This subspecies is native to northern Sumatra. External morphological characteristics are as follows: The upper surface of the leaves are green, mottled with light-green and the underside are green with purple spots. The margins of the leaves are wavy and are ciliated from the base to the middle. The peduncle bears some flowers which continued to open one after another. The dorsal sepal is ovate. The base color of the dorsal sepal is green, margined with white, and wears brown from the base to the middle. The white horizontal petals are twisted, mottled with reddish brown oblong. The base color of the pouch is pink, with small pinkish purple spots in the whole (Fig. 22A).

The chromosome number of this subspecies was examined to be 2n=32. The chromosomes at resting stage and mitotic phase were shown in Fig. 22. The results of the measurement of chromosome length and centromere position were shown in Table 22.

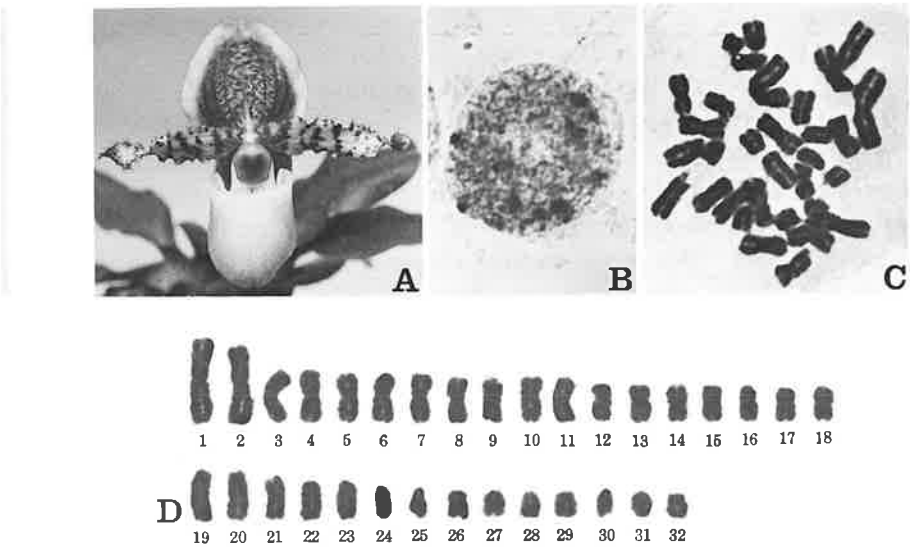


Fig. 22. *Paphiopedilum victoria-regina* ssp. *liemianum*, 2n=32. A, flower. B, interphase nucleus. C and D, somatic metaphase chromosomes. A, × 0.5. B-D, ×1200.

Among 32 chromosomes two longest chromosomes (Nos. 1, 2) were distinguished. They were 9.7 μm and 8.9 μm in length. Their arm ratios were both 1.1, and the positions of centromeres were median. Sixteen chromosomes (Nos. 3-18) ranged from 6.0 to 4.0 μm in length, and decreased in descending order of size from the longest to the shortest chromosomes. These arm ratios varied from 1.1 to 1.4, and the positions of centromeres were median. Among these 16 chromosomes the four chromosomes (Nos. 7-10) had the small constrictions on their short arms and the two chromosomes (Nos. 17, 18) had those on their long arms. The 14 chromosomes (Nos. 19-32) ranged from 5.5 to 2.9 μm in length, and the positions of centromeres were terminal. These 14 telocentric chromosomes could be divided into two quantiative groups: One consisted of the four longest chromosomes and the other consisted of the ten small chromosomes which decreased in descending order of size from the longest to the shortest chromosomes. These ten small chromosomes had the small constrictions, respectively on their arms.

As mentioned above, the 32 metaphase chromosomes of this subspecies were morphologically composed of 16 pairs of matched chromosomes and they could be divided into two groups: One consisted of 18 metacentric chromosomes and the other consisted of 14 telocentric chromosomes. In addition the 18 metacentric chromosomes could be divided into two quantiative groups: One consisted of a pair of longest chromosomes and the other consisted of eight pairs of small chromosomes and samely, the 14 telocentric chromosomes could be divided into two quantitative groups: One consisted of two pairs of longest chromosomes and the other consisted of five pairs of small chromosomes. In these 32 chromosomes several chromosomes had the small constrictions on their arms.

2) *Paphiopedilum victoria-regina* (Sander) Wood subsp. *primulinum* (Wood & Taylor) Wood, 2n=32

Validated specimen No. 1102, 1136.

This subspecies, native to the northern part of Sumatra, is similar with abovementioned ssp. *liemianum*. The base color of the flower is slight-green without any anthocyanin pigments in the whole plant (Fig. 23A).

The chromosome number of 2n=32 in this subspecies was previously reported by Wood (1976). In the present investigation the number of chromosomes was reexamined to be 2n=32. The chromosomes at mitotic phase were shown in Fig. 23. The results of the measurement of chromosome length and centromere position were shown in Table 23.

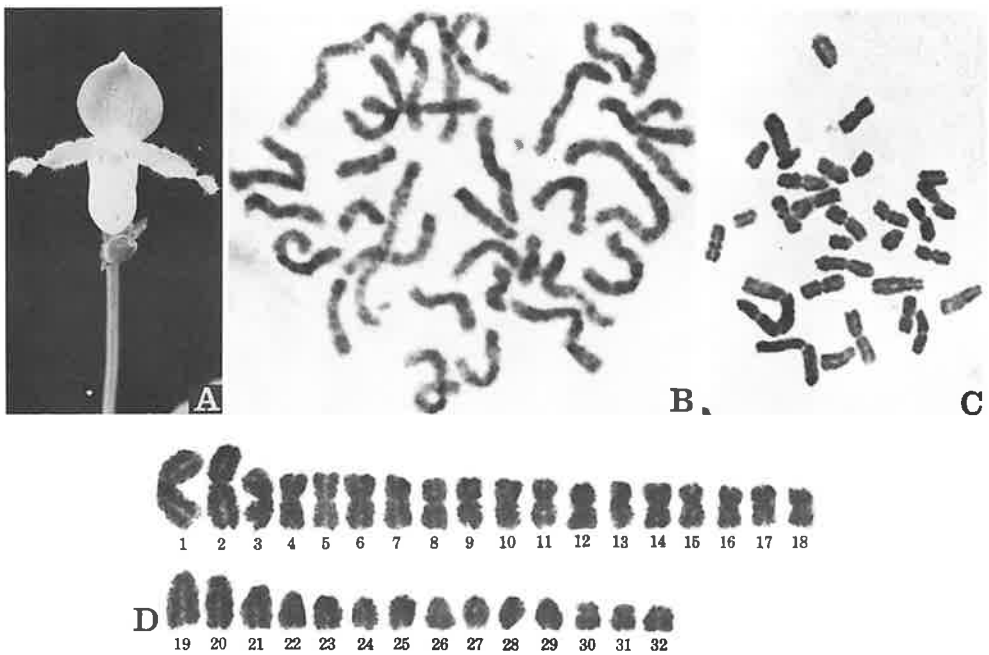


Fig. 23. *Paphiopedilum victoria-regina* ssp. *primulinum*, 2n=32. A, flower. B, somatic prophase chromosomes. C and D, somatic metaphase chromosomes. A, ×0.5. B-D, ×1200.

Among the 32 chromosomes two longest chromosomes (Nos. 1, 2) were distinguished. They were 10.7 μm and 9.4 μm in length. Arm ratios of their chromosomes were both 1.1, and the positions of centromeres were median. Sixteen chromosomes (Nos. 3-18) ranged from 6.4 to 4.2 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Their arm ratios varied from 1.1 to 1.4, and the positions of centromeres were median. Fourteen chromosomes (Nos. 19-32) ranged from 6.2

to 2.9 μm in length, and the positions of centromeres were terminal. These 14 chromosomes were consisted of four longest chromosomes and ten small chromosomes, decreased gradually in size from the longest to the shortest chromosomes.

As mentioned above, *P. victoria-regina* ssp. *primulinum,* was extremely similar to *P. victoria-regina* ssp. *liemianum,* in morphology of the chromosome complement of the karyotype.

3) *Paphiopedilum victoria-regina* (Sander) Wood subsp. *primulinum* (Wood & Taylor) Wood forma *purpurascens* Wood, 2n=32

Validated specimen No. 1146, BG-2.

Compared with *P. victoria-regina* ssp. *primulinum,* this forma is suffused with purplish brown. The dorsal sepal is green, suffused with brown at the base. The petals are yellowish green, mottled with purplish brown. The lip is yellowish brown purple (Fig. 24A).

The chromosome number of 2n=32 in this forma was previously reported by Wood (1976). In the present investigation the chromosome numbers of this three clones were reexamined to be 2n=32. The chromosomes at mitotic phase were shown in Fig. 24. The results of the measurement of chromosome length and centromere position were

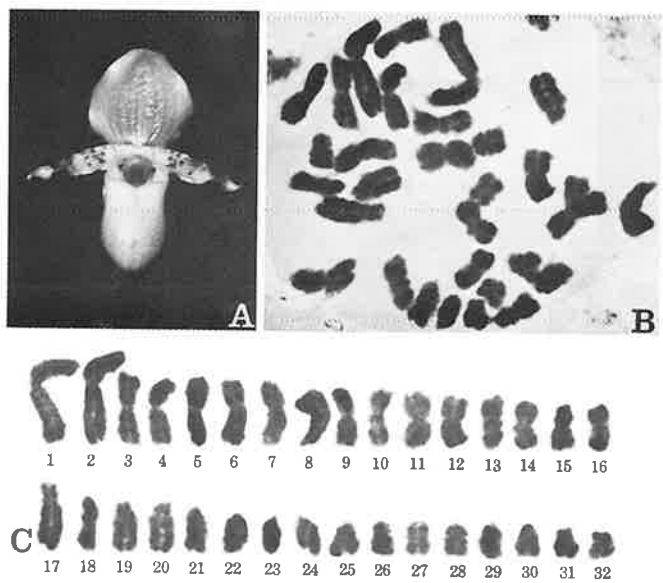


Fig. 24. *Paphiopedilum victoria-regina* ssp. *primulinum* forma *purpurascens,* 2n=32. A, flower. B and C, somatic metaphase chromosomes. A, × 0.6. B and C, × 1200.

shown in Table 24.

Among the 32 chromosomes two longest chromosomes (Nos. 1, 2) were distinguished. They were 13.1 μm and 11.8 μm in length. Arm ratios of their chromosomes were both 1.2, and the positions of centromeres were median. Fourteen chromosomes (Nos. 3-16) ranged from 8.5 to 5.1 μm in length. Arm ratios of their chromosomes varied from 1.1 to 1.3, and the positions of centromeres were median. Two (Nos. 13, 14) out of their 14 chromosomes had the small constrictions on each long arms. The leftover 16 chromosomes (Nos. 17-32) ranged from 7.6 to 3.3 μm in length, and the positions of centromeres were terminal. Among these 16 telocentric chromosomes four chromosomes were clearly longer than the other 12 chromosomes which decreased gradually in size from the longest to the shortest chromosomes. Seven (Nos. 25-29, 31, 32) of these telocentric chromosomes had small constrictions on their long arms.

According to the morphology of chromosome complement, *P. victoria-regina* ssp. *primulinum* forma *purpurascens* was clearly different from above ssp. *primulinum*. The 32 chromosomes of this forma consisted of 16 metacentric and 16 telocentric chromosomes.

4) *Paphiopedilum victoria-regina* (Sander) Wood subsp. *chamberlainianum* (Sander) Wood, 2n=34

Validated specimen No. 1305.

This subspecies is native to northern part of Sumatra. External morphological characteristics are as follows: The leaves are large. The upper surface of leaves is green, mottled slightly and the bottom surface is deep purple. The peduncle bears some flowers which continued to open one after another. The dorsal sepal is white, suffused with green in the middle, and with broad purplish brown stripes from the base. The petals spread horizontally, and are twisted. The petals color is white, with purplish brown mottling. The margins bear the white hairs. The lip is pale pink with small deep pinkish purple spots (Fig. 25A).

The chromosome number of 2n=32 in this subspecies was previously reported by Hofmann (1929, 1930), Duncan (1949) and Duncan & MacLeod (1949). In the present investigation the number of chromosomes were examined to be 2n=34 on the two clones. The chromosome at mitotic phase were shown in Fig. 25. The results of the measurement of chromosome length and centromere position were shown in Table 25.

Among the 34 chromosomes two longest chromosomes (Nos. 1, 2) were distinguished. They were 8.6 μm and 7.8 μm in length. Arm ratios of their chromosomes were 1.1 and 1.2, and the positions of centromeres were median. Fourteen chromosomes (Nos. 3-16) ranged from 6.0 to 4.2 μm in length. Arm ratios of their chromosomes varied from 1.1 to 1.4, and the positions of centromeres were median. Among these 14 chromosomes six chromosomes (Nos. 3, 4, 9-12) had the small constictions on their long arms.

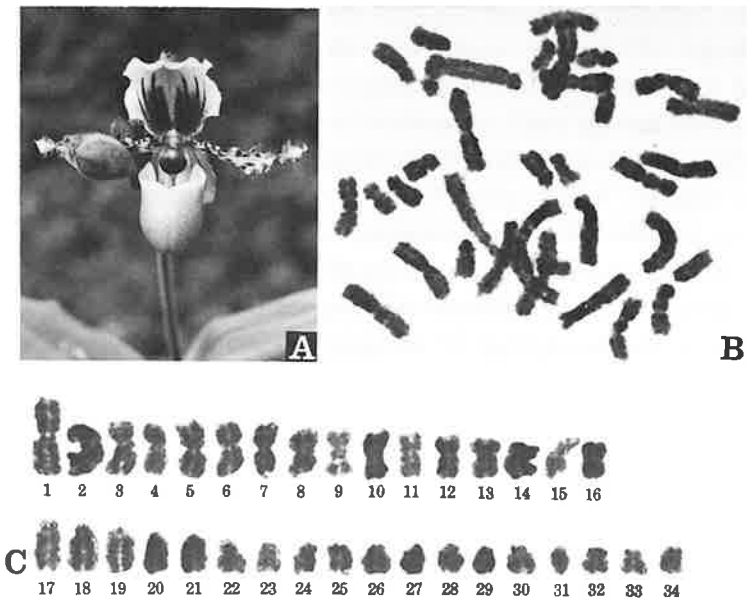


Fig. 25. *Paphiopedilum victoria-regina* ssp. *chamberlainianum*, 2n=34. A, flower. B, somatic prometaphase chromosomes. C, somatic metaphase chromosomes. A, × 0.4. B and C, × 1200.

Eighteen chromosomes (Nos. 17-34) ranged from 5.5 to 2.8 μm in length, and the positions of centromeres were terminal. Among these 18 telocentric chromosomes four chromosomes were clearly longer than the other 14 chromosomes which decreased gradually in size from the longest to the shortest chromosomes. Seven (Nos. 22, 24, 27, 29, 31, 32, 34) out of 18 telocentric chromosomes had the small constrictions on their long arms.

According to the morphology of chromosome complement, *P. victoria-regina* ssp. *chamberlainianum* was clearly different from *P. victoria-regina* ssp. *liemianum*. The chromosome complement of the karyotype was consisted of 16 metacentric and 18 telocentric chromosomes.

5) *Paphiopedilum victoria-regina* (Sander) Wood subsp. *glaucophyllum* (Smith) Wood, 2n=36, 37

Validated specimen No. 1163, 1244, BG-128.

This subspecies was collected from Java. External morphological characteristics are as follows: The upper surface of leaves is grayish green. The peduncle bears some flowers

which continued to open one after another. The dorsal sepal is brownish green and the margins are white with purplish brown veins. The petals elongate slantly downward and are twisted, bearing white hairs on the margins. The petals color is white with purple mottling. The lip is pink with small deep pinkish purple spots (Fig. 26A).

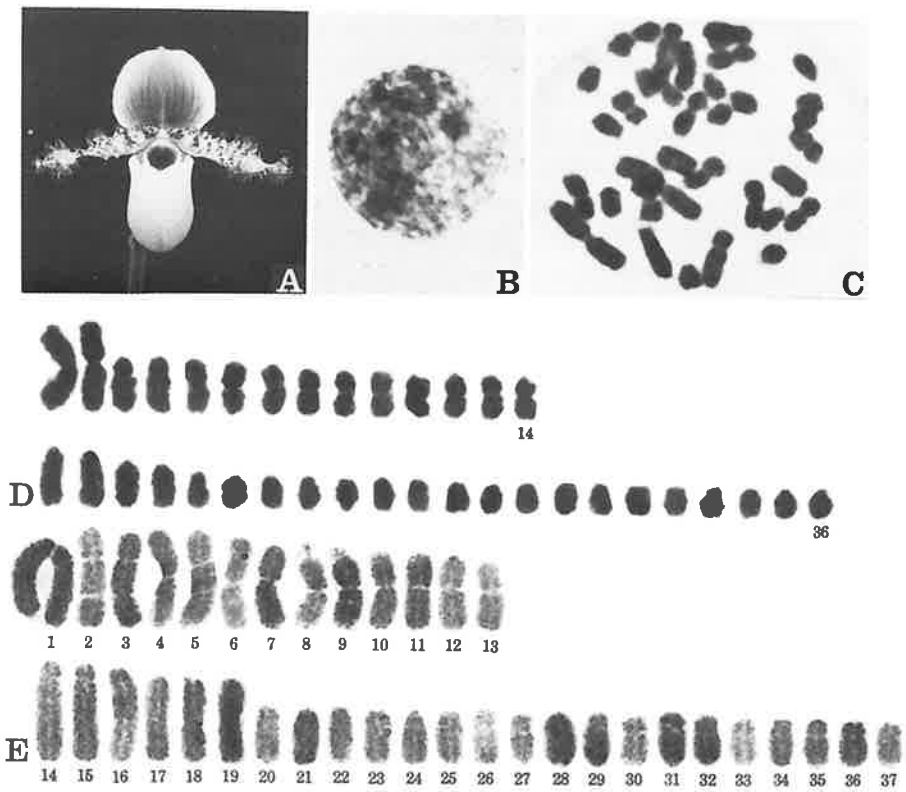


Fig. 26. *Paphiopedilum victoria-regina* ssp. *glaucophyllum*, 2n=36, 37. A, flower. B, interphase nucleus. C and D, somatic metaphase chromosomes (2n=36). E, somatic prometaphase chromosomes (2n=37). A, × 0.5. B-E, × 1200.

The chromosome number of 2n=36 in this subspecies was previously reported by Duncan (1947) and Duncan & MacLeod (1949). In the present investigation the number of chromosomes of one clone was reexamined to be 2n=36. On the other hand, another four clones investigated showed to be 2n=37. There was no difference in external morphology in those individuals. The chromosomes at resting stage and mitotic phase were shown in Fig. 26. The results of the measurement of chromosome length and centromere position were shown in Table 26.

Among the 36 chromosomes two longest chromosomes (Nos. 1, 2) were distinguished. They were both 10.0 μm in length. Arm ratios of their chromosomes were both 1.1, and

the positions of centromeres were median. Twelve chromosomes (Nos. 3-14) ranged from 6.1 to 4.4 μm in length, and gradually decreased from the longest to the shortest chromosomes. Arm ratios of the two chromosomes (Nos. 3, 4) were both 2.1, and the positions of centromeres were submedian. Arm ratios of the ten chromosomes (Nos. 5-14) varied from 1.0 to 1.3, and the positions of centromeres were median. Twenty-two chromosomes (Nos. 15-36) ranged from 6.3 to 3.0 μm in length, and the positions of centromeres were terminal. Among these 22 telocentric chromosomes four chromosomes (Nos. 15-18) were clearly longer than the other 18 chromosomes which decreased gradually in size from the longest to the shortest chromosomes. The 36 chromosomes could be divided into two groups: One consisted of 14 metacentric chromosomes and the other consisted of 22 telocentric chromosomes.

On the other hand, the 37 chromosomes in the four clones consisted of 13 metacentric and 24 telocentric chromosomes. Their prometaphase chromosomes were shown in Fig. 26E.

Among the 37 chromosomes two chromosomes (Nos. 8, 9) had minute satellites on their short arms. Two chromosomes (Nos. 14, 15) had the small constrictions near the centromeres. Eight chromosomes (Nos. 26-37) of them had small constrictions near by their centromeres.

According to the morphology of chromosome complement, *P. victoria-regina* ssp. *glaucophyllum* (2n=36) was clearly different from *P. victoria-regina* ssp. *chamberlainianum*.

This subspecies with 2n=36 chromosomes had two longest metacentric, 12 metacentric and 22 telocentric chromosomes. The other clones with the chromosome number of 2n=37 had one longest metacentric, 12 metacentric and 24 telocentric chromosomes. It was presumed that the clones with the chromosome number of 2n=37 were derived from the clones with the chromosome number of 2n=36 of which one of the longest chromosome produced two telocentric chromosomes by centric fission.

6) *Paphiopedilum victoria-regina* (Sander) Wood subsp. *glaucophyllum* (Smith) Wood var. *moquetteanum* (Smith) Wood, 2n=34

Validated specimen No. BG-6, BG-89.

This variety, native to western Java, is extremely similar to *P. victoria-regina* ssp. *glaucophyllum* in external morphology, but their flowers are clearly different from each other. The dorsal sepal is bright yellowish green with purple spots. The lip is pink with faint pinkish purple spots (Fig. 27A).

In the present investigation the chromosome number of this variety was examined to be 2n=34. The chromosomes at mitotic phase were shown in Fig. 27. The results of the measurement of chromosome length and centromere position were shown in table 27.

Among the 34 chromosomes two longest chromosomes (Nos. 1, 2) were distinguished. They were 9.6 μm and 9.4 μm in length. Arm ratios of their chromosomes were both 1.1, and the positions of centromeres were median. Fourteen chromosomes (Nos. 3-16)

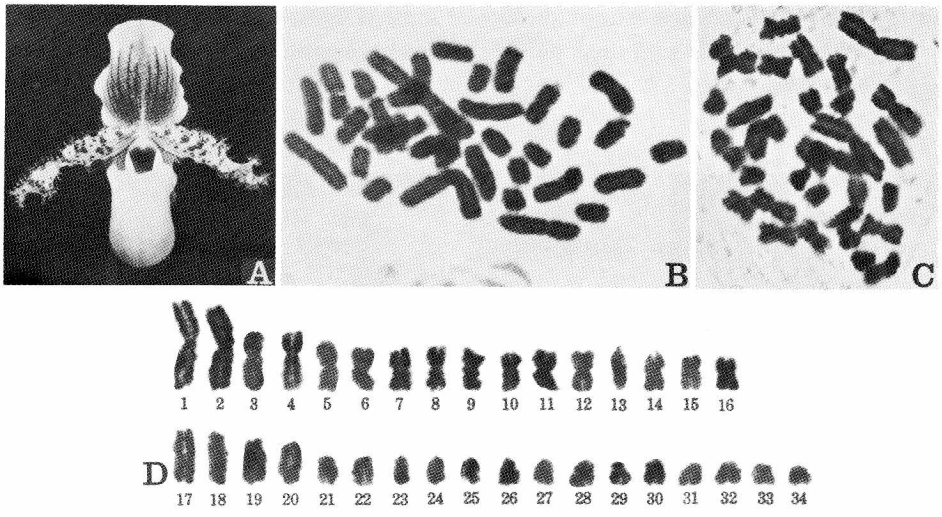


Fig. 27. *Paphiopedilum victoria-regina* ssp. *glaucophyllum* var. *moquetteanum*, 2n=34. A, flower. B, somatic prometaphase chromosomes. C and D, somatic metaphase chromosomes. A, × 0.4. B-D, × 1200.

of them ranged from 6.9 to 3.7 μm in length and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of their chromosomes varied from 1.0 to 1.6, and the positions of centromeres were median. Among these 14 chromosomes six chromosomes (Nos. 7-10, 15, 16) had small constrictions on their long arms while two other chromosomes (Nos. 11, 12) had small constrictions in their short arms. The remaining 18 chromosomes (Nos. 17-34) ranged from 6.0 to 2.2 μm in length, and the positions of centromeres were terminal. Among these 18 chromosomes four chromosomes (Nos. 17-20) were clearly longer than the other 14 chromosomes. Six chromosomes (Nos. 21, 26, 28-30, 33) of them had the small constrictions on their long arms.

This variety was extremely similar to *P. victoria-regina* ssp. *chamberlainianum* in the morphology of chromosome complement. Compared with *P. victoria-regina* ssp. *glaucophyllum* it was characteristics that this variety had 16 metacentric and 18 telocentric chromosomes.

7) *Paphiopedilum victoria-regina* ssp., 2n=33, 35, 36
Validated specimen No. 1220, 1221, 1306.

In the present investigation, three clones showed 2n=33, 35 and 36, respectively. These three clones of the typica were morphologically similar to those of *P. victoria-regina* subsp. *victoria-regina,* but their flower were differed. The large leaves of these clones were similar to that of subsp. *chamberlainianum.* The upper surface of leaves is plain or slightly mottled and the bottom surface is from dark to pale purple. The flower of the clone with the chromosome number of 2n=33 is similar to that of *P. victoria-*

regina ssp. *chamberlainianum* except the dorsal sepal is white-yellow at the margins and is pale green at the middle with small purple spots and brownish purple stripes (Fig. 28A).

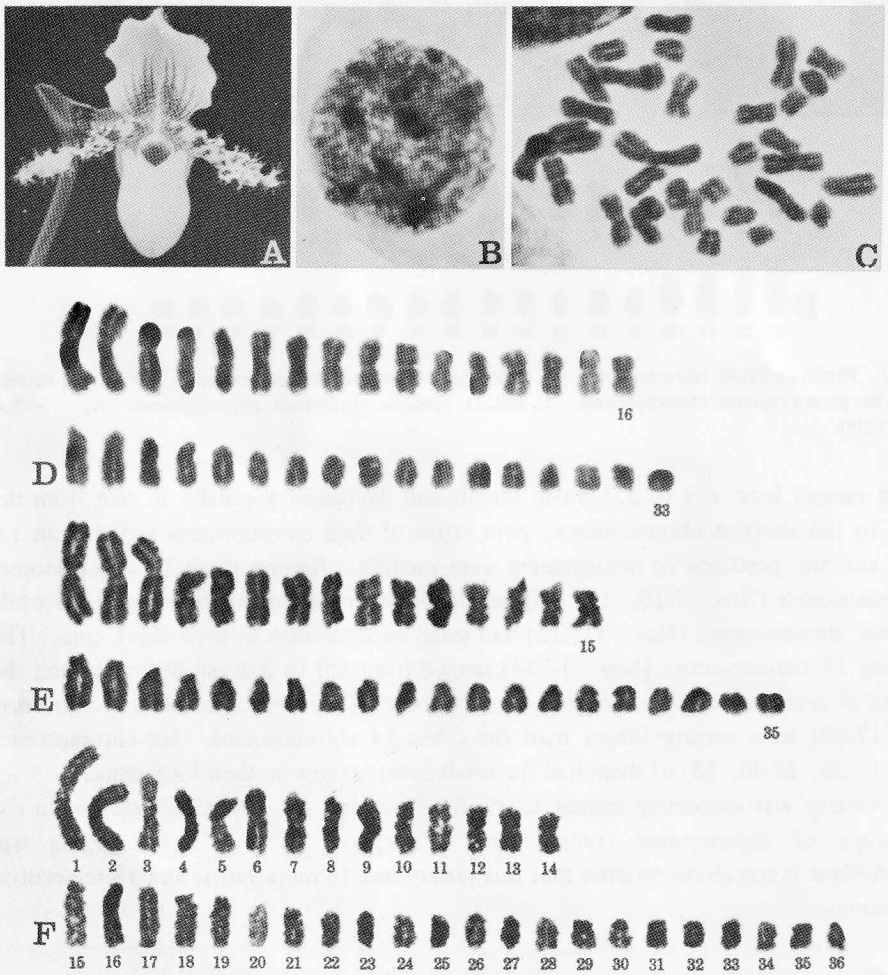


Fig. 28. *Paphiopedilum victoria-regina* ssp. A, flower (2n=33). B, interphase nucleus (2n=33). C and D, somatic metaphase chromosomes (2n=33). E, somatic metaphase chromosomes (2n=35). F, somatic metaphase chromosomes (2n=36). A, × 0.4. B-F, × 1200.

The chromosomes of the three clones at mitotic phase were shown in Fig. 28. The results of the measurement of chromosome length and centromere position were shown in Table 28, 29 and 30.

One clone studied showed 2n=33 chromosomes (Fig. 28D). Among these 33 chromosomes two chromosomes (Nos. 1, 2) were clearly longer than the others. They were

10.5 μm and 9.9 μm in length. Arm ratios of them were 1.3 and 1.4, and the positions of centromeres were median. Fourteen (Nos. 3-16) out of those chromosomes ranged from 8.3 to 4.3 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of their chromosomes varied from 1.0 to 1.5, and the positions of centromeres were median. These 16 metacentric chromosomes did not make so clear pairs as those of other subspecies. The leftover 17 chromosomes (Nos. 17-33) ranged from 6.1 to 2.5 μm in length, and decreased gradually in size The positions of centromeres of their chromosomes were terminal. Among these 17 chromosomes, six chromosomes (Nos. 22, 23, 25, 29, 31, 32) had the small constrictions on their long arms.

According to the morphology of chromosome complement, this clone had 16 metacentric and 17 telocentric chromosomes. Sixteen metacentric chromosomes among them consisted of two largest chromosomes and the other 14 small chromosomes, decreased gradually in size from the longest to the shortest chromosomes. Another 17 telocentric chromosomes were decreased gradually in size, also. The metacentric chromosomes of this clone did not make clear pairs.

The second clone studied showed 2n=35 chromosomes (Fig. 28E). Among these 35 chromosomes three chromosomes (Nos. 1-3) were clearly longer than the others. They ranged from 11.1 to 9.8 μm in length. Arm ratios of them varied from 1.0 to 1.3, and the positions of centromeres were median. Twelve chromosomes (Nos. 4-15) of them ranged from 6.5 to 4.0 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of their chromosomes varied from 1.0 to 1.7, and the positions of centromeres were median. The third chromosome of them had small constriction on the short arm while five chromosomes (Nos. 10, 12-15) had small constrictions on their long arms. The remaining 20 chromosomes (Nos. 16-35) rangesd from 6.0 to 2.4 μm in length, and the positions of centromeres were terminal. Among these 20 chromosomes four (Nos. 16-19) were clearly longer than the others which decreased gradually in size from the longest to the shortest chromosomes. Among these 20 telocentric chromosomes 12 (Nos. 16, 17, 19-21, 23, 24, 26, 28-31) had small constrictions on their long arms.

The 35 chromosomes included 15 metacentric and 20 telocentric chromosomes. According to the morphology of chromosome complement this clone had characteristically three largest metacentric chromosomes.

The last clone studied showed 2n=36 chromosomes (Fig. 28F). The first longest chromosome was 11.6 μm in length, and was clearly longer than the others. The arm ratio was 1.2, and the position of centromere was median. Thirteen chromosomes (Nos. 2-14) ranged from 9.8 to 4.8 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of their chromosomes varied from 1.1 to 1.7, and the positions of centromeres were median. Among these 14 metacentric chromosomes the first chromosome had small constriction on its short arm while the ninth and tenth chromosomes had small constictions on their long arms. The leftover 22 chromosomes (Nos. 15-36) ranged from 7.0 to 2.8 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. The positions of centromeres of their

22 chromosomes were all terminal. Eight (Nos. 15, 18, 19, 27, 29, 30, 33, 34) of the 22 chromosomes had small constrictions on their long arms.

According to the morphology of chromosome complement this clone had 14 metacentric and 22 telocentric chromosomes. Only one largest chromosome was a distinct characteristic for this clone. The 22 telocentric chromosomes were decreased gradually in size from the longest to the shortest chromosomes.

III. PAPHIOPEDILUM

1. STICTOPETALUM

1) *Paphiopedilum esquirolei* Schltr., 2n=26
Validated specimen No. 1083, 1091, 1017.

This species was first discovered in the southwestern parts of China and Laos, but was later reported from Thailand. This species is morphologically characterized as follows: The leaves are linear and green. The peduncle bears single flower. The dorsal sepal is oval, deep purple brown, lustrous and the margin is wavy, yellowish brown. The petals spread slightly downward the edges are wavy. The basal portion of the petals is yellow-brown with brown purple dots and the distal area is deep purple. The lip is yellowish brown with tiny brownish purple spots (Fig. 29A). Flowering season is summer.

Three clones investigated showed 2n=26 chromosomes. The chromosomes at mitotic

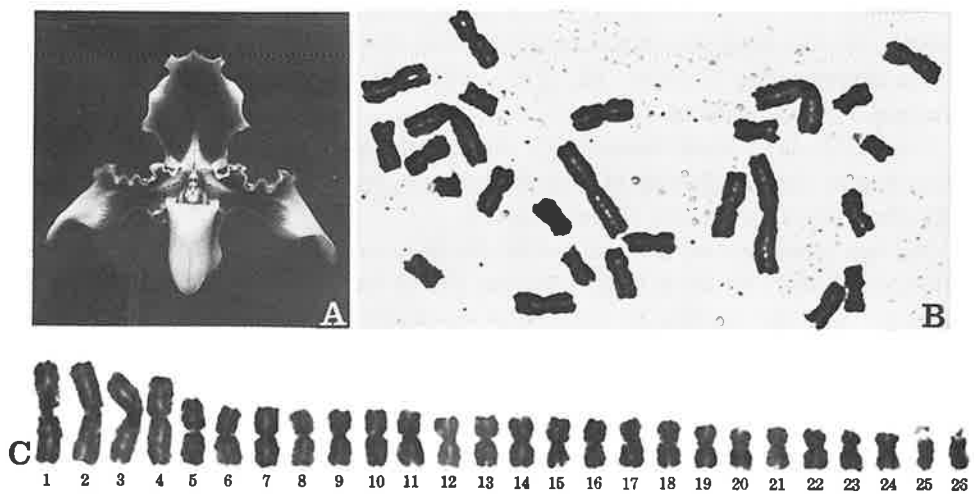


Fig. 29. *Paphiopedilum esquirolei*, 2n=26. A, flower. B and C, somatic metaphase chromosomes. A, ×0.3. B and C, ×1200.

phase were shown in Fig. 29. The results of the measurement of chromosome length and centromere position were shown in Table 31.

Among the 26 chromosomes four longest chromosomes (Nos. 1- 4) were distinguished. They ranged from 11.3 to 9.8 μm in length. Their arm ratios were 1.0 and 1.1, and the positions of centromeres were median. The other 22 chromosomes (Nos. 5-26) ranged from 7.5 to 3.9 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Their arm ratios varied from 1.0 to 1.4 and the positions of centromeres were median. Nine of 22 chromosomes (Nos. 11, 12, 15-19, 20, 26) had small constrictions on their short arms while two (Nos. 23, 24) had the small constrictions on their long arms. Two chromosomes (Nos. 25, 26) had satellites on their short arms. The short arms were 1.8 μm (0.5+1.3 μm) and 1.7 μm (0.2+1.5 μm) in length, and the long arms were 2.4 μm and 2.2 μm in length.

The karyotype of this species were consisted of morphologically 13 pairs of matched chromosomes, and could be divided mainly into two groups showing a bimodal karyotype: One consisted of four large chromosomes and the other consisted of 22 small chromosomes. The positions of these 13 pairs of chromosomes were all metacentric. Eleven out of these 26 chromosomes had small constrictions respectively. One pair of matched chromosomes (Nos. 25, 26) had satellites on their short arms.

2) *Paphiopedilum hirsutissimum* (Lindl.) Pfitz., 2n=26
Validated specimen No. 1159, 1177, HU-2.

This species is widely distributed throughout Assam into Burma. Morphology of this species is extremely similar to *P. esquirolei.* The leaves of this species are strap shape, and the color of the flower is pale purple brown. The petals spread horizontally and the edges are wavy (Fig. 30A). The flowering season of this species is spring.

The chromosome number of 2n=26 in this species was previously reported by Duncan (1947), Duncan & MacLeod (1949) and Tanaka & Aoyama (1974). In the present investigation the number of chromosomes was reexamined to be 2n=26. The chromosomes at resting stage and mitotic phase were shown in Fig. 30. The results of the measurement of chromosome length and centromere position were shown in Table 32.

Among the 26 chromosomes four longest chromosomes (Nos. 1- 4) were distinguished. They ranged from 10.9 to 8.8 μm in length. Their arm ratios varied from 1.0 to 1.3 and the positions of centromeres were median. The other 22 chromosomes (Nos. 5-26) ranged from 7.4 to 4.9 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of the first two chromosomes (Nos. 5, 6) were both 1.4, and the positions of centromeres were median. Arm ratios of the second two chromosomes (Nos. 7, 8) were 1.9 and 1.8, and the positions of centromeres were submedian. These two chromosomes had small constrictions near the centromeric region of their long arms. Arm ratios of four chromosomes (Nos. 9-12) varied from 1.1 to 1.5, and the positions of centromeres were median. Arm ratios of the third two chromosomes (Nos. 13, 14) were both 2.0, and the positions of centromeres were submedian.

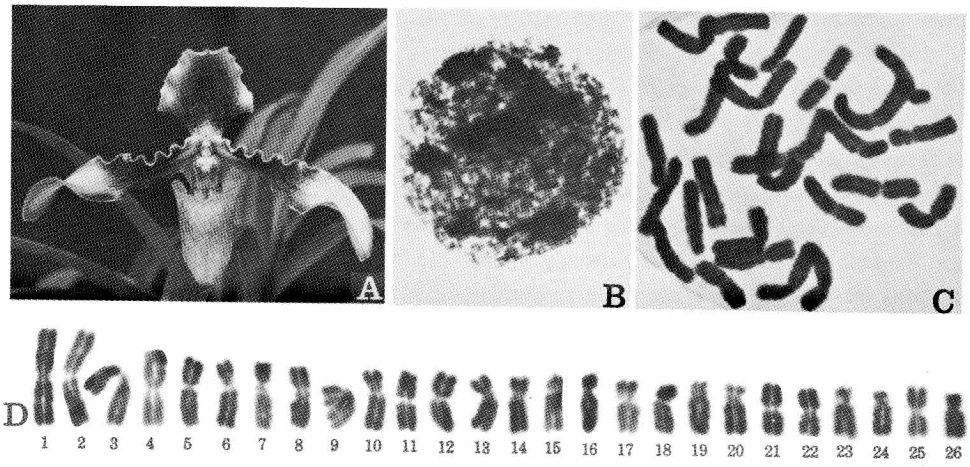


Fig. 30. *Paphiopedilum hirsutissimum*, 2n=26. A, flower. B, interphase nucleus. C, somatic prometaphase chromosomes. D, somatic metaphase chromosomes. A, ×0.4. B-D, ×1200.

These two chromosomes had small constrictions near the centromeric region of their long arms. Arm ratios of four chromosomes (Nos. 15-18) were 2.4 and 1.8, and the positions of centromeres were submedian. Arm ratios of the fourth two chromosomes (Nos. 19, 20) were 2.9 and 2.6, and the positions of centromeres were submedian. These two chromosomes had small constrictions near the centromeric region of their short arms. Arm ratios of the fifth two chromosomes (Nos. 21, 22) were both 1.0, and the positions of centromeres were median. Arm ratios of the sixth two chromosomes (Nos. 23, 24) were 2.3 and 2.8, and the positions of centromeres were submedian. These two chromosomes had the small constrictions on the bases of their long arms. Arm ratios of the last two chromosomes (Nos. 25, 26) were 1.1 and 1.7, and the positions of centromeres were median.

As mentioned in the morphology of the chromosome complement this species was clearly different from *P. esquirolei.* Arm ratios of this species were generally higher than those of *P. esquirolei.* This species had 12 submetacentric chromosomes, and had no satellite.

2. NEUROPETALUM

1) *Paphiopedilum exul* (O'Brien) Pfitz., 2n=26
Validated specimen No. 1010, 1238.

This species comes from Thailand. External morphological characteristics of this species are as follows: The leaves are green, thick and broadly linear. The peduncle bears single

flower. The dorsal sepal is yellowish green with purplish brown spots in the middle and is broadly white at the margins. The petals are yellowish green with purplish brown veins. The lip is lustrous yellow (Fig. 31A).

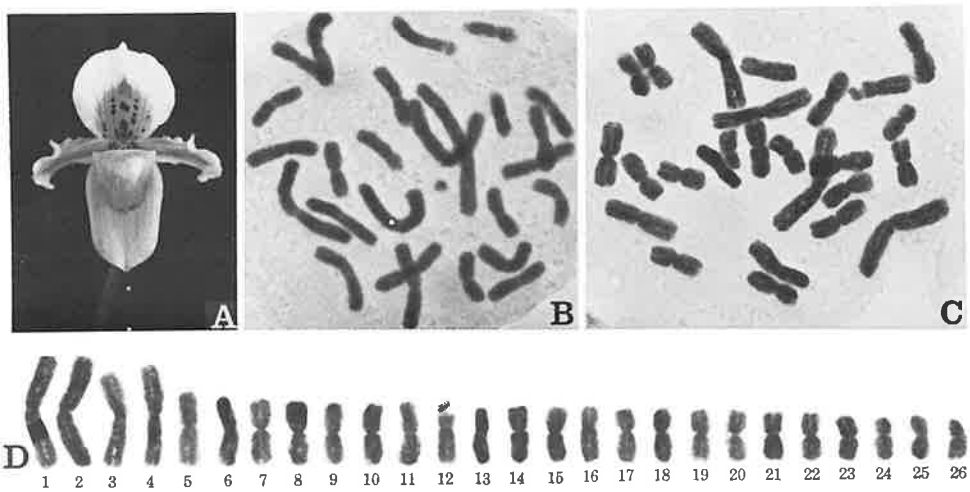


Fig. 31. *Paphiopedilum exul*, 2n=26. A, flower. B, somatic prometaphase chromosomes. C and D, somatic metaphase chromosomes. A, × 0.4. B-D, × 1200.

The chromosome number of 2n=26 in this species was previously reported by Duncan (1947), Duncan & MacLeod (1949) and Kamemoto *et al.* (1963). In the present investigation the number of chromosomes of the two clones was reexamined to be 2n=26. The chromosomes at mitotic phase were shown in Fig. 31. The results of the measurement of chromosome length and centromere position were shown in Table 33.

Among the 26 chromosomes four longest chromosomes (Nos. 1- 4) were distinguished. They ranged from 12.8 to 10.3 μm in length. Their arm ratios were 1.0 and 1.1, and the positions of centromeres were median. The other 22 chromosomes (Nos. 5-26) ranged from 7.6 to 3.8 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of six chromosomes (Nos. 5-10) varied from 1.0 to 1.2, and the positions of centromeres were median. Two chromosomes (Nos. 11, 12) had satellites on their short arms. The short arms of them were 2.9 μm (1.1+1.8 μm) and 2.5 μm (1.0+1.5 μm) in length and their long arms were 3.4 μm and 3.5 μm respectively in length. Thus, their arm ratios were 1.2 and 1.4. The positions of centromeres of these satellited chromosomes were median. Arm ratios of 14 chromosomes (Nos. 13-26) varied from 1.0 to 1.4, and the positions of centromeres were median.

As mentioned above, the 26 chromosomes of this species could be divided mainly into two groups showing a bimodal karyotype: One consisted of four large chromosomes and the other consisted of 22 small chromosomes. Arm ratios of their chromosomes varied from 1.0 to 1.4, and the positions of centromeres were all median. Only two chromosomes (Nos. 11, 12) had satellites on their short arms.

2) *Paphiopedilum insigne* (Wall.) Pfitz., 2n=26
Validated specimen No. 1018, 1030, 1021, 1032.

This species is found in Assam. External morphological characteristics of this species are as follows: The leaves are green. The peduncle bears single flower. The dorsal sepal is yellowish green and decorated with numerous purpulish brown spots. The margin of the dorsal sepal is white. The petals are yellowish green, stained with brown (Fig. 32A).

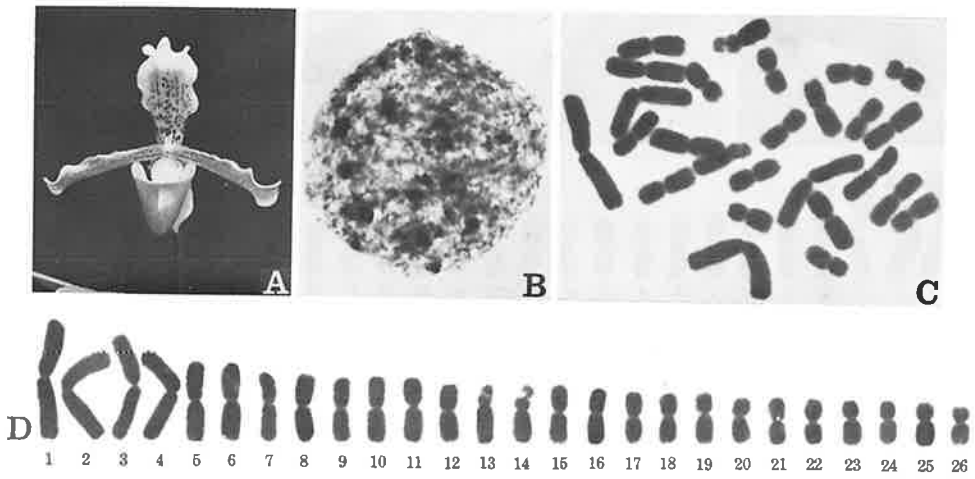


Fig. 32. *Paphiopedilum insigne*, 2n=26. A, flower. B, interphase nucleus. C and D, somatic metaphase chromosomes. A, ×0.3. B-D, ×1200.

The chromosome number of 2n=26 in this species was previously reported by Mehlquist (1947) Duncan (1947), Tanaka (1964, 1965), Sasa & Torikata (1967), Tanaka & Aoyama (1974) and Karasawa (1978). In the present investigation the number of chromosomes of the 5 clones was reexamined to be 2n=26. The chromosomes at resting stage and mitotic phase were shown in Fig. 32. The results of the measurement of chromosome length and centromere position were shown in Table. 34.

Among the 26 chromosomes four longest chromosomes (Nos. 1- 4) were distinguished. They ranged from 14.1 to 12.2 μm in length. Their arm ratios varied from 1.0 to 1.1, and the positions of centromeres were median. The other 22 chromosomes (Nos. 5-26) ranged from 9.3 to 4.9 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of eight chromosomes (Nos. 5-12) varied from 1.1 to 1.2, and the positions of centromeres were median. Two chromosomes (Nos. 13, 14) had the satellites on their short arms. Those short arms were both 2.7 μm(1.2+ 1.5 μm) and the long arm were 4.2 μm and 4.1 μm in length respectively. Arm ratios of those satellited chromosomes were 1.6 and 1.5 respectively, and the positions of centromeres were median. Arm ratios of 12 chromosomes (Nos. 15-26) varied from 1.0 to 1.4, and the positions of centromeres were median.

According to the morphology of chromosome complement this species was extremely similar to *P. exul* except for the order of two satellited chromosomes (Nos. 13, 14).

3) *Paphiopedilum charlesworthii* (Rolfe) Pfitz., 2n=26
Validated specimen No. 1101, 1307.

This species, native to Burma and eastern Assam, is a dwarf species. Morphological characteristics of this species are as follows: The upper surface of the leaves is bright green. The peduncle bears single flower. The dorsal sepal is wide and pink, veined with rosy purple radiating from the base. The petals spread horizontally and are greenish brown (Fig. 33A).

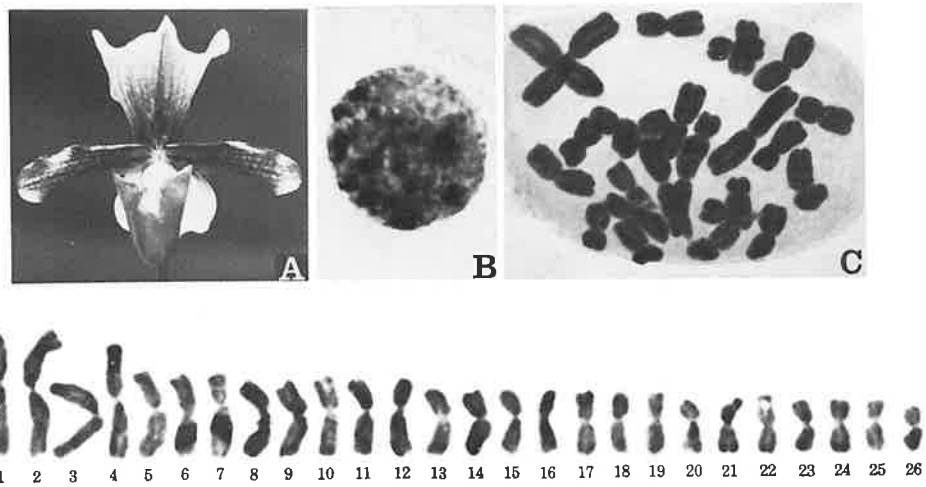


Fig. 33. *Paphiopedilum charlesworthii*, 2n=26. A, flower. B, interphase nucleus. C and D, somatic metaphase chromosomes. A, × 0.5. B-D, × 1200.

The chromosome number of 2n=26 in this species was previously reported by Duncan (1947) and Duncan & MacLeod (1949). In the present investigation the number of chromosomes of two clones was reexamined to be 2n=26. The chromosomes at resting stage and mitotic phase were shown in Fig. 33. The results of the measurement of chromosome length and centromere position were shown in Table. 35.

Among the 26 chromosomes four longest chromosomes (Nos. 1-4) were distinguished. They ranged from 14.4 to 11.7 μm in length. Their arm ratios varied from 1.0 to 1.1, and the positions of centromeres were median. The other 22 chromosomes (Nos. 5-26) ranged from 9.2 to 4.3 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of 16 chromosomes (Nos. 5-20) varied from 1.1 to 1.6, and the positions of centromeres were median. Two chromosomes (Nos. 21, 22) had the satellites on each short arms. The short arms were 2.6 μm (1.0+1.6 μm) and 2.5 μm (0.8+1.7 μm) in length respectively and the long arms were both 2.9 μm. Arm

ratios of their satellited chromosomes were 1.1 and 1.2, and the positions of centromeres were median. Arm ratios of four chromosomes (Nos. 23-26) varied from 1.2 to 1.4, and the positions of centromeres were median.

According to the morphology of chromosome complement, this species was extremely similar to *P. exul* except for the orders of two satellited chromosomes (Nos. 21, 22).

4) *Paphiopedilum villosum* (Lindl.) Pfitz., 2n=26
Validated specimen No. 1308, 1309.

This species is widely distributed througout Assam, Burma and Thailand. Morphological characteristics of this species are as follows: The upper surface of leaves is leathery dull green and the underside is light green with many purplish brown spots, basally. The peduncle bears single flower. The dorsal sepal is folded back at its base, and is yellow with brownish purple streaking. The petals are narrow at their bases and widening toward the tips. The base color is yellowish brown with a broad purple median line (Fig. 34A).

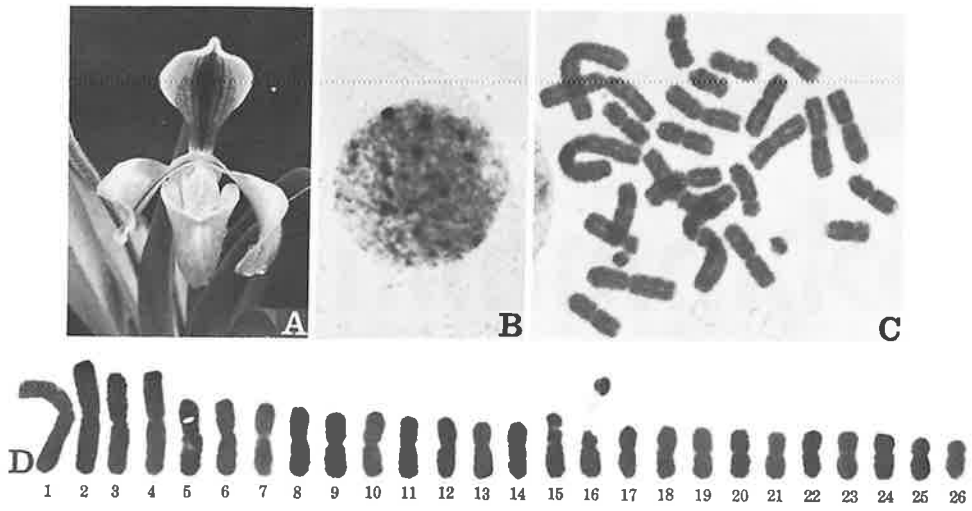


Fig. 34. *Paphiopedilum villosum*, 2n=26. A, flower. B, interphase nucleus. C and D, somatic metaphase chromosomes. A ×0.4. B-D, ×1200.

The chromosome number of 2n=26 in this species was previously reported by Francini (1934), Mehlquist (1947), Duncan (1947), Duncan & MacLeod (1948) and Kamemoto *et al.* (1963). In the present investigation the number of chromosomes of two clones was reexamined to be 2n=26. The chromosomes at resting stage and mitotic phase were shown in Fig. 34. The results of the measurement of chromosome length and centromere position were shown in Table 36.

Among the 26 chromosomes four longest chromosomes (Nos. 1-4) were distinguished. They ranged from 13.6 to 10.2 μm in length. Their arm ratios varied from 1.0 to 1.1,

and the positions of centromeres were median. The other 22 chromosomes (Nos. 5-26) ranged from 8.4 to 3.8 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of ten chromosomes (Nos. 5-14) varied from 1.0 to 1.5, and the positions of centromeres were median. Two chromosomes (Nos. 15, 16) had satellites on their short arms. The short arms were 2.3 μm (0.9+1.4 μm) and 2.4 μm (0.9+1.5 μm) in length respectively and the long arms were 3.5 μm and 3.3 μm in length respectively. Thus, arm ratios of these satellited chromosomes were 1.5 and 1.4, and the positions of centromeres were median. Arm ratios of eight chromosomes (Nos. 17-24) varied from 1.0 to 1.4, and the positions of centromeres were median. Arm ratio of the 25th chromosome was 1.4, and the position of centromere was median. Arm ratio of the last 26th chromosome was 1.9, and the position of centromere was submedian.

As mentioned above, this species was similar to *P. exul,* in the morphology of chromosome complement. Two satellited chromosomes (Nos. 15, 16) and one submetacentric chromosome (No. 26) of this species were the marked chromosomes for the chromosome complement of this species.

5) *Paphiopedilum boxalli* (Rchb. f.) Pfitz., 2n=26
Validated specimen No. 1231.

This species, native to Tongu and Moulmein in Burma, is similar to *P. villosum.* The leaves are broader and the dorsal sepal has numerous purplish black spots, when compared to *P. villosum* (Fig. 35A).

The chromosome number of this species was examined to be 2n=26. The chromosomes at resting stage and mitotic phase were shown in Fig. 35. The results of the measurement of chromosome length and centromere position were shown in Table 37.

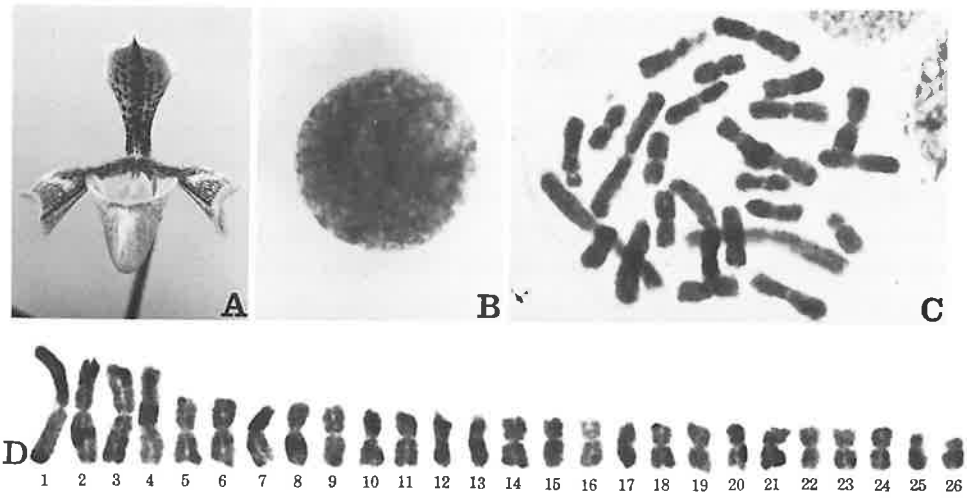


Fig. 35. *Paphiopedilum boxalli,* 2n=26. A, flower. B, interphase nucleus. C, somatic prometaphase chromosomes. D, somatic metaphase chromosomes. A, ×0.4. B-D, ×1200.

Among the 26 chromosomes four longest chromosomes (Nos. 1- 4) were distinguished. They ranged from 13.5 to 10.5 μm in length. Their arm ratios varied from 1.0 to 1.1, and the positions of centromeres were median. The other 22 chromosomes (Nos. 5-26) ranged from 7.5 to 3.5 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of ten chromosomes (Nos. 5-14) varied from 1.0 to 1.3, and the positions of centromeres were median. Two chromosomes (Nos. 15, 16) had satellites on each short arms. The short arms were both 2.1 μm (1.0+1.1 μm) and the long arms were 3.1 μm and 3.0 μm. Arm ratios of their chromosomes were 1.5 and 1.4, and the positions of centromeres were median. Arm ratios of eight chromosomes (Nos. 17-24) varied from 1.0 to 1.2, and the positions of centromeres were median. Arm ratio of the 25th chromosome was 1.6, and the position of centromere was median. Arm ratio of the last 26th chromosome was 1.9, and the position of centromere was submedian.

As mentioned above, the karyotype of this species was extremely similar to that of *P. villosum*.

3. CYMATOPETALUM

1) *Paphiopedilum spicerianum* (Rchb. f.) Pfitz., 2n=30
Validated specimen No. 1044, 1263, HU-3.

This species is indigenous to Assam, India. External morphological characteristics of this species are as follows: The upper surface of the leasves is medium green and the underside is spotted with anthocyanin pigment. The peduncle bears single flower. The dorsal sepal is broad. The base color is white, except at the midline fold, where there is a purplish red line. The color of the base of the dorsal sepal is green. The petals are strap shaped with undulate margins and point at the apex. The base color is yellowish green, spotted with dull red, and decorated with purplish red midline. The lip is brown (Fig. 36A).

The chromosome number of 2n=30 in this species was previously reported by Francini (1930, 1931, 1945) and Tanaka & Aoyama (1974). While Duncan & MacLeod (1949) reported this to be 2n=28. In the present investigation the number of chromosomes of five clones was reexamined to be 2n=30. The chromosomes at resting stage and mitotic phase were shown in Fig. 36. The results of the measurement of chromosome length and centromere position were shown in Table 38.

Among the 30 chromosomes four longest chromosomes (Nos. 1- 4) were distinguished. They ranged from 13.1 to 11.8 μm in length. Eight chromosomes (Nos. 5-12) were longer than the other ten metacentric chromosomes. They ranged from 9.8 to 8.5 μm in length. The leftover short ten metacentric chromosomes ranged from 6.7 to 4.2 μm in length. Thus, these 22 metacentric chromosomes could be divided into three quantitative groups showing trimodal karyotype. Morphological characteristics of 30 chromosomes were as follows: Arm ratios of two chromosomes (Nos. 1, 2) were 1.0 and 1.1, and the posi-

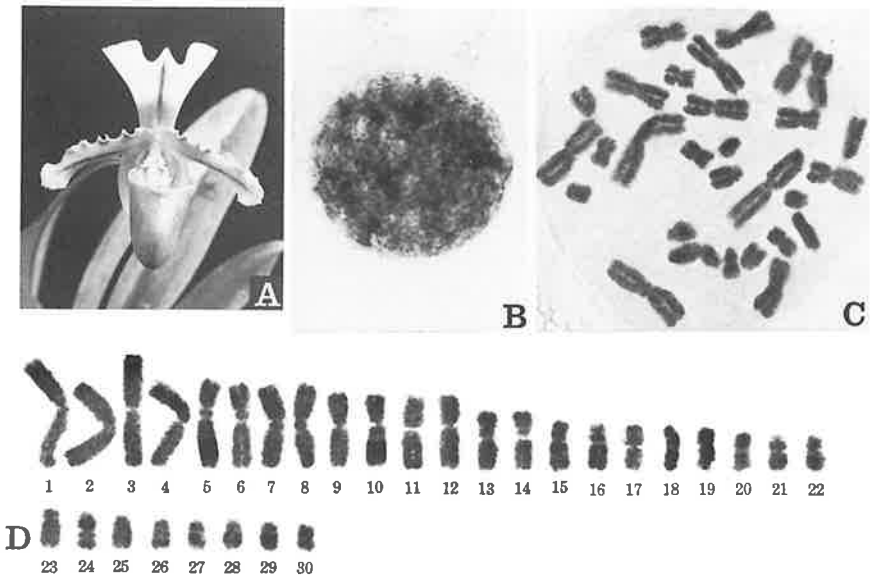


Fig. 36. *Paphiopedilum spicerianum*, 2n=30. A, flower. B, interphase nucleus. C and D, somatic metaphase chromosomes. A, × 0.5. B-D, × 1200.

tions of centromeres were median. Arm ratios of two chromosomes (Nos. 3, 4) were 1.0 and 1.1, and the positions of centromeres were median. These two chromosomes had small constrictions near the centromeric region of their short arms. Arm ratios of the third two chromosomes (Nos. 5, 6) were both 1.3, and the positions of centromeres were median. These two chromosomes had the small constrictions near the centromeric region of their short arms. Arm ratios of two chromosomes (Nos. 7, 8) were both 1.4, and the positions of centromeres were median. These two chromosomes had small constrictions near the centromeric region of their long arms, also. Arm ratios of four chromosomes (Nos. 9-12) were all 1.2, and the positions of centromeres were median. Arm ratios of two chromosomes (Nos. 13, 14) were both 1.2, and the positions of centromeres were median. These two chromosomes had the small constrictions on the middle of the short arms. Two chromosomes (Nos. 15, 16) had the small constrictions on their short and long arms. Their arm ratios were 1.4 and 1.5, and the positions of centromeres were median. Arm ratios of two chromosomes (Nos. 17, 18) were both 1.1, and the positions of centromeres were median. These two chromosomes had small constrictions both on their long and short arms respectively. Arm ratios of four chromosomes (Nos. 19-22) varied from 1.3 to 1.1, and the positions of centromeres were median. The leftover eight chromosomes (Nos. 23-30) ranged from 4.5 to 3.1 μm in length, and the positions of centromeres were all terminal. These eight chromosomes had small constrictions.

Comparing with the karyotype of other 2n=26 species, this species had eight telocentric chromosomes instead of four small metacentric chromosomes.

As mentioned above, the 2n=30 chromosomes were consisted of morphologically

15 pairs of matched chromosomes, and could be divided mainly into two groups: One consisted of 22 metacentric chromosomes and the other consisted of eight telocentric chromosomes. Besides their 22 metacentric chromosomes were divided into three quantitative groups showing trimodal karyotype. Among the 30 chromosomes 22 (Nos. 3-8, 13-18, 23-30) had small constrictions on either long or short arms, sometimes on both long and short arms.

4. THIOPETALUM

1) *Paphiopedilum druryi* (Bedd.) Pfitz., 2n=30
Validated specimen No. 1310.

This species, native to the Travancore Hills in southern India, is morphologically characterized as follows: It has the creeping rhizome. The leaves are leathery, strap shaped and apple green. The peduncle bears single flower. The dorsal sepal is broad and curved forward, and yellowish green in color with blackish brown band in the midrib. The petals are broad and curve forward, and the base color is yellow with brownish black band in the midrib (Fig. 37A).

The chromosome number of 2n=26 in this species was previously reported by Duncan (1947) and Duncan & MacLeod (1949). In the present investigation, however, the number of chromosomes was examined to be 2n=30. The chromosomes at resting stage and mitotic phase were shown in Fig. 37. The results of the measurement of chromosome length and centromere position were shown in Table 39.

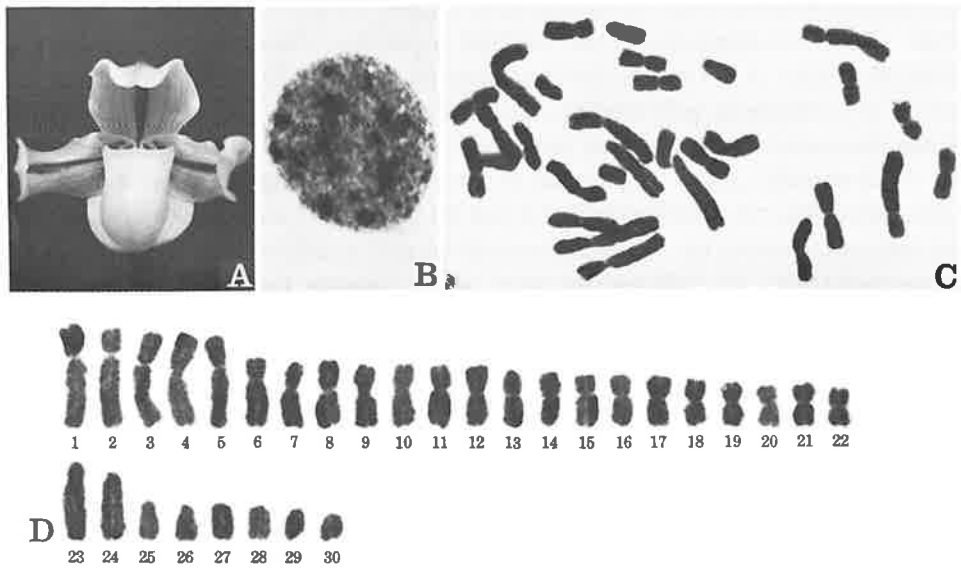


Fig. 37. *Paphiopedilum druryi*, 2n=30. A, flower. B, interphase nucleus. C, somatic prometaphase chromosomes. D, somatic metaphase chromosomes. A, ×0.5. B-D, ×1200.

Five chromosomes (Nos. 1-5) ranged from 11.5 to 10.1 μm in length, were clearly longer than the others. Arm ratios of four chromosomes (Nos. 1-3, 5) varied from 1.8 to 2.7, and the positions of centromeres were submedian. Arm ratio of the fourth chromosome was 1.4, and the position of centromere was median. Seventeen chromosomes (Nos. 6-22) ranged from 7.5 to 4.2 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratio of the sixth chromosome was 2.0 and the position of centromere was submedian. Arm ratios of 16 chromosomes (Nos. 7-22) varied from 1.0 to 1.5, and the positions of centromeres were median. The positions of centromeres of eight chromosomes (Nos. 23-30) were terminal. Two (Nos. 23, 24) of their telocentric chromosomes being 8.5 μm and 7.5 μm in length, were clearly longer than the others. Six chromosomes (Nos. 25-30) varied from 4.3 to 3.2 μm in length, and decreased gradually in size from the longest to the shortest chromosomes.

The 2n=30 chromosomes included 22 metacentric and eight telocentric chromosomes.

According to the morphology of chromosome complement, this species was clearly different from *P. spicerianum*. This species had the five submetacentric chromosomes (Nos. 1-3, 5, 6) and had no small constriction.

IV. BARBATA

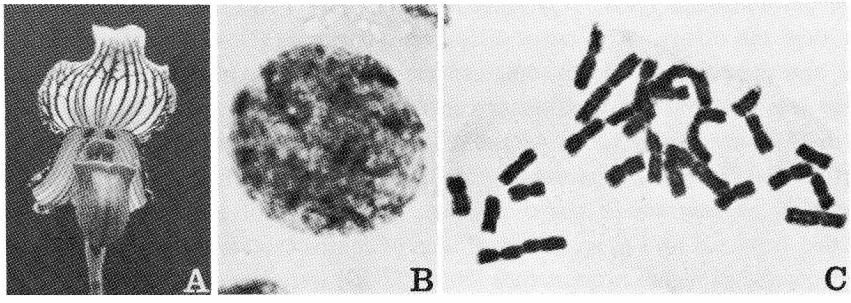
1. CERATOPETALUM

1) *Paphiopedilum fairieanum* (Lindl.) Pfitz., 2n=26
Validated speciemen No. 1035, 1311, 1312.

This species is distributed in Sikkim, Bhutan and Assam. Morphological characteristics of this species are as follows: The surface of the leaves is green, with faintly shaded. The peduncle bears single flower. The dorsal sepal is white with purplish red stripes. The petals elongate underwide, and the point of petals are curved backward. Their color is light yellowish green and is purplish red at the margins with purple hairs (Fig. 38A).

The chromosome number of 2n=26 in this species was previously reported by Mehlquist (1947), Duncan (1947) and Duncan & MacLeod (1949). In the present investigation the chromosome number of this species was reexamined with three clones to be 2n=26. The chromosomes at resting stage and mitotic phase were shown in Fig. 38. The results of the measurement of chromosome length and centromere position were shown in Table 40.

Among the 26 chromosomes four longest chromosomes (Nos. 1-4) were distinguished. They ranged from 13.5 to 10.5 μm in length. Their arm ratios varied from 1.0 to 1.3 and the positions of centromeres were median. The other 22 chromosomes (Nos. 5-



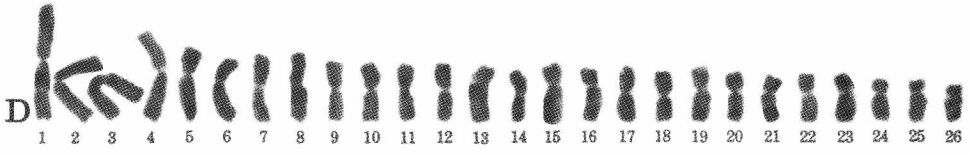


Fig. 38. *Paphiopedilum fairieanum*, 2n=26. A, flower. B, interphase nucleus. C and D, somatic metaphase chromosomes. A, × 0.6. B-D, × 1200.

26) ranged from 8.2 to 4.5 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of two chromosomes (Nos. 5, 6) were both 1.7, and the positions of centromeres were median. Arm ratios of eight chromosomes (Nos. 7-14) varied from 1.1 to 1.3, and the positions of centromeres were median. Arm ratios of two chromosomes (Nos. 15, 16) were both 2.0, and the positions of centromeres were submedian. The 17th chromosome had a satellite in the short arm. The short arm was 2.9 μm (0.9+2.0 μm) in length and the long arm was 3.0 μm in length. Arm ratio of this chromosome was 1.0, and the position of centromere was median. The 18th metacentric chromosome had not satellite in one of arms, the short arm was 2.9 μm in length and the long arm was 3.0 μm in length. Arm ratios of four chromosomes (Nos. 19-22) varied from 1.5 to 1.6, and the positions of centromeres were median. Arm ratios of the four chromosomes (Nos. 23-26) varied from 1.8 to 2.0, and the positions of centromeres were submedian.

As mentioned above, the characteristics of the chromosome complement of this species were as follows: The 2n=26 chromosomes of this species, which were consisted of morphologically 13 pairs of matched chromosomes, could be divided into two quantitative groups: One consisted of four large chromosomes and the other consisted of 22 small chromosomes. Arm ratios of six chromosomes (Nos. 15, 16, 23-26) varied from 1.8 to 2.0, and the positions of centromeres were submedian. The seventeenth chromosome had a satellite on the short arm.

2. SIGMATOPETALUM

1) *Paphiopedilum hookerae* (Rchb. f.) Pfitz., 2n=28
Validated specimen No. 1078, 1115, 1313, 1314.

This species is native to northern Borneo. External morphological characteristics of this species are as follows: The leaves are dark green, mottled with light grayish green. The peduncle bears single flower. The dorsal sepal is subtrianglar. The petals are spathulate and their distal regions are purplish pink. The upper half portion of the based petals is black-purple (Fig. 39A).

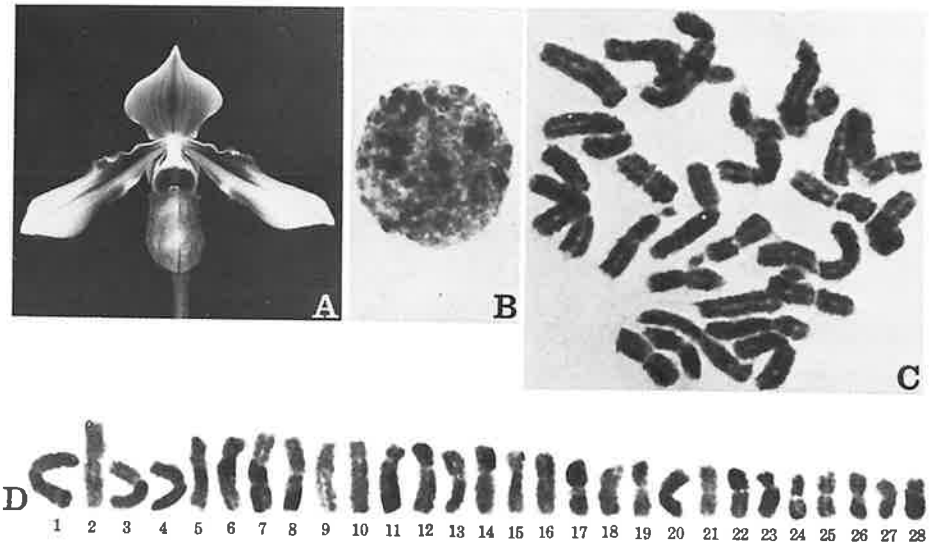


Fig. 39. *Paphiopedilum hookerae*, 2n=28. A, flower. B, interphase nucleus. C, somatic prometaphase chromosomes. D somatic metaphase chromosomes. A, × 0.4. B-D, ×1200.

The chromosome number of four clones of this species was examined to be 2n=28. The chromosomes at resting stage and mitotic phase were shown in Fig. 39. The results of the measurement of chromosome length and centromere position were shown in Table 41.

Among the 28 chromosomes two longest chromosomes (Nos. 1, 2) were distinguished. They were 11.5 μm and 10.3 μm in length. Their arm ratios were both 1.1, and the positions of centromeres were median. The other 26 chromosomes (Nos. 3-28) ranged from 9.0 to 5.0 μm, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of four chromosomes (Nos. 3-6) varied from 1.3 to 1.2, and the positions of centromeres were median. Arm ratios of two chromosomes (Nos. 7, 8) were both 2.3, and the positions of centromeres were submedian. Arm ratios of two chromosomes (Nos. 9, 10) were both 3.2, and the position of centromeres were subterminal. Arm ratios of two chromosomes (Nos. 11, 12) were 2.9 and 2.2, and the positions of centromeres were submedian. Arm ratios of two chromosomes (Nos. 13, 14) were both 1.7, and the positions of centromeres were median. Arm ratios of two chromosomes (Nos. 15, 16) were 1.1 and 1.3, and the positions of centromeres were median. Two chromosomes (Nos. 17, 18) had the satellites on their short arms. The short arms of them

were 3.5 μm (1.0+2.5 μm) and the long arms were both 3.5 μm. Their arm ratios were both 1.0, and the positions of centromeres were median. Generally these satellites had inclination to obscure themselves at metaphase. Arm ratios of ten chromosomes (Nos. 19-28) varied from 1.1 to 1.5, and the positions of centromeres were median.

According to the morphology of chromosome complement the 2n=28 chromosomes, which formed morphologically 14 pairs of matched chromosomes, could be divided into two quantiative groups leading a bimodal karyotype: One consisted of two longest chromosomes and the other consisted of 26 chromosomes. Two subtelocentric chromosomes, four submetacentric chromosomes and two satellited chromosomes were the characteristics of the karyotype for this species.

2) *Paphiopedilum appletonianum* (Gower) Pfitz., 2n=38
Validated specimen No. 1100, 1116, 1153, 1257, 1261, BG-57.

This species is indigenous to Thailand and the Large Sunda Islands. This is extremely similar to *P. wolterianum* and hardly distinguished with regard to their flowers. Seidenfaden (1972) considered these two species to be conspecific. In the present investigation two specimens, one comes from Thailand and the other comes from the Large Sunda Islands, are dealt with. However, karyomorphological difference in these two clones could not be observed. External morphological characteristics of this species are as follows: The surface of the leaves was dark green, mottled with pale grayish green.

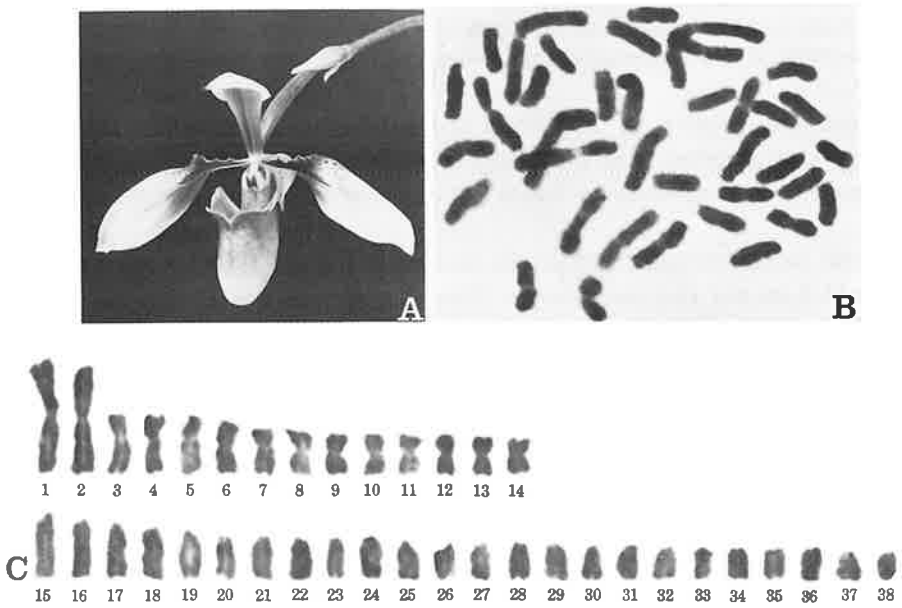


Fig. 40. *Paphiopedilum appletonianum*, 2n=38. A, flower. B, somatic prometaphase chromosomes. C, somatic metaphase chromosomes. A, $\times$ 0.5. B and C, $\times$ 1200.

The peduncle is long and bears single flower. The basal margins of dorsal sepal are strongly recurved. Its color is apple green with dark green veins, basally. The petals are spathulate, slightly drooping. Its color is dark brownish green with brown spots, basally, blending to pink purple distally (Fig. 40A).

The chromosome number of this species was examined in three clones from the two sources, Thailand and the Sunda Islands to be 2n=38. The chromosomes at mitotic phase were shown in Fig. 40. The results of the measurement of chromosome length and centromere position were shown in Table 42.

Among the 38 chromosomes two longest chromosomes (Nos. 1, 2) were distinguished. They were 12.6 μm and 11.9 μm in length. Their arm ratios were both 1.1, and the positions of centromeres were median. Twerve chromosomes (Nos. 3-14) of them ranged from 7.0 to 4.4 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Their arm ratios varied from 1.1 to 1.6, and the positions of centromeres were median. The remaining 24 chromosomes (Nos. 15-38) of them ranged from 7.5 to 3.5 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. The positions of centromeres of their 24 chromosomes were all terminal.

According to the morphology of chromosome complement the 2n=38 chromosomes, which formed morphologically 19 pairs of chromosomes, could be divided into two quantitative groups: One consisted of 14 metacentric chromosomes and the other consisted of 24 telocentric chromosomes. Furthermore, 14 metacentric chromosomes of them were divided into two groups: One with two long chromosomes and the other with 12 small chromomes which decreased gradually in size. The 24 telocentric chromosomes were decreased gradually in size from the longest to the shortest chromosomes.

3) *Paphiopedilum bullenianum* (Rchb. f.) Pfitz., 2n=40
Validated specimen No. 1164, 1179.

This species, native to northern Borneo and to Malaya, is morphologically characterized as follows: The leaves are dwarfish and dark green, mottled with pale green. The peduncle is tall and bears single flower. The dorsal sepal is green and with dark brownish green vertical veins, basally. The upper margins of the dorsal sepal are curved inside, the margins of its base are recurved. The petals are spathulate and elongate horizontally. Basally, the color of the petals is dark green and the distal portions are purplish pink (Fig. 41A).

The chromosome number of two clones of this species was examined to be 2n=40. The chromosomes at resting stage and mitotic phase were shown in Fig. 41. The results of the measurement of chromosome length and centromere position were shown in Table 43. The 2n=40 chromosomes included 12 metacentric chromosomes and 28 telocentric chromosomes.

Among the 12 metacentric chromosomes two (Nos. 1, 2) were distinguished. They were both 8.7 μm in length. Their arm ratios were both 1.9, and the positions of centromeres were submedian. Ten chromosomes (Nos. 3-12) of them ranged from 7.3 to 5.7 μm in length. Their arm ratios varied from 1.0 to 1.2, and the positions of centro-

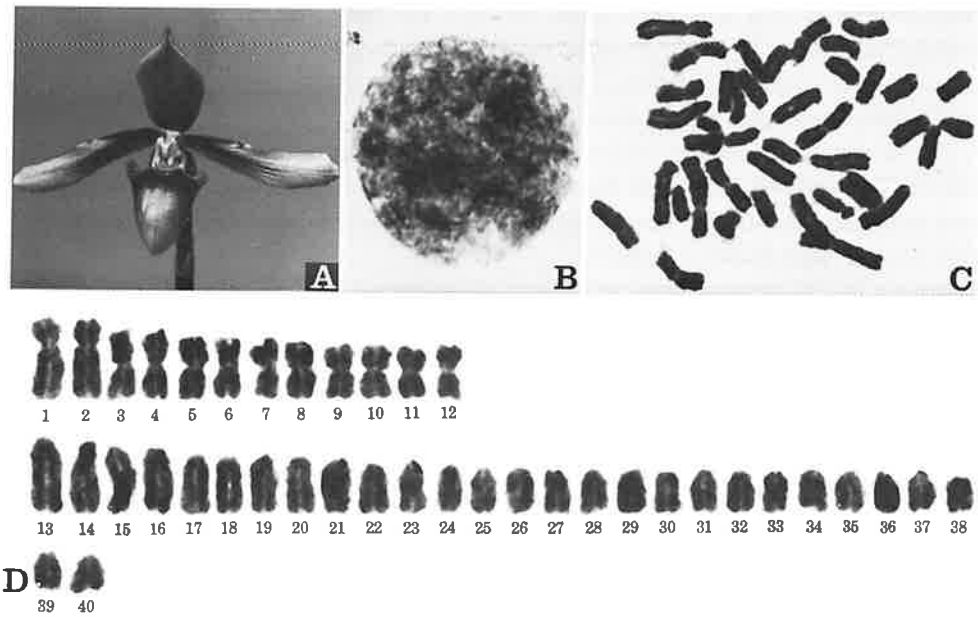


Fig. 41. *Paphiopedilum bullenianum*, 2n=40. A, flower. B, interphase nucleus. C and D, somatic metaphase chromosomes. A, ×0.5. B-D, ×1200.

meres were median. Four chromosomes (Nos. 13-16) of them ranged from 8.1 to 7.1 μm in length, and the positions of centromeres were terminal. Four chromosomes were slightly longer than the below 24 chromosomes. Twenty-four chromosomes (Nos. 17- 40) of them ranged from 6.5 to 4.0 μm in length, and the positions of centromeres were terminal.

According to the morphology of chromosome complement, this speciese was clearly different from above *P. appletonianum.* Among the 40 chromosomes of this species there could not observed any longest chromosomes, conspicuously. Two submetacentric chromosomes (Nos. 1, 2) were the marked chromosomes for the karyotype of this species.

4) *Paphiopedilum celebesense* Hort., 2n=42
Validated specimen No. 1266, 1267.

This species is indigenous to the Celebes. External morphological characteristics of this species are as follows: The surface of the leaves is dark green, mottled with greenish white. The peduncle bears single flower. The flower of this species is similar to that of *P. bullenianum.* The dorsal sepal and the petals of this species are broad. The lip is like a pot in shape (Fig. 42A).

The chromosome number of two clones of this species was examined to be 2n=42. The chromosomes at mitotic phase were shown in Fig. 42. The results of the measure-

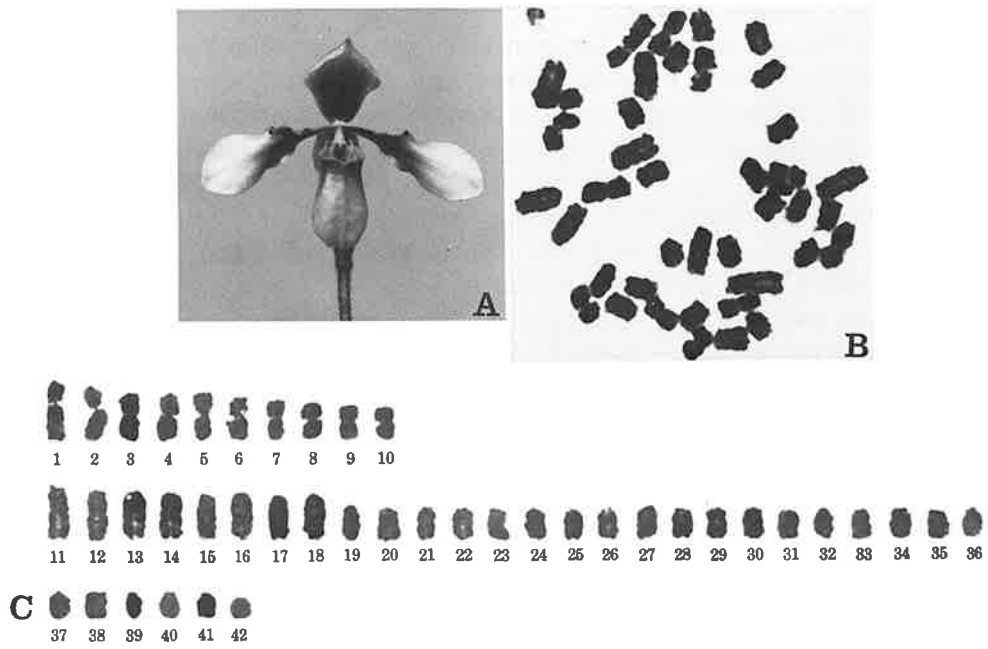


Fig. 42. *Paphiopedilum celebesense*, 2n=42. A, flower. B and C, somatic metaphase chromosomes. A, × 0.4. B and C ×1200.

ment of chromosome length and the centromere position were shown in Table 44.

Among the 42 chromosomes two longest chromosomes (Nos. 1, 2) were distinguished. They were both 6.4 μm in length, Arm ratios of their chromosomes were both 1.8, and the positions of centromeres were median. Eight chromosomes (Nos. 3-10) ranged from 5.7 to 4.0 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Their arm ratios varied from 1.1 to 1.2, and the positions of centromeres were median. Thirty-two chromosomes (Nos. 11-42) ranged from 6.2 to 2.6 μm in length, and the positions of centromeres were terminal. These 32 chromosomes consisted of eight long chromosomes and 24 short chromosomes which decreased in descending order of size.

According to the morphology of chromosome complement, this species was clearly different from *P. bullenianum*. The chromosome complement of the former consisted of ten metacentric chromosomes and 32 telocentric chromosomes.

3. BLEPHAROPETALUM

1) *Paphiopedilum tonsum* (Rchb. f.) Pfitz., 2n=32

Validated specimen No. 1016, 1271, 1272, 1273, BG-3, 1315.

This species is found in Sumatra. External morphological characteristics are as follows: Color of the leaves is variable, dark green mottled with pale green to dark greenish purple mottled with pale green. The peduncle bears single flower. The dorsal sepal is ovate. The base color is creamy white, shading pale brownish green with greenish brown veins. The petals are stretched-oval, pale brownish yellow. They bear brownish purple veins with black brown spots (Fig. 43A).

The chromosome number of 2n=34 in this species was previously reported by Duncan (1947) and Duncan & MacLeod (1950). In the present investigation, the number of metaphase chromomes, in the five materials of which color of leaves differed from each other was examined to be 2n=32. The chromosomes at resting stage and mitotic phase were shown in Fig. 43. The results of the measurement of chromosome length and centromere position were shown in Table 45.

Among the 32 chromosomes two longest chromosomes (Nos. 1, 2) were distinguished.

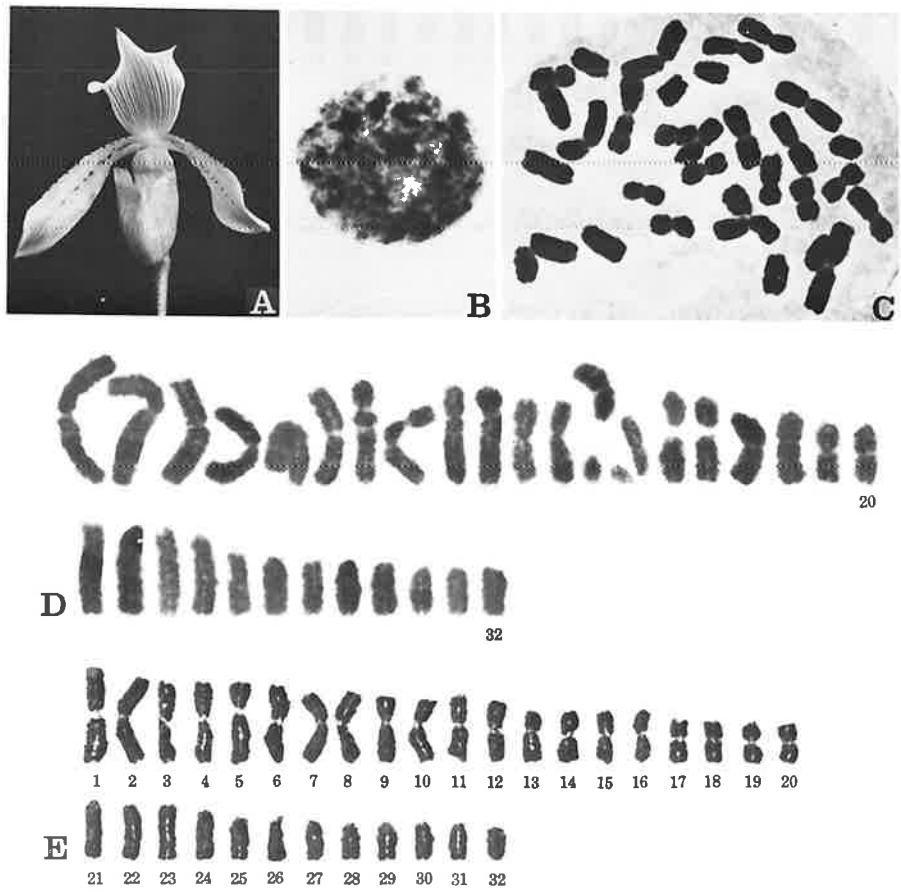


Fig. 43. *Paphiopedilum tonsum*, 2n=32. A, flower. B, interphase nucleus. C and E, somatic metaphase chromosomes. D, somatic prometaphase chromosomes. A, ×0.4. B-E, ×1200.

They were 10.5 μm and 10.3 μm in length. Their arm ratios were both 1.1, and the positions of centromeres were median. Eighteen chromosomes (Nos. 3-20) of them ranged from 8.8 to 4.4 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of six (Nos. 3-8) of those 18 chromosomes varied from 1.1 to 1.6, and the positions of centromeres were median. Arm ratios of the next two chromosomes (Nos. 9, 10) were both 1.8, and the positions of centromeres were submedian. Arm ratios of ten chromosomes (Nos. 11-20) varied from 1.1 to 1.5, and the positions of centromeres were median. The positions of centromeres of the leftover 12 chromosomes (Nos. 21-32) were all terminal. Four (Nos. 21-24) of those 12 telocentric chromosomes, ranged from 6.5 to 5.6 μm in length, were clearly longer than the ohter telocentric chromosomes. The leftover eight chromosomes (Nos. 25-32) ranged from 4.8 to 3.7 μm in length, and decreased gradually in size.

The 32 chromosomes of this species included 20 metacentric chromosomes and 12 telocentric chromosomes. These 20 metacentric chromosomes formed morphologically 10 pairs of matched chromosomes. These ten pairs of chromosomes included one pair of longest chromosomes and nine pairs of small chromosomes which decreased gradually in size.

In the same manner, 12 telocentric chromosomes included morphologically six pairs of matched chromosomes. These six pairs of chromosomes included four longest and eight small chromosomes which decreased gradually in size.

According to chromosome morphology at prometaphase in this species (Fig. 43D), two chromosomes (Nos. 7, 8) had distinct small constrictions on the middle part of their short arms, and another two chromosomes (Nos. 13, 14) had them on the middle part of their long arms. These small constrictions were obscured themselves at metaphase. The long and short arms of the other two chromosomes (Nos. 15, 16) were easily to be fissionable by the squash technique and they were often observed separately like four telocentric chromosomes in cells.

2) *Paphiopedilum dayanum* (Rchb. f.) Pfitz., 2n=36
Validated specimen No. 1205, 1316.

This species is indigenous to Mt. Kinabalu, North Borneo. External morphological characteristics are as follows: The leaves are dark green, mottled with pale green. The peduncle bears single flower. The dorsal sepal is white, veined with green. The petals are strap-shaped. The color is white, shaded with purplish pink and veined with purplish brown (Fig. 44A).

The chromosome number of 2n=34 in this specis was previously reported by Duncan (1947) and Duncan & MacLeod (1950). In the present investigation, however, the number of chromosomes was examined in two clones to be 2n=36. The chromosomes at resting stage and mitotic phase were shown in Fig. 44. The results of the measurement of chromosome length and centromere position were shown in Table 46.

Among the 36 chromosomes four chromosomes (Nos. 1- 4) were distinguished. Two

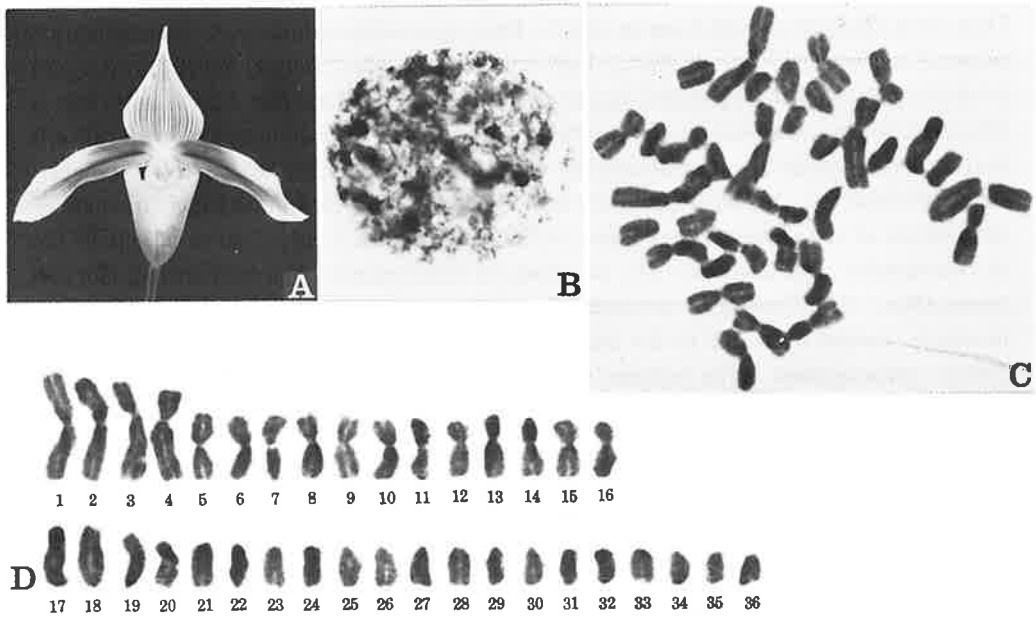


Fig. 44. *Paphiopedilum dayanum*, 2n=36. A, flower. B, interphase nucleus. C and D, somatic metaphase chromosomes. A, × 0.4. B-D, × 1200.

chromosomes (Nos. 1, 2) of them were 12.4 μm and 12.0 μm in length, respectively. Their arm ratios were both 1.1, and the positions of centromeres were median. Two chromosomes (Nos. 3, 4) of them were 11.3 μm and 10.3 μm in length, respectively. Their arm ratios were 1.8 and 1.9, and the positions of centromeres were submedian. Twelve chromosomes (Nos. 5-16) ranged from 7.7 to 6.4 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Their arm ratios varied from 1.1 to 1.5, and the positions of centromeres were median. The leftover 20 chromosomes (Nos. 17-36) ranged from 7.0 to 3.5 μm in length and the positions of centromeres were terminal. Two (Nos. 17, 18) of them were clearly longer than the other 18 telocentric chromosomes.

The 2n=36 chromosomes included 16 two-armed and 20 one-armed chromosomes. According to the morphology of chromosome complement, this species was characterized by two longest metacentric (Nos. 1, 2) and two longest submetacentric chromosomes (Nos. 3, 4).

3) *Paphiopedilum mastersianum* (Rchb. f.) Pfitz., 2n=36
Validated specimen No. 1160, 1232, BG-29.

This species grows in Molucca and Amboina Island. External morphological characteristics are as follows: The leaves are green, mottled with pale green. The peduncle bears single flower. The dorsal sepal is apple green, veined with dark green. The petals are outspread, narrow at the base. The color of petals is purplish brown, with purplish black

spots at the base. The lip is chestnut brown in color (Fig. 45A).

The chromosome number of 2n=32 in this species was previously reported by Duncan (1947) and Duncan & MacLeod (1950). In the present investigation, however, the number of chromosomes was examined in three clones of this species to be 2n=36. The chromosomes at resting stage and mitotic phase were shown in Fig. 45. The results of the measurement of chromosome length and centromere position were shown in Table 47.

Among the 36 chromosomes two longest chromosomes (Nos. 1, 2) were distinguished. They were 13.5 μm and 13.0 μm in length. Their arm ratios were 1.1 and 1.2, and the positions of centromeres were median. Fourteen chromosomes (Nos. 3-16) ranged from 9.3 to 6.9 μm in length, and decreased gradually in size. Arm ratios of six chromosomes (Nos. 3-8) varied from 1.9 to 2.1, and the positions of centromeres were submedian. Arm ratios of another eight chromosomes (Nos. 9-16) of them varied from 1.3 to 1.6, and the positions of centromeres were submedian. The leftover 20 chromosomes (Nos. 17-36) ranged from 9.0 to 4.5 μm in length, and the positions of centromeres were all terminal. Among these 20 telocentric chromosomes four (Nos. 17-20) were clearly longer than the others.

The 2n=36 chromosomes included 16 metacentric and 20 telocentric chromosomes. As mentioned above this species was different from *P. acmodontum*, in morphology of the chromosome complement of the karyotype. *P. mastersianum* is characterized by the six submetacentric chromosomes.

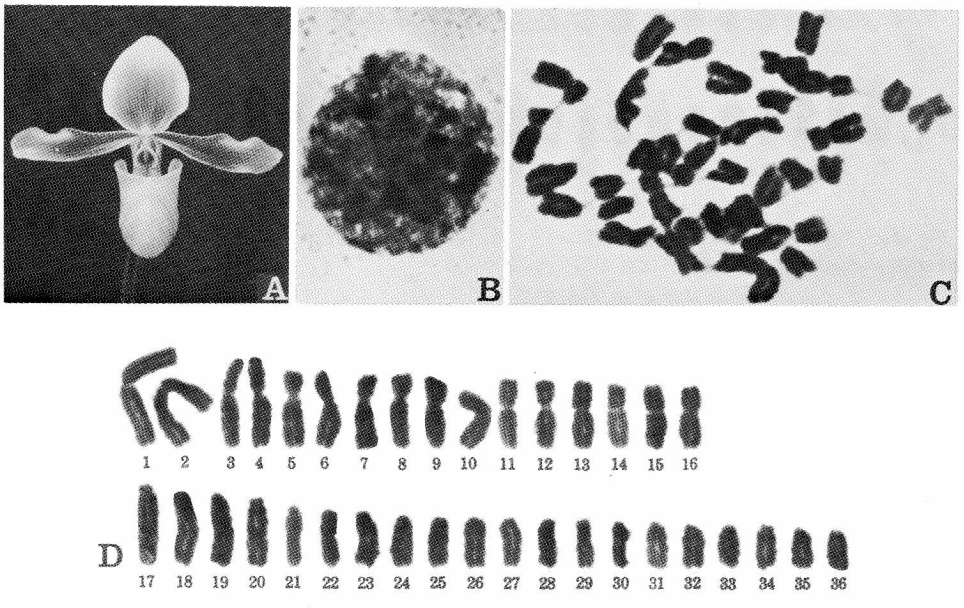


Fig. 45. *Paphiopedilum mastersianum*, 2n=36. A, flower. B, interphase nucleus. C and D, somatic metaphase chromosomes. A, ×0.3. B-D, ×1200.

4) *Paphiopedilum javanicum* (Reinw.) Pfitz., 2n=38
Validated specimen No. 1065, 1137, 1317.

This species is indigenous to Java. External morphological characteristics are as follows: The leaves are grayish green, mottled with dark green. The peduncle bears single flower. The dorsal sepal is pale green with dark green veins. The petals elongate downward slightly. Their color is pale green and pale pink at the top, with small purple spots (Fig. 46A).

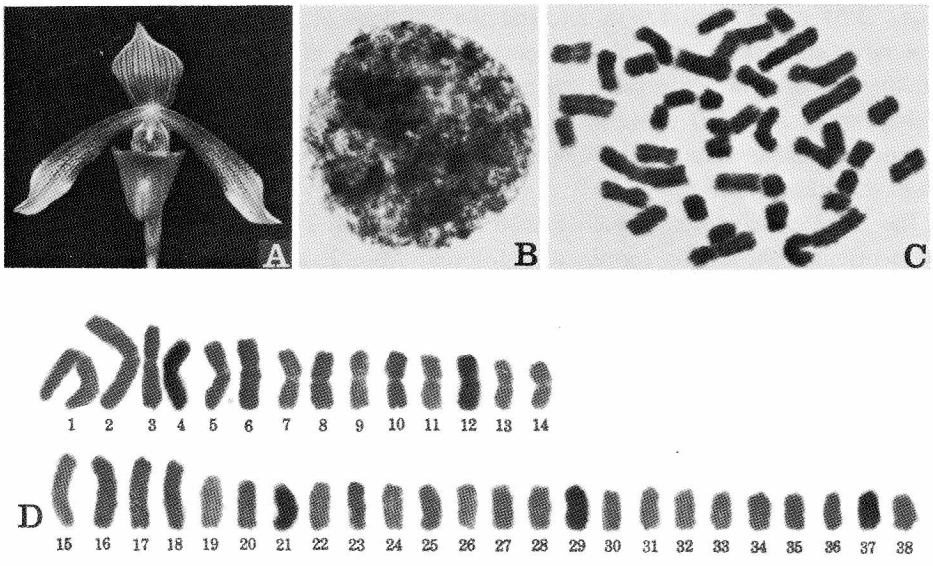


Fig. 46. *Paphiopedilum javanicum*, 2n=38. A, flower. B, interphase nucleus. C and D, somatic metaphase chromosomes. A, ×0.5. B-D, ×1200.

The chromosome number of 2n=36 in this species was previously reported by Duncan (1947) and Duncan & MacLeod (1950). In the present paper, however, the number of chromosomes of three clones of this species was examined to be 2n=38. The chromosomes at resting stage and mitotic phase were shown in Fig. 46. The results of the measurement of chromosome length and centromere position were shown in Table 48.

Among the 38 chromosomes two longest chromosomes (Nos. 1, 2) were distinguished. They were 13.2 μm and 12.8 μm in length. Their arm ratios were both 1.0, and the positions of centromeres were median. Twelve chromosomes (Nos. 3-14) of the ranged from 9.0 to 5.4 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Their arm ratios varied from 1.0 to 1.3, and the positions of centromeres were median. The leftover 24 chromosomes (Nos. 15-38) ranged from 8.2 to 4.0 μm in length, and decreased gradually in size. The positions of their centromeres were all terminal.

According to the morphology of chromosome complement, the 2n=38 chromosomes which form morphologically 19 pairs of matched chromosomes could be divided into two quantiative groups: One consisted of 14 metacentric chromosomes and the other consisted of 24 telocentric chromoeomes. Furthermore, these two grouped chromosomes were respectively divided into two quantiative groups: 14 metacentric chromosomes included one pair of large chromosomes and six pairs of small chromosomes and 24 telocentric chromosomes included two pairs of large chromosomes and ten pairs of small chromosomes.

5) *Paphiopedilum violascens* Schltr., 2n=38
Validated specimen No. 1196, 1318, 1319, 1320.

This species is found in Papua New Guinea. External morphological characteristics are as follows: The leaves are pale green, mottled with grayish green. The peduncle bears single flower. The dorsal sepal is purplish pink, and white at the margins, veined with reddish purple and green. The petals are strap shape, dark pinkish purple and white at the point (Fig. 47A).

The chromosome number of four clones of this species was examined to be 2n=38. The chromosomes at resting stage and mitotic phase were shown in Fig. 47. The results of the measurement of chromosome length and centromere position were shown in Table 49.

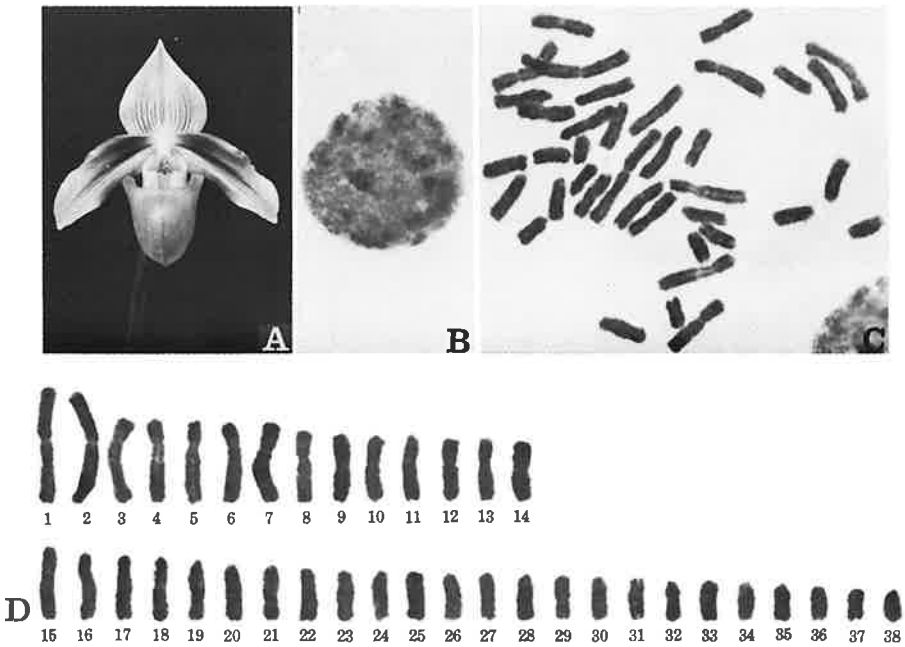


Fig. 47. *Paphiopedilum violascens*, 2n=38. A, flower. B, interphase nucleus. C and D, somatic metaphase chromosomes. A, × 0.4. B-D, × 1200.

Among the 38 chromosomes two longest chromosomes (Nos. 1, 2) were distinguished. They were each 12.8 μm and 12.7 μm in length. Their arm ratios were 1.1 and 1.2, and the positions of centromeres were median. Twelve chromosomes (Nos. 3-14) ranged from 9.1 to 6.5 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of four chromosomes (Nos. 3-6) out of these 12 chromosomes varied from 2.6 to 2.4, and the positions of centromeres were submedian. Arm ratios of eight chromosomes (Nos. 7-14) out of these chromosomes varied from 1.2 to 1.7, and the positions of centromeres were median. The leftover 24 chromosomes (Nos. 15-38) ranged from 7.8 to 3.5 μm in length, and the positions of centromeres were terminal. Four (Nos. 15-18) out of these telocentric chromosomes were clearly longer than the others.

Thus, this species was different from *P. mastersianum* (2n=36), in morphology of the chromosome complement of the karyotype. *P. violascens* contained 14 metacentric and 24 telocentric chromosomes.

6) *Paphiopedilum wentworthianum* Schoser & Fowlie, 2n=40
Validated specimen No. 1321.

This species is indigenous to the Bougainville Island. Externaly morphological characteristics are as follows: This species is similar to that of *P. violascens*. Upper dorsal

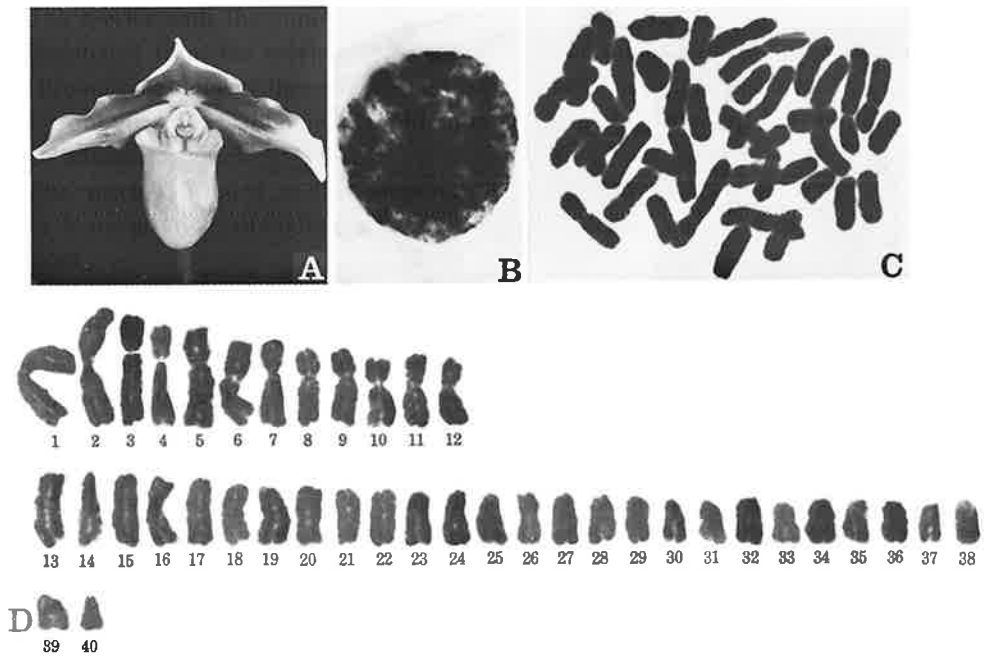


Fig. 48. *Paphiopedilum wentworthianum*, 2n=40. A, flower. B, interphase nucleus. C, somatic prometaphase chromosomes. D, somatic metaphase chromosomes. A, ×0.5. B-D, ×1200.

sepal is broader than that of *P. violascens*. The petals are broad at the middle and wavy at the margins. They spread slightly downwards. The color of petals is dark, brownish purple (Fig. 48A).

The chromosome number of this species was examined to be 2n=40. The chromosomes at resting stage and mitotic phase were shown in Fig. 48. The results of the measurement of chromosome length and centromere position were shown in Table 50.

Among the 40 chromosomes two longest chromosomes (Nos. 1, 2) were distinguished. They were both 13.5 μm in length. Arm ratios of their chromosomes were both 1.1, and the positions of centromeres were median. Ten chromosomes (Nos. 3-12) ranged from 11.2 to 7.5 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of the eight chromosomes (Nos. 3-10) varied from 2.0 to 1.8, and the positions of centromeres were all submedian. Arm ratios of the two chromosomes (Nos. 11, 12) were both 1.3, and the positions of centromeres were median. The leftover 28 chromosomes (Nos. 13- 40) ranged from 8.4 to 4.1 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. The positions of their centromeres were all terminal.

Thus, the 40 chromosomes of this species were consisted of 12 metacentric and 28 telocentric chromosomes. Compared with the chromosome complement of karyotype of *P. violascens* (2n=38), two metacentric chromosomes were decreased, and reversely increased four telocentric chromosomes. Furthermore, this species had the eitht sub-metacentric chromosomes (Nos. 3-10).

7) *Paphiopedilum bougainvilleanum* Fowl., 2n=40
Validated specimen No. 1028, 1213.

This species is found in Bougainville Island. External morphological characteristics of this tesselated species are similar to *P. violascens*. The flower of this species is basally green with less purplish pink (Fig. 49A).

The chromosome number of two clones of this species was examined to be 2n=40. The chromosomes at resting stage and mitotic phase were shown in Fig. 49. The results of the measurement of chromosome length and centromere position were shown in Table 51. The first 12 chromosomes (Nos. 1-12) out of the 40 chromosomes ranged from 11.0 to 7.9 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of six (Nos. 1-6) out of these 12 chromosomes varied from 2.0 to 2.2, and the positions of centromeres were submedian. Arm ratios of two chromosomes (Nos. 7, 8) were both 1.3, and the positions of centromeres were median. Arm ratios of four chromosomes (Nos. 9-12) varied from 1.9 to 2.0, and the positions of centromeres were submedian. The leftover 28 chromosomes (Nos. 13-40) ranged from 8.0 to 4.4 μm in length, and decreased gradually in size. The positions of centromeres of their chromosomes were all terminal.

According to the morphology of chromosome complement, this species was clearly different from *P. violascens* (2n=38). *Paphiopedilum bougainvilleanum* carried 40 chro-

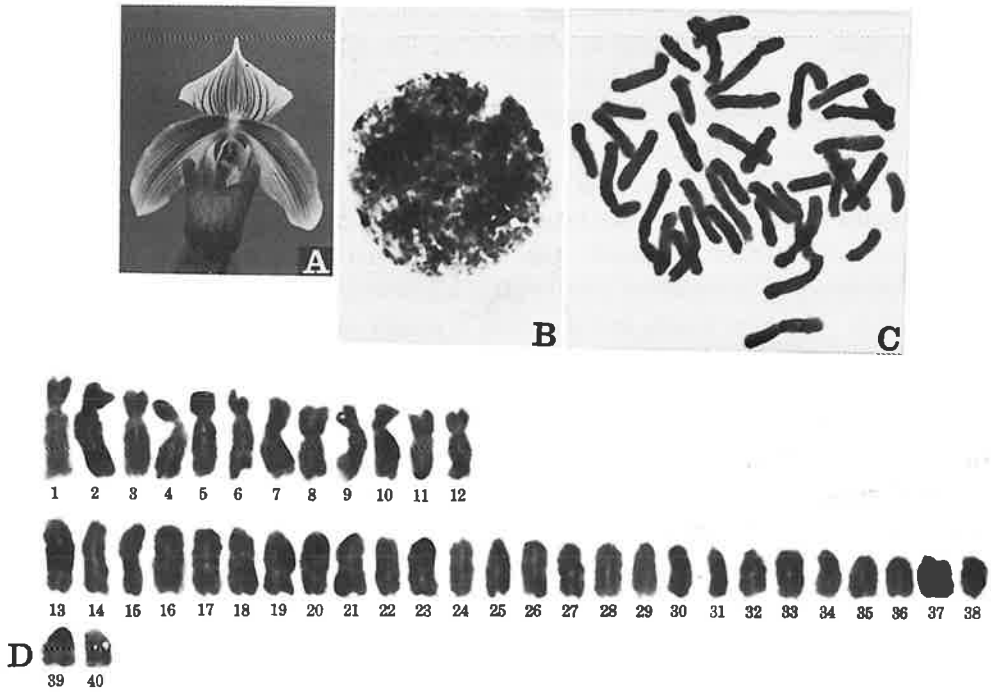


Fig. 49. *Paphiopedilum bougainvilleanum*, 2n=40. A, flower. B, interphase nucleus. C, somatic prometaphase chromosomes. D, somatic metaphase chromosomes. A, ×0.5. B-D, ×1200.

mosomes which can be divided into two groups: One consisted of 12 metacentric chromosomes and the other consisted of 28 telocentric chromosomes. In the 12 metacentric chromosomes which decreased gradually in size, there could not seen any marking chromosomes. In addition the position of centromeres of ten chromosomes (Nos. 1-6, 9-12) were submedian.

8) *Paphiopedilum Sukhakulii* Schoser-Senghas, 2n=40
Validated specimen No. 1048, 1076, 1094.

This species is found in Thailand. External morphological characteristics are as follows: The leaves are dark green, mottled with pale greenish white. The peduncle bears single flower. The dorsal sepal is white with the 10-13 green vertical stripes. The petals elongate horizontally, veined with dark green with brownish red spots, wholly (Fig. 50A).

The chromosome number of 2n=40 in this species was previously reported by Senghas & Schoser (1965) and Tanaka & Aoyama (1974). In the present investigation the number of chromosomes of three clones of this species was reexamined to be 2n=40. The chromosomes at resting stage and mitotic phase were shown in Fig. 50. The results of the measurement of chromosome length and centromere position were shown in Table 52.

Among the 40 chromosomes two longest chromosomes (Nos. 1, 2) were distinguished. They were 10.7 μm and 10.6 μm in length. Their arm ratios were both 1.1, and the positions of centromeres were median. Ten chromosomes (Nos. 3-12) ranged from 7.2 to 4.6 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Their arm ratios varied from 1.0 to 1.3, and the positions of centromeres were median. The leftover 28 chromosomes (Nos. 13- 40) ranged from 5.7 to 2.7 μm in length, and the positions of centromeres were all terminal. Four (Nos. 17-20) out of these telocentric chromosomes were clearly longer than the others. Twenty chromosomes (Nos. 21-40) were decreased gradually in size from the longest to the shortest chromosomes.

According to the morphology of chromosome complement, the 2n=40 chromosomes which form morphologically 20 pairs of matched chromosomes could be divided into two quantitative groups: One consisted of 12 metacentric chromosomes and the other consisted of 28 telocentric chromosomes. Among the 40 chromosomes 12 matacentric chromosomes included one pair of long chromosomes and five pairs of small chromosomes which decreased gdradually in size, while the other 28 telocentric chromosomes included two pairs of long chromosomes and 12 pairs of small chromosomes which decreased gradually in size.

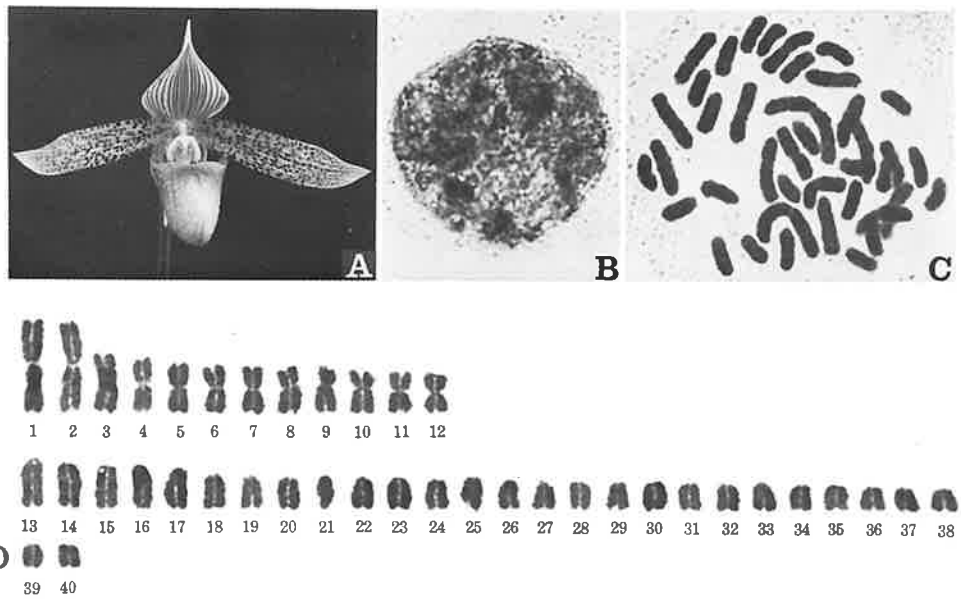


Fig. 50. *Paphiopedilum sukhakulii*, 2n=40. A, flower. B, interphase nucleus. C, somatic prometaphase chromosomes. D, somatic metaphase chromosomes. A, ×0.4. B-D, ×1200.

9) *Paphiopedilum purpuratum* (Lindl.) Pfitz., 2n=40
Validated specimen No. 1227, BG-4.

Paphiopedilum purpuratum, native to Hong Kong, is a dwarf species. External morphological characteristics are as follows: The leaves are dark green, mottled with pale green. The peduncle bears single flower. The dorsal sepal is white with purple vertical stripes. The petals are spathulate and dark purple with a lot of black warts at the base (Fig. 51A).

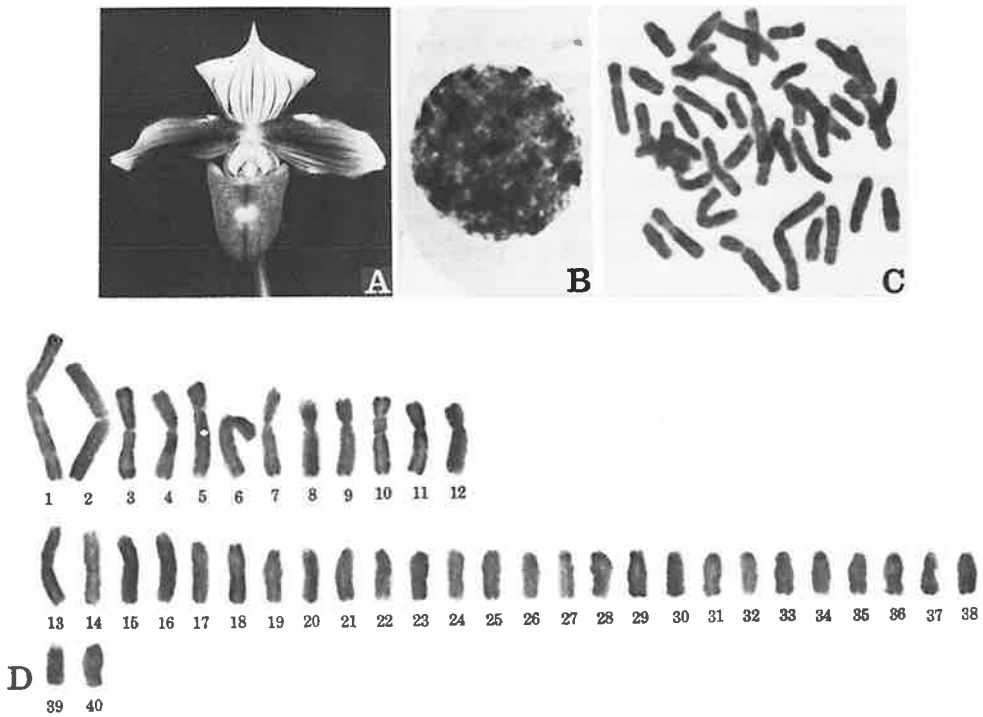


Fig. 51. *Paphiopedilum purpuratum,* 2n=40. A, flower. B, interphase nucleus. C, somatic prometaphase chromosomes. D, somatic metaphase chromosomes. A, ×0.6. B-D, ×1200.

The chromosome number of 2n=ca. 48 in this species was previously counted by Hofman (1930). In the present investigation, however, the number of chromosomes of two clones of this species was examined to be 2n=40. The chromosomes at resting stage and mitotic phase were shown in Fig. 51. The results of the measurement of chromosome length and centromere position were shown in Table 53.

Among the 40 chromosomes two longest chromosomes (Nos. 1, 2) were distinguished. They were 16.5 μm and 14.5 μm in length. Their arm ratios were 1.2 and 1.1 respectively, and the positions of centromeres were median. Ten chromosomes (Nos. 3-12) ranged from 10.3 to 7.8 μm in length, and decreased gradually in size. Arm ratios of two chromosomes (Nos. 3, 4) were both 2.4, and the positions of centromeres were submedian.

Arm ratios of four chromosomes (Nos. 5-8) were 1.2 and 1.6 respectively, and the positions of centromeres were median. Arm ratios of four chromosomes (Nos. 9-12) were 1.9 and 1.8 respectively, and the positions of centromeres were submedian. The leftover 28 chromosomes (Nos. 13- 40) ranged from 8.7 to 4.3 μm in length, and the positions of centromeres were terminal. Four (Nos. 13-16) of their telocentric chromosomes were clearly longer than the other telocentric chromosomes which decreased gradually in size. The 2n=40 chromosomes were composed of 12 metacentric and 28 telocentric chromosomes. According to the morphology of chromosome complement this species was clearly different from above *P. sukhakulii*. *P. purpuratum* was characterized by the six submetacentric chromosomes (Nos. 3, 4, 9-12).

10) *Paphiopedilum virens* (Rchb. f.) Pfitz., 2n=40
Validated specimen No. 1045, 1047, 1152, 1322.

This species is found in Mt. Kinabalu in northern Borneo. External morphological characteristics are as follows: The leaves are green, mottled with greenish white. The peduncle bears single flower. The dorsal sepal is pale green with about 20 dark green stripes. The petals are strap shaped and spread horizontally. The color is pale green and pinkish purple with brown spots at the top (Fig. 52A).

The number of chromosomes of four clones of this species was counted to be 2n=40. The chromosomes at resting stage and mitotic phase were shown in Fig. 52. The results

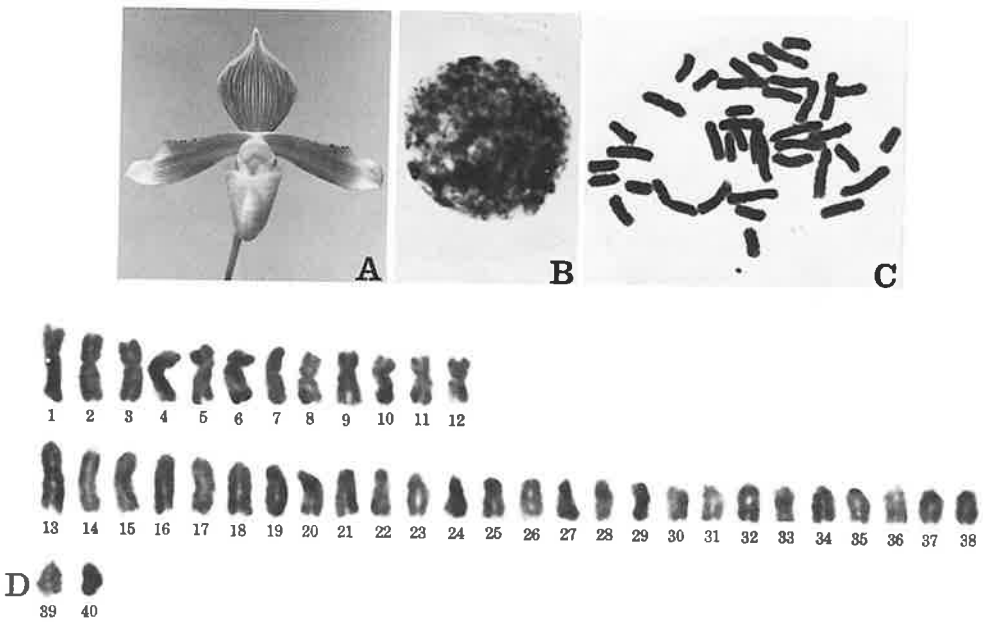


Fig. 52. *Paphiopedilum virens*, 2n=40. A, flower. B, interphase nucleus. C, somatic prometaphase chromosomes. D, somatic metaphase chromosomes. A, $\times$0.4. B-D, $\times$1200.

of the measurement of chromosome length and centromere position were shown in Table 54.

Among the 40 chromosomes 12 chromosomes (Nos. 1-12) ranged from 8.1 to 5.4 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratio of the first chromosome was 1.7 and arm ratios of the next three chromosomes (Nos. 2-4) were all 1.4. The positions of centromeres of these four chromosomes were all median. Arm ratios of two chromosomes (Nos. 5, 6) were both 2.3, and the positions of centromeres were submedian. Arm ratios of six chromosomes (Nos. 7-12) varied from 1.1 to 1.6, and the positions of centromeres were median. The leftover 28 chromosomes (Nos. 13- 40) ranged from 7.5 to 3.6 μm in length, and decreased gradually in size. The positions of their centromeres were terminal. At earlier metaphase two nucleoli were observed. Since certain chromosomes are easily cut off technically at position of nucleolar organizer during preparation of slides, the number of chromosomes had been often mis-documented to be 2n=42.

According to the morphology of chromosome complement this species was clearly different from *P. sukhakulii.* This species did not have quite long chromosome among the 12 metacentric chromosomes which decreased gradually in size from the longest to the shortest chromosomes. Furthermore, the positions of centromeres of two chromosomes (Nos. 5, 6) were submedian and the arm ratio of the first chromosome (1.7) was higher than that of the second chromosome (1.4).

4. BARBATA

1) *Paphiopedilum callosum* (Rchb. f.) Pfitz., 2n=32
Validated specimen No. 1042, 1054, 1323, 1324.

This species is native to Thailand and Cambodia. External morphological characteristics are as follows: The leaves are dark green, mottled with pale green. The peduncle bears single flower. The dorsal sepal is broad and large. The color is white, splashed with pale purple at the base and veined with vertical dark purple. The petals are strap-shaped and elongate downward, and are same as the dorsal sepal in color and pale purple at the tips. The superior margin bears warts and hairs (Fig. 53A).

The chromosome number of 2n=32 in this species was previously documented by Mehlquist (1947), Duncan (1947), Duncan & MacLeod (1950), Kamemoto *et al.* (1963) and Tanaka & Aoyama (1974). In the present investigation with seven clones of this species the chromosome number was reexamined to be 2n=32. The chromosome at mitotic phase were shown in Fig. 53. The results of the measurement of chromosome length and centromere position were shown in Table 55.

Among the 32 chromosomes two longest chromosomes (Nos. 1, 2) were distinguished. They were 10.6 μm and 9.9 μm in length. Their arm ratios were 1.0 to 1.1, and the positions of centromeres were median. Eighteen chromosomes (Nos. 3-20) ranged from 6.8 to 3.7 μm in length, and decreased gradually in size. Their arm ratios varied from

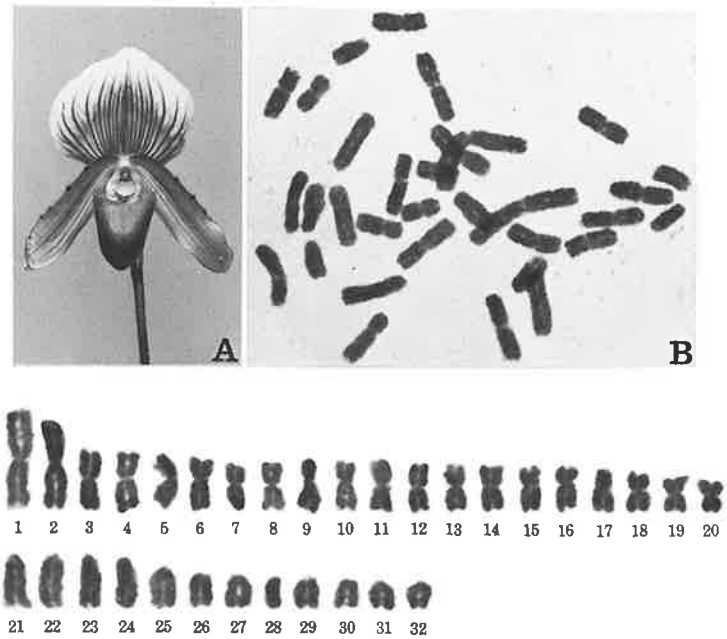


Fig. 53. *Paphiopedilum callosum*, 2n=32. A, flower. B and C, somatic metaphase chromosomes. A, ×0.3. B and C ×1200.

1.1 to 1.5, and the positions of centromeres were median. Twelve chromosomes (Nos. 21-32) ranged from 6.0 to 3.1 μm in length, and the positions of centromeres were terminal. Four (Nos. 21-24) of their telocentric chromosomes were clearly longer than the others which decreased gradually in size.

According to the morphology of chromosome complement the 32 chromosomes which form morphologically 16 pairs of chromosomes could be divided into two quantitative groups: One consisted of 20 metacentric chromosomes and the other consisted of 12 telocentric chromosomes. Among these chromosomes the 20 metacentric chromosomes contained one pair of long chromosomes and nine pairs of short chromosomes which decreased gradually in size, while the 12 telocentric chromosomes included two pairs of long chromosomes and four pairs of short chromosomes.

2) *Paphiopedilum ciliorare* (Rchb. f.) Pfitz., 2n=32
Validated specimen No. 1206, BG-63.

This species is found in Luzon and Mindanao in the Philippines. External morphological characteristics are as follows: The leaves are dark green, mottled with pale green. The peduncle bears single flower. The dorsal sepal is broad and large. Its base color is white with purple at the base, and with greenish purple vertical stripes. The petals are strap-shaped, bearing purplish black hairs at the margins. Its color is pale purple with purplish brown spots and warts, at the superior margin (Fig. 54A).

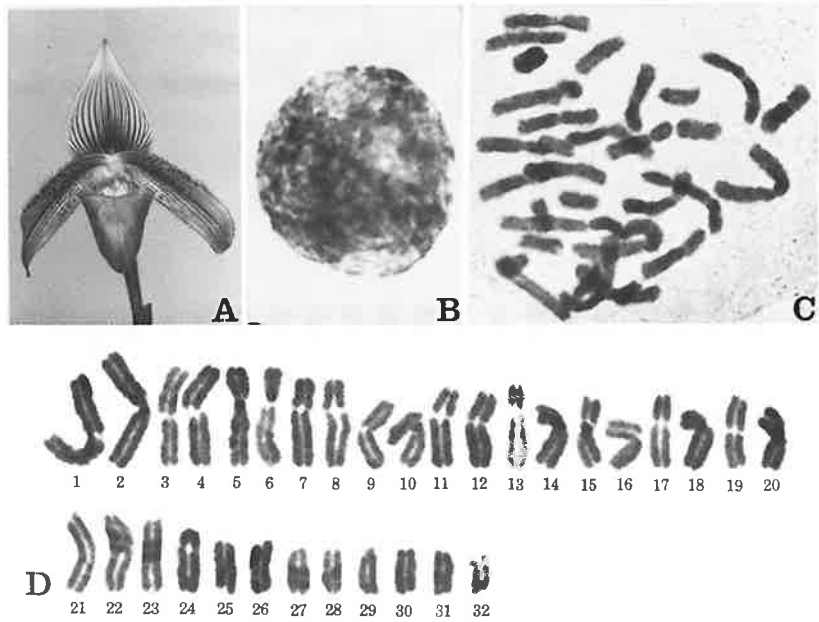


Fig. 54. *Paphiopedilum ciliolare*, 2n=32. A, flower. B, interphase nucleus. C, somatic prometaphase chromosomes. D, somatic metaphase chromosomes. A, ×0.3. B-D, ×1200.

The chromosome number of this species was counted in two clones to be 2n=32. The chromosomes at resting stage and mitotic phase were shown in Fig. 54. The results of the measurement of chromosome length and centromere position were shown in Table 56.

Among the 32 chromosomes two longest chromosomes (Nos. 1, 2) were distinguished. They were both 14.5 μm in length. Their arm ratios were both 1.1, and the positions of centromeres were median. Eighteen chromosomes (Nos. 3-20) ranged from 11.0 to 7.8 μm in length, and decreased gradually in size. Arm ratios of two chromosomes (Nos. 3, 4) were both 1.0, and the positions of centromeres were median. Arm ratios of four chromosomes (Nos. 5-8) were 1.8 and 1.9 respectively, and the positions of centromeres were submedian. Arm ratios of the next four chromosomes (Nos. 9-12) were 1.1 and 1.5 respectively, and the positions of centromeres were median. Arm ratios

of two chromosomes (Nos. 13, 14) were both 1.8, and the positions of centromeres were submedian. Arm ratios of two chromosomes (Nos. 15, 16) were both 1.1, and the positions of centromeres were median. Arm ratios of four chromosomes (Nos. 17-20) were 1.6 and 1.1 respectively, and the positions of centromeres were median. The leftover 12 chromosomes (Nos. 21-32) ranged from 9.0 to 4.5 μm in length, and the positions of centromeres were terminal. Among these 12 telocentric chromosomes four chromosomes (Nos. 21-24) were clearly longer than the others which decreased gradually in size.

According to the morphology of chromosome complement, this species was similar to *P. callosum* except for the presence of six submetacentric chromosomes (Nos. 5-8, 13, 14).

3) *Paphiopedilum acmodontum* Schoser, 2n=36
Validated specimen No. 1084, BG-5.

This species is found in the Philippines. External morphological characteristics of this species are as follows: The surface of the leaves are green, mottled with greenish white. The peduncle bears single flower. The dorsal sepal is inversed heart shape and is white, shaded with rose and having numerous brown purple veins in color. The petals are spathulate and green basally, shading to pinkish purple distally in color, and the margins of them bear hairy warts (Fig. 55A).

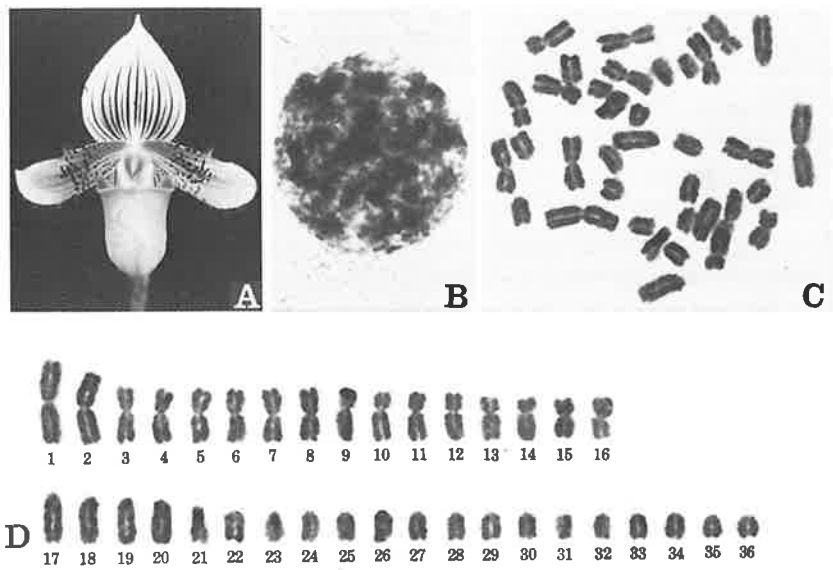


Fig. 55. *Paphiopedilum acmodontum*, 2n=36. A, flower. B, interphase nucleus. C and D, somatic metaphase chromosomes. A, × 0.4. B-D, × 1200.

The chromosome number of two clones of this species was examined to be 2n=36. The chromosomes at resting stage and mitotic phase were shown in Fig. 55. The results of the measurement of chromosome length and centromere position were shown in Table 57.

Among the 36 chromosomes two longest chromosomes (Nos. 1, 2) were distinguished. They were 10.0 μm and 8.8 μm in length. Their arm ratios were both 1.0, and the positions of centromeres were median. Fourteen chromosomes (No. 3-16) ranged from 6.9 to 4.7 μm, and decreased gradually in size from the longest to the shortest chromosomes. Their arm ratios varied from 1.0 to 1.7, and the positions of centromeres were median. The leftover 20 chromosomes (Nos. 17-36) ranged from 6.0 to 2.6 μm in length, and the positions of centromeres were terminal. Four (Nos. 17-20) of 20 telocentric chromosomes were clearly longer than the other 16 chromosomes which were decreased in descending order of size.

The 2n=36 chromosomes included 16 metacentric and 20 telocentric chromosomes. Among the 36 chromosomes 16 metacentric chromosomes included a pair of long chromosomes and seven pairs of small chromosomes which decreased gradually in size, while the other 20 telocentric chromosomes included two pairs of long chromosomes and eight pairs of small chromosomes which decreased gradually in size.

4) *Paphiopedilum lawrenceanum* (Rchb. f.) Pfitz., 2n=36
Validated specimen No. 1079.

This species is native to northern Borneo. External morphological characterisics are as follows: The leaves are dark green, mottled with yellowish green. The dorsal sepal is broad and large. The base color is white, splashed with pale purple, and green at the tips and with 12-13 greenish brown vertical stripes. The petals elongate horizontally, and yellowish green with black purple warts (Fig. 56A).

The chromosome number of 2n=36 in this species was previously reported by Mehlquist (1947) and McQuade (1949), and that of 2n=40 by Duncan & MacLeod (1950). In the present investigation the chromosome number of this species was examined to be 2n=36. The chromosomes at resting stage and mitotic phase were shown in Fig. 56. The results of the measurement of chromosome length and centromere position were shown in Table 58. The 2n=36 chromosomes included 16 metacentric and 20 telocentric chromosomes.

Among the 16 metacentric chromosomes two longest chromosomes (Nos. 1, 2) were distinguished. They were 13.4 μm and 12.9 μm in length respectively. Their arm ratios were both 1.2, and the positions of centromeres were median. Fourteen chromosomes (Nos. 3-16) ranged from 9.2 to 6.0 μm in length, and decreased gradually in size. Arm ratios of six chromosomes (Nos. 3-8) varied from 1.0 to 1.5, and the positions of centromeres were median. Arm ratios of two chromosomes (Nos. 9, 10) were 2.4 and 2.5, and the positions of centromeres were submedian. Arm ratios of six chromosomes (Nos. 11-16) varied from 1.1 to 1.6, and the positions of centromeres were median. The leftover 20 chromosomes (Nos. 17-36) ranged from 8.2 to 4.4 μm in length, and the positions of

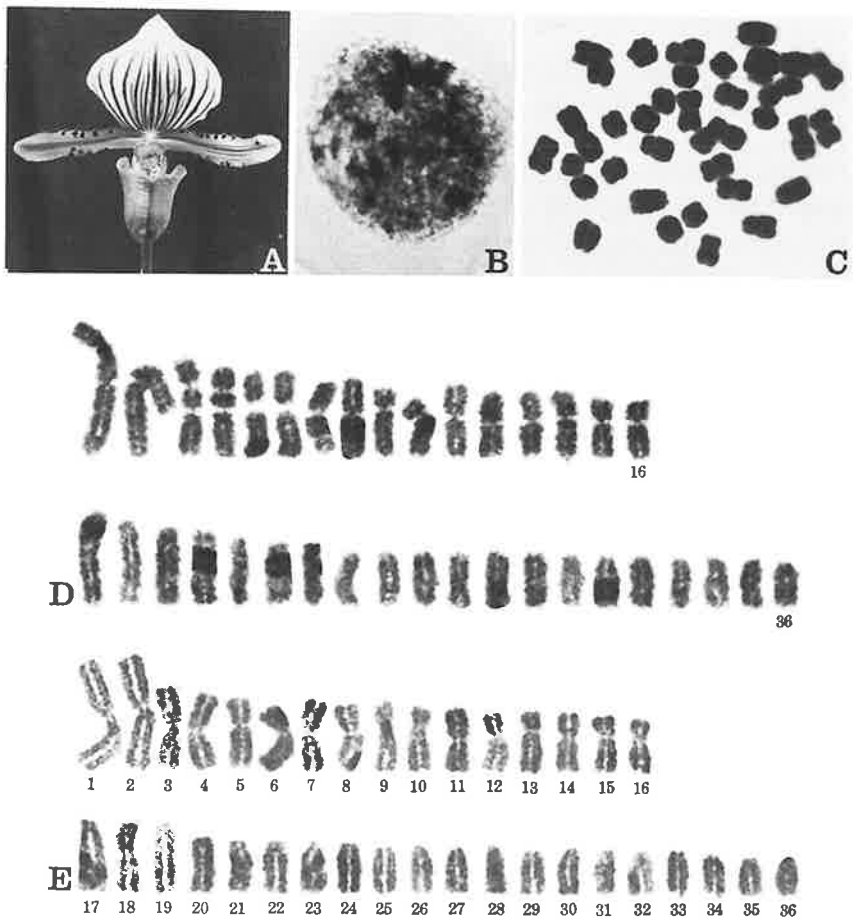


Fig. 56. *Paphiopedilum lawrenceanum*, 2n=36. A, flower. B, interphase nucleus. C and E, somatic metaphase chromosomes. D, somatic prometaphase chromosomes. A, × 0.3. B-E, × 1200.

centromeres were terminal. Three (Nos. 17-19) of the 20 telocentric chromosomes were clearly longer than the others which decreased gradually in size.

According to the observation of prometaphase chromosomes (Fig. 56D), two chromosomes (Nos. 3, 4) had clearly small constrictions in their short arms. Their small constrictions got obscure themselves at metaphase. A wide gap was often seen at the centromeric regions of the two chromosomes (Nos. 5, 6) at earlier metaphase, and

it could be easily broken physically by the chromosome squash technique during the preparation of slides. As a result, two armed chromosomes (Nos. 5, 6) sometimes produce two artificial one-armed chromosomes.

According to the morphology of chromosome complement this species was similar to *P. acmodontum* except for the presence of two small submetacentric chromosomes (Nos. 9, 10).

5) *Paphiopedilum hennisianum* Schoser, 2n=36
Validated specimen No. 1096, 1228.

This species is collected in the Visayan area of the Philippines. External morphological characteristics are as follows: The leaves are green, mottled with pale green. The peduncle bears single flower. The dorsal sepal is ovate and white with a lot of vertical green stripes. The petals are strap-shaped and white, veined with green and shaded with pink at the middle. The petals bears purplish brown, hairly warts at the margins (Fig. 57A).

The chromosome number of this species was examined in two clones to be 2n=36. The chromosomes at resting stage and mitotic phase were shown in Fig. 57. The results of the measurement of chromosome length and centromere position were shown in Table 59.

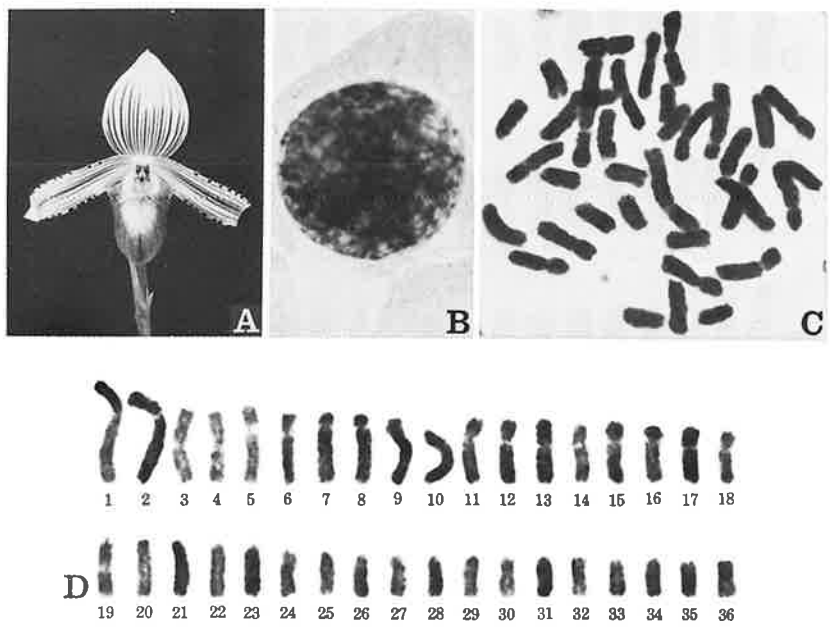


Fig. 57. *Paphiopedilum hennisianum*, 2n=36. A, flower. B, interphase nucleus. C and D, somatic metaphase chromosomes. A, × 0.4. B-D, × 1200.

Among the 36 chromosomes two longest chromosomes (Nos. 1, 2) were distinguished. They were 11.6 μm and 11.5 μm in length. Their arm ratios were 1.8 and 1.9, and the positions of centromeres were submedian. Sixteen chromosomes (Nos. 3-18) of them ranged from 8.2 to 6.2 μm in length, and decreased gradually in size. Arm ratios of two chromosomes (Nos. 3, 4) were both 1.1, and the positions of centromeres were median. Arm ratios of two chromosomes (Nos. 5, 6) were both 2.2, and the positions of centromeres were submedian. Both the long and short arms of each of these chromosomes could be easily separated into two telocentric chromosomes by centric fission. Arm ratios of two chromosomes (Nos. 7, 8) were both 3.4, and the positions of centromeres were subterminal. Arm ratios of four chromosomes (Nos. 9-12) were 2.0 and 1.9, respectively and the positions of centromeres were submedian. Arm ratios of two chromosomes (Nos. 13, 14) were both 1.4, and the positions of centromeres were median. Arm ratios of two chromosomes (Nos. 15, 16) were both 1.8, and the positions of centromeres were submedian. Arm ratios of two chromosomes (Nos. 17, 18) were 1.6 and 1.7 respectively, and the positions of centromeres were median. The leftover 18 chromosomes (Nos. 19-36) ranged from 6.5 to 4.1 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. The positions of centromeres of their chromosomes were all terminal.

According to the morphology of chromosome complement, this species was clearly different from *P. lawrenceanum*. *P. hennisianum* had 18 metacentric chromosomes while *P. lawrenceanum* had 16 metacentric chromosomes. In contrast, *P. hennisianum* had 18 telocentric chromosomes while *P. lawrenceanum* had 20 telocentric chromosomes. Furthermore, *P. hennisianum* had 10 submetacentric and two subtelocentric chromosomes.

6) *Paphiopedilum curtisii* (Rchb. f.) Pfitz., 2n=36
Validated specimen No. 1215, 1275.

This species, native to Sumatra, is extremely similar to *P. superbiens*. *P. curtisii* was reduced into a synonym of *P. superbiens* (Wood 1975). In the present investigation, because of karyotypic differences *P. curtisii* and *P. superbiens* are independently discussed.

External morphological characteristics are as follows: The leaves are green, mottled with pale yellowish green. The peduncle bears single flower. The dorsal sepal is broad, and green in the middle, white at the margins and veined with vertical purplish brown stripes. The petals stretch horizontally or somewhat elongate downward. The color is same as the dorsal sepal, with many purplish brown spots (Fig. 58A).

The chromosome number of 2n=36 in this species was previously documented by Mehlquist (1947) and Duncan & MacLeod (1950). In the present investigation the chromosome number of this species was reexamined in two clones to be 2n=36. The chromosomes at resting stage and mitotic phase were shown in Fig. 58. The results of the measurement of chromosome length and centromere position were shown in Table 60.

Among the 36 chromosomes two longest chromosomes (Nos. 1, 2) were distinguished. They were 12.5 μm and 12.0 μm in length. Their arm ratios were 1.2 and 1.1, and the

positions of centromeres were median. Fourteen chromosomes (Nos. 3-16) ranged from 9.0 to 5.3 μm in length, and decreased gradually in size. Their arm ratios varied from 1.0 to 1.7, and the positions of centromeres were median. Arm ratio of the fourth chromosome of them was 1.7, and was higher than that of the third chromosome. The leftover 20 chromosomes (Nos. 17-36) ranged from 7.8 to 4.3 μm in length, and the positions of centromeres were terminal. Four (Nos. 17-20) among these 20 chromosomes were clearly longer than the others which decreased gradually in size.

According to morphology of the chromosome complement of the karyotype the 2n=36 chromosomes, which formed morphologically 18 pairs of matched chromosomes, could be divided into two quantitative groups: One consisted of 16 metacentric chromosomes and the other consisted of 20 telocentric chromosomes. Among these 36 chromosomes 16 metacentric chromosomes included a pair of long chromosomes and seven pairs of short chromosomes. In contrast, the 20 telocentric chromosomes were made out of two pairs of long chromosomes and eight pairs of short chromosomes which decreased gradually in size. As mentioned this species was extremely similar to *P. acmodontum*, in morphology of the chromosome complement of the karyotype.

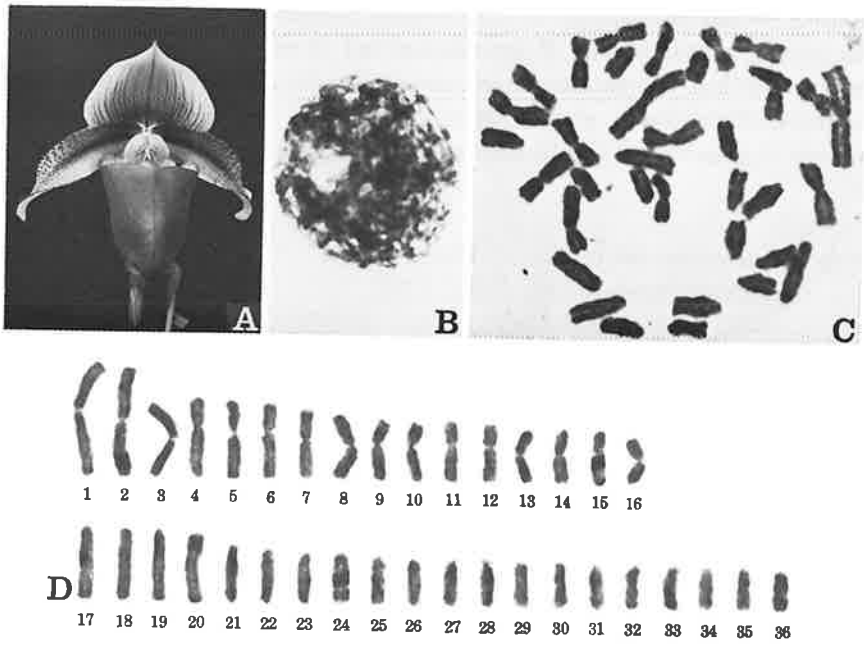


Fig. 58. *Paphiopedilum curtisii*, 2n=36. A, flower. B, interphase nucleus. C and D, somatic metaphase chromosomes. A, ×0.4. B-D, × 1200.

7) *Paphiopedilum superbiens* (Rchb. f.) Pfitz., 2n=38
Validated specimen No. 1097, 1113, 1245.

This species is endemic to the Molucca Islands, Indonesia. External morphological characteristics are as follows: The leaves are dark green, mottled with greenish white. The peduncle bears single flower. The dorsal sepal of this species is narrower and more oblong than that of *P. curtisii.* The base color is white with purplish black veins. The petals are longer than that of above species. They are strap-shaped and somewhat pendulous and twisted. Their base color is white with greenish brown veins and numerous black purple warts and purplish black hairs (Fig. 59A).

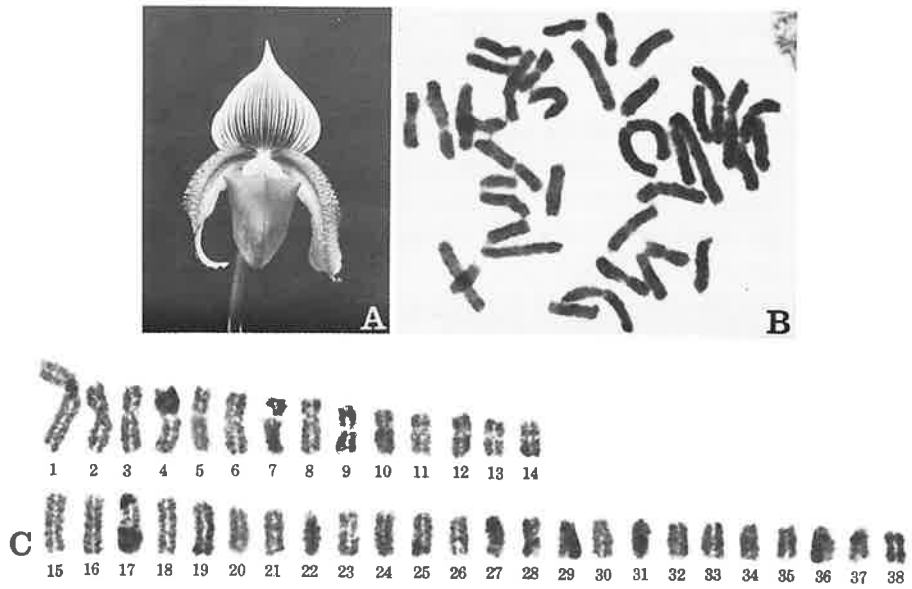


Fig. 59. *Paphiopedilum superbiens,* 2n=38. A, flower. B, somatic prometaphase chromosomes. C, somatic metaphase chromosomes. A, ×0.3. B and C, ×1200.

The chromosome number of 2n=38 in this species was previously examined by Duncan (1947) and Duncan & MacLeod (1950). In the present investigation the number of chromosomes was reexamined in three clones to be 2n=38. The chromosomes at mitotic phase were shown in Fig. 59. The results of the measurement of chromosome length and centromere position were shown in Table 61.

Among the 38 chromosomes the first chromosome was extremely long and was 12.8 μm in length. The arm ratio was 1.3, and the position of centromere was median. The second chromosome, on the other hand, was 8.7 μm in length. The arm ratio was 1.1, and the position of centromere was median. Twelve chromosomes (Nos. 3-14) of them ranged from 7.7 to 4.4 μm in length, and decreased gradually in size. Arm ratios of four chromosomes (Nos. 3-6) varied from 1.1 to 1.3, and the positions of centromeres were median.

Arm ratios of two chromosomes (Nos. 7, 8) were both 2.0, and the positions of centromeres were submedian. Arm ratios of six chromosomes (Nos. 9-14) varied from 1.0 to 1.7, and the positions of centromeres were median. The leftover 24 chromosomes (Nos. 15-38) ranged from 7.0 to 3.8 μm in length, and decreased gradually in size. The positions of centromeres of their chromosomes were all terminal.

According to the morphology of chromosome complement this species was clearly different from *P. curtisii: P. superbiens* had the 12 metacentric and two submetacentric and 24 telocentric chromosomes which decreased gradually in size from the longest to the shortest chromosomes. Furthermore the first and the second chromosomes of this species did not match with each other.

8) *Paphiopedilum barbatum* (Lindl.) Pfitz., 2n=38
Validated specimen No. 1018, 1064.

This species is distributed in the Malay Peninsula. External morphological characterestics are as follows: The leaves are dark green with a mottling of pale green. The peduncle bears single flower. The dorsal sepal is broad and greenish white with vertical purple veins. The petals are strap-shaped and purplish green with purplish black warts and hairs at the martins (Fig. 60A).

The chromosome number of 2n=38 in this species was previously reported by Francini (1934), Duncan (1947) and Duncan & MacLeod (1950). In the present investigation

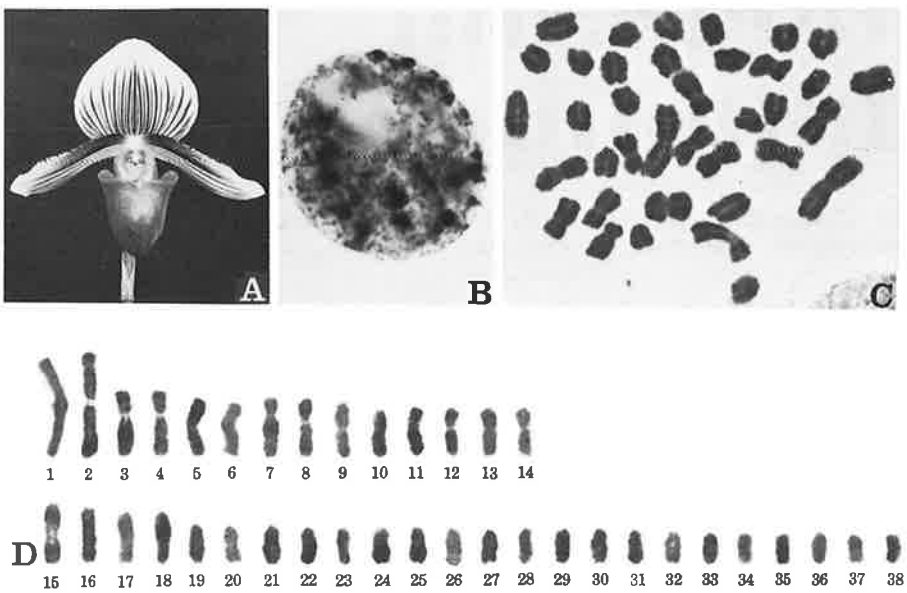


Fig. 60. *Paphiopedilum barbatum*, 2n=38. A, flower. B, interphase nucleus. C and D, somatic metaphase chromosomes. A, ×0.5. B-D, ×1200.

the number of chromosomes was reexamined in two clones to be 2n=38. The chromosomes at resting stage and mitotic phase were shown in Fig. 60. The results of the measurement of chromosome length and centromere position were shown in Table 62.

Among the 38 chromosomes two longest chromosomes (Nos. 1, 2) were distinguished. They were both 11.9 μm in length. Their arm ratios were both 1.1, and the positions of centromeres were median. Twelve chromosomes (Nos. 3-14) ranged from 7.3 to 5.4 μm in length, and decreased gradually in size from the longest to the shortest chromosomes. Arm ratios of two chromosomes (Nos. 3, 4) were both 1.8, and the positions of centromeres were submedian. Arm ratios of two chromosomes (Nos. 5, 6) were both 1.0, and the positions of centromeres were median. Arm ratios of two chromosomes (Nos. 7, 8) were 1.9 and 1.8, respectively, and the positions of centromeres were submedian. Arm ratios of six chromosomes (Nos. 9-14) varied from 1.1 to 1.3, and the position of centromeres were median. The leftover 24 chromosomes (Nos. 15-38) ranged from 6.8 to 3.2 μm in length, and the positions of centromeres were terminal. Four chromosomes (Nos. 15-18) among their telocentric chromosomes were clearly longer than the others which decreased gradually in size.

The 2n=38 chromosomes were composed of 14 metacentric and 24 telocentric chromosomes. According to the morphology of chromosome complement this species was similar to *P. javanicum* except for the four small submetacentric chromosomes (Nos. 3, 4, 8, 9).

9) *Paphiopedilum argus* (Rchb. f.) Pfitz., 2n=38
Validated specimen No. BG-57, HU-4.

This species is distributed in Oriental Negros and Luzon in the Philippines. External morphological characteristics are as follows: The leaves are dark green, mottled with pale green. The peduncle bears single flower. The dorsal sepal is white with brownish green veins, same as the petals. The points of the petals are purple with purplish black dots and the margins of them bear purplish black warts, ciliated with same color (Fig. 61A).

The chromosome number of 2n=26 in this species was previously reported by Pancho (1965), and that of 2n=38 was reported by Tanaka & Aoyama (1974). In the present investigation the number of chromosomes was examined in three clones to be 2n=38. The chromosomes at resting stage and mitotic phase were shown in Fig. 61. The results of the measurement of chromosome length and centromere position were shown in Table 63. The 2n=38 chromosomes were made up of 14 metacentric and 24 telocentric chromosomes.

The 14 metacentric chromosomes (Nos. 1-14) ranged from 11.1 to 7.8 μm in length, and decreased gradually in size. Arm ratios of two chromosomes (Nos. 1, 2) were both 1.8, and the positions of centromeres were submedian. Arm ratios of two chromosomes (Nos. 3, 4) were both 1.2, and the positions of centromeres were median. Arm ratios of two chromosomes (Nos. 5, 6) were both 1.8, and the positions of centromeres were

submedian. Arm ratios of six chromosomes (Nos. 7-12) varied from 1.0 to 1.5, and the positions of centromeres were median. Arm ratio of the 13th chromosome was 2.0, and the position of centromere was submedian. Arm ratio of the 14th chromosome was 1.6, and the position of centromere was median. The leftover 24 chromosomes (Nos. 15-38) ranged from 9.1 to 4.4 μm in length, and decreased gradually in size and the positions of centromeres were terminal.

According to the morphology of chromosome complement *P. argus* was clearly different from *P. javanicum,* since both the 14 metacentric and the 24 telocentric chromosomes of *P. argus* were decreased gradually in size from the longest to the shortest chromosomes and any particular chromosome with regard to length was not distinct. Furthermore *P. argus* had five submetacentric chromosomes (Nos. 1, 2, 5, 6, 13) in their chromosome complement of the karyotype.

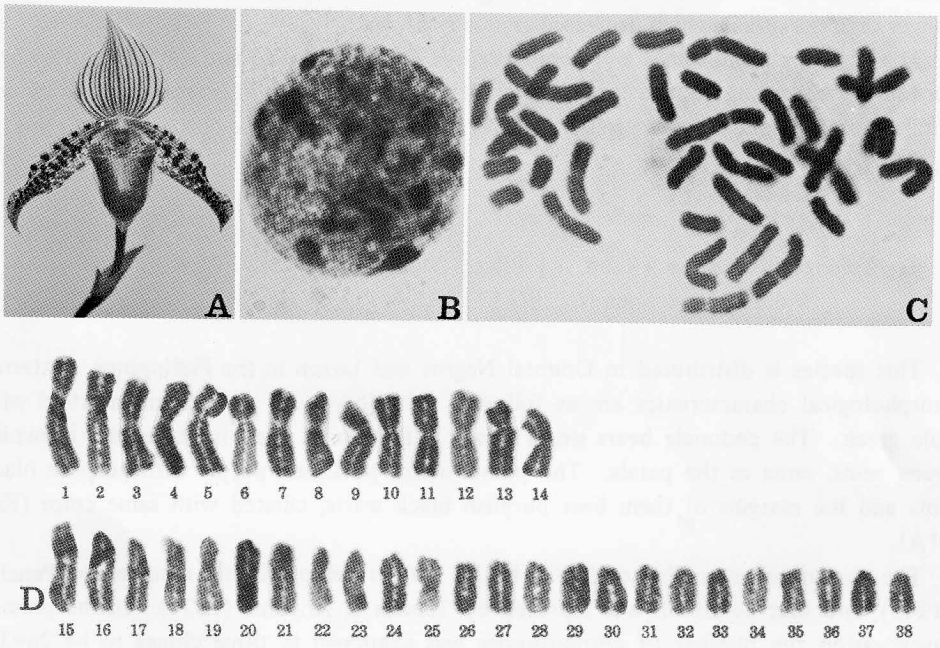


Fig. 61. *Paphiopedilum argus,* 2n=38. A, flower. B, interphase nucleus. C, somatic prometaphase chromosomes. D, somatic metaphase chromosomes. A, × 0.4. B-D, × 1200.

10) *Paphiopedilum venustum* (Wall.) Pfitz., 2n=40, 41
Validated specimen No. 1053, 1057, 1070, BG-59, HU-5.

This species is native to Nepal and Assam. External morphological characteristics are as follows: The upper surface of the leaf is dark green, mottled with grayish green.

The underside of the leaf bears purple anthocyanin pigments in the whole. The peduncle bears single flower. The dorsal sepal is white with dark green vertical stripes. The petals are strap-shaped, with white hairs at the margins. The color of the petals are green at the base and pale pink at the tips and veined with purplish black at the central vein (Fig. 62A). Although two cytotypes with 2n=40 and 2n=41 were found in this species (Tanaka & Aoyama 1974), their flowers showed no morphological difference.

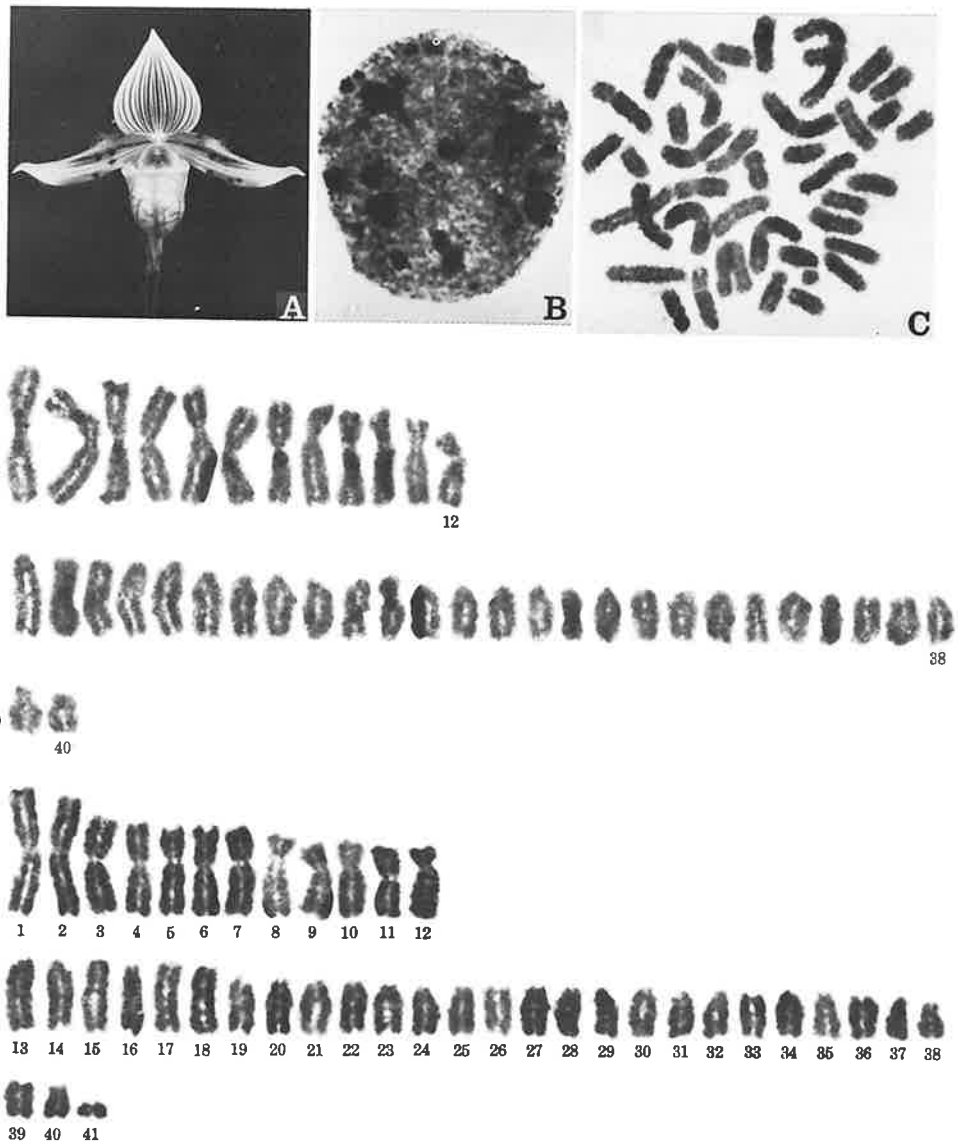


Fig. 62. *Paphiopedilum venustum*, 2n=40, 41. A, flower (2n=40). B, interphase nucleus (2n=40). C, somatic prometaphase chromosomes (2n=41). D, somatic metaphase chromosomes (2n=40). E, somatic metaphase chromosomes (2n=40). A, × 0.4. B-E × 1200.

The chromosome number of 2n=42 in this species was previously reported by Duncan (1947) and Duncan & MacLeod (1950), and differently, 2n=40, 41 by Tanaka & Aoyama (1974). In the present investigation the number of chromosomes was reexamined in a clone to be 2n=40 (Fig. 62D) and in four clones to be 2n=41 (Fig. 62C, E). The chromosomes at resting stage and mitotic phase were shown in Fig. 62. The results of the measurement of chromosome length and centromere position were shown in Table 64. The 2n=40 chromosomes included 12 metacentric and 28 telocentric chromosomes.

Among the 40 chromosomes 12 (Nos. 1-12) ranged from 15.4 to 8.3 μm in length, and decreased gradually in size. Arm ratios of eight chromosomes (Nos. 1-7, 11) varied from 1.1 to 1.6, and the positions of centromeres were median. Arm ratios of four chromosomes (Nos. 8-10, 12) varied from 1.8 to 2.1, and the positions of centromeres were submedian. The leftover 28 chromosomes (Nos. 13-40) ranged from 9.0 to 4.6 μm in length, and decreased gradually in size. The positions of centromeres of their chromosomes were all terminal.

According to the morphology of chromosome complement, *P. venustum* was clearly different from *P. bullenianum* (2n=40), since *P. venustum* had the four submetacentric chromosomes (Nos. 8-10, 12).

The clone with the chromosome number of 2n=41 was similar to the clone with the chromosome number of 2n=40 in regard to morphology of chromosomes, except it had a small accessary chromosome (1.8 μm in length).

Discussion

I Karyomorphological characteristics of *Paphiopedilum*

Interphase nuclei of all the species of *Paphiopedilum* were the chromocenter type (cf. Tanaka 1971) and had approximately ten chromocenters of which border was not rounded but complicated and transformed gradually to the diffused chromatin. At prophase chromosomes were stained uniformly and could not be distinguished between heterochromatin and euchromatin.

Several small constrictions were observed in certain chromosomes at somatic prometaphase in *P. bellatulum* (2n=26), *P. stonei* (2n=26), *P. tonsum* (2n=32) and others. However, those small constrictions turned not to be clearly visible at metaphase because of the shortening of chromosomes. In addition, some easily brokenable chromosomes may be observed at prometaphase; e. g., the 15th and 16th chromosomes in *P. tonsum*, the 5th and 6th chromosomes in *P. lawrenceanum* and the 5th and 6th chromosomes in *P. hennisianum*.

In contrast to the similarity of morphological features of interphase chromosomes, chromosome numbers of the species of *Paphiopedilum* were highly variable, 2n=26-42 (Tanaka & Kamemoto 1972 and 1974). It was speculated that the variability might be occurred by centric fission (Duncan & MacLeod 1949, 1950, Kamemoto *et al.* 1963,

Tanaka & Aoyama 1974). Karasawa & Tanaka (1978) substantiated the occurrence of centric fission in the chromosomes of *Paphiopedilum* by the analyses of C-bandings and the observations of meiosis. In the present investigation, the chromosome numbers of 2n=26, 28, 30, 32, 34, 36, 38, 40, 41 and 42 in *Paphiopedilum* were reexamined and those of 2n=33, 35 and 37 were newly added. The chromosome numbers of 8 species were here redocumented and corrected as follows: 2n=26 to 2n=30 in *P. druryi,* 2n=28 to 2n=26 in *P. praestans,* 2n=32 to 2n=36 in *P. mastersianum,* 2n=32 to 2n=34 in *P. victoria-regina* ssp. *chamberlainianum,* 2n=34 to 2n=32 in *P. tonsum,* 2n=34 to 2n=36 in *P. dayanum,* 2n=36 to 2n=38 in *P. javanicum,* 2n=48 to 2n=40 in *P. purpuratum.* Among them the smallest chromosome number of 2n=26 consisted of morphologically 13 pairs of matched chromosomes, and could be divided into two quantitative groups showing a bimodal karyotype: One consisted of four large chromosomes and the other consisted of 22 small chromosomes of which a gradual decrease in size from the longest to the shortest chromosomes was observed. These results support previous reports (Kamemoto *et al.* 1963, Tanaka & Aoyama 1974). The positions of centromeres of 26 chromosomes were somewhat variable on each species, but there could not see any chromosome of which arm ratio was over 3.0. Thus, they varied from median to submedian. There were some characteristics on arm ratios of the chromosomes in the species with 2n=26; arm ratios of *P. bellatulum* and *P. stonei* varied from 1.0 to 1.3, and those of *P. exul, P. esquirolei* and *P. rothschildianum* varied from 1.0 to 1.4, and thus the positions of centromeres of them were mostly median. On the other hand, *p. philippinense* had 12 chromosomes, of which arm ratios were over 1.5, while *P. concolor* Type 2, *P. parishii* and *P. hirsutissimum* had 8, 18 and 15, respectively.

In the case of the species with 2n=30- 42 in the members of subgenus Paphiopedilum and Barbata, it has been suspected that the two-armed chromosomes were divided into two one-armed chromosomes by centric fission. In the present investigation, the number of one-armed chromosomes which might be originated by centric fission was usually even number. It is easy to explain if the one-armed chromosomes were derived from two-armed ones, the number of chromosome-arms of all species should be correspond with that of 2n=26. Thus, the increase of number of chromosome seemed to be based on centric fission (Duncan & MacLeod 1950, Kamemoto *et al.* 1963 and Tanaka & Aoyama 1974). Recently, Karasawa & Tanaka (1978) confirmed that the 2n=32 chromosomes of *P. callosum* was corresponded with that of 2n=26 chromosomes of *P. insigne* var. *sanderae* by the results of C-banding analysis. Furthermore, they confirmed, by the results of observation of meiosis, that the centric fission might be occurred in each set of matched chromosomes.

In the case of *P. spicerianum* 2n=30, when a centric fission occurred on four small metacentric chromosomes, eight telocentric chromosomes might be newly appeared. Similarly, in the case of *P. callosum* with 2n=32, two large and four small metacentric chromosomes might be changed by centric fission into 12 telocentric chromosomes. Two large and 12 small metacentric chromosomes of *P. purpuratum* with 2n=40 might be changed by centric fission into 28 telocentric chromosomes. Four large and ten small metacentric chromosomes of *P. virens* with 2n=40 might be changed into 28 telocentric

chromosomes. As a result, numbers of metacentric chromosomes which were subjected to the centric fission varied in each species. Among the 30 somatic chromosomes of *P. spicerianum,* 22 two-armed ones were median in position of centromere, while among the 30 somatic chromosomes of *P. druryi,* 17 two-armed ones were median and five two-armed ones were submedian in position of centromere. Out of the 40 somatic chromosomes of *P. sukhakulii,* 12 two-armed ones were composed of all metacentric ones, while out of the 40 somatic chromosomes of *P. bougainvilleanum,* 12 two-armed ones included two metacentric ones and 10 submetacentric ones.

Fourteen out of 27 species with the somatic chromosome number of 2n=26 had satellites on certain chromosomes. Those satellites varied from distinctly visible and 1.0 μm in length to faintly visible and 0.5 μm in length. *P. exul, P. insigne* and *P. charlesworthii* had distinctly visible satellites, length with 1.0 μm, on the short arms of the matched, medium-sized chromosomes and *P. concolor* Type 2 had the same ones on the long arms of the matched, medium-sized chromosomes. On the other hand, *P. rothschidianum* had the faintly visible satellites of 0.5 μm in length on the short arms of the matched, medium-sized chromosomes. *P. glanduliferum,* which is closely related to *P. rothschildianum,* had the same ones on the long arms of the matched, medium-sized chromosomes, but could be distinguished from *P. rothschildianum* because of having two submetacentric chromosomes. *P. godefroyae* and *P. fairieanum* had single satellite on the arm of the medium-sized chromosome. *P. haynaldianum* had two satellites on the short arms of the 20th and 25th chromosomes which did not make a pair with each other. The same phenomenon was found in the species of the present investigation as observed by Tanaka & Aoyama (1974) who reported that the species with the chromosome number over 2n=30 have no satellited chromosomes. In the present investigation further details on the extinction of satellites were confirmed in the following species. The species with the chromosome numbers of 2n=32- 42 among the members of subgenus Barbata have all mottling leaves and did not have any satellited chromosomes at metaphase.

According to these karyotypic variation, it is concluded that the differentiation of species might be originated with the increase of telocentric chromosomes by centric fission and the structural variation of some chromosomes. The species with mottling leaves showed the chromosome numbers of 2n=32 or more did not have any satellite.

The members of section Cochlopetalum, subgenus Polyantha, consist of three species according to Brieger (1971). Recently, Wood (1976) retreated those three species to be conspecific and to be reduced to the rank of five subspecies, one variety and one forma. The chromosome numbers of these species ranged aneuploidily from 2n=32 to 2n=37. The chromosome complements of *P. victoria-regina* ssp. *liemianum* with the chromosome number of 2n=32 and ssp. *primulinum* with the chromosome number of 2n=32 were same and consisted of 18 metacentric chromosomes and 14 telocentric chromosomes. Similarly, the chromosome complements of ssp. *chamberlainianum* with the chromosome number of 2n=34 and ssp. *glaucophyllum* var. *moquetteanum* with the chromosome number of 2n=34 were same and consisted of 16 metacentric chromosomes and 18 telocentric chromosomes. In contrast, the chromosome complements of ssp. *glaucophyllum* with the chromosome number of 2n=36 consisted of 14 metacentric chromosomes and 22

telocentric chromosomes. Then, this increase of chromosome number, which is similar to that of subgenus Barbata, might be originated with the centric fission which caused each pair of metacentric chromosomes decreased every case and then led reversely four telocentric chromosomes increased.

It is easy to explain that all the species of sect. Cochlopetalum can be corresponded with the chromosome numbers of 2n=25 if the telocentric chromosomes were produced from some metacentric chromosomes by centric fission. Thus, it seems that the occurrence of 2n=25 could be originated from the loss of a pair of telocentric chromosome derived from 2n=26 by centric fission.

There are many more subjects to be solved cytologically in sect. Cochlopetalum. Expecting additional cytological examinations for proving the concept of the chromosomal interrelationships in the section are as follows: The original chromosome number of the species in sect. Barbata and sect. Cochlopetalum might be 2n=26, but certain process of changing number of chromosomes is not clear: The 2n=32 composed of 18 metacentrics and 14 telocentrics might be derived from the 2n=34 composed of 18 metacentrics and 16 telocentrics or 2n=30 composed of 20 metacentrics and 10 telocentrics. The species of sect. Cochlopetalum is indigenous to Great Sunda Islands. The course of differentiation of the species of sect. Cochlopetalum could be different from that of subgenus Barbata. Furthermore, it is possible that natural hybridization might occur in sect. Cochlopetalum since *P. victoria-regina* ssp. *primulinum* forma *purpurascens* with the chromosome number of 2n=32 had 16 metacentric chromosomes and 16 telocentric chromosomes and some species had odd numbers of chromosomes (*i. e.* 2n=33, 35).

II. Cytotaxonomical comparisons in the species of *Paphiopedilum*

The genus *Paphiopedilum* has been classified into three subgenus and 14 sections by Fowlie (1966), while it has been reviewed and rearranged into four subgenus and nine sections by Brieger (1971). These holotaxonomical classifications are reviewed and discussed here in relation to cytotaxonomical and karyomorphological relationships in the genus as follows:

(1) BRACHYPETALUM

The species of subgenus Brachypetalum are distributed in Burma, Thailand, Malay Peninsula and islands near there. The external morphological characteristics of this subgenus are as follows: The leaves are thick and mottling. The peduncle bears 1-2 flowers. The petals are round and the margins of the lip curve into inside, without "ears" on both sides.

The chromosome number of this subgenus are all 2n=26. Their two-armed chromosome complements consist of two groups forming a bimodal karyotype; one group is

composed of four long chromosomes and the other group is composed of 22 short chromosomes. In latter group the chromosomes decreased gradually in size from the longest to the shortest chromosomes. The karyotype of the 2n=26 chromosomes is considered to be the most primitive because of all the chromosomes of it are metacentric.

Paphiopedilum concolor Type 2 (2n=26) has two satellited chromosomes on their long arms (Nos. 15, 16) and four small submetacentric chromosomes (Nos. 21-24) as the distinct characteristics of the species. *P. godefroyae* (2n=26) has single satellited chromosome (No. 16) and two small submetacentric (Nos. 21, 23) all of which might correspond to the satellited chromosomes and the small submetacentric chromosomes of *P. concolor* Type 2. Analysing karyotypes, *P. godefroyae* was presumed to be a natural hybrid between *P. concolor* Type 2 and other species such as *P. bellatulum* which has no satellited chromosome and submetacentric chromosome. *P. ang-thong* (2n=26) is described as the natural hybrid between *P. godefroyae* and *P. niveum* by Fowlie (1977). The present karyomorphological investigation substantiates the Fowlie's hypothesis.

(2) POLYANTHA

The species of subgenus Polyantha set always green leaves, and their peduncles bear some flowers. They are native to the Philippines, Borneo, West Irian, Sunda Islands and a part of Malay Peninsula where are the center of the distribution of *Paphiopedilum.*

Among the members of this subgenus both the species with the chromosome number of 2n=26 and the species with the chromosome numbers of 2n=32-37 were investigated for karyomorphological analysis. The karyotype of the species of this subgenus with the chromosome number of 2n=26 is essentially the same as that of the members of subgenus Brachypetalum.

The chromosome complement of *P. stonei* (2n=26) showed the most primitive karyotype and did not have any satellited chromosome. The karyotype of *P. rothschildianum* (2n=26) is similar to that of *P. stonei* except it has only a pair of satellited chromosomes. The arm ratios of the chromosomes in *P. praestans* (2n=26) and *P. bodegomii* (2n=26) were slightly higher than those in *P. stonei* (2n=26) and *P. rothschildianum* (2n=26). Thus, the karyotypes of those species are somewhat different from each other.

Three species, *P. philippinense* (2n=26), *P. laevigatum* (2n=26) and *P. roebbelenii* (2n=26) are very similar to each other in external morphology and they are then considered conspecific (Hawkes 1965, Waters & Waters 1973). However, the karyotypes of the three species are less different from each other.

P. glanduliferum and *P. rothschildianum* are taxonomically different from each other but the karyotype of *P. glanduliferum* is similar to that of *P. rothschildianum,* except *P. glanduliferum* has two submetacentric chromosomes.

P. lowii (2n=26), *P. haynaldianum* (2n=26) and *P. parishii* (2n=26), which are placed in the sect. Polyantha by Brieger (1971), show high arm ratios in the majority of chromosomes. This karyotypical feature is found to be one of the great differences, in comparison with other species in Polyantha. Among the three species *P. lowii* and *P.*

haynaldianum could be distinguished from *P. parishii* by having satellites and small constrictions.

The members of sect. Cochlopetalum of the subgenus Polyantha have sometimes been reduced or increased their taxonomical ranks; recently, Wood (1976) retreated it to the monotypic section with *P. victoria-regina* with five subspecies, one variety and one forma. This species in indigenous to Java and Sumatra; It bears some flowers which continue to bloom, one after another. The chromosomes in the taxa of section Cochlopetalum are slightly smallar than those of the other sections and the chromosome numbers ranged from 2n=32 to 2n=37. As mentioned above, it seems that this variation of chromosome numbers, which might be caused by centric fission, belongs to the 2n=25 series which is different from the 2n=26 series of section Paphiopidilum and Barbata of which numbers of somatic chromosomes are 2n=30- 42. These differences in karyomorphology, external morphology and blooming habit, must be the major principal for this section in compared with those shown in the other section. *P. victoria-regina* ssp. *primulinum* (2n=32) is extremely similar to ssp. *liemianum* in external morphology and karyomorphology. *P. victoria-regina* ssp. *glaucophyllum* (2n=36) shows the karyotype with four one-armed chromosomes which might be equal value to a pair of two-armed chromosomes of *P. victoria-regina* ssp. *glaucophyllum* var. *moquetteanum* (2n=34) after the hypothesis of centric fission. Thus, it is speculated that ssp. *glaucophyllum* (2n=36) could be lately differentiated.

(3) PAPHIOPEDILUM

The species of subgenus Paphiopedilum have green leaves, and their peduncles bear single flower. They are distributed in the continental Asia and its neighboring island. Each species has the chromosome number of either 2n=26 or 2n=30 that might be originated from the former 2n=26 by centric fission.

The karyotype of the species with the chromosome number of 2n=26 is essentially same to that of the species of the above two subgenera. Two species of section Stictopetalum, *P. esquirolei* (2n=26) and *P. hirsutissimum* (2n=26) are extremely similar to each other in the external morphology, but their karyotypes are clearly different from each other; *e. g., P. esquirolei* has only the metacentric chromosomes while *P. hirsutissimum* included 12 submetacentric chromosomes. Each chromosome in the members of this section has usually small constriction which is distinct. In contrast, the species of section Paphiopedilum with the chromosome number of 2n=26 have usually distinct satellites on a pair of chromosomes, and carry mostly metacentric chromosomes.

P. boxalli (2n=26) are sometimes reduced to the varietal rank of *P. villosum* (2n=26). The karyotypes of both taxa are extremely similar to each other and it supports that both taxa are conspecific.

The karyotypes of *P. spicerianum* (2n=30) and *P. druryi* (2n=30) are clearly different from those of the other species of this section. Fowlie (1966) treated both species to be placed in other sections, respectively. The 22 chromosomes of *P. spicerianum* consist

of metacentric chromosomes, and have small constrictions. In contrast, *P. druryi* has five submetacentric chromosomes, but does not show any small constriction on chromosome. Thus, the present results of karyomorphological analysis is suported the Fowlie's treatment (1966).

(4) BARBATA

Among the members of the genus *Paphiopedilum* the species included in subgenus Barbata have the widest spread distribution from continental East Assam, Thailand and Malay Peninsula and in the islands, from Hong Kong, the Philippines, down to New Guinea and the Island of Bougainville. Brieger (1971) classified subgenus Barbata into three sections, while Fowlie (1966) did it into four section, since he gave an independent section for *P. fairieanum* (2n=26). The species of this subgenus bear every single flower sometime two on each scape, and the leaves of the species are mottled except for those of one species, *P. fairieanum.* The karyotype of *P fairieanum* (2n=26) was essentially same as that of the other species with the chromosome number of 2n=26.

The flower of *P. hookerae* (2n=28) is similar to that of the members of sect. Sigmatopetalum except for roundish staminode. The chromosomes of *P. hookerae* are all two-armed, and among their chromosomes a pair of satellited chromosomes can be seen. Thus, it seems that this species with a distinct karyotype may be placed in a new section, separately.

The species with the chromosome numbers of 2n=32- 42 of this subgenus might be differentiated from the species with the chromosome number of 2n=26 by the increase of chromosome number through centric fission. Such a phenomenon is seemed to correlate with the absence of satellited chromosomes and the occurrence of mottling leaves in the advanced species.

The species included in this subgenus show respectively distinct karyotypes, while there is no positive correlation with external morphological characteristics to divide into sections.

As a conclusion of karyomorphological analyses in the species of *Paphiopedilum,* each distinct karyotype is found to be useful for the validation of not only species but also sectioning of genus, except for that of the species of subgenus Barbata with the chromosome numbers of 2n=32- 42.

The classification listed in Table 1 follows Fowlie (1966), Brieger (1971) and the present karyomorphological documentation. According to Table 1, the species with the chromosome number of 2n=26 can be seen throughout the majority of the subgenera but are concentrated in three subgenera, Brachypetalum, Polyantha and Paphiopedilum which have certain species with rather primitive karyotypes. Most of the species of the subgenus Barbata showed the chromosome numbers of 2n=32- 42 except for only a species with the chromosome number of 2n=26. Thus, the phylogenetic differentiation of *Paphiopedilum* can be considered as follows: The species with the chromosome number of 2n=26 might be the most primitive or be originated from an original species with the

chromosome number of 2n=26. Karyomorphological differentiation of them might be led mainly by chromosomal centric fission, and might introduce the present species having various chromosome numbers.

Summary

1. Karyomorphological investigations were carried out in 53 species, five subspecies, one variety and one forma of *Paphiopedilum*.
2. Among these 60 taxa, the chromosome numbers of 19 species, two subspecies and one variety were recorded for the first time, and those of seven species and one subspecies listed here differed from those which have been published previously. The chromosome numbers indicated these taxa showed an aneuploid series: 2n=26, 28, 30, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41 and 42.
3. The species with the chromosome number of 2n=26 showed uniformly bimodal karyotype: One group consisted of four large chromosomes and the other group consisted of 22 small chromosomes. In both groups the chromosomes were decreased gradually in size from the longest to the shortest chromosomes. The chromosome complement of 2n=26 were composed of metacentric chromosomes showing variation in the combination of these chromosomes.
4. The species with the chromosome number of 2n=28 showed distinct karyotype, and the chromosome complement of the karyotype was found to be composed of metacentric chromosomes including a pair of subterminal chromosomes.
5. The species with the chromosome numbers of 2n=32- 42 showed decreased number of metacentric chromosomes and reversely increased number of telocentric chromosomes. It might be caused directly by centric fission on a pair of metacentric chromosomes. Thus, a pair of metacentric chromosomes might be divided at their positions of centromeres and formed into four telocentric chromosomes, each time.
6. Converting every two telocentric chromosomes into one metacentric chromosome, the chromosome numbers of 2n=32- 42 of all taxa can be all connected to 2n=26, except the species of the section Cochlopetalum of subgenus Polyantha with the chromosome numbers of 2n=32-37 can be connected to 2n=25.
7. All the species of subgenus Barbata with the chromosome numbers of 2n=32- 42 bear mottled leaves.
8. Satellites were observed in more than a half of the species with the chromosome numbers of 2n=26, while they were not observed in the species with the chromosome numbers of 2n=32 or more.
9. All the species of *Paphiopedilum* showed distinct numbers of chromosomes and karyotypes. Since those karyotypic distinctions could be correlated with external morphology of the species, they may be important characteristics of section.
10. The phylogenetic differentiation of *Paphiopedilum* was considered as follows: The species with 2n=26 might be the most primitive or be originated from an original

species with the chromosome number of 2n=26. Karyomorphological differentiation of them might be led mainly by chromosomal centric fission and partly by certain chromosomal structural changes, and might introduce the present species having various karyotypes.

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Table 2. Measurements of somatic chromosomes of *Paphiopedilum bellatulum* at metaphase, 2n=26

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	5.1+5.5=10.6	6.5	1.1	m
2	5.1+5.5=10.6	6.5	1.1	m
3	4.5+5.0= 9.5	5.8	1.1	m
4	4.3+5.0= 9.3	5.7	1.2	m
5	3.6+3.9= 7.5	4.6	1.1	m
6	3.6+3.9= 7.5	4.6	1.1	m
7	3.0+3.7= 6.7	4.1	1.2	m
8	2.9+3.8= 6.7	4.1	1.3	m
9	3.3+3.3= 6.6	4.1	1.0	m
10	3.3+3.3= 6.6	4.1	1.0	m
11	2.9+3.4= 6.3	3.9	1.2	m
12	2.9+3.4= 6.3	3.9	1.2	m
13	3.0+3.2= 6.2	3.8	1.1	m
14	3.0+3.2= 6.2	3.8	1.1	m
15	2.5+3.0= 5.5	3.4	1.2	m
16	2.4+3.0= 5.4	3.3	1.2	m
17	2.4+2.8= 5.2	3.2	1.2	m
18	2.4+2.8= 5.2	3.2	1.2	m
19	2.4+2.6= 5.0	3.1	1.1	m
20	2.4+2.6= 5.0	3.1	1.1	m
21	2.0+2.5= 4.5	2.8	1.3	m
22	2.0+2.5= 4.5	2.8	1.3	m
23	2.0+2.4= 4.4	2.7	1.2	m
24	2.0+2.4= 4.4	2.7	1.2	m
25	1.6+2.0= 3.6	2.2	1.3	m
26	1.7+1.7= 3.4	2.1	1.0	m

Table 3. Measurements of somatic chromosomes of *Paphiopedilum niveum* at metaphase, 2n=26

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	5.2+5.2=10.4	6.2	1.0	m
2	5.2+5.2=10.4	6.2	1.0	m
3	4.2+4.8= 9.0	5.4	1.1	m
4	4.2+4.8= 9.0	5.4	1.1	m
5	3.7+4.1= 7.8	4.7	1.1	m
6	3.7+4.1= 7.8	4.7	1.1	m

Table 3. (continued)

7	3.5+3.8= 7.3	4.4	1.1	m
8	3.4+3.8= 7.2	4.3	1.1	m
9	3.0+4.0= 7.0	4.2	1.3	m
10	3.0+4.0= 7.0	4.2	1.3	m
11	3.3+3.5= 6.8	4.1	1.1	m
12	3.3+3.5= 6.8	4.1	1.1	m
13	2.5+3.8= 6.3	3.8	1.5	m
14	2.5+3.8= 6.3	3.8	1.5	m
15	2.5+3.5= 6.0	3.6	1.4	m
16	2.5+3.5= 6.0	3.6	1.4	m
17	2.7+3.0= 5.7	3.4	1.1	m
18	2.5+3.0= 5.5	3.3	1.1	m
19	2.4+2.5= 4.9	2.9	1.0	m
20	2.4+2.5= 4.9	2.9	1.0	m
21	2.0+2.5= 4.5	2.7	1.3	m
22	2.0+2.5= 4.5	2.7	1.3	m
23	1.6+2.5= 4.1	2.5	1.6	m
24	1.6+2.5= 4.1	2.5	1.6	m
25	1.8+2.0= 3.8	2.3	1.1	m
26	1.8+2.0= 3.8	2.3	1.1	m

Table 4. Measurements of somatic chromosomes of *Paphiopedilum concolor* Type 1 at metaphase, 2n=26

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	5.0+5.5=10.5	6.3	1.1	m
2	5.0+5.5=10.5	6.3	1.1	m
3	4.6+4.7= 9.3	5.6	1.0	m
4	4.6+4.7= 9.3	5.6	1.0	m
5	3.4+4.0= 7.4	4.4	1.2	m
6	3.3+4.0= 7.3	4.4	1.2	m
7	3.4+3.9= 7.3	4.4	1.1	m
8	3.4+3.8= 7.2	4.3	1.1	m
9	3.4+3.5= 6.9	4.1	1.0	m
10	3.3+3.4= 6.7	4.0	1.0	m
11	3.0+3.5= 6.5	3.9	1.2	m
12	3.0+3.5= 6.5	3.9	1.2	m
13	2.8+3.5= 6.3	3.8	1.3	m
14	2.8+3.5= 6.3	3.8	1.3	m

Table 4. (continued)

15	2.9+3.2= 6.1	3.6	1.1	m
16	2.9+3.2= 6.1	3.6	1.1	m
17	2.3+3.4= 5.7	3.4	1.5	m
18	2.1+3.2= 5.3	3.2	1.5	m
19	0.5+1.9+3.0= 5.4 *	3.2	1.3	m
20	0.2+1.8+2.8= 4.8 *	2.9	1.4	m
21	2.2+2.5= 4.7	2.8	1.1	m
22	2.2+2.5= 4.7	2.8	1.1	m
23	1.6+2.7= 4.3	2.6	1.7	m
24	1.5+2.6= 4.1	2.5	1.7	m
25	2.0+2.1= 4.1	2.5	1.1	m
26	1.9+2.0= 3.9	2.3	1.1	m

* Chromosome with secondary constriction

Table 5. Measurements of somatic chromosomes of *Paphiopedilum concolor* Type 2 at metaphase, 2n=26

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	5.5+5.5=1 1.0	5.5	1.0	m
2	5.5+5.5=1 1.0	5.5	1.0	m
3	4.5+4.6= 9.1	4.5	1.0	m
4	4.5+4.6= 9.1	4.5	1.0	m
5	4.0+4.5= 8.5	4.2	1.1	m
6	4.0+4.5= 8.5	4.2	1.1	m
7	3.8+4.5= 8.3	4.1	1.2	m
8	3.8+4.5= 8.3	4.1	1.2	m
9	4.0+4.0= 8.0	4.0	1.0	m
10	4.0+4.0= 8.0	4.0	1.0	m
11	3.5+4.5= 8.0	4.0	1.3	m
12	3.5+4.5= 8.0	4.0	1.3	m
13	3.8+4.2= 8.0	4.0	1.1	m
14	3.8+4.2= 8.0	4.0	1.1	m
15	3.0+3.5+1.3=7.8 *	3.9	1.6	m
16	3.0+3.5+1.3=7.8 *	3.9	1.6	m
17	3.3+4.3= 7.6	3.8	1.3	m
18	3.3+4.2= 7.5	3.7	1.3	m
19	3.5+3.9= 7.4	3.7	1.1	m
20	3.5+3.8= 7.3	3.6	1.1	m
21	2.1+4.6= 6.7	3.3	2.2	sm
22	2.1+4.6= 6.7	3.3	2.2	sm

Table 5. (continued)

23	1.8+3.9= 5.7	2.8	2.2	sm
24	1.8+3.9= 5.7	2.8	2.2	sm
25	1.6+2.7= 4.3	2.1	1.7	m
26	1.6+2.7= 4.3	2.1	1.7	m

* Chromosome with secondary constriction

Table 6. Measurements of somatic chromosomes of *Paphiopedilum leucochilum* at metaphase, 2n=26

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	4.4+4.6=9.0	5.5	1.0	m
2	4.4+4.5=8.9	5.4	1.0	m
3	3.9+4.5=8.4	5.1	1.1	m
4	3.7+4.3=8.0	4.9	1.1	m
5	3.5+3.8=7.3	4.4	1.0	m
6	3.4+3.7=7.1	4.3	1.0	m
7	3.3+3.5=6.8	4.1	1.0	m
8	3.3+3.5=6.8	4.1	1.0	m
9	3.2+3.5=6.7	4.1	1.0	m
10	3.2+3.5=6.7	4.1	1.0	m
11	3.2+3.3=6.5	4.0	1.0	m
12	3.2+3.3=6.5	4.0	1.0	m
13	3.0+3.5=6.5	4.0	1.1	m
14	3.0+3.4=6.4	3.9	1.1	m
15	2.6+3.5=6.1	3.7	1.3	m
16	2.5+3.6=6.1	3.7	1.4	m
17	2.7+3.0=5.7	3.5	1.1	m
18	2.7+3.0=5.7	3.5	1.1	m
19	2.5+2.7+0.5=5.7 *	3.5	1.3	m
20	2.5+2.7+0.5=5.7 *	3.5	1.3	m
21	2.5+2.9=5.4	3.3	1.2	m
22	2.5+2.8=5.3	3.2	1.1	m
23	2.0+2.5=4.5	2.7	1.3	m
24	1.8+2.5=4.3	2.6	1.4	m
25	2.0+2.1=4.1	2.5	1.1	m
26	2.0+2.0=4.0	2.4	1.0	m

* Chromosome with secondary constriction

Table 7. Measurements of somatic chromosomes of *Paphiopedilum godefroyae* at metaphase, 2n=26

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	8.0+8.5=16.5	6.6	1.1	m
2	6.5+7.7=14.2	5.7	1.2	m
3	5.8+7.1=12.9	5.1	1.2	m
4	5.7+6.0=11.7	4.7	1.1	m
5	4.7+5.7=10.4	4.1	1.2	m
6	4.7+5.7=10.4	4.1	1.2	m
7	5.0+5.1=10.1	4.0	1.0	m
8	5.0+5.1=10.1	4.0	1.0	m
9	4.8+5.1= 9.9	3.9	1.1	m
10	4.8+5.1= 9.9	3.9	1.1	m
11	4.6+5.1= 9.7	3.9	1.1	m
12	4.5+5.1= 9.6	3.8	1.1	m
13	4.4+5.0= 9.4	3.7	1.1	m
14	4.5+4.8= 9.3	3.7	1.1	m
15	4.5+4.7= 9.2	3.7	1.0	m
16	3.5+4.5+1.0=9.0*	3.6	1.6	m
17	4.3+4.6= 8.9	3.5	1.1	m
18	4.3+4.6= 8.9	3.5	1.1	m
19	3.9+4.3= 8.2	3.3	1.1	m
20	3.9+4.3= 8.2	3.3	1.1	m
21	2.6+5.6= 8.2	3.3	2.2	sm
22	3.9+4.3= 8.2	3.3	1.1	m
23	2.4+5.3= 7.7	3.1	2.2	sm
24	3.4+3.7= 7.1	2.8	1.1	m
25	3.1+3.9= 7.0	2.8	1.3	m
26	3.0+3.4= 6.4	2.6	1.1	m

* Chromosome with secondary constriction

Table 8. Measurements of somatic chromosomes of *Paphiopedilum ang-thong* at metaphase, 2n=26

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	6.0+6.5=12.5	6.6	1.1	m
2	6.0+6.5=12.5	6.6	1.1	m
3	4.7+5.3=10.0	5.3	1.1	m
4	4.7+5.1= 9.8	5.2	1.1	m
5	3.9+4.9= 8.8	4.6	1.3	m
6	3.7+4.8= 8.5	4.5	1.3	m

Table 8. (continued)

7	3.7+4.1= 7.8	4.1	1.1	m
8	3.7+4.1= 7.8	4.1	1.1	m
9	3.5+3.8= 7.3	3.8	1.1	m
10	3.0+4.2= 7.2	3.8	1.4	m
11	3.5+3.5= 7.0	3.7	1.0	m
12	3.5+3.5= 7.0	3.7	1.0	m
13	3.0+3.8= 6.8	3.6	1.3	m
14	2.7+4.0= 6.7	3.5	1.5	m
15	3.2+3.5= 6.7	3.5	1.1	m
16	3.1+3.6= 6.7	3.5	1.2	m
17	2.9+3.7= 6.6	3.5	1.3	m
18	3.0+3.6= 6.6	3.5	1.2	m
19	2.9+3.3= 6.2	3.3	1.1	m
20	2.8+3.4= 6.2	3.3	1.2	m
21	2.0+4.2= 6.2	3.3	2.1	sm
22	2.5+3.1= 5.6	2.9	1.2	m
23	2.4+2.9= 5.3	2.8	1.2	m
24	2.0+3.2— 5.2	2.7	1.6	m
25	2.3+2.4= 4.7	2.5	1.0	m
26	2.1+2.2= 4.3	2.3	1.0	m

Table 9. Measurements of somatic chromosomes of *Paphiopedilum delenatii* at metaphase, 2n=26

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	5.4+6.5=1 1.9	7.5	1.2	m
2	3.9+7.8=1 1.7	7.3	2.0	sm
3	5.0+5.6=1 0.6	6.6	1.1	m
4	3.5+6.6=1 0.1	6.3	1.9	sm
5	3.5+3.5= 7.0	4.4	1.0	m
6	3.5+3.5= 7.0	4.4	1.0	m
7	3.0+3.5= 6.5	4.1	1.2	m
8	3.0+3.5= 6.5	4.1	1.2	m
9	2.6+3.3= 5.9	3.7	1.3	m
10	2.6+3.3= 5.9	3.7	1.3	m
11	2.5+3.4= 5.9	3.7	1.4	m
12	2.5+3.4= 5.9	3.7	1.4	m
13	2.5+3.0= 5.5	3.4	1.2	m
14	2.5+3.0= 5.5	3.4	1.2	m

Table 9. (continued)

15	2.2+3.0= 5.2	3.3	1.4	m
16	2.2+3.0= 5.2	3.3	1.4	m
17	2.2+3.0= 5.2	3.3	1.4	m
18	2.0+2.8= 4.8	3.0	1.4	m
19	1.8+2.8= 4.6	2.9	1.6	m
20	1.8+2.8= 4.6	2.9	1.6	m
21	2.1+2.1= 4.2	2.6	1.0	m
22	2.1+2.1= 4.2	2.6	1.0	m
23	2.0+2.0= 4.0	2.5	1.0	m
24	2.0+2.0= 4.0	2.5	1.0	m
25	2.0+2.0= 4.0	2.5	1.0	m
26	1.7+1.9= 3.6	2.3	1.1	m

Table 10. Measurements of somatic chromosomes of *Paphiopedilum stonei* at metaphase, 2n=26

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	5.8+6.2=12.0	7.0	1.1	m
2	5.5+5.8=11.3	6.6	1.1	m
3	5.2+5.4=10.6	6.2	1.0	m
4	5.1+5.2=10.3	6.0	1.0	m
5	3.7+4.3= 8.0	4.7	1.2	m
6	3.7+4.3= 8.0	4.7	1.2	m
7	3.4+4.0= 7.4	4.3	1.2	m
8	3.4+4.0= 7.4	4.3	1.2	m
9	3.2+3.8= 7.0	4.1	1.2	m
10	3.0+3.4= 6.4	3.7	1.1	m
11	2.8+3.4= 6.2	3.6	1.2	m
12	2.8+3.4= 6.2	3.6	1.2	m
13	2.9+3.1= 6.0	3.5	1.1	m
14	2.7+3.1= 5.8	3.4	1.1	m
15	2.8+3.0= 5.8	3.4	1.1	m
16	2.8+3.0= 5.8	3.4	1.1	m
17	2.3+2.9= 5.2	3.0	1.3	m
18	2.3+2.9= 5.2	3.0	1.3	m
19	2.2+2.8= 5.0	2.9	1.3	m
20	2.2+2.8= 5.0	2.9	1.3	m
21	2.2+2.4= 4.6	2.7	1.1	m
22	2.2+2.4= 4.6	2.7	1.1	m

Table 10. (continued)

23	2.2+2.4= 4.6	2.7	1.1	m
24	2.2+2.4= 4.6	2.7	1.1	m
25	1.8+2.2= 4.0	2.3	1.2	m
26	1.7+2.1= 3.8	2.2	1.2	m

Table 11. Measurements of somatic chromosomes of *Paphiopedilum rothschildianum* at metaphase, 2n=26

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	6.5+7.4=1 3.9	6.9	1.1	m
2	6.0+7.5=1 3.5	6.7	1.3	m
3	5.6+6.5=1 2.1	6.0	1.2	m
4	5.7+6.2=1 1.9	5.9	1.1	m
5	4.8+5.0= 9.8	4.9	1.2	m
6	4.8+5.0= 9.8	4.9	1.2	m
7	3.6+5.1= 8.7	4.3	1.4	m
8	3.5+5.0= 8.5	4.2	1.4	m
9	3.5+4.6= 8.1	4.0	1.3	m
10	3.5+4.5= 8.0	4.0	1.3	m
11	3.9+4.1= 8.0	4.0	1.1	m
12	3.8+4.0= 7.8	3.9	1.1	m
13	3.4+3.5= 6.9	3.4	1.0	m
14	3.4+3.5= 6.9	3.4	1.0	m
15	3.1+3.5= 6.6	3.3	1.1	m
16	3.0+3.5= 6.5	3.2	1.2	m
17	0.6+2.4+3.4= 6.4 *	3.2	1.1	m
18	0.3+2.3+3.4= 6.0 *	3.0	1.3	m
19	2.5+3.4= 5.9	2.9	1.4	m
20	2.5+3.4= 5.9	2.9	1.4	m
21	2.3+3.1= 5.4	2.7	1.3	m
22	2.3+3.1= 5.4	2.7	1.3	m
23	2.5+2.5= 5.0	2.5	1.0	m
24	2.5+2.5= 5.0	2.5	1.0	m
25	2.1+2.8= 4.9	2.4	1.3	m
26	2.0+2.7= 4.7	2.3	1.4	m

* Chromosome with secondary constriction

Table 12. Measurements of somatic chromosomes of *Paphiopedilum granduliferum* at metaphase, 2n=26

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	5.5+6.2=1 1.7	6.9	1.1	m
2	5.5+5.7=1 1.2	6.6	1.0	m
3	5.3+5.5=1 0.8	6.4	1.0	m
4	5.2+5.6=1 0.8	6.4	1.1	m
5	3.7+5.0= 8.7	5.2	1.4	m
6	3.0+4.3= 7.3	4.3	1.4	m
7	3.1+4.1= 7.2	4.3	1.3	m
8	3.1+4.1= 7.2	4.3	1.3	m
9	3.0+3.5= 6.5	3.9	1.2	m
10	3.0+3.5= 6.5	3.9	1.2	m
11	2.7+3.0+0.6=6.3 *	3.7	1.3	m
12	2.8+3.0+0.5=6.3 *	3.7	1.3	m
13	2.9+3.3= 6.2	3.7	1.1	m
14	3.0+3.1= 6.1	3.6	1.0	m
15	2.9+3.1= 6.0	3.6	1.1	m
16	2.8+3.0= 5.8	3.4	1.1	m
17	2.6+3.2= 5.8	3.4	1.2	m
18	2.5+3.0= 5.5	3.3	1.2	m
19	2.5+2.6= 5.1	3.0	1.0	m
20	2.4+2.5= 4.9	2.9	1.0	m
21	1.9+2.3= 4.2	2.5	1.2	m
22	1.9+2.3= 4.2	2.5	1.2	m
23	1.4+2.5= 3.9	2.3	1.8	sm
24	1.2+2.4= 3.6	2.1	2.0	sm
25	1.5+1.9= 3.4	2.0	1.3	m
26	1.5+1.9= 3.4	2.0	1.3	m

* Chromosome with secondary constriction

Table 13. Measurements of somatic chromosomes of *Paphiopedilum praestans* at metaphase, 2n=26

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	6.0+7.5=1 3.5	6.9	1.3	m
2	6.0+6.7=1 2.7	6.5	1.1	m
3	6.1+6.4=1 2.5	6.4	1.1	m
4	5.5+6.0=1 1.5	5.9	1.1	m
5	4.7+5.6=1 0.3	5.3	1.2	m
6	4.8+5.0= 9.8	5.0	1.0	m

Table 13. (continued)

7	3.9+4.3= 8.2	4.2	1.1	m
8	3.9+4.3= 8.2	4.2	1.1	m
9	3.7+4.3= 8.0	4.1	1.2	m
10	3.7+4.3= 8.0	4.1	1.2	m
11	3.0+4.4= 7.4	3.8	1.5	m
12	3.0+4.4= 7.4	3.8	1.5	m
13	2.9+3.8= 6.7	3.4	1.3	m
14	2.9+3.8= 6.7	3.4	1.3	m
15	3.0+3.5= 6.5	3.3	1.2	m
16	3.0+3.5= 6.5	3.3	1.2	m
17	3.0+3.2= 6.2	3.2	1.1	m
18	3.0+3.2= 6.2	3.2	1.1	m
19	3.0+3.1= 6.1	3.1	1.0	m
20	2.5+3.0= 5.5	2.8	1.2	m
21	2.5+2.5= 5.0	2.6	1.0	m
22	2.5+2.5= 5.0	2.6	1.0	m
23	1.9+2.5= 4.4	2.3	1.3	m
24	1.9+2.4= 4.3	2.2	1.3	m
25	2.0+2.0= 4.0	2.1	1.0	m
26	1.6+2.4= 4.0	2.1	1.5	m

Table 14. Measurements of somatic chromosomes of *Paphiopedilum bodegomii* at metaphase, 2n=26

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	5.7+7.3=13.0	6.1	1.3	m
2	5.7+7.3=13.0	6.1	1.3	m
3	5.7+6.0=11.7	5.5	1.1	m
4	5.7+6.0=11.7	5.5	1.1	m
5	4.1+6.5=10.6	5.0	1.6	m
6	4.1+6.5=10.6	5.0	1.6	m
7	4.2+5.7= 9.9	4.7	1.4	m
8	4.2+5.7= 9.9	4.7	1.4	m
9	3.9+5.1= 9.0	4.2	1.3	m
10	3.9+5.1= 9.0	4.2	1.3	m
11	4.3+4.6= 8.9	4.2	1.1	m
12	4.3+4.6= 8.9	4.2	1.1	m
13	3.6+4.3= 7.9	3.7	1.2	m
14	3.6+4.3= 7.9	3.7	1.2	m

Table 14. (continued)

15	3.5+4.0= 7.5	3.5	1.1	m
16	3.5+4.0= 7.5	3.5	1.1	m
17	3.0+4.0= 7.0	3.3	1.3	m
18	2.9+4.0= 6.9	3.2	1.4	m
19	2.9+3.7= 6.6	3.1	1.3	m
20	2.9+3.7= 6.6	3.1	1.3	m
21	2.9+3.0= 5.9	2.7	1.0	m
22	2.7+2.8= 5.5	2.6	1.0	m
23	1.7+2.7= 4.4	2.1	1.6	m
24	1.7+2.7= 4.4	2.1	1.6	m
25	2.0+2.4= 4.4	2.1	1.2	m
26	1.6+2.4= 4.0	1.9	1.5	m

Table 15. Measurements of somatic chromosomes of *Paphiopedilum philippinense* at metaphase, 2n=26

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	5.8+6.0=11.8	6.3	1.0	m
2	5.5+5.6=11.1	5.9	1.0	m
3	5.0+5.6=10.6	5.7	1.1	m
4	4.5+5.5=10.0	5.4	1.2	m
5	3.6+5.2= 8.8	4.7	1.4	m
6	3.5+4.9= 8.4	4.5	1.4	m
7	3.5+4.1= 7.6	4.1	1.2	m
8	3.5+4.1= 7.6	4.1	1.2	m
9	3.0+4.5= 7.5	4.0	1.5	m
10	3.0+4.4= 7.4	4.0	1.5	m
11	2.7+4.2= 6.9	3.7	1.6	m
12	2.7+4.2= 6.9	3.7	1.6	m
13	2.8+3.7= 6.5	3.5	1.3	m
14	2.8+3.7= 6.5	3.5	1.3	m
15	3.0+3.4= 6.4	3.4	1.1	m
16	3.0+3.4= 6.4	3.4	1.1	m
17	2.2+4.2= 6.4	3.4	1.9	sm
18	2.2+4.1= 6.3	3.4	1.9	sm
19	2.8+3.5= 6.3	3.4	1.3	m
20	2.8+3.1= 5.9	3.2	1.1	m
21	2.2+3.5= 5.7	3.1	1.6	m
22	2.2+3.5= 5.7	3.1	1.6	m

Table 15. (continued)

23	2.0+3.1= 5.1	2.7	1.6	m
24	2.0+3.1= 5.1	2.7	1.6	m
25	2.0+3.0= 5.0	2.7	1.5	m
26	1.7+3.0= 4.7	2.5	1.8	sm

Table 16. Measurements of somatic chromosomes of *Paphiopedilum laevigatum* at metaphase, 2n=26

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	6.0+6.6=12.6	6.0	1.1	m
2	5.5+6.5=12.0	5.7	1.2	m
3	5.6+6.0=11.6	5.5	1.1	m
4	5.2+6.1=11.3	5.4	1.2	m
5	3.3+5.1= 8.4	4.0	1.5	m
6	3.3+5.1= 8.4	4.0	1.5	m
7	3.3+5.0= 8.3	4.0	1.5	m
8	3.3+5.0= 8.3	4.0	1.5	m
9	2.6+5.4= 8.0	3.8	2.1	sm
10	2.7+5.3= 8.0	3.8	2.0	sm
11	3.3+4.6= 7.9	3.8	1.4	m
12	3.4+4.5= 7.9	3.8	1.3	m
13	3.5+4.2= 7.7	3.7	1.2	m
14	3.5+4.2= 7.7	3.7	1.2	m
15	3.0+4.6= 7.6	3.6	1.5	m
16	3.1+4.5= 7.6	3.6	1.5	m
17	3.5+4.0= 7.5	3.6	1.1	m
18	3.5+4.0= 7.5	3.6	1.1	m
19	2.6+4.4= 7.0	3.3	1.7	m
20	2.6+4.4= 7.0	3.3	1.7	m
21	3.1+3.9= 7.0	3.3	1.3	m
22	3.0+4.0= 7.0	3.3	1.3	m
23	2.5+3.8= 6.3	3.0	1.5	m
24	2.7+3.5= 6.2	3.0	1.3	m
25	2.4+2.9= 5.3	2.5	1.2	m
26	2.3+2.8= 5.1	2.4	1.2	m

Table 17. Measurements of somatic chromosomes of *Paphiopedilum roebelenii* at metaphase, 2n=26

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	6.8+7.5=1 4.3	6.7	1.1	m
2	6.3+6.5=1 2.8	6.0	1.0	m
3	5.7+5.8=1 1.5	5.4	1.0	m
4	5.7+5.8=1 1.5	5.4	1.0	m
5	4.5+5.1= 9.6	4.5	1.1	m
6	4.5+5.1= 9.6	4.5	1.1	m
7	3.9+5.0= 8.9	4.2	1.3	m
8	3.9+5.0= 8.9	4.2	1.3	m
9	3.0+5.5= 8.5	4.0	1.8	sm
10	3.0+5.5= 8.5	4.0	1.8	sm
11	3.1+5.0= 8.1	3.8	1.6	m
12	3.1+5.0= 8.1	3.8	1.6	m
13	3.6+4.2= 7.8	3.7	1.2	m
14	3.6+4.2= 7.8	3.7	1.2	m
15	2.6+5.1= 7.7	3.6	2.0	sm
16	2.5+5.0= 7.5	3.5	2.0	sm
17	2.8+4.5= 7.3	3.4	1.6	m
18	2.7+4.5= 7.2	3.4	1.7	m
19	3.4+3.5= 6.9	3.2	1.0	m
20	3.4+3.5= 6.9	3.2	1.0	m
21	2.5+4.0= 6.5	3.1	1.6	m
22	2.5+4.0= 6.5	3.1	1.6	m
23	2.2+3.4= 5.6	2.6	1.5	m
24	2.2+3.4= 5.6	2.6	1.5	m
25	2.0+2.4= 4.4	2.1	1.2	m
26	2.0+2.4= 4.4	2.1	1.2	m

Table 18. Measurements of somatic chromosomes of *Paphiopedilum randsii* at metaphase, 2n=26

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	6.0+6.0=1 2.0	6.6	1.0	m
2	5.2+5.7=1 0.9	6.0	1.1	m
3	5.0+5.5=1 0.5	5.8	1.1	m
4	4.7+5.0= 9.7	5.3	1.1	m
5	3.8+3.9= 7.7	4.2	1.0	m
6	3.1+4.4= 7.5	4.1	1.4	m

Table 18. (continued)

7	3.5+3.7= 7.2	3.9	1.1	m
8	3.5+3.7= 7.2	3.9	1.1	m
9	3.4+3.7= 7.1	3.9	1.1	m
10	3.4+3.6= 7.0	3.8	1.1	m
11	3.3+3.5= 6.8	3.7	1.1	m
12	3.3+3.5= 6.8	3.7	1.1	m
13	2.7+3.9= 6.6	3.6	1.4	m
14	2.7+3.9= 6.6	3.6	1.4	m
15	2.8+3.5= 6.3	3.5	1.3	m
16	2.5+3.6= 6.1	3.3	1.4	m
17	2.1+4.0= 6.1	3.3	1.9	sm
18	2.1+4.0= 6.1	3.3	1.9	sm
19	1.8+4.3= 6.1	3.3	2.4	sm
20	1.8+4.2= 6.0	3.3	2.4	sm
21	2.5+3.2= 5.7	3.1	1.3	m
22	2.5+3.0= 5.5	3.0	1.2	m
23	2.5+2.8= 5.3	2.9	1.1	m
24	2.5+2.8= 5.3	2.9	1.1	m
25	2.1+3.1= 5.2	2.9	1.5	m
26	2.5+2.6= 5.1	2.8	1.0	m

Table 19. Measurements of somatic chromosomes of *Paphiopedilum parishii* at metaphase, 2n=26

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	6.5+8.0=1 4.5	5.8	1.2	m
2	6.3+7.8=1 4.1	5.6	1.2	m
3	5.7+8.0=1 3.7	5.5	1.4	m
4	5.6+8.1=1 3.7	5.5	1.4	m
5	5.0+6.5=1 1.5	4.6	1.3	m
6	4.9+6.3=1 1.2	4.5	1.3	m
7	4.3+6.9=1 1.2	4.5	1.6	m
8	4.0+6.8=1 0.8	4.3	1.7	m
9	4.0+6.4=1 0.4	4.1	1.6	m
10	4.0+6.3=1 0.3	4.1	1.6	m
11	3.5+6.5=1 0.0	4.0	1.9	sm
12	3.6+6.4=1 0.0	4.0	1.8	sm
13	3.8+6.0= 9.8	3.9	1.6	m
14	3.7+6.0= 9.7	3.9	1.6	m

Table 19. (continued)

15	4.4+5.0= 9.4	3.7	1.1	m
16	4.2+5.1= 9.3	3.7	1.2	m
17	3.0+5.6= 8.6	3.4	1.9	sm
18	2.5+5.5= 8.0	3.2	2.2	sm
19	3.1+4.9= 8.0	3.2	1.6	m
20	2.9+4.8= 7.7	3.1	1.7	m
21	3.0+4.5= 7.5	3.0	1.5	m
22	2.7+4.0= 6.7	2.7	1.5	m
23	2.6+4.1= 6.7	2.7	1.6	m
24	2.4+4.0= 6.4	2.5	1.7	m
25	2.0+4.0= 6.0	2.4	2.0	sm
26	2.0+4.0= 6.0	2.4	2.0	sm

Table 20. Measurements of somatic chromosomes of *Paphiopedilum lowii* at metaphase, 2n=26

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	5.2+5.5=10.7	6.3	1.1	m
2	5.0+5.4=10.4	6.2	1.1	m
3	4.8+5.3=10.1	6.0	1.1	m
4	4.7+5.0= 9.7	5.7	1.1	m
5	2.4+4.9= 7.3	4.3	2.0	sm
6	2.4+4.9= 7.3	4.3	2.0	sm
7	2.8+4.2= 7.0	4.1	1.5	m
8	2.8+4.2= 7.0	4.1	1.5	m
9	3.0+3.9= 6.9	4.1	1.3	m
10	3.0+3.9= 6.9	4.1	1.3	m
11	2.8+3.6= 6.4	3.8	1.3	m
12	2.7+3.5= 6.2	3.7	1.3	m
13	2.4+3.6= 6.0	3.6	1.5	m
14	2.4+3.6= 6.0	3.6	1.5	m
15	2.4+3.6= 6.0	3.6	1.5	m
16	2.4+3.6= 6.0	3.6	1.5	m
17	2.1+3.6= 5.7	3.4	1.7	m
18	2.1+3.6= 5.7	3.4	1.7	m
19	2.1+3.3= 5.4	3.2	1.6	m
20	2.0+3.3= 5.3	3.1	1.7	m
21	1.9+2.8= 4.7	2.8	1.5	m
22	1.9+2.8= 4.7	2.8	1.5	m

Table 20. (continued)

23	2.0+2.5= 4.5	2.7	1.3	m
24	2.0+2.5= 4.5	2.7	1.3	m
25	2.0+2.4= 4.4	2.6	1.2	m
26	1.9+2.3= 4.2	2.5	1.2	m

Table 21. Measurements of somatic chromosomes of *Paphiopedilum haynaldianum* at metaphase, 2n=26

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	6.0+6.0=12.0	6.0	1.0	m
2	5.8+6.0=11.8	5.9	1.0	m
3	5.5+5.8=11.3	5.7	1.1	m
4	5.4+5.5=10.9	5.5	1.0	m
5	3.2+5.1= 8.3	4.2	1.6	m
6	3.0+5.1= 8.1	4.1	1.7	m
7	3.0+5.0= 8.0	4.0	1.7	m
8	3.0+5.0= 8.0	4.0	1.7	m
9	3.2+4.6= 7.8	3.9	1.4	m
10	3.2+4.6= 7.8	3.9	1.4	m
11	3.0+4.5= 7.5	3.8	1.5	m
12	3.0+4.5= 7.5	3.8	1.5	m
13	2.8+4.5= 7.3	3.7	1.6	m
14	2.8+4.5= 7.3	3.7	1.6	m
15	2.5+4.2= 6.7	3.4	1.7	m
16	2.5+4.2= 6.7	3.4	1.7	m
17	2.7+4.0= 6.7	3.4	1.5	m
18	2.7+4.0= 6.7	3.4	1.5	m
19	2.7+4.0= 6.7	3.4	1.5	m
20	3.3+2.9+0.5=6.7 *	3.4	1.0	m
21	2.7+3.8= 6.5	3.3	1.4	m
22	2.1+3.8= 5.9	3.0	1.8	sm
23	2.4+3.4= 5.8	2.9	1.4	m
24	2.4+3.4= 5.8	2.9	1.4	m
25	2.5+2.0+1.0=5.5 *	2.8	1.2	m
26	2.5+2.7= 5.2	2.6	1.1	m

* Chromosome with secondary constriction

Table 22. Measurements of somatic chromosomes of *Paphiopedilum victoria-regina* ssp. *liemianum* at metaphase, 2n=32

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	4.7+5.0=9.7	6.5	1.1	m
2	4.2+4.7=8.9	6.0	1.1	m
3	2.8+3.2=6.0	4.0	1.1	m
4	2.7+3.1=5.8	3.9	1.1	m
5	2.5+2.8=5.3	3.6	1.1	m
6	2.5+2.8=5.3	3.6	1.1	m
7	2.5+2.8=5.3	3.6	1.1	m
8	2.5+2.7=5.2	3.5	1.1	m
9	2.2+2.8=5.0	3.4	1.3	m
10	2.2+2.8=5.0	3.4	1.3	m
11	2.4+2.6=5.0	3.4	1.1	m
12	2.2+2.5=4.7	3.2	1.1	m
13	2.0+2.4=4.4	3.0	1.2	m
14	1.9+2.3=4.2	2.8	1.2	m
15	1.7+2.4=4.1	2.7	1.4	m
16	1.7+2.4=4.1	2.7	1.4	m
17	1.9+2.1=4.0	2.7	1.1	m
18	1.9+2.1=4.0	2.7	1.1	m
19	d+5.5=5.5	3.7	$<\infty$	t
20	d+5.5=5.5	3.7	$<\infty$	t
21	d+4.7=4.7	3.2	$<\infty$	t
22	d+4.7=4.7	3.2	$<\infty$	t
23	d+4.3=4.3	2.8	$<\infty$	t
24	d+3.8=3.8	2.5	$<\infty$	t
25	d+3.5=3.5	2.3	$<\infty$	t
26	d+3.4=3.4	2.3	$<\infty$	t
27	d+3.1=3.1	2.1	$<\infty$	t
28	d+3.0=3.0	2.0	$<\infty$	t
29	d+2.9=2.9	1.9	$<\infty$	t
30	d+2.9=2.9	1.9	$<\infty$	t
31	d+2.9=2.9	1.9	$<\infty$	t
32	d+2.9=2.9	1.9	$<\infty$	t

d : dot

Table 23. Measurements of somatic chromosomes of *Paphiopedilum victoria-regina* ssp. *primulinum* at metaphase, 2n=32

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	5.2+5.5=10.7	6.7	1.1	m
2	4.5+4.9= 9.4	5.9	1.1	m
3	3.0+3.4= 6.4	4.0	1.1	m
4	2.9+3.3= 6.2	3.9	1.1	m
5	2.9+3.2= 6.1	3.8	1.1	m
6	2.9+3.1= 6.0	3.8	1.1	m
7	2.8+3.0= 5.8	3.6	1.1	m
8	2.7+2.9= 5.6	3.5	1.1	m
9	2.5+3.0= 5.5	3.4	1.2	m
10	2.5+3.0= 5.5	3.4	1.2	m
11	2.5+2.8= 5.3	3.3	1.1	m
12	2.5+2.8= 5.3	3.3	1.1	m
13	2.3+2.6= 4.9	3.1	1.1	m
14	2.2+2.5= 4.7	2.9	1.1	m
15	2.0+2.7= 4.7	2.9	1.4	m
16	2.0+2.7= 4.7	2.9	1.4	m
17	2.0+2.4= 4.4	2.8	1.2	m
18	1.9+2.3= 4.2	2.6	1.2	m
19	d+6.2= 6.2	3.9	$<\infty$	t
20	d+5.8= 5.8	3.6	$<\infty$	t
21	d+4.8= 4.8	3.0	$<\infty$	t
22	d+4.1= 4.1	2.6	$<\infty$	t
23	d+4.0= 4.0	2.5	$<\infty$	t
24	d+3.5= 3.5	2.2	$<\infty$	t
25	d+3.5= 3.5	2.2	$<\infty$	t
26	d+3.5= 3.5	2.2	$<\infty$	t
27	d+3.4= 3.4	2.1	$<\infty$	t
28	d+3.4= 3.4	2.1	$<\infty$	t
29	d+3.2= 3.2	2.0	$<\infty$	t
30	d+3.0= 3.0	1.9	$<\infty$	t
31	d+3.0= 3.0	1.9	$<\infty$	t
32	d+2.9= 2.9	1.8	$<\infty$	t

d : dot

Table 24. Measurements of somatic chromosomes of *Paphiopedilum victoria-regina* ssp. *primulinum* forma *purpurascens* at metaphase, 2n=32

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	6.0+7.1=13.1	6.9	1.2	m
2	5.3+6.5=11.8	6.2	1.2	m
3	4.0+4.5= 8.5	4.5	1.1	m
4	3.6+4.3= 7.9	4.2	1.2	m
5	3.6+4.0= 7.6	4.0	1.1	m
6	3.5+4.0= 7.5	4.0	1.1	m
7	3.0+4.0= 7.0	3.7	1.3	m
8	3.0+4.0= 7.0	3.7	1.3	m
9	3.0+3.5= 6.5	3.4	1.2	m
10	2.9+3.5= 6.4	3.4	1.2	m
11	3.0+3.3= 6.3	3.3	1.1	m
12	2.8+3.2= 6.0	3.2	1.1	m
13	2.6+3.2= 5.8	3.1	1.2	m
14	2.5+3.0= 5.5	2.9	1.2	m
15	2.5+2.8= 5.3	2.8	1.1	m
16	2.3+2.8= 5.1	2.7	1.2	m
17	d+7.6= 7.6	4.0	$<\infty$	t
18	d+6.0= 6.0	3.2	$<\infty$	t
19	d+5.9= 5.9	3.1	$<\infty$	t
20	d+5.6= 5.6	3.0	$<\infty$	t
21	d+5.1= 5.1	2.7	$<\infty$	t
22	d+4.5= 4.5	2.4	$<\infty$	t
23	d+4.4= 4.4	2.3	$<\infty$	t
24	d+4.0= 4.0	2.1	$<\infty$	t
25	d+3.8= 3.8	2.0	$<\infty$	t
26	d+3.8= 3.8	2.0	$<\infty$	t
27	d+3.7= 3.7	2.0	$<\infty$	t
28	d+3.7= 3.7	2.0	$<\infty$	t
29	d+3.5= 3.5	1.9	$<\infty$	t
30	d+3.5= 3.5	1.9	$<\infty$	t
31	d+3.4= 3.4	1.8	$<\infty$	t
32	d+3.3= 3.3	1.7	$<\infty$	t

d : dot

Table 25. Measurements of somatic chromosomes of *Paphiopedilum victoria-regina* ssp. *chamberlainianum* at metaphase, 2n=34

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	4.1+4.5=8.6	5.7	1.1	m
2	3.6+4.2=7.8	5.1	1.2	m
3	2.5+3.5=6.0	3.9	1.4	m
4	2.5+3.5=6.0	3.9	1.4	m
5	2.5+3.0=5.5	3.6	1.2	m
6	2.5+3.0=5.5	3.6	1.2	m
7	2.5+2.8=5.3	3.5	1.1	m
8	2.4+2.8=5.2	3.4	1.2	m
9	2.2+2.8=5.0	3.3	1.3	m
10	2.2+2.8=5.0	3.3	1.3	m
11	2.0+2.7=4.7	3.1	1.4	m
12	2.0+2.7=4.7	3.1	1.4	m
13	1.9+2.6=4.5	3.0	1.4	m
14	1.9+2.6=4.5	3.0	1.4	m
15	2.0+2.2=4.2	2.8	1.1	m
16	2.0+2.2=4.2	2.8	1.1	m
17	d+5.5=5.5	3.6	$<\infty$	t
18	d+5.3=5.3	3.5	$<\infty$	t
19	d+4.9=4.9	3.2	$<\infty$	t
20	d+4.6=4.6	3.0	$<\infty$	t
21	d+4.1=4.1	2.7	$<\infty$	t
22	d+4.0=4.0	2.6	$<\infty$	t
23	d+3.4=3.4	2.2	$<\infty$	t
24	d+3.4=3.4	2.2	$<\infty$	t
25	d+3.3=3.3	2.2	$<\infty$	t
26	d+3.3=3.3	2.2	$<\infty$	t
27	d+3.1=3.1	2.0	$<\infty$	t
28	d+3.1=3.1	2.0	$<\infty$	t
29	d+3.0=3.0	2.0	$<\infty$	t
30	d+3.0=3.0	2.0	$<\infty$	t
31	d+2.9=2.9	1.9	$<\infty$	t
32	d+2.9=2.9	1.9	$<\infty$	t
33	d+2.8=2.8	1.8	$<\infty$	t
34	d+2.8=2.8	1.8	$<\infty$	t

d : dot

Table 26. Measurements of somatic chromosomes of *Paphiopedilum victoria-regina* ssp. *glaucophyllum* at metaphase, 2n=36

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	4.8+5.2=10.0	6.1	1.1	m
2	4.8+5.2=10.0	6.1	1.1	m
3	2.0+4.1= 6.1	3.7	2.1	sm
4	2.0+4.1= 6.1	3.7	2.1	sm
5	2.8+2.9= 5.7	3.5	1.0	m
6	2.8+2.9= 5.7	3.5	1.0	m
7	2.6+2.7= 5.3	3.2	1.0	m
8	2.6+2.7= 5.3	3.2	1.0	m
9	2.3+2.7= 5.0	3.0	1.2	m
10	2.3+2.7= 5.0	3.0	1.2	m
11	2.4+2.5= 4.9	3.0	1.0	m
12	2.4+2.5= 4.9	3.0	1.0	m
13	2.0+2.5= 4.5	2.8	1.3	m
14	1.9+2.5= 4.4	2.7	1.3	m
15	d+6.3= 6.3	3.8	$<\infty$	t
16	d+6.1= 6.1	3.7	$<\infty$	t
17	d+5.0= 5.0	3.0	$<\infty$	t
18	d+4.9= 4.9	3.0	$<\infty$	t
19	d+3.7= 3.7	2.2	$<\infty$	t
20	d+3.6= 3.6	2.2	$<\infty$	t
21	d+3.5= 3.5	2.1	$<\infty$	t
22	d+3.5= 3.5	2.1	$<\infty$	t
23	d+3.4= 3.4	2.1	$<\infty$	t
24	d+3.4= 3.4	2.1	$<\infty$	t
25	d+3.3= 3.3	2.0	$<\infty$	t
26	d+3.3= 3.3	2.0	$<\infty$	t
27	d+3.3= 3.3	2.0	$<\infty$	t
28	d+3.3= 3.3	2.0	$<\infty$	t
29	d+3.3= 3.3	2.0	$<\infty$	t
30	d+3.3= 3.3	2.0	$<\infty$	t
31	d+3.2= 3.2	1.9	$<\infty$	t
32	d+3.2= 3.2	1.9	$<\infty$	t
33	d+3.2= 3.2	1.9	$<\infty$	t
34	d+3.1= 3.1	1.9	$<\infty$	t
35	d+3.0= 3.0	1.8	$<\infty$	t
36	d+3.0= 3.0	1.8	$<\infty$	t

d : dot

Table 27. Measurements of somatic chromosomes of *Paphiopedilum victoria-regina* ssp. *glaucophyllum* var. *moquetteanum* at metaphase, 2n=34

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	4.5+5.1=9.6	6.6	1.1	m
2	4.4+5.0=9.4	6.4	1.1	m
3	2.8+4.1=6.9	4.7	1.4	m
4	2.4+3.9=6.3	4.3	1.6	m
5	2.5+2.7=5.2	3.6	1.1	m
6	2.4+2.6=5.0	3.4	1.1	m
7	2.2+2.5=4.7	3.2	1.1	m
8	2.2+2.5=4.7	3.2	1.1	m
9	2.1+2.5=4.6	3.1	1.2	m
10	2.1+2.5=4.6	3.1	1.2	m
11	2.1+2.2=4.3	2.9	1.0	m
12	2.1+2.2=4.3	2.9	1.0	m
13	1.9+2.3=4.2	2.9	1.2	m
14	1.9+2.3=4.2	2.9	1.2	m
15	1.8+2.1=3.9	2.7	1.2	m
16	1.8+1.9=3.7	2.5	1.1	m
17	d+6.0=6.0	4.1	$<\infty$	t
18	d+5.5=5.5	3.8	$<\infty$	t
19	d+4.6=4.6	3.1	$<\infty$	t
20	d+4.6=4.6	3.1	$<\infty$	t
21	d+3.2=3.2	2.2	$<\infty$	t
22	d+3.2=3.2	2.2	$<\infty$	t
23	d+3.1=3.1	2.1	$<\infty$	t
24	d+3.1=3.1	2.1	$<\infty$	t
25	d+3.0=3.0	2.1	$<\infty$	t
26	d+3.0=3.0	2.1	$<\infty$	t
27	d+2.9=2.9	2.0	$<\infty$	t
28	d+2.9=2.9	2.0	$<\infty$	t
29	d+2.8=2.8	1.9	$<\infty$	t
30	d+2.8=2.8	1.9	$<\infty$	t
31	d+2.7=2.7	1.8	$<\infty$	t
32	d+2.6=2.6	1.8	$<\infty$	t
33	d+2.4=2.4	1.6	$<\infty$	t
34	d+2.2=2.2	1.5	$<\infty$	t

d : dot

Table 28. Measurements of somatic chromosomes of *Paphiopedilum victoria-regina* ssp. at metaphase, 2n=33

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	4.5+6.0=10.5	6.4	1.3	m
2	4.1+5.8= 9.9	6.0	1.4	m
3	3.6+4.7= 8.3	5.1	1.3	m
4	3.3+4.3= 7.6	4.6	1.3	m
5	3.5+3.6= 7.1	4.3	1.0	m
6	3.2+3.6= 6.8	4.1	1.1	m
7	2.7+3.0= 5.7	3.5	1.1	m
8	2.7+3.0= 5.7	3.5	1.1	m
9	2.7+2.7= 5.4	3.3	1.0	m
10	2.5+2.9= 5.4	3.3	1.2	m
11	2.0+2.8= 4.8	2.9	1.4	m
12	2.0+2.8= 4.8	2.9	1.4	m
13	1.9+2.8= 4.7	2.9	1.5	m
14	2.2+2.5= 4.7	2.9	1.1	m
15	1.8+2.7= 4.5	2.7	1.5	m
16	1.9+2.4= 4.3	2.6	1.3	m
17	d+6.1= 6.1	3.7	$<\infty$	t
18	d+6.0= 6.0	3.7	$<\infty$	t
19	d+5.5= 5.5	3.3	$<\infty$	t
20	d+4.9= 4.9	3.0	$<\infty$	t
21	d+4.3= 4.3	2.6	$<\infty$	t
22	d+4.0= 4.0	2.4	$<\infty$	t
23	d+3.5= 3.5	2.1	$<\infty$	t
24	d+3.5= 3.5	2.1	$<\infty$	t
25	d+3.4= 3.4	2.1	$<\infty$	t
26	d+3.3= 3.3	2.0	$<\infty$	t
27	d+3.0= 3.0	1.8	$<\infty$	t
28	d+3.0= 3.0	1.8	$<\infty$	t
29	d+2.9= 2.9	1.8	$<\infty$	t
30	d+2.9= 2.9	1.8	$<\infty$	t
31	d+2.7= 2.7	1.6	$<\infty$	t
32	d+2.6= 2.6	1.6	$<\infty$	t
33	d+2.5= 2.5	1.5	$<\infty$	t

d : dot

Table 29. Measurements of somatic chromosomes of *Paphiopedilum victoria-regina* ssp. at metaphase, 2n=35

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	5.5+5.6=11.1	6.7	1.0	m
2	5.0+5.6=10.6	6.4	1.1	m
3	4.2+5.6= 9.8	5.9	1.3	m
4	3.2+3.3= 6.5	3.9	1.0	m
5	3.2+3.3= 6.5	3.9	1.0	m
6	2.7+3.2= 5.9	3.5	1.2	m
7	2.8+2.8= 5.6	3.4	1.0	m
8	2.3+3.0= 5.3	3.2	1.3	m
9	2.5+2.7= 5.2	3.1	1.1	m
10	2.3+2.9= 5.2	3.1	1.3	m
11	2.3+2.9= 5.2	3.1	1.3	m
12	2.4+2.7= 5.1	3.1	1.1	m
13	2.1+2.5= 4.6	2.8	1.2	m
14	1.7+2.5= 4.2	2.5	1.5	m
15	1.5+2.5= 4.0	2.4	1.7	m
16	d+6.0= 6.0	3.6	$<\infty$	t
17	d+5.6= 5.6	3.4	$<\infty$	t
18	d+5.0= 5.0	3.0	$<\infty$	t
19	d+4.1= 4.1	2.5	$<\infty$	t
20	d+3.6= 3.6	2.2	$<\infty$	t
21	d+3.6= 3.6	2.2	$<\infty$	t
22	d+3.6= 3.6	2.2	$<\infty$	t
23	d+3.5= 3.5	2.1	$<\infty$	t
24	d+3.5= 3.5	2.1	$<\infty$	t
25	d+3.4= 3.4	2.0	$<\infty$	t
26	d+3.4= 3.4	2.0	$<\infty$	t
27	d+3.3= 3.3	2.0	$<\infty$	t
28	d+3.2= 3.2	1.9	$<\infty$	t
29	d+3.0= 3.0	1.8	$<\infty$	t
30	d+3.0= 3.0	1.8	$<\infty$	t
31	d+3.0= 3.0	1.8	$<\infty$	t
32	d+2.9= 2.9	1.7	$<\infty$	t
33	d+2.8= 2.8	1.7	$<\infty$	t
34	d+2.5= 2.5	1.5	$<\infty$	t
35	d+2.4= 2.4	1.4	$<\infty$	t

d : dot

Table 30. Measurements of somatic chromosomes of *Paphiopedilum victoria-regina* ssp. at metaphase, 2n=36

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	5.3+6.3=11.6	6.2	1.2	m
2	4.5+5.3= 9.8	5.3	1.2	m
3	3.0+5.1= 8.1	4.4	1.7	m
4	3.3+3.7= 7.0	3.8	1.1	m
5	3.0+4.0= 7.0	3.8	1.3	m
6	3.3+3.7= 7.0	3.8	1.1	m
7	2.9+3.1= 6.0	3.2	1.1	m
8	2.9+3.1= 6.0	3.2	1.1	m
9	2.8+3.2= 6.0	3.2	1.1	m
10	2.5+3.2= 5.7	3.1	1.3	m
11	2.3+2.9= 5.2	2.8	1.3	m
12	2.3+2.9= 5.2	2.8	1.3	m
13	2.4+2.6= 5.0	2.7	1.1	m
14	2.3+2.5= 4.8	2.6	1.1	m
15	d+7.0= 7.0	3.8	$<\infty$	t
16	d+7.0= 7.0	3.8	$<\infty$	t
17	d+6.7= 6.7	3.6	$<\infty$	t
18	d+5.9= 5.9	3.2	$<\infty$	t
19	d+5.8= 5.8	3.1	$<\infty$	t
20	d+4.8= 4.8	2.6	$<\infty$	t
21	d+4.4= 4.4	2.4	$<\infty$	t
22	d+3.9= 3.9	2.1	$<\infty$	t
23	d+3.9= 3.9	2.1	$<\infty$	t
24	d+3.6= 3.6	1.9	$<\infty$	t
25	d+3.6= 3.6	1.9	$<\infty$	t
26	d+3.6= 3.6	1.9	$<\infty$	t
27	d+3.6= 3.6	1.9	$<\infty$	t
28	d+3.6= 3.6	1.9	$<\infty$	t
29	d+3.4= 3.4	1.8	$<\infty$	t
30	d+3.4= 3.4	1.8	$<\infty$	t
31	d+3.0= 3.0	1.6	$<\infty$	t
32	d+3.0= 3.0	1.6	$<\infty$	t
33	d+2.9= 2.9	1.6	$<\infty$	t
34	d+2.9= 2.9	1.6	$<\infty$	t
35	d+2.8= 2.8	1.5	$<\infty$	t
36	d+2.8= 2.8	1.5	$<\infty$	t

d : dot

Table 31. Measurements of somatic chromosomes of *Paphiopedilum esquerolei* at metaphase, 2n=26

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	5.5+5.8=11.3	7.0	1.1	m
2	5.5+5.5=11.0	6.7	1.0	m
3	5.3+5.5=10.8	6.6	1.0	m
4	4.6+5.2= 9.8	6.0	1.1	m
5	3.6+3.9= 7.5	4.6	1.1	m
6	3.3+3.7= 7.0	4.3	1.1	m
7	3.1+3.6= 6.7	4.1	1.2	m
8	2.9+3.5= 6.4	3.9	1.2	m
9	3.0+3.4= 6.4	3.9	1.1	m
10	3.0+3.4= 6.4	3.9	1.1	m
11	2.9+3.5= 6.4	3.9	1.2	m
12	2.9+3.2= 6.1	3.7	1.1	m
13	2.6+3.1= 5.7	3.5	1.2	m
14	2.6+3.0= 5.6	3.4	1.2	m
15	2.6+2.8= 5.4	3.3	1.1	m
16	2.6+2.8= 5.4	3.3	1.1	m
17	2.5+2.8= 5.3	3.2	1.1	m
18	2.5+2.8= 5.3	3.2	1.1	m
19	2.3+2.4= 4.7	2.9	1.0	m
20	2.3+2.4= 4.7	2.9	1.0	m
21	2.1+2.5= 4.6	2.8	1.2	m
22	2.1+2.5= 4.6	2.8	1.2	m
23	1.8+2.6= 4.4	2.7	1.4	m
24	1.8+2.5= 4.3	2.6	1.4	m
25	0.5+1.3+2.4= 4.2*	2.6	1.3	m
26	0.2+1.5+2.2= 3.9*	2.4	1.3	m

* Chromosome with secondary constriction

Table 32. Measurements of somatic chromosomes of *Paphiopedilum hirsutissimum* at metaphase, 2n=26

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	5.4+5.5=10.9	6.1	1.0	m
2	5.4+5.5=10.9	6.1	1.0	m
3	4.6+5.8=10.4	5.9	1.3	m
4	4.4+4.4= 8.8	5.0	1.0	m
5	3.1+4.3= 7.4	4.2	1.4	m
6	3.0+4.3= 7.3	4.1	1.4	m

Table 32. (continued)

7	2.5+4.8= 7.3	4.1	1.9	sm
8	2.5+4.5= 7.0	3.9	1.8	sm
9	2.8+4.2= 7.0	3.9	1.5	m
10	2.8+4.2= 7.0	3.9	1.5	m
11	3.3+3.5= 6.8	3.8	1.1	m
12	3.2+3.5= 6.7	3.8	1.1	m
13	2.1+4.3= 6.4	3.6	2.0	sm
14	2.1+4.3= 6.4	3.6	2.0	sm
15	1.9+4.5= 6.4	3.6	2.4	sm
16	1.9+4.5= 6.4	3.6	2.4	sm
17	2.1+3.8= 5.9	3.3	1.8	sm
18	2.1+3.8= 5.9	3.3	1.8	sm
19	1.5+4.3= 5.8	3.3	2.9	sm
20	1.6+4.1= 5.7	3.2	2.6	sm
21	2.8+2.8= 5.6	3.2	1.0	m
22	2.8+2.8= 5.6	3.2	1.0	m
23	1.6+3.6= 5.2	2.9	2.3	sm
24	1.3+3.7= 5.0	2.8	2.8	sm
25	2.4+2.6= 5.0	2.8	1.1	m
26	1.8+3.1= 4.9	2.8	1.7	m

Table 33. Measurements of somatic chromosomes of *Paphiopedilum exul* at metaphase, 2n=26

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	6.3+6.5=1 2.8	7.5	1.0	m
2	6.3+6.3=1 2.6	7.4	1.0	m
3	5.2+5.5=1 0.7	6.3	1.1	m
4	4.8+5.5=1 0.3	6.0	1.1	m
5	3.7+3.9= 7.6	4.5	1.1	m
6	3.6+3.9= 7.5	4.4	1.1	m
7	3.2+3.6= 6.8	4.0	1.1	m
8	3.0+3.5= 6.5	3.8	1.2	m
9	3.2+3.3= 6.5	3.8	1.0	m
10	3.1+3.2= 6.3	3.7	1.0	m
11	1.1+1.8+3.4= 6.3*	3.7	1.2	m
12	1.0+1.5+3.5= 6.0*	3.5	1.4	m
13	2.6+3.3= 5.9	3.5	1.3	m
14	2.6+3.3= 5.9	3.5	1.3	m

Table 33. (continued)

15	2.5+3.0= 5.5	3.2	1.2	m
16	2.4+3.1= 5.5	3.2	1.3	m
17	2.3+3.2= 5.5	3.2	1.4	m
18	2.3+3.2= 5.5	3.2	1.4	m
19	2.5+2.7= 5.2	3.0	1.1	m
20	2.5+2.6= 5.1	3.0	1.0	m
21	2.3+2.6= 4.9	2.9	1.1	m
22	2.3+2.6= 4.9	2.9	1.1	m
23	2.1+2.5= 4.6	2.7	1.2	m
24	2.0+2.5= 4.5	2.6	1.3	m
25	1.9+2.0= 3.9	2.3	1.1	m
26	1.6+2.2= 3.8	2.2	1.4	m

* Chromosome with secondary constriction

Table 34. Measurements of somatic chromosomes of *Paphiopedilum insigne* at metaphase, 2n=26

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	6.8+7.3=1 4.1	7.0	1.1	m
2	6.8+7.0=1 3.8	6.8	1.0	m
3	6.3+6.8=1 3.1	6.5	1.1	m
4	6.0+6.2=1 2.2	6.0	1.0	m
5	4.5+4.8= 9.3	4.6	1.1	m
6	4.3+4.8= 9.1	4.5	1.1	m
7	3.8+4.4= 8.2	4.1	1.1	m
8	3.8+4.2= 8.0	4.0	1.1	m
9	3.8+4.0= 7.8	3.9	1.1	m
10	3.8+4.0= 7.8	3.9	1.1	m
11	3.5+4.2= 7.7	3.8	1.2	m
12	3.4+4.1= 7.5	3.7	1.2	m
13	1.2+1.5+4.2= 6.9 *	3.4	1.6	m
14	1.2+1.5+4.1= 6.8 *	3.4	1.5	m
15	3.1+3.5= 6.6	3.3	1.1	m
16	3.0+3.5= 6.5	3.2	1.2	m
17	3.0+3.4= 6.4	3.2	1.1	m
18	3.0+3.4= 6.4	3.2	1.1	m
19	2.6+3.5= 6.1	3.0	1.3	m
20	2.5+3.3= 5.8	2.9	1.3	m
21	2.8+2.8= 5.6	2.8	1.0	m
22	2.8+2.8= 5.6	2.8	1.0	m

Table 34. (continued)

23	2.2+3.0= 5.2	2.6	1.4	m
24	2.2+3.0= 5.2	2.6	1.4	m
25	2.3+2.9= 5.2	2.6	1.3	m
26	2.1+2.8= 4.9	2.4	1.3	m

* Chromosome with secondary constriction

Table 35. Measurements of somatic chromosomes of *Paphiopedilum charlesworthii* at metaphase, 2n=26

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	7.2+7.2=1 4.4	7.3	1.0	m
2	6.7+6.8=1 3.5	6.8	1.0	m
3	5.6+6.3=1 1.9	6.0	1.1	m
4	5.6+6.1=1 1.7	5.9	1.1	m
5	4.3+4.9= 9.2	4.6	1.1	m
6	4.0+4.8= 8.8	4.4	1.2	m
7	3.5+5.2= 8.7	4.4	1.5	m
8	3.3+5.3= 8.6	4.3	1.6	m
9	3.5+4.5= 8.0	4.0	1.3	m
10	3.4+4.4= 7.8	4.0	1.3	m
11	3.3+4.4= 7.7	3.9	1.3	m
12	3.1+4.4= 7.5	3.8	1.4	m
13	2.9+3.7= 6.6	3.3	1.3	m
14	2.7+3.8= 6.5	3.3	1.4	m
15	2.9+3.6= 6.5	3.3	1.3	m
16	2.8+3.6= 6.4	3.2	1.3	m
17	2.9+3.4= 6.3	3.2	1.2	m
18	2.8+3.4= 6.2	3.1	1.2	m
19	2.6+3.3= 5.9	3.0	1.3	m
20	2.3+3.3= 5.6	2.8	1.4	m
21	1.0+1.6+2.9= 5.5 *	2.8	1.1	m
22	0.8+1.7+2.9= 5.4 *	2.7	1.2	m
23	2.5+2.9= 5.4	2.7	1.2	m
24	2.4+2.8= 5.2	2.6	1.2	m
25	2.0+2.8= 4.8	2.4	1.4	m
26	1.9+2.4= 4.3	2.2	1.3	m

* Chromosome with secondary constriction

Table 36. Measurements of somatic chromosomes of *Paphiopedilum villosum* at metaphase, 2n=26

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	6.5+7.1=1 3.6	7.7	1.1	m
2	5.6+5.8=1 1.4	6.4	1.0	m
3	5.3+5.5=1 0.8	6.1	1.0	m
4	5.1+5.1=1 0.2	5.8	1.0	m
5	4.0+4.4= 8.4	4.7	1.1	m
6	4.0+4.1= 8.1	4.6	1.0	m
7	3.5+4.5= 8.0	4.5	1.3	m
8	3.7+4.1= 7.8	4.4	1.1	m
9	3.6+3.7= 7.3	4.1	1.0	m
10	3.2+4.0= 7.2	4.1	1.3	m
11	3.0+3.5= 6.5	3.7	1.2	m
12	2.9+3.5= 6.4	3.6	1.2	m
13	2.5+3.8= 6.3	3.6	1.5	m
14	2.5+3.8= 6.3	3.6	1.5	m
15	0.9+1.4+3.5= 5.8*	3.3	1.5	m
16	0.9+1.5+3.3= 5.7*	3.2	1.4	m
17	2.4+3.0= 5.4	3.1	1.3	m
18	2.3+3.0= 5.3	3.0	1.3	m
19	2.6+2.7= 5.3	3.0	1.0	m
20	2.5+2.6= 5.1	2.9	1.0	m
21	2.1+2.6= 4.7	2.7	1.2	m
22	2.0+2.7= 4.7	2.7	1.4	m
23	2.1+2.3= 4.4	2.5	1.1	m
24	2.1+2.3= 4.4	2.5	1.1	m
25	1.7+2.4= 4.1	2.3	1.4	m
26	1.3+2.5= 3.8	2.1	1.9	sm

* Chromosome with secondary constriction

Table 37. Measurements of somatic chromosomes of *Paphiopedilum boxalli* at metaphase, 2n=26

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	6.5+7.0=1 3.5	8.0	1.1	m
2	5.7+5.8=1 1.5	6.8	1.0	m
3	5.5+5.5=1 1.0	6.6	1.0	m
4	5.2+5.3=1 0.5	6.3	1.0	m
5	3.7+3.8= 7.5	4.5	1.0	m
6	3.5+4.0= 7.5	4.5	1.1	m

Table 37. (continued)

7	3.4+4.0= 7.4	4.4	1.2	m
8	3.2+4.0= 7.2	4.3	1.3	m
9	3.0+3.5= 6.5	3.9	1.2	m
10	3.0+3.4= 6.4	3.8	1.1	m
11	2.9+3.3= 6.2	3.7	1.1	m
12	2.9+3.2= 6.1	3.6	1.1	m
13	2.8+3.2= 6.0	3.6	1.1	m
14	2.7+3.1= 5.8	3.5	1.1	m
15	1.0+1.1+3.1= 5.2*	3.1	1.5	m
16	1.0+1.1+3.0= 5.1*	3.0	1.4	m
17	2.3+2.5= 4.8	2.9	1.1	m
18	2.3+2.5= 4.8	2.9	1.1	m
19	2.4+2.4= 4.8	2.9	1.0	m
20	2.4+2.4= 4.8	2.9	1.0	m
21	2.1+2.5= 4.6	2.7	1.2	m
22	2.1+2.4= 4.5	2.7	1.1	m
23	2.1+2.3= 4.4	2.6	1.1	m
24	2.1+2.3= 4.4	2.6	1.1	m
25	1.5+2.4= 3.9	2.3	1.6	m
26	1.2+2.3= 3.5	2.1	1.9	sm

* Chromosome with secondary constriction

Table 38. Measurements of somatic chromosomes of *Paphiopedilum spicerianum* at metphase, 2n=30

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	6.3+6.8=13.1	6.4	1.1	m
2	6.3+6.5=12.8	6.2	1.0	m
3	6.0+6.5=12.5	6.1	1.1	m
4	5.8+6.0=11.8	5.7	1.0	m
5	4.3+5.5= 9.8	4.8	1.3	m
6	4.3+5.5= 9.8	4.8	1.3	m
7	4.0+5.5= 9.5	4.6	1.4	m
8	4.0+5.5= 9.5	4.6	1.4	m
9	4.0+4.8= 8.8	4.3	1.2	m
10	4.0+4.8= 8.8	4.3	1.2	m
11	4.0+4.7= 8.7	4.2	1.2	m
12	3.8+4.7= 8.5	4.1	1.2	m
13	3.0+3.7= 6.7	3.3	1.2	m
14	3.0+3.7= 6.7	3.3	1.2	m

Table 38. (continued)

15	2.4+3.4= 5.8	2.8	1.4	m
16	2.2+3.2= 5.4	2.6	1.5	m
17	2.5+2.7= 5.2	2.5	1.1	m
18	2.5+2.7= 5.2	2.5	1.1	m
19	2.0+2.5= 4.5	2.2	1.3	m
20	2.0+2.5= 4.5	2.2	1.3	m
21	2.0+2.2= 4.2	2.0	1.1	m
22	2.0+2.2= 4.2	2.0	1.1	m
23	d+4.5= 4.5	2.2	<∞	t
24	d+4.5= 4.5	2.2	<∞	t
25	d+3.8= 3.8	1.8	<∞	t
26	d+3.6= 3.6	1.8	<∞	t
27	d+3.5= 3.5	1.7	<∞	t
28	d+3.5= 3.5	1.7	<∞	t
29	d+3.2= 3.2	1.6	<∞	t
30	d+3.1= 3.1	1.5	<∞	t

d : dot

Table 39. Measurements of somatic chromosomes of *Paphiopedilum druryi* at metaphase, 2n=30

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	3.8+7.7=11.5	5.9	2.0	sm
2	3.0+8.0=11.0	5.6	2.7	sm
3	3.8+7.0=10.8	5.5	1.8	sm
4	4.5+6.1=10.6	5.4	1.4	m
5	3.5+6.6=10.1	5.2	1.9	sm
6	2.5+5.0= 7.5	3.8	2.0	sm
7	3.1+4.2= 7.3	3.7	1.4	m
8	3.3+4.0= 7.3	3.7	1.2	m
9	3.4+3.6= 7.0	3.6	1.1	m
10	2.9+4.0= 6.9	3.5	1.4	m
11	2.8+4.0= 6.8	3.5	1.4	m
12	3.0+3.6= 6.6	3.4	1.2	m
13	2.8+3.5= 6.3	3.2	1.3	m
14	2.6+3.3= 5.9	3.0	1.3	m
15	2.4+3.5= 5.9	3.0	1.5	m
16	2.3+3.4= 5.7	2.9	1.5	m
17	2.5+3.0= 5.5	2.8	1.2	m
18	2.5+2.6= 5.1	2.6	1.0	m

Table 39. (continued)

19	2.2+2.6= 4.8	2.5	1.2	m
20	2.2+2.6= 4.8	2.5	1.2	m
21	2.0+2.5= 4.5	2.3	1.3	m
22	2.0+2.2= 4.2	2.2	1.1	m
23	d+8.5= 8.5	4.4	<∞	t
24	d+7.5= 7.5	3.8	<∞	t
25	d+4.3= 4.3	2.2	<∞	t
26	d+4.0= 4.0	2.1	<∞	t
27	d+4.0= 4.0	2.1	<∞	t
28	d+3.8= 3.8	2.0	<∞	t
29	d+3.5= 3.5	1.8	<∞	t
30	d+3.2= 3.2	1.6	<∞	t

d : dot

Table 40. Measurements of somatic chromosomes of *Paphiopedilum fairieanum* at metaphase, 2n=26

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	6.5+7.0=1 3.5	7.5	1.1	m
2	5.6+5.8=1 1.4	6.3	1.0	m
3	4.7+6.1=1 0.8	6.0	1.3	m
4	4.7+5.8=1 0.5	5.8	1.2	m
5	3.0+5.2= 8.2	4.5	1.7	m
6	3.0+5.1= 8.1	4.5	1.7	m
7	3.6+4.0= 7.6	4.2	1.1	m
8	3.5+4.0= 7.5	4.1	1.1	m
9	3.2+3.6= 6.8	3.8	1.1	m
10	3.0+3.6= 6.6	3.6	1.2	m
11	3.0+3.5= 6.5	3.6	1.2	m
12	3.0+3.5= 6.5	3.6	1.2	m
13	2.7+3.5= 6.2	3.4	1.3	m
14	2.8+3.2= 6.0	3.3	1.1	m
15	2.0+4.0= 6.0	3.3	2.0	sm
16	2.0+4.0= 6.0	3.3	2.0	sm
17	0.9+2.0+3.0= 5.9*	3.3	1.0	m
18	2.9+3.0= 5.9	3.3	1.0	m
19	2.2+3.3= 5.5	3.0	1.5	m
20	2.2+3.3= 5.5	3.0	1.5	m
21	2.1+3.4= 5.5	3.0	1.6	m
22	2.2+3.3= 5.5	3.0	1.5	m

Table 40. (continued)

23	1.7+3.1= 4.8	2.7	1.8	sm
24	1.7+3.1= 4.8	2.7	1.8	sm
25	1.6+3.2= 4.8	2.7	2.0	sm
26	1.5+3.0= 4.5	2.5	2.0	sm

* Chromosome with secondary constriction

Table 41. Measurements of somatic chromosomes of *Paphiopedilum hookerae* at metaphase, 2n=28

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	5.5+6.0=11.5	5.5	1.1	m
2	4.8+5.5=10.3	4.9	1.1	m
3	4.0+5.0= 9.0	4.3	1.3	m
4	4.0+5.0= 9.0	4.3	1.3	m
5	4.0+4.9= 8.9	4.2	1.2	m
6	4.0+4.9= 8.9	4.2	1.2	m
7	2.6+5.9= 8.5	4.1	2.3	sm
8	2.6+5.9= 8.5	4.1	2.3	sm
9	2.0+6.4= 8.4	4.0	3.2	st
10	2.0+6.4= 8.4	4.0	3.2	st
11	2.1+6.1= 8.2	3.9	2.9	sm
12	2.5+5.5= 8.0	3.8	2.2	sm
13	3.0+4.7= 7.7	3.7	1.7	m
14	3.0+4.7= 7.7	3.7	1.7	m
15	3.5+3.9= 7.4	3.5	1.1	m
16	3.2+4.2= 7.4	3.5	1.3	m
17	1.0+2.5+3.5= 7.0*	3.3	1.0	m
18	1.0+2.5+3.5= 7.0*	3.3	1.0	m
19	3.1+3.5= 6.6	3.1	1.1	m
20	3.1+3.5= 6.6	3.1	1.1	m
21	2.9+3.1= 6.0	2.9	1.1	m
22	2.9+3.1= 6.0	2.9	1.1	m
23	2.4+3.5= 5.9	2.8	1.5	m
24	2.5+3.3= 5.8	2.8	1.3	m
25	2.6+2.8= 5.4	2.6	1.1	m
26	2.6+2.8= 5.4	2.6	1.1	m
27	2.4+2.8= 5.2	2.5	1.2	m
28	2.4+2.6= 5.0	2.4	1.1	m

* Chromosome with secondary constriction

Table 42. Measurements of somatic chromosomes of *Paphiopedilum appletonianum* at metaphase, 2n=38

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	6.0+6.6=12.6	6.2	1.1	m
2	5.7+6.2=11.9	5.8	1.1	m
3	2.7+4.3= 7.0	3.4	1.6	m
4	2.7+4.3= 7.0	3.4	1.6	m
5	3.0+3.5= 6.5	3.2	1.2	m
6	3.0+3.3= 6.3	3.1	1.1	m
7	2.2+3.1= 5.3	2.6	1.4	m
8	2.4+2.9= 5.3	2.6	1.2	m
9	2.5+2.7= 5.2	2.5	1.1	m
10	2.5+2.7= 5.2	2.5	1.1	m
11	2.3+2.5= 4.8	2.3	1.1	m
12	2.2+2.5= 4.7	2.3	1.1	m
13	2.0+2.5= 4.5	2.2	1.3	m
14	2.0+2.4= 4.4	2.2	1.2	m
15	d+7.5= 7.5	3.7	$<\infty$	t
16	d+6.9= 6.9	3.4	$<\infty$	t
17	d+6.5= 6.5	3.2	$<\infty$	t
18	d+6.0= 6.0	2.9	$<\infty$	t
19	d+6.0= 6.0	2.9	$<\infty$	t
20	d+5.4= 5.4	2.6	$<\infty$	t
21	d+5.1= 5.1	2.5	$<\infty$	t
22	d+5.0= 5.0	2.4	$<\infty$	t
23	d+4.9= 4.9	2.4	$<\infty$	t
24	d+4.8= 4.8	2.3	$<\infty$	t
25	d+4.6= 4.6	2.2	$<\infty$	t
26	d+4.6= 4.6	2.2	$<\infty$	t
27	d+4.4= 4.4	2.2	$<\infty$	t
28	d+4.4= 4.4	2.2	$<\infty$	t
29	d+4.4= 4.4	2.2	$<\infty$	t
30	d+4.0= 4.0	2.0	$<\infty$	t
31	d+4.0= 4.0	2.0	$<\infty$	t
32	d+3.8= 3.8	1.9	$<\infty$	t
33	d+3.7= 3.7	1.8	$<\infty$	t
34	d+3.6= 3.6	1.8	$<\infty$	t
35	d+3.6= 3.6	1.8	$<\infty$	t
36	d+3.6= 3.6	1.8	$<\infty$	t
37	d+3.5= 3.5	1.7	$<\infty$	t
38	d+3.5= 3.5	1.7	$<\infty$	t

d : dot

Table 43. Measurements of somatic chromosomes of *Paphiopedilum bullenianum* at metaphase, 2n=40

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	3.0+5.7=8.7	3.8	1.9	sm
2	3.0+5.7=8.7	3.8	1.9	sm
3	3.5+3.8=7.3	3.2	1.1	m
4	3.5+3.8=7.3	3.2	1.1	m
5	3.1+3.5=6.6	2.8	1.1	m
6	3.1+3.5=6.6	2.8	1.1	m
7	2.9+3.5=6.4	2.8	1.2	m
8	2.9+3.5=6.4	2.8	1.2	m
9	3.0+3.1=6.1	2.6	1.0	m
10	3.0+3.1=6.1	2.6	1.0	m
11	2.7+3.0=5.7	2.5	1.1	m
12	2.7+3.0=5.7	2.5	1.1	m
13	d+8.1=8.1	3.5	$<\infty$	t
14	d+7.9=7.9	3.4	$<\infty$	t
15	d+7.7=7.7	3.3	$<\infty$	t
16	d+7.1=7.1	3.1	$<\infty$	t
17	d+6.5=6.5	2.8	$<\infty$	t
18	d+6.2=6.2	2.7	$<\infty$	t
19	d+6.2=6.2	2.7	$<\infty$	t
20	d+6.1=6.1	2.6	$<\infty$	t
21	d+6.0=6.0	2.6	$<\infty$	t
22	d+5.5=5.5	2.4	$<\infty$	t
23	d+5.5=5.5	2.4	$<\infty$	t
24	d+5.3=5.3	2.3	$<\infty$	t
25	d+5.0=5.0	2.2	$<\infty$	t
26	d+5.0=5.0	2.2	$<\infty$	t
27	d+4.9=4.9	2.1	$<\infty$	t
28	d+4.9=4.9	2.1	$<\infty$	t
29	d+4.6=4.6	2.0	$<\infty$	t
30	d+4.5=4.5	1.9	$<\infty$	t
31	d+4.5=4.5	1.9	$<\infty$	t
32	d+4.5=4.5	1.9	$<\infty$	t
33	d+4.5=4.5	1.9	$<\infty$	t
34	d+4.5=4.5	1.9	$<\infty$	t
35	d+4.5=4.5	1.9	$<\infty$	t
36	d+4.4=4.4	1.9	$<\infty$	t
37	d+4.3=4.3	1.9	$<\infty$	t
38	d+4.0=4.0	1.7	$<\infty$	t
39	d+4.0=4.0	1.7	$<\infty$	t
40	d+4.0=4.0	1.7	$<\infty$	t

d : dot

Table 44. Measurements of somatic chromosomes of *Paphiopedilum celebesense* at metaphase, 2n=42

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	2.3+4.1=6.4	3.8	1.8	sm
2	2.3+4.1=6.4	3.8	1.8	sm
3	2.7+3.0=5.7	3.2	1.1	m
4	2.7+3.0=5.7	3.2	1.1	m
5	2.5+2.9=5.4	3.0	1.2	m
6	2.5+2.9=5.4	3.0	1.2	m
7	2.0+2.4=4.4	2.5	1.2	m
8	1.9+2.3=4.2	2.3	1.2	m
9	1.9+2.1=4.0	2.2	1.1	m
10	1.9+2.1=4.0	2.2	1.1	m
11	d+6.2=6.2	3.5	$<\infty$	t
12	d+6.0=6.0	3.3	$<\infty$	t
13	d+5.6=5.6	3.1	$<\infty$	t
14	d+5.4=5.4	3.0	$<\infty$	t
15	d+5.4=5.4	3.0	$<\infty$	t
16	d+5.4=5.4	3.0	$<\infty$	t
17	d+5.2=5.2	2.9	$<\infty$	t
18	d+5.2=5.2	2.9	$<\infty$	t
19	d+4.0=4.0	2.2	$<\infty$	t
20	d+3.9=3.9	2.2	$<\infty$	t
21	d+3.8=3.8	2.1	$<\infty$	t
22	d+3.8=3.8	2.1	$<\infty$	t
23	d+3.8=3.8	2.1	$<\infty$	t
24	d+3.6=3.6	2.0	$<\infty$	t
25	d+3.6=3.6	2.0	$<\infty$	t
26	d+3.6=3.6	2.0	$<\infty$	t
27	d+3.6=3.6	2.0	$<\infty$	t
28	d+3.5=3.5	1.9	$<\infty$	t
29	d+3.5=3.5	1.9	$<\infty$	t
30	d+3.5 3.5	1.9	$<\infty$	t
31	d+3.4=3.4	1.9	$<\infty$	t
32	d+3.4=3.4	1.9	$<\infty$	t
33	d+3.4=3.4	1.9	$<\infty$	t
34	d+3.4=3.4	1.9	$<\infty$	t
35	d+3.3=3.3	1.8	$<\infty$	t
36	d+3.3=3.3	1.8	$<\infty$	t
37	d+3.2=3.2	1.8	$<\infty$	t
38	d+3.2=3.2	1.8	$<\infty$	t
39	d+3.2=3.2	1.8	$<\infty$	t
40	d+3.2=3.2	1.8	$<\infty$	t

Table 44. (continued)

41	d+2.9=2.9	1.6	<∞	t
42	d+2.6=2.6	1.4	<∞	t

d : dot

Table 45. Measurements of somatic chromosomes of *Paphiopedilum tonsum* at metaphase, 2n=32

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	5.2+5.3=10.5	5.2	1.1	m
2	5.0+5.3=10.3	5.1	1.1	m
3	4.0+4.8= 8.8	4.4	1.2	m
4	4.0+4.8= 8.8	4.4	1.2	m
5	3.3+5.4= 8.7	4.3	1.6	m
6	4.1+4.5= 8.6	4.3	1.1	m
7	3.7+4.5= 8.2	4.1	1.2	m
8	3.7+4.5= 8.2	4.1	1.2	m
9	2.6+4.6= 7.2	3.6	1.8	sm
10	2.6+4.6= 7.2	3.6	1.8	sm
11	3.3+3.6= 6.9	3.4	1.1	m
12	3.3+3.6= 6.9	3.4	1.1	m
13	2.3+3.5= 5.8	2.9	1.5	m
14	2.4+3.4= 5.8	2.9	1.4	m
15	2.6+3.1= 5.7	2.8	1.2	m
16	2.6+3.1= 5.7	2.8	1.2	m
17	2.3+2.7= 5.0	2.5	1.2	m
18	2.2+2.7= 4.9	2.4	1.2	m
19	2.1+2.3= 4.4	2.2	1.1	m
20	2.1+2.3= 4.4	2.2	1.1	m
21	d+6.5= 6.5	3.2	<∞	t
22	d+6.2= 6.2	3.1	<∞	t
23	d+6.1= 6.1	3.0	<∞	t
24	d+5.6= 5.6	2.8	<∞	t
25	d+4.8= 4.8	2.4	<∞	t
26	d+4.8= 4.8	2.4	<∞	t
27	d+4.5= 4.5	2.2	<∞	t
28	d+4.3= 4.3	2.1	<∞	t
29	d+4.3= 4.3	2.1	<∞	t
30	d+4.1= 4.1	2.0	<∞	t
31	d+4.0= 4.0	2.0	<∞	t
32	d+3.7= 3.7	1.8	<∞	t

d : dot

Table 46. Measurements of somatic chromosomes of *Paphiopedilum dayanum* at metaphase, 2n=36

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	6.0+6.4=1 2.4	5.4	1.1	m
2	5.6+6.4=1 2.0	5.3	1.1	m
3	4.1+7.2=1 1.3	5.0	1.8	sm
4	3.6+6.7=1 0.3	4.5	1.9	sm
5	3.7+4.0= 7.7	3.4	1.1	m
6	3.6+4.0= 7.6	3.3	1.1	m
7	3.6+4.0= 7.6	3.3	1.1	m
8	3.4+4.2= 7.6	3.3	1.2	m
9	3.2+4.1= 7.3	3.2	1.3	m
10	3.2+4.1= 7.3	3.2	1.3	m
11	3.2+3.8= 7.0	3.1	1.2	m
12	3.0+4.0= 7.0	3.1	1.3	m
13	2.8+4.2= 7.0	3.1	1.5	m
14	2.8+4.0= 6.8	3.0	1.5	m
15	2.7+3.7= 6.4	2.8	1.4	m
16	2.7+3.7= 6.4	2.8	1.4	m
17	d+7.0= 7.0	3.1	$<\infty$	t
18	d+7.0= 7.0	3.1	$<\infty$	t
19	d+6.2= 6.2	2.7	$<\infty$	t
20	d+5.6= 5.6	2.5	$<\infty$	t
21	d+5.1= 5.1	2.2	$<\infty$	t
22	d+4.9= 4.9	2.2	$<\infty$	t
23	d+4.8= 4.8	2.1	$<\infty$	t
24	d+4.8= 4.8	2.1	$<\infty$	t
25	d+4.8= 4.8	2.1	$<\infty$	t
26	d+4.7= 4.7	2.1	$<\infty$	t
27	d+4.6= 4.6	2.0	$<\infty$	t
28	d+4.4= 4.4	1.9	$<\infty$	t
29	d+4.4= 4.4	1.9	$<\infty$	t
30	d+4.4= 4.4	1.9	$<\infty$	t
31	d+4.2= 4.2	1.8	$<\infty$	t
32	d+4.1= 4.1	1.8	$<\infty$	t
33	d+4.0= 4.0	1.8	$<\infty$	t
34	d+4.0= 4.0	1.8	$<\infty$	t
35	d+3.7= 3.7	1.6	$<\infty$	t
36	d+3.5= 3.5	1.5	$<\infty$	t

d : dot

Table 47. Measurements of somatic chromosomes of *paphiopedilum mastersianum* at metaphase, 2n=36

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	6.5+7.0=1 3.5	5.3	1.1	m
2	6.0+7.0=1 3.0	5.1	1.2	m
3	3.2+6.1= 9.3	3.6	1.9	sm
4	3.2+6.1= 9.3	3.6	1.9	sm
5	2.8+5.5= 8.3	3.2	2.0	sm
6	2.8+5.5= 8.3	3.2	2.0	sm
7	2.6+5.5= 8.1	3.2	2.1	sm
8	2.6+5.5= 8.1	3.2	2.1	sm
9	3.1+4.9= 8.0	3.1	1.6	m
10	3.1+4.9= 8.0	3.1	1.6	m
11	3.2+4.5= 7.7	3.0	1.4	m
12	3.2+4.5= 7.7	3.0	1.4	m
13	3.0+4.3= 7.3	2.9	1.4	m
14	2.9+4.3= 7.2	2.8	1.5	m
15	3.0+3.9= 6.9	2.7	1.3	m
16	3.0+3.9= 6.9	2.7	1.3	m
17	d+9.0= 9.0	3.5	$<\infty$	t
18	d+8.0= 8.0	3.1	$<\infty$	t
19	d+7.9= 7.9	3.1	$<\infty$	t
20	d+7.6= 7.6	3.0	$<\infty$	t
21	d+6.6= 6.6	2.6	$<\infty$	t
22	d+6.5= 6.5	2.5	$<\infty$	t
23	d+6.0= 6.0	2.3	$<\infty$	t
24	d+5.6= 5.6	2.2	$<\infty$	t
25	d+5.5= 5.5	2.2	$<\infty$	t
26	d+5.5= 5.5	2.2	$<\infty$	t
27	d+5.4= 5.4	2.1	$<\infty$	t
28	d+5.4= 5.4	2.1	$<\infty$	t
29	d+5.2= 5.2	2.0	$<\infty$	t
30	d+5.2= 5.2	2.0	$<\infty$	t
31	d+5.0= 5.0	2.0	$<\infty$	t
32	d+5.0= 5.0	2.0	$<\infty$	t
33	d+4.8= 4.8	1.9	$<\infty$	t
34	d+4.8= 4.8	1.9	$<\infty$	t
35	d+4.5= 4.5	1.8	$<\infty$	t
36	d+4.5= 4.5	1.8	$<\infty$	t

d : dot

Table 48. Measurements of somatic chromosomes of *Paphiopedilum javanicum* at metaphase, 2n=38

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	6.5+6.7=1 3.2	5.6	1.0	m
2	6.4+6.4=1 2.8	5.4	1.0	m
3	4.0+5.0= 9.0	3.8	1.3	m
4	3.8+4.6= 8.4	3.5	1.2	m
5	3.5+4.5= 8.0	3.4	1.3	m
6	3.5+4.5= 8.0	3.4	1.3	m
7	3.3+3.5= 6.8	2.9	1.1	m
8	3.3+3.5= 6.8	2.9	1.1	m
9	3.1+3.2= 6.3	2.7	1.0	m
10	3.1+3.2= 6.3	2.7	1.0	m
11	2.8+3.3= 6.1	2.6	1.2	m
12	2.8+3.3= 6.1	2.6	1.2	m
13	2.7+2.9= 5.6	2.4	1.1	m
14	2.7+2.7= 5.4	2.3	1.0	m
15	d+8.2= 8.2	3.5	$<\infty$	t
16	d+8.2= 8.2	3.5	$<\infty$	t
17	d+8.0= 8.0	3.4	$<\infty$	t
18	d+7.9= 7.9	3.3	$<\infty$	t
19	d+6.0= 6.0	2.5	$<\infty$	t
20	d+5.5= 5.5	2.3	$<\infty$	t
21	d+5.3= 5.3	2.2	$<\infty$	t
22	d+5.3= 5.3	2.2	$<\infty$	t
23	d+5.2= 5.2	2.2	$<\infty$	t
24	d+5.1= 5.1	2.1	$<\infty$	t
25	d+5.0= 5.0	2.1	$<\infty$	t
26	d+5.0= 5.0	2.1	$<\infty$	t
27	d+5.0= 5.0	2.1	$<\infty$	t
28	d+5.0= 5.0	2.1	$<\infty$	t
29	d+4.9= 4.9	2.1	$<\infty$	t
30	d+4.8= 4.8	2.0	$<\infty$	t
31	d+4.7= 4.7	2.0	$<\infty$	t
32	d+4.5= 4.5	1.9	$<\infty$	t
33	d+4.4= 4.4	1.9	$<\infty$	t
34	d+4.4= 4.4	1.9	$<\infty$	t
35	d+4.1= 4.1	1.7	$<\infty$	t
36	d+4.1= 4.1	1.7	$<\infty$	t
37	d+4.0= 4.0	1.7	$<\infty$	t
38	d+4.0= 4.0	1.7	$<\infty$	t

d : dot

Table 49. Measurements of somatic chromosomes of *Paphiopedilum violascens* at metaphase, 2n=38

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	6.0+6.8=12.8	5.3	1.1	m
2	5.9+6.8=12.7	5.2	1.2	m
3	2.5+6.6= 9.1	3.8	2.6	sm
4	2.5+6.6= 9.1	3.8	2.6	sm
5	2.5+6.1= 8.6	3.5	2.4	sm
6	2.5+6.1= 8.6	3.5	2.4	sm
7	3.1+5.3= 8.4	3.5	1.7	m
8	3.0+5.0= 8.0	3.3	1.7	m
9	3.1+4.0= 7.1	2.9	1.3	m
10	3.1+4.0= 7.1	2.9	1.3	m
11	2.7+4.0= 6.7	2.8	1.5	m
12	2.7+4.0= 6.7	2.8	1.5	m
13	3.0+3.5= 6.5	2.7	1.2	m
14	3.0+3.5= 6.5	2.7	1.2	m
15	d+7.8= 7.8	3.2	$<\infty$	t
16	d+7.2= 7.2	3.0	$<\infty$	t
17	d+7.0= 7.0	2.9	$<\infty$	t
18	d+7.0= 7.0	2.9	$<\infty$	t
19	d+6.6= 6.6	2.7	$<\infty$	t
20	d+5.9= 5.9	2.4	$<\infty$	t
21	d+5.6= 5.6	2.3	$<\infty$	t
22	d+5.5= 5.5	2.3	$<\infty$	t
23	d+5.5= 5.5	2.3	$<\infty$	t
24	d+5.2= 5.2	2.1	$<\infty$	t
25	d+5.2= 5.2	2.1	$<\infty$	t
26	d+5.0= 5.0	2.1	$<\infty$	t
27	d+5.0= 5.0	2.1	$<\infty$	t
28	d+4.8= 4.8	2.0	$<\infty$	t
29	d+4.7= 4.7	1.9	$<\infty$	t
30	d+4.5= 4.5	1.9	$<\infty$	t
31	d+4.5= 4.5	1.9	$<\infty$	t
32	d+4.4= 4.4	1.8	$<\infty$	t
33	d+4.4= 4.4	1.8	$<\infty$	t
34	d+4.1= 4.1	1.7	$<\infty$	t
35	d+4.0= 4.0	1.6	$<\infty$	t
36	d+3.7= 3.7	1.5	$<\infty$	t
37	d+3.6= 3.6	1.5	$<\infty$	t
38	d+3.5= 3.5	1.4	$<\infty$	t

d : dot

Table 50. Measurements of somatic chromosomes of *Paphiopedilum wentworthianum* at metaphase, 2n=40

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	6.5+7.0=13.5	4.8	1.1	m
2	6.5+7.0=13.5	4.8	1.1	m
3	3.7+7.5=11.2	4.0	2.0	sm
4	3.6+7.3=10.9	3.8	2.0	sm
5	3.9+6.9=10.8	3.8	1.8	sm
6	3.9+6.9=10.8	3.8	1.8	sm
7	3.3+5.8= 9.1	3.2	1.8	sm
8	3.2+5.7= 8.9	3.1	1.8	sm
9	2.8+4.9= 7.7	2.7	1.8	sm
10	2.8+4.9= 7.7	2.7	1.8	sm
11	3.2+4.3= 7.5	2.6	1.3	m
12	3.2+4.3= 7.5	2.6	1.3	m
13	d+8.4= 8.4	3.0	$<\infty$	t
14	d+8.4= 8.4	3.0	$<\infty$	t
15	d+8.1= 8.1	2.9	$<\infty$	t
16	d+8.1= 8.1	2.9	$<\infty$	t
17	d+7.4= 7.4	2.6	$<\infty$	t
18	d+6.9= 6.9	2.4	$<\infty$	t
19	d+6.9= 6.9	2.4	$<\infty$	t
20	d+6.5= 6.5	2.3	$<\infty$	t
21	d+6.3= 6.3	2.2	$<\infty$	t
22	d+6.3= 6.3	2.2	$<\infty$	t
23	d+6.3= 6.3	2.2	$<\infty$	t
24	d+6.2= 6.2	2.2	$<\infty$	t
25	d+5.7= 5.7	2.0	$<\infty$	t
26	d+5.7= 5.7	2.0	$<\infty$	t
27	d+5.5= 5.5	1.9	$<\infty$	t
28	d+5.3= 5.3	1.9	$<\infty$	t
29	d+5.3= 5.3	1.9	$<\infty$	t
30	d+5.0= 5.0	1.8	$<\infty$	t
31	d+4.9= 4.9	1.7	$<\infty$	t
32	d+4.9= 4.9	1.7	$<\infty$	t
33	d+4.7= 4.7	1.7	$<\infty$	t
34	d+4.7= 4.7	1.7	$<\infty$	t
35	d+4.7= 4.7	1.7	$<\infty$	t
36	d+4.6= 4.6	1.6	$<\infty$	t
37	d+4.6= 4.6	1.6	$<\infty$	t
38	d+4.5= 4.5	1.6	$<\infty$	t
39	d+4.1= 4.1	1.4	$<\infty$	t
40	d+4.1= 4.1	1.4	$<\infty$	t

d : dot

Table 51. Measurements of somatic chromosomes of *Paphiopedilum bougainvilleanum* at metaphase, 2n=40

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	3.5+7.5=11.0	3.9	2.1	sm
2	3.5+7.3=10.8	3.8	2.1	sm
3	3.2+6.5= 9.7	3.4	2.0	sm
4	3.2+6.5= 9.7	3.4	2.0	sm
5	3.0+6.5= 9.5	3.4	2.2	sm
6	3.0+6.5= 9.5	3.4	2.2	sm
7	3.8+4.9= 8.7	3.1	1.3	m
8	3.5+4.7= 8.2	2.9	1.3	m
9	2.7+5.4= 8.1	2.9	2.0	sm
10	2.8+5.3= 8.1	2.9	1.9	sm
11	2.7+5.2= 7.9	2.8	1.9	sm
12	2.7+5.2= 7.9	2.8	1.9	sm
13	d+8.0= 8.0	2.8	$<\infty$	t
14	d+8.0= 8.0	2.8	$<\infty$	t
15	d+8.0= 8.0	2.8	$<\infty$	t
16	d+7.6− 7.6	2.7	$<\infty$	t
17	d+7.5= 7.5	2.7	$<\infty$	t
18	d+7.5= 7.5	2.7	$<\infty$	t
19	d+7.3= 7.3	2.6	$<\infty$	t
20	d+7.2= 7.2	2.6	$<\infty$	t
21	d+6.8= 6.8	2.4	$<\infty$	t
22	d+6.6= 6.6	2.3	$<\infty$	t
23	d+6.5= 6.5	2.3	$<\infty$	t
24	d+6.5= 6.5	2.3	$<\infty$	t
25	d+6.4− 6.4	2.3	$<\infty$	t
26	d+6.3= 6.3	2.2	$<\infty$	t
27	d+6.1= 6.1	2.2	$<\infty$	t
28	d+6.1= 6.1	2.2	$<\infty$	t
29	d+6.0= 6.0	2.1	$<\infty$	t
30	d+5.8= 5.8	2.1	$<\infty$	t
31	d+5.5= 5.5	1.9	$<\infty$	t
32	d+5.3= 5.3	1.9	$<\infty$	t
33	d+5.3= 5.3	1.9	$<\infty$	t
34	d+5.2= 5.2	1.8	$<\infty$	t
35	d+4.8= 4.8	1.7	$<\infty$	t
36	d+4.6= 4.6	1.6	$<\infty$	t
37	d+4.6= 4.6	1.6	$<\infty$	t
38	d+4.5= 4.5	1.6	$<\infty$	t
39	d+4.5= 4.5	1.6	$<\infty$	t
40	d+4.4= 4.4	1.6	$<\infty$	t

d : dot

Table 52. Measurements of somatic chromosomes of *Paphiopedilum sukhakulii* at metaphase, 2n=40

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	5.0+5.7=10.7	5.9	1.1	m
2	5.0+5.6=10.6	5.9	1.1	m
3	3.2+4.0= 7.2	4.0	1.3	m
4	3.1+3.5= 6.6	3.7	1.1	m
5	2.8+3.0= 5.8	3.2	1.1	m
6	2.7+3.0= 5.7	3.2	1.1	m
7	2.7+3.0= 5.7	3.2	1.1	m
8	2.6+3.0= 5.6	3.1	1.2	m
9	2.3+3.0= 5.3	2.9	1.3	m
10	2.3+3.0= 5.3	2.9	1.3	m
11	2.3+2.5= 4.8	2.7	1.1	m
12	2.3+2.3= 4.6	2.5	1.0	m
13	d+5.7= 5.7	3.2	$<\infty$	t
14	d+5.3= 5.3	2.9	$<\infty$	t
15	d+5.1= 5.1	2.8	$<\infty$	t
16	d+5.1= 5.1	2.8	$<\infty$	t
17	d+4.8= 4.8	2.7	$<\infty$	t
18	d+4.0= 4.0	2.2	$<\infty$	t
19	d+3.9= 3.9	2.2	$<\infty$	t
20	d+3.8= 3.8	2.1	$<\infty$	t
21	d+3.8= 3.8	2.1	$<\infty$	t
22	d+3.7= 3.7	2.1	$<\infty$	t
23	d+3.7= 3.7	2.1	$<\infty$	t
24	d+3.6= 3.6	2.0	$<\infty$	t
25	d+3.6= 3.6	2.0	$<\infty$	t
26	d+3.5= 3.5	1.9	$<\infty$	t
27	d+3.4= 3.4	1.9	$<\infty$	t
28	d+3.4= 3.4	1.9	$<\infty$	t
29	d+3.3= 3.3	1.8	$<\infty$	t
30	d+3.3= 3.3	1.8	$<\infty$	t
31	d+3.2= 3.2	1.8	$<\infty$	t
32	d+3.2= 3.2	1.8	$<\infty$	t
33	d+3.2= 3.2	1.8	$<\infty$	t
34	d+3.0= 3.0	1.7	$<\infty$	t
35	d+3.0= 3.0	1.7	$<\infty$	t
36	d+2.8= 2.8	1.6	$<\infty$	t
37	d+2.8= 2.8	1.6	$<\infty$	t
38	d+2.8= 2.8	1.6	$<\infty$	t
39	d+2.7= 2.7	1.5	$<\infty$	t
40	d+2.7= 2.7	1.5	$<\infty$	t

d : dot

Table 53. Measurements of somatic chromosomes of *Paphiopedilum purpuratum* at metaphase, 2n=40

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	7.5+9.0=16.5	5.9	1.2	m
2	7.0+7.5=14.5	5.2	1.1	m
3	3.0+7.3=10.3	3.7	2.4	sm
4	3.0+7.3=10.3	3.7	2.4	sm
5	4.7+5.5=10.2	3.6	1.2	m
6	4.7+5.5=10.2	3.6	1.2	m
7	3.5+5.5= 9.0	3.2	1.6	m
8	3.3+5.3= 8.6	3.1	1.6	m
9	3.0+5.6= 8.6	3.1	1.9	sm
10	3.0+5.6= 8.6	3.1	1.9	sm
11	2.8+5.0= 7.8	2.8	1.8	sm
12	2.8+5.0= 7.8	2.8	1.8	sm
13	d+8.7= 8.7	3.1	$<\infty$	t
14	d+8.2= 8.2	2.9	$<\infty$	t
15	d+7.6= 7.6	2.7	$<\infty$	t
16	d+7.6= 7.6	2.7	$<\infty$	t
17	d+6.9= 6.9	2.5	$<\infty$	t
18	d+6.7= 6.7	2.4	$<\infty$	t
19	d+6.0= 6.0	2.1	$<\infty$	t
20	d+6.0= 6.0	2.1	$<\infty$	t
21	d+5.7= 5.7	2.0	$<\infty$	t
22	d+5.7= 5.7	2.0	$<\infty$	t
23	d+5.5= 5.5	2.0	$<\infty$	t
24	d+5.5= 5.5	2.0	$<\infty$	t
25	d+5.4= 5.4	1.9	$<\infty$	t
26	d+5.4= 5.4	1.9	$<\infty$	t
27	d+5.1= 5.1	1.8	$<\infty$	t
28	d+5.1= 5.1	1.8	$<\infty$	t
29	d+5.0= 5.0	1.8	$<\infty$	t
30	d+5.0= 5.0	1.8	$<\infty$	t
31	d+4.9= 4.9	1.8	$<\infty$	t
32	d+4.9= 4.9	1.8	$<\infty$	t
33	d+4.8= 4.8	1.7	$<\infty$	t
34	d+4.8= 4.8	1.7	$<\infty$	t
35	d+4.6= 4.6	1.6	$<\infty$	t
36	d+4.6= 4.6	1.6	$<\infty$	t
37	d+4.5= 4.5	1.6	$<\infty$	t
38	d+4.5= 4.5	1.6	$<\infty$	t
39	d+4.3= 4.3	1.5	$<\infty$	t
40	d+4.3= 4.3	1.5	$<\infty$	t

d : dot

Table 54. Measurements of somatic chromosomes of *Paphiopedilum virens* at metaphase, 2n=40

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	3.0+5.1=8.1	3.7	1.7	m
2	3.3+4.5=7.8	3.6	1.4	m
3	3.0+4.1=7.1	3.2	1.4	m
4	3.0+4.1=7.1	3.2	1.4	m
5	2.0+4.5=6.5	3.0	2.3	sm
6	2.0+4.5=6.5	3.0	2.3	sm
7	2.9+3.5=6.4	2.9	1.2	m
8	3.0+3.4=6.4	2.9	1.1	m
9	2.2+3.6=5.8	2.6	1.6	m
10	2.2+3.6=5.8	2.6	1.6	m
11	2.5+3.0=5.5	2.5	1.2	m
12	2.5+2.9=5.4	2.5	1.2	m
13	d+7.5=7.5	3.4	$<\infty$	t
14	d+7.4=7.4	3.4	$<\infty$	t
15	d+7.3=7.3	3.3	$<\infty$	t
16	d+7.0=7.0	3.2	$<\infty$	t
17	d+6.7=6.7	3.1	$<\infty$	t
18	d+6.4=6.4	2.9	$<\infty$	t
19	d+5.9=5.9	2.7	$<\infty$	t
20	d+5.9=5.9	2.7	$<\infty$	t
21	d+5.5=5.5	2.5	$<\infty$	t
22	d+5.5=5.5	2.5	$<\infty$	t
23	d+4.9=4.9	2.2	$<\infty$	t
24	d+4.9=4.9	2.2	$<\infty$	t
25	d+4.6=4.6	2.1	$<\infty$	t
26	d+4.5=4.5	2.1	$<\infty$	t
27	d+4.5=4.5	2.1	$<\infty$	t
28	d+4.5=4.5	2.1	$<\infty$	t
29	d+4.3=4.3	2.0	$<\infty$	t
30	d+4.3=4.3	2.0	$<\infty$	t
31	d+4.2=4.2	1.9	$<\infty$	t
32	d+4.2=4.2	1.9	$<\infty$	t
33	d+4.1=4.1	1.9	$<\infty$	t
34	d+4.1=4.1	1.9	$<\infty$	t
35	d+4.0=4.0	1.8	$<\infty$	t
36	d+4.0=4.0	1.8	$<\infty$	t
37	d+3.8=3.8	1.7	$<\infty$	t
38	d+3.8=3.8	1.7	$<\infty$	t
39	d+3.6=3.6	1.6	$<\infty$	t
40	d+3.6=3.6	1.6	$<\infty$	t

d : dot

Table 55. Measurements of somatic chromosomes of *Paphiopedilum callosum* at metaphase, 2n=32

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	5.2+5.4=10.6	6.3	1.0	m
2	4.7+5.2= 9.9	5.9	1.1	m
3	3.3+3.5= 6.8	4.0	1.1	m
4	3.1+3.5= 6.6	3.9	1.1	m
5	2.8+3.1= 5.9	3.5	1.1	m
6	2.7+3.1= 5.8	3.4	1.1	m
7	2.6+3.1= 5.7	3.4	1.2	m
8	2.6+3.1= 5.7	3.4	1.2	m
9	2.2+3.4= 5.6	3.3	1.5	m
10	2.2+3.4= 5.6	3.3	1.5	m
11	2.6+2.8= 5.4	3.2	1.1	m
12	2.6+2.8= 5.4	3.2	1.1	m
13	2.5+2.8= 5.3	3.1	1.1	m
14	2.5+2.8= 5.3	3.1	1.1	m
15	2.0+3.0= 5.0	3.0	1.5	m
16	2.0+3.0= 5.0	3.0	1.5	m
17	2.2+2.6= 4.8	2.8	1.2	m
18	2.1+2.5= 4.6	2.7	1.2	m
19	1.8+2.1= 3.9	2.3	1.2	m
20	1.7+2.0= 3.7	2.2	1.2	m
21	d+6.0= 6.0	3.6	$<\infty$	t
22	d+6.0= 6.0	3.6	$<\infty$	t
23	d+5.8= 5.8	3.4	$<\infty$	t
24	d+5.6= 5.6	3.3	$<\infty$	t
25	d+4.5= 4.5	2.7	$<\infty$	t
26	d+4.0= 4.0	2.4	$<\infty$	t
27	d+3.7= 3.7	2.2	$<\infty$	t
28	d+3.5= 3.5	2.1	$<\infty$	t
29	d+3.3= 3.3	2.0	$<\infty$	t
30	d+3.3= 3.3	2.0	$<\infty$	t
31	d+3.2= 3.2	2.0	$<\infty$	t
32	d+3.1= 3.1	1.8	$<\infty$	t

d : dot

Table 56. Measurements of somatic chromosomes of *Paphiopedilum ciliolare* at metaphase, 2n=32

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	7.0+7.5=1 4.5	5.4	1.1	m
2	7.0+7.5=1 4.5	5.4	1.1	m
3	5.5+5.5=1 1.0	4.1	1.0	m
4	5.5+5.5=1 1.0	4.1	1.0	m
5	4.0+7.0=1 1.0	4.1	1.8	sm
6	4.0+7.0=1 1.0	4.1	1.8	sm
7	3.3+6.4= 9.7	3.6	1.9	sm
8	3.3+6.4= 9.7	3.6	1.9	sm
9	4.4+5.0= 9.4	3.5	1.1	m
10	4.4+5.0= 9.4	3.5	1.1	m
11	3.5+5.4= 8.9	3.3	1.5	m
12	3.5+5.4= 8.9	3.3	1.5	m
13	3.0+5.5= 8.5	3.2	1.8	sm
14	3.0+5.5= 8.5	3.2	1.8	sm
15	4.0+4.3= 8.3	3.1	1.1	m
16	4.0+4.3= 8.3	3.1	1.1	m
17	3.1+4.9= 8.0	3.0	1.6	m
18	3.1+4.9= 8.0	3.0	1.6	m
19	3.8+4.0= 7.8	2.9	1.1	m
20	3.8+4.0= 7.8	2.9	1.1	m
21	d+9.0= 9.0	3.4	$<\infty$	t
22	d+8.8= 8.8	3.3	$<\infty$	t
23	d+8.0= 8.0	3.0	$<\infty$	t
24	d+7.0= 7.0	2.6	$<\infty$	t
25	d+5.5= 5.5	2.0	$<\infty$	t
26	d+5.5= 5.5	2.0	$<\infty$	t
27	d+5.4= 5.4	2.0	$<\infty$	t
28	d+5.4= 5.4	2.0	$<\infty$	t
29	d+5.2= 5.2	1.9	$<\infty$	t
30	d+5.2= 5.2	1.9	$<\infty$	t
31	d+4.7= 4.7	1.8	$<\infty$	t
32	d+4.5= 4.5	1.7	$<\infty$	t

d : dot

Table 57. Measurements of somatic chromosomes of *Paphiopedilum acmodontum* at metaphase, 2n=36

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	5.0+5.0=10.0	5.6	1.0	m
2	4.3+4.5= 8.8	5.0	1.0	m
3	3.0+3.9= 6.9	3.9	1.3	m
4	3.0+3.7= 6.7	3.8	1.2	m
5	3.1+3.4= 6.5	3.7	1.1	m
6	3.1+3.4= 6.5	3.7	1.1	m
7	3.1+3.1= 6.2	3.5	1.0	m
8	3.1+3.1= 6.2	3.5	1.0	m
9	2.4+3.7= 6.1	3.4	1.5	m
10	2.4+3.7= 6.1	3.4	1.5	m
11	2.5+3.5= 6.0	3.4	1.4	m
12	2.5+3.5= 6.0	3.4	1.4	m
13	2.0+3.2= 5.2	2.9	1.6	m
14	1.9+3.2= 5.1	2.9	1.7	m
15	2.2+2.5= 4.7	2.6	1.1	m
16	2.2+2.5= 4.7	2.6	1.1	m
17	d+6.0= 6.0	3.4	$<\infty$	t
18	d+5.6= 5.6	3.2	$<\infty$	t
19	d+5.5= 5.5	3.1	$<\infty$	t
20	d+5.2= 5.2	2.9	$<\infty$	t
21	d+4.2= 4.2	2.4	$<\infty$	t
22	d+3.7= 3.7	2.1	$<\infty$	t
23	d+3.7= 3.7	2.1	$<\infty$	t
24	d+3.6= 3.6	2.0	$<\infty$	t
25	d+3.5= 3.5	2.0	$<\infty$	t
26	d+3.5= 3.5	2.0	$<\infty$	t
27	d+3.5= 3.5	2.0	$<\infty$	t
28	d+3.5= 3.5	2.0	$<\infty$	t
29	d+3.4= 3.4	1.9	$<\infty$	t
30	d+3.3= 3.3	1.9	$<\infty$	t
31	d+3.1= 3.1	1.7	$<\infty$	t
32	d+3.1= 3.1	1.7	$<\infty$	t
33	d+3.0= 3.0	1.7	$<\infty$	t
34	d+3.0= 3.0	1.7	$<\infty$	t
35	d+2.8= 2.8	1.6	$<\infty$	t
36	d+2.6= 2.6	1.5	$<\infty$	t

d : dot

Table 58. Measurements of somatic chromosomes of *Paphiopedilum lawrenceanum* at metaphase, 2n=36

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	6.2+7.2=1 3.4	5.5	1.2	m
2	6.0+6.9=1 2.9	5.3	1.2	m
3	4.6+4.6= 9.2	3.8	1.0	m
4	4.5+4.5= 9.0	3.7	1.0	m
5	3.3+4.9= 8.2	3.4	1.5	m
6	3.3+4.9= 8.2	3.4	1.5	m
7	3.6+4.4= 8.0	3.3	1.2	m
8	3.6+4.4= 8.0	3.3	1.2	m
9	2.3+5.6= 7.9	3.2	2.4	sm
10	2.2+5.4= 7.6	3.1	2.5	sm
11	3.3+3.7= 7.0	2.9	1.1	m
12	3.1+3.7= 6.8	2.8	1.2	m
13	2.5+4.0= 6.5	2.7	1.6	m
14	2.4+3.9= 6.3	2.6	1.6	m
15	2.5+3.8= 6.3	2.6	1.5	m
16	2.4+3.6= 6.0	2.5	1.5	m
17	d+8.2= 8.2	3.3	$<\infty$	t
18	d+8.1= 8.1	3.3	$<\infty$	t
19	d+8.0= 8.0	3.3	$<\infty$	t
20	d+6.0= 6.0	2.5	$<\infty$	t
21	d+5.9= 5.9	2.4	$<\infty$	t
22	d+5.9= 5.9	2.4	$<\infty$	t
23	d+5.6= 5.6	2.3	$<\infty$	t
24	d+5.6= 5.6	2.3	$<\infty$	t
25	d+5.5= 5.5	2.2	$<\infty$	t
26	d+5.5= 5.5	2.2	$<\infty$	t
27	d+5.3= 5.3	2.2	$<\infty$	t
28	d+5.3= 5.3	2.2	$<\infty$	t
29	d+5.1= 5.1	2.1	$<\infty$	t
30	d+5.1= 5.1	2.1	$<\infty$	t
31	d+5.0= 5.0	2.0	$<\infty$	t
32	d+5.0= 5.0	2.0	$<\infty$	t
33	d+4.7= 4.7	1.9	$<\infty$	t
34	d+4.7= 4.7	1.9	$<\infty$	t
35	d+4.4= 4.4	1.8	$<\infty$	t
36	d+4.4= 4.4	1.8	$<\infty$	t

d : dot

Table 59. Measurements of somatic chromosomes of *Paphiopedilum hennisianum* at metaphase, 2n=36

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	4.1+7.5=11.6	5.1	1.8	sm
2	4.0+7.5=11.5	5.0	1.9	sm
3	4.0+4.2= 8.2	3.6	1.1	m
4	4.0+4.2= 8.2	3.6	1.1	m
5	2.5+5.5= 8.0	3.5	2.2	sm
6	2.5+5.5= 8.0	3.5	2.2	sm
7	1.6+6.0= 7.6	3.3	3.4	st
8	1.6+6.0= 7.6	3.3	3.4	st
9	2.5+5.0= 7.5	3.3	2.0	sm
10	2.5+5.0= 7.5	3.3	2.0	sm
11	2.5+4.7= 7.2	3.1	1.9	sm
12	2.5+4.7= 7.2	3.1	1.9	sm
13	2.8+4.0= 6.8	3.0	1.4	m
14	2.7+4.0= 6.7	2.9	1.4	m
15	2.4+4.2= 6.6	2.9	1.8	sm
16	2.4+4.2= 6.6	2.9	1.8	sm
17	2.4+3.9= 6.3	2.7	1.6	m
18	2.3+3.9= 6.2	2.7	1.7	m
19	d+6.5= 6.5	2.8	$<\infty$	t
20	d+6.4= 6.4	2.8	$<\infty$	t
21	d+6.3= 6.3	2.7	$<\infty$	t
22	d+6.2= 6.2	2.7	$<\infty$	t
23	d+5.7= 5.7	2.5	$<\infty$	t
24	d+5.5= 5.5	2.4	$<\infty$	t
25	d+4.8= 4.8	2.1	$<\infty$	t
26	d+4.8= 4.8	2.1	$<\infty$	t
27	d+4.7= 4.7	2.0	$<\infty$	t
28	d+4.6= 4.6	2.0	$<\infty$	t
29	d+4.6= 4.6	2.0	$<\infty$	t
30	d+4.6= 4.6	2.0	$<\infty$	t
31	d+4.5= 4.5	2.0	$<\infty$	t
32	d+4.5= 4.5	2.0	$<\infty$	t
33	d+4.2= 4.2	1.8	$<\infty$	t
34	d+4.2= 4.2	1.8	$<\infty$	t
35	d+4.1= 4.1	1.8	$<\infty$	t
36	d+4.1= 4.1	1.8	$<\infty$	t

d : dot

Table 60. Measurements of somatic chromosomes of *Paphiopedilum curtisii* at metaphase, 2n=36

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	5.7+6.8=12.5	5.4	1.2	m
2	5.8+6.2=12.0	5.2	1.1	m
3	4.5+4.5= 9.0	3.9	1.0	m
4	3.1+5.3= 8.4	3.6	1.7	m
5	3.3+4.8= 8.1	3.5	1.5	m
6	3.3+4.8= 8.1	3.5	1.5	m
7	3.5+4.0= 7.5	3.2	1.1	m
8	3.5+4.0= 7.5	3.2	1.1	m
9	2.6+3.9= 6.5	2.8	1.5	m
10	2.6+3.9= 6.5	2.8	1.5	m
11	2.5+3.7= 6.2	2.7	1.5	m
12	2.5+3.7= 6.2	2.7	1.5	m
13	2.8+3.2= 6.0	2.6	1.1	m
14	2.8+3.2= 6.0	2.6	1.1	m
15	2.6+3.0= 5.6	2.4	1.2	m
16	2.6+2.7= 5.3	2.3	1.0	m
17	d+7.8= 7.8	3.4	$<\infty$	t
18	d+7.7= 7.7	3.3	$<\infty$	t
19	d+7.7= 7.7	3.3	$<\infty$	t
20	d+7.6= 7.6	3.3	$<\infty$	t
21	d+6.1= 6.1	2.6	$<\infty$	t
22	d+5.7= 5.7	2.5	$<\infty$	t
23	d+5.4= 5.4	2.3	$<\infty$	t
24	d+5.4= 5.4	2.3	$<\infty$	t
25	d+5.1= 5.1	2.2	$<\infty$	t
26	d+5.0= 5.0	2.2	$<\infty$	t
27	d+4.8= 4.8	2.1	$<\infty$	t
28	d+4.8= 4.8	2.1	$<\infty$	t
29	d+4.8= 4.8	2.1	$<\infty$	t
30	d+4.8= 4.8	2.1	$<\infty$	t
31	d+4.7= 4.7	2.0	$<\infty$	t
32	d+4.7= 4.7	2.0	$<\infty$	t
33	d+4.7= 4.7	2.0	$<\infty$	t
34	d+4.6= 4.6	2.0	$<\infty$	t
35	d+4.5= 4.5	1.9	$<\infty$	t
36	d+4.3= 4.3	1.9	$<\infty$	t

d : dot

Table 61. Measurements of somatic chromosomes of *Paphiopedilum superbiens* at metaphase, 2n=38

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	5.6+7.2=12.8	5.8	1.3	m
2	4.1+4.6= 8.7	4.0	1.1	m
3	3.5+4.2= 7.7	3.5	1.2	m
4	3.5+4.2= 7.7	3.5	1.2	m
5	3.3+4.3= 7.6	3.5	1.3	m
6	3.5+4.0= 7.5	3.4	1.1	m
7	2.2+4.4= 6.6	3.0	2.0	sm
8	2.2+4.4= 6.6	3.0	2.0	sm
9	2.3+3.0= 5.3	2.4	1.3	m
10	2.3+3.0= 5.3	2.4	1.3	m
11	1.8+3.1= 4.9	2.2	1.7	m
12	1.8+3.1= 4.9	2.2	1.7	m
13	2.0+2.4= 4.4	2.0	1.2	m
14	2.0+2.4= 4.4	2.0	1.2	m
15	d+7.0= 7.0	3.2	$<\infty$	t
16	d+7.0= 7.0	3.2	$<\infty$	t
17	d+6.7= 6.7	3.1	$<\infty$	t
18	d+6.6= 6.6	3.0	$<\infty$	t
19	d+6.3= 6.3	2.9	$<\infty$	t
20	d+5.6= 5.6	2.6	$<\infty$	t
21	d+5.5= 5.5	2.5	$<\infty$	t
22	d+5.5= 5.5	2.5	$<\infty$	t
23	d+5.4= 5.4	2.5	$<\infty$	t
24	d+5.4= 5.4	2.5	$<\infty$	t
25	d+5.4— 5.4	2.5	$<\infty$	t
26	d+5.3= 5.3	2.4	$<\infty$	t
27	d+5.3= 5.3	2.4	$<\infty$	t
28	d+4.9= 4.9	2.2	$<\infty$	t
29	d+4.5= 4.5	2.1	$<\infty$	t
30	d+4.5= 4.5	2.1	$<\infty$	t
31	d+4.5= 4.5	2.1	$<\infty$	t
32	d+4.5= 4.5	2.1	$<\infty$	t
33	d+4.4= 4.4	2.0	$<\infty$	t
34	d+4.4= 4.4	2.0	$<\infty$	t
35	d+4.2= 4.2	1.9	$<\infty$	t
36	d+4.2= 4.2	1.9	$<\infty$	t
37	d+4.0= 4.0	1.8	$<\infty$	t
38	d+3.8= 3.8	1.7	$<\infty$	t

d : dot

Table 62. Measurements of somatic chromosomes of *Paphiopedilum barbatum* at metaphase, 2n=38

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	5.8+6.1=11.9	6.0	1.1	m
2	5.8+6.1=11.9	6.0	1.1	m
3	2.6+4.7= 7.3	3.7	1.8	sm
4	2.6+4.7= 7.3	3.7	1.8	sm
5	3.3+3.4= 6.7	3.4	1.0	m
6	3.3+3.4= 6.7	3.4	1.0	m
7	2.3+4.3= 6.6	3.3	1.9	sm
8	2.3+4.1= 6.4	3.2	1.8	sm
9	2.7+3.0= 5.7	2.9	1.1	m
10	2.6+2.9= 5.5	2.8	1.1	m
11	2.4+3.1= 5.5	2.8	1.3	m
12	2.4+3.1= 5.5	2.8	1.3	m
13	2.4+3.0= 5.4	2.7	1.3	m
14	2.4+3.0= 5.4	2.7	1.3	m
15	d+6.8= 6.8	3.5	$<\infty$	t
16	d+6.3= 6.3	3.2	$<\infty$	t
17	d+5.7= 5.7	2.9	$<\infty$	t
18	d+5.7= 5.7	2.9	$<\infty$	t
19	d+4.3= 4.3	2.2	$<\infty$	t
20	d+4.3= 4.3	2.2	$<\infty$	t
21	d+4.2= 4.2	2.1	$<\infty$	t
22	d+4.1= 4.1	2.1	$<\infty$	t
23	d+4.0= 4.0	2.0	$<\infty$	t
24	d+4.0= 4.0	2.0	$<\infty$	t
25	d+4.0= 4.0	2.0	$<\infty$	t
26	d+3.9= 3.9	2.0	$<\infty$	t
27	d+3.8= 3.8	1.9	$<\infty$	t
28	d+3.8= 3.8	1.9	$<\infty$	t
29	d+3.7= 3.7	1.9	$<\infty$	t
30	d+3.7= 3.7	1.9	$<\infty$	t
31	d+3.6= 3.6	1.8	$<\infty$	t
32	d+3.6= 3.6	1.8	$<\infty$	t
33	d+3.4= 3.4	1.7	$<\infty$	t
34	d+3.4= 3.4	1.7	$<\infty$	t
35	d+3.3= 3.3	1.7	$<\infty$	t
36	d+3.3= 3.3	1.7	$<\infty$	t
37	d+3.2= 3.2	1.6	$<\infty$	t
38	d+3.2= 3.2	1.6	$<\infty$	t

d : dot

Table 63. Measurements of somatic chromosomes of *Paphiopedilum argus* at metaphase, 2n=38

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	4.0+7.1=11.1	3.9	1.8	sm
2	4.0+7.1=11.1	3.9	1.8	sm
3	4.8+5.6=10.4	3.7	1.2	m
4	4.8+5.6=10.4	3.7	1.2	m
5	3.3+5.9= 9.2	3.3	1.8	sm
6	3.3+5.9= 9.2	3.3	1.8	sm
7	3.7+5.5= 9.2	3.3	1.5	m
8	3.7+5.5= 9.2	3.3	1.5	m
9	4.0+5.1= 9.1	3.2	1.3	m
10	4.0+5.1= 9.1	3.2	1.3	m
11	4.3+4.4= 8.7	3.1	1.0	m
12	4.3+4.4= 8.7	3.1	1.0	m
13	2.6+5.2= 7.8	2.8	2.0	sm
14	3.0+4.8= 7.8	2.8	1.6	m
15	d+9.1= 9.1	3.2	$<\infty$	t
16	d+8.8= 8.8	3.1	$<\infty$	t
17	d+8.5= 8.5	3.0	$<\infty$	t
18	d+8.1= 8.1	2.9	$<\infty$	t
19	d+8.1= 8.1	2.9	$<\infty$	t
20	d+8.0= 8.0	2.8	$<\infty$	t
21	d+7.7= 7.7	2.7	$<\infty$	t
22	d+7.3= 7.3	2.6	$<\infty$	t
23	d+7.0= 7.0	2.5	$<\infty$	t
24	d+6.6= 6.6	2.3	$<\infty$	t
25	d+6.4= 6.4	2.3	$<\infty$	t
26	d+5.6= 5.6	2.0	$<\infty$	t
27	d+5.6= 5.6	2.0	$<\infty$	t
28	d+5.6= 5.6	2.0	$<\infty$	t
29	d+5.5= 5.5	1.9	$<\infty$	t
30	d+5.1= 5.1	1.8	$<\infty$	t
31	d+5.1= 5.1	1.8	$<\infty$	t
32	d+5.1= 5.1	1.8	$<\infty$	t
33	d+5.0= 5.0	1.8	$<\infty$	t
34	d+4.9= 4.9	1.7	$<\infty$	t
35	d+4.8= 4.8	1.7	$<\infty$	t
36	d+4.8= 4.8	1.7	$<\infty$	t
37	d+4.7= 4.7	1.7	$<\infty$	t
38	d+4.4= 4.4	1.6	$<\infty$	t

d : dot

Table 64. Measurements of somatic chromosomes of *Paphiopedilum venustum* at metaphase, 2n=40

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	7.4+8.0=1 5.4	4.8	1.1	m
2	7.1+7.7=1 4.8	4.6	1.1	m
3	6.5+7.0=1 3.5	4.2	1.1	m
4	6.3+7.0=1 3.3	4.2	1.1	m
5	4.6+7.2=1 1.8	3.7	1.6	m
6	5.4+6.3=1 1.7	3.7	1.2	m
7	5.0+6.1=1 1.1	3.5	1.2	m
8	3.6+7.5=1 1.1	3.5	2.1	sm
9	4.0+7.0=1 1.0	3.4	1.8	sm
10	3.6+6.9=1 0.5	3.3	1.9	sm
11	3.7+5.9= 9.6	3.0	1.6	m
12	3.0+5.3= 8.3	2.6	1.8	sm
13	d+9.0= 9.0	2.8	$<\infty$	t
14	d+8.6= 8.6	2.7	$<\infty$	t
15	d+8.4= 8.4	2.6	$<\infty$	t
16	d+8.4= 8.4	2.6	$<\infty$	t
17	d+8.1= 8.1	2.5	$<\infty$	t
18	d+7.5= 7.5	2.3	$<\infty$	t
19	d+7.3= 7.3	2.3	$<\infty$	t
20	d+7.0= 7.0	2.2	$<\infty$	t
21	d+6.8= 6.8	2.1	$<\infty$	t
22	d+6.5= 6.5	2.0	$<\infty$	t
23	d+6.5= 6.5	2.0	$<\infty$	t
24	d+6.4= 6.4	2.0	$<\infty$	t
25	d+6.0= 6.0	1.9	$<\infty$	t
26	d+5.8= 5.8	1.8	$<\infty$	t
27	d+5.7= 5.7	1.8	$<\infty$	t
28	d+5.6= 5.6	1.7	$<\infty$	t
29	d+5.6= 5.6	1.7	$<\infty$	t
30	d+5.6= 5.6	1.7	$<\infty$	t
31	d+5.5= 5.5	1.7	$<\infty$	t
32	d+5.5= 5.5	1.7	$<\infty$	t
33	d+5.5= 5.5	1.7	$<\infty$	t
34	d+5.5= 5.5	1.7	$<\infty$	t
35	d+5.5= 5.5	1.7	$<\infty$	t
36	d+5.3= 5.3	1.7	$<\infty$	t
37	d+5.3= 5.3	1.7	$<\infty$	t
38	d+5.3= 5.3	1.7	$<\infty$	t
39	d+5.2= 5.2	1.6	$<\infty$	t
40	d+4.6= 4.6	1.4	$<\infty$	t

d : dot