Karyomorphological studies on *Lycaste*, Orchidaceae*

Mikio Aoyama** and Kohji Karasawa**

ラン科リカステ属の核形態学的研究*

青 山 幹 男**・唐 澤 耕 司**

Introduction

The genus *Lycaste*, Orchidaceae, which consists of approximately 30 species (Fowlie 1970), is widely distributed in central and south America. Its pseudobulbs were flatened fusiform and had two or three large leaves near the apex.

One to many inflorescences with a solitaly showy flower had arisen from the base of pseudobulbs.

It has been cultivated by orchid lovers for many years, and a large number of interspecific hybrids within the genus have been produced by artificial hybridization for horticultural purposes. Moreover, intergeneric hybrids between the genus *Lycaste* and the genera *Anguloa*, *Bifrenaria* or *Cymbidium* have been reported (Sander's list of orchid hybrids 1987, Kojima *et al.* 1987). However, some species have failed to synthesize any interspecific hybrids.

The chromosome numbers of *Lycaste* were reported in two species, n=20 in *L. aromatica* (Hoffmann 1929, 1930) and 2n=40 in *L. virginalis* (Kojima *et al.* 1987), however the detail of the chromosome analysis has not yet been made.

In the present investigation the morphology of chromosomes was studied in 16 species of *Lycaste* in order to elucidate interrelationships among them.

Materials and Methods

The species, the sources and number of materials studied are listed in Table 1. These materials were grown in the Hiroshima Botanical Garden, Hiroshima City, Japan. Taxonomic treatments of the materials followed mostly Fowlie (1970) and partly Hawkes (1965). Systematic arrangement followed Fowlie (1970).

---

* Contribution from the Hiroshima Botanical Garden No. 36

** The Hiroshima Botanical Garden

Bulletin of The Hiroshima Botanical Garden, No. 10: 7–45, 1988.

Table 1. Sources, number of clones and chromosme number of the species of *Lycaste* studied

Species	Source	No. of clones	Chromosome number (2n)
Section DECIDUOSAE			
brevispatha (Klotz.) Lindl.	Panama	1	40
tricolor (Klotz.) Rchb. f.	Panama	2	40
deppei (Lodd.) Lindl.	Mexico	1	40
cruenta (Lindl.) Lindl.	Mexico	1	40
campbellii C. Schweinf.	Panama	1	40
aromatica (Graham ex Hook.) Lindl.	Mexico	2	40*
bradeorum Schltr.	Costa Rica	1	40
Section MACROPHYLLAE			
dowiana Endres et Rchb. f.	Costa Rica	1	40
virginalis (Scheid) Linden	Guatemala	2	40*
macrophylla (Poepping et Endlicher) Lindl.	Costa Rica	2	40
Section FIMBRIATAE			
linguella Rchb. f.	Peru	1	48
locusta Rchb. f.	Peru	1	48
denningiana Rchb. f.	Peru	2	50
barringtoniae (Smith) Lindl.	Jamaica	1	44
ciliata (Ruiz et Pavon) Lindl. ex Rchb. f.	Peru	1	44
dyeriana Sander ex Rolfe	Peru	1	48

* confirmed the previous reports

Somatic chromosomes were observed in meristematic cells of root tips in the species studied. Somatic chromosomes were stained and observed by the aceto-orcein squash method of Tanaka (1959) with slight modifications: Growing root tips were cut into small pieces 1–2mm long and immersed in 0.002M 8–hydroxyquinoline for five hours at 18°C. They were then fixed in 45% acetic acid for ten minutes at 5°C. The fixed materials were hydrolyzed in a 2:1 mixture of 1N hydrochloric acid and 45% acetic acid for a minute at 60°C, and were stained in 1% aceto-orcein by the usual squash method.

Karyotype analysis was made on the chromosomes at resting stage, mitotic prophase and metaphase. The position of centromere was expressed by the terms of median, submedian, subterminal and terminal according to Levan *et al.* (1964). The karyotype formulas were based on the condensed segments at prophase and the chromosome lengths and positions of centromeres at metaphase according to Tanaka's classifications (1971, 1980).

Observations

I. Section DECIDUOSAE

1. *Lycaste brevispatha* (Klotz.) Lindl., 2n=40, Tables 1 and 2, Fig. 1.

One plant was obtained from Panama. Flowers were 4 cm wide across. Sepals were green. Petals were light pink. Lips were white with purple spots.

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

The chromosomes at resting stage contained numerous chromomeric granules, fibrous threads and chromatin blocks scattered throughout the nucleus. The chromatin blocks which varied in number from 15 to 20 per nucleus were irregular in size and form and varied from 1.0–2.5 μm in diameter. The chromosome features at resting stage were of the complex chromocenter type according to Tanaka's classification (1971).

The chromosomes at mitotic prophase formed early condensed segments located in the interstitial regions of both arms. The segregated condensed-segments of each chromosome were later joined to each other following the progress of cell division. Late condensed segments were observed in the proximal and distal regions of the chromosomes.

The 2n = 40 chromosomes at mitotic metaphase showed a gradual decrease in length from the longest (2.05 μm) to the shortest (0.70 μm) chromosomes. Among the 40 chromosomes in the complement, 34 were median in centromeric position with arm ratios from 1.0 to 1.7. The other six chromosomes (Nos. 23–24, 33–36) were submedian with arm ratios between 2.0 and 2.5.

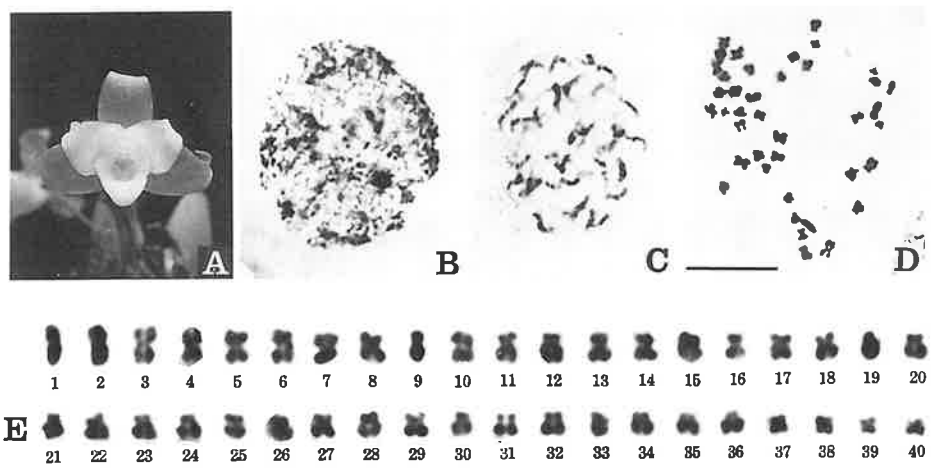

Fig. 1. *Lycaste brevispatha*, 2n=40. A, a flower. B, chromosomes at resting stage. C. chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bar indicates 27 mm for A, 10 μm for B–D and 5 μm for E.

According to the definition of the karyotype proposed by Tanaka (1980), the karyotype of this species was homogeneous and gradual due to the gradual decrease of the chromosome lengths and symmetric due to the low arm ratios.

2. *Lycaste tricolor* (Klotz.) Rchb.f., 2n=40, Tables 1 and 3, Fig. 2.

Two plants were obtained from Panama. Flowers were 6 cm wide across. Petals were yellowish pink in color. Sepals and lips were pink.

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

The chromosomes at resting stage and mitotic prophase were similar in morphology to those of *L. brevispatha* described above. The chromosome features at resting stage were of the complex chromocenter type.

In the 2n=40 chromosomes at mitotic metaphase a gradual decrease in length from the longest (2.35 μm) to the shortest (1.00 μm) chromosomes was observed. Among the 40 chromosomes, 24 were median with arm ratios between 1.0 and 1.7, and 14 (Nos. 2, 9–12, 18, 25–29, 33–34, 40) were submedian with arm ratios between 1.8 and 3.0. The other two chromosomes (Nos. 15–16) were subterminal with the arm ratio of 3.8.

The karyotype of this species was homogeneous and gradual in length and symmetric in arm ratio.

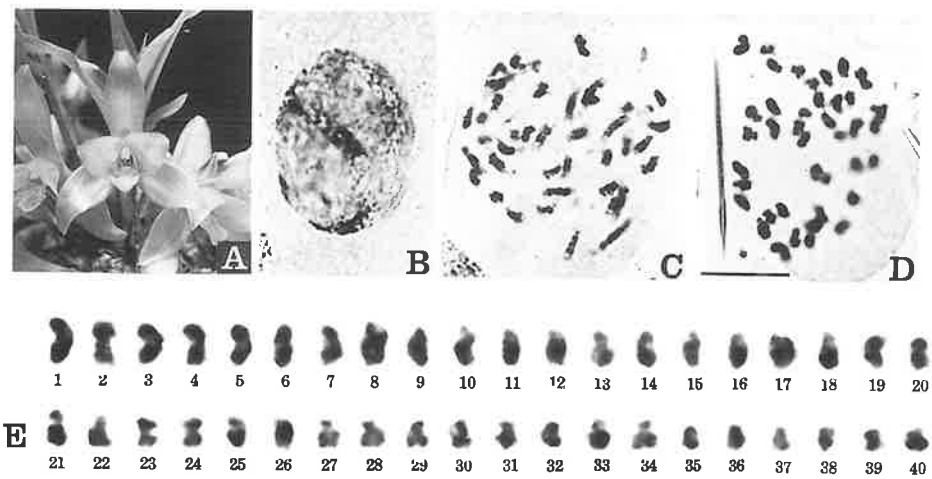

Fig. 2. *Lycaste tricolor*, 2n=40. A, a flower. B, chromosomes at resting stage. C. chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bar indicates 31 mm for A, 10 μm for B–D and 5 μm for E.

3. *Lycaste deppei* (Lodd.) Lindl., 2n=40, Tables 1 and 4, Fig. 3.

One plant was obtained from Mexico. Flowers were 7 cm wide across. Sepals were yellowish green in color with maroon spots. Petals were creamy white. Lips were yellow with red spots.

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

The chromosomes at resting stage and mitotic prophase were similar in morphology to those of *L. brevispatha* described above. The chromosome features at resting stage were of the complex chromocenter type.

A gradual decrease in length was observed from the longest (2.75 μm) to the shortest (1.20 μm) chromosomes in the 2n = 40 chromosomes at mitotic metaphase. Among 40 chromosomes, 29 were median with arm ratios between 1.0 and 1.7. Another eight chromosomes (Nos. 14–15, 17–20, 31–32) were submedian with arm ratios between 1.8 and 2.4, while the other three chromosomes (Nos. 16, 29–30) were subterminal with the arm ratios of 3.1 and 3.2.

The karyotype of this species was homogeneous and gradual in size and symmetric in form.

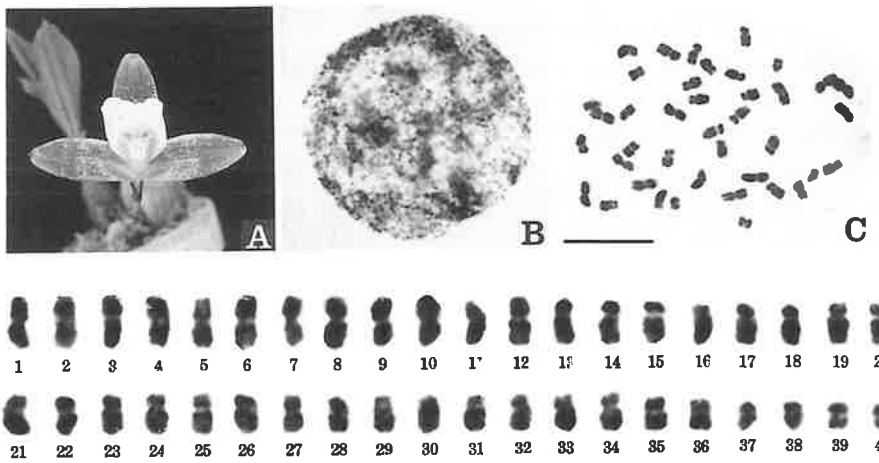

Fig. 3. *Lycaste deppei*, 2n=40. A, a flower. B, chromosomes at resting stage. C and D, chromosomes at mitotic metaphase. Bar indicates 38 mm for A, 10 μm for B–C and 5 μm for D.

4. *Lycaste cruenta* (Lindl.) Lindl., 2n=40, Tables 1 and 5, Fig. 4

One plant was obtained from Mexico. Flowers were 6 cm wide across. Petals were yellowish green in color. Sepals and lips were yellow with red spots near the bases.

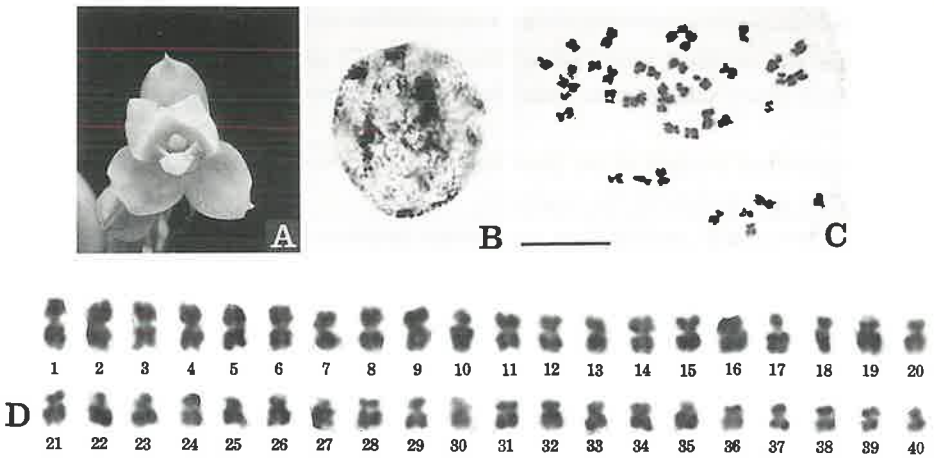

Fig. 4. *Lycaste cruenta*, 2n=40. A, a flower. B, chromosomes at resting stage. C and D, chromosomes at mitotic metaphase. Bar indicates 24 mm for A, 10 μm for B–C and 5 μm for D.

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

The chromosomes at resting stage and mitotic prophase were similar in morphology to those of *L. brevispatha* described above. The chromosome features at resting stage were of the complex chromocenter type.

A gradual decrease in length was observed from the longest (2.65 μm) to the shortest (1.10 μm) chromosomes in the 2n = 40 chromosomes at mitotic metaphase. Among 40 chromosomes, 28 were median with arm ratios between 1.0 and 1.7. The other 12 chromosomes (Nos. 19, 21–22, 25–28, 30–32, 35–36) were submedian with arm ratios between 1.8 and 2.2.

The karyotype of this species was homogeneous and gradual in length and symmetric in arm ratio.

5. *Lycaste campbellii* C. Schweinf., 2n=40, Tables 1 and 6, Fig. 5.

One plant was obtained from Panama. Flowers were 4 cm wide across. Petals were pale green in color. Sepals and lips were yellow.

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

The chromosomes at resting stage and mitotic prophase were similar in morphology to those of *L. brevispatha* described above. The chromosome features at resting stage were of the complex chromocenter type.

The 2n=40 chromosomes at mitotic metaphase showed a degradation in length from the longest (4.25 μm) to the shortest (1.85 μm) chromosomes. Among the 40 chromosomes, 31

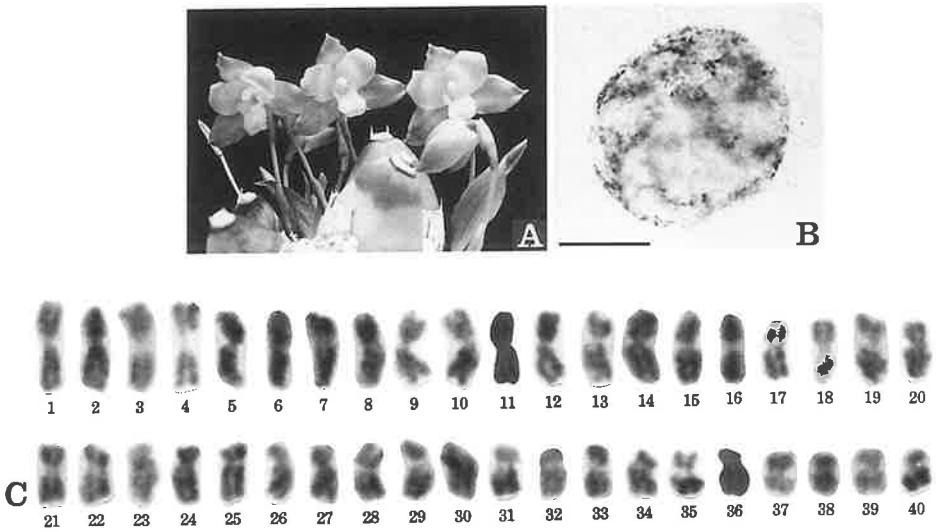

Fig. 5. *Lycaste campbellii*, 2n=40. A, flowers. B, chromosomes at resting stage. C, chromosomes at mitotic metaphase. Bar indicates 27 mm for A, 10 μm for B and 5 μm for C.

were median with arm ratios between 1.1 and 1.6, and nine (Nos. 7, 23–27, 31–32, 34) were submedian with arm ratios between 1.8 and 3.0.

The karyotype of this species was homogeneous and gradual in length and symmetric in arm ratio.

6. *Lycaste aromatica* (Graham ex Hook.) Lindl., 2n=40, Tables 1 and 7, Fig. 6.

Two plants were obtained from Mexico. Flowers were 6 cm wide across. Sepals were orange in color. Petals and lips were yellow.

The chromosome number of two plants was 2n=40 at mitotic metaphase and confirmed the meiotic chromosome number of n=20 reported by Hoffmann (1929, 1930).

The chromosomes at resting stage and mitotic prophase were similar in morphology to those of *L. brevispatha* described above. The chromosome features at resting stage were of the complex chromocenter type.

A gradual decrease in length was observed from the longest (3.40 μm) to the shortest (1.20 μm) chromosomes in the 2n = 40 chromosomes at mitotic metaphase. Among 40 chromosomes, 27 were median with arm ratios between 1.0 and 1.7. Another nine chromosomes (Nos. 13, 19–26) were submedian with arm ratios between 2.3 and 3.0, while the other four chromosomes (Nos. 14, 18, 35–36) were subterminal with the arm ratios between 3.3 and 4.1. Two chromosomes (Nos. 13–14) had a secondary constriction on the distal region of their short arms, and formed small satellites.

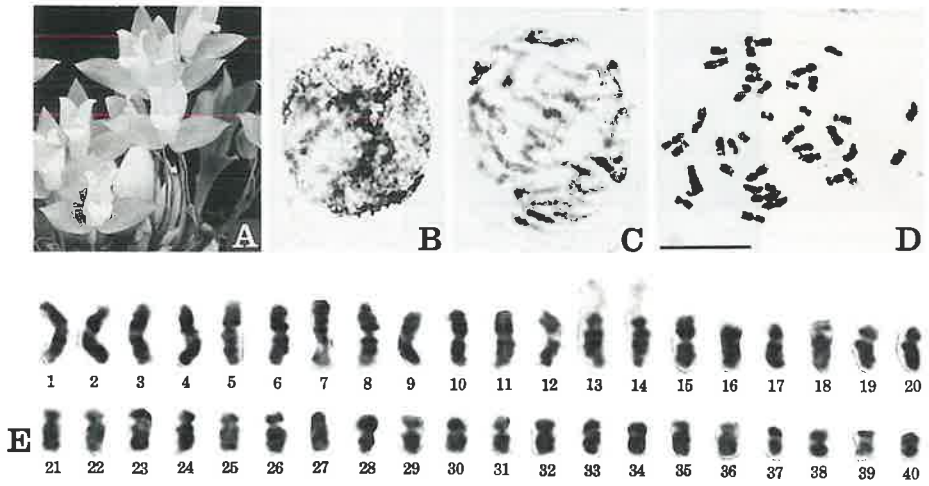

Fig. 6. *Lycaste aromatica*, 2n = 40. A, flowers. B, chromosomes at resting stage. C. chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bar indicates 35 mm for A, 10 μm for B–D and 5 μm for E.

The karyotype of this species was homogeneous and gradual in length and symmetric in arm ratio.

7. *Lycaste bradeorum* Schltr., 2n = 40, Tables 1 and 8, Fig. 7

One plant was obtained from Costa Rica. Flowers were 5 cm wide across. Petals were yellow in color. Sepals and lips were yellowish orange.

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

The chromosomes at resting stage and mitotic prophase were similar in morphology to those of *L. brevispatha* described above. The chromosome features at resting stage were of the complex chromocenter type.

A gradual decrease in length was observed from the longest (2.80 μm) to the shortest (1.10 μm) chromosomes in the 2n = 40 chromosomes at mitotic metaphase. Among the 40 chromosomes, 28 were median with arm ratios between 1.0 and 1.7. The other 12 chromosomes (Nos. 5–6, 10–12, 19, 23–24, 33–34, 37–38) were submedian with arm ratios between 1.8 and 2.7.

The karyotype of this species was homogeneous and gradual in length and symmetric in arm ratio.

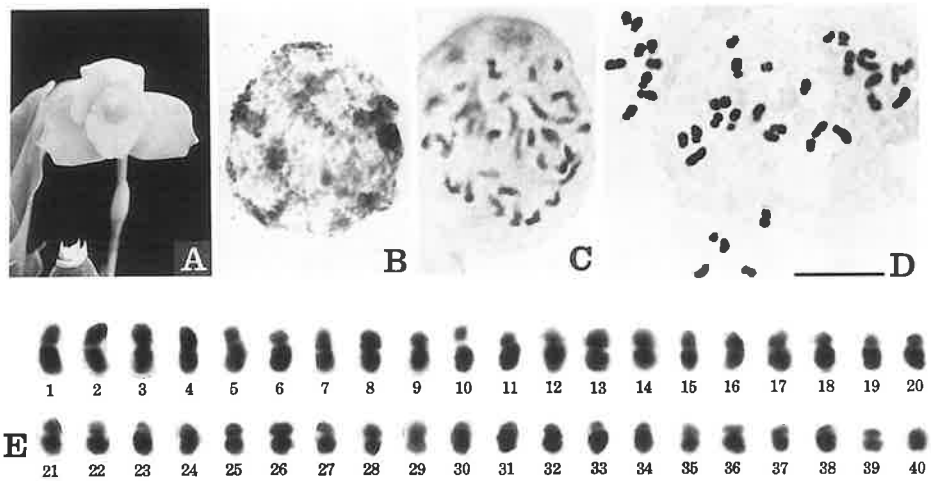

Fig. 7. *Lycaste bradeorum*, 2n=40. A, a flower. B, chromosomes at resting stage. C. chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bar indicates 20 mm for A, 10 μm for B–D and 5 μm for E.

II. Section MACROPHYLLAE

8. *Lycaste dowiana* Endres et Rchb.f., 2n=40, Tables 1 and 9, Fig. 8.

One plant was obtained from Costa Rica. Flowers were 6 cm wide across. Sepals were brownish green. Petals and lips were creamy white.

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

The chromosomes at resting stage and mitotic prophase were similar in morphology to those of *L. brevispatha* described above. The chromosome features at resting stage were of the complex chromocenter type.

The chromosomes of 2n=40 at mitotic metaphase showed a gradual decrease in length from the longest (3.45 μm) to the shortest (1.50 μm) chromosomes. Among the 40 chromosomes in the complement, 23 were median with arm ratios between 1.0 and 1.7. The other 17 chromosomes (Nos. 5–6, 9–12, 14, 19–20, 22, 26–29, 34, 37–38) were submedian with arm ratios between 1.8 and 2.3.

The karyotype of this species was homogeneous and gradual in length and symmetric in arm ratio.

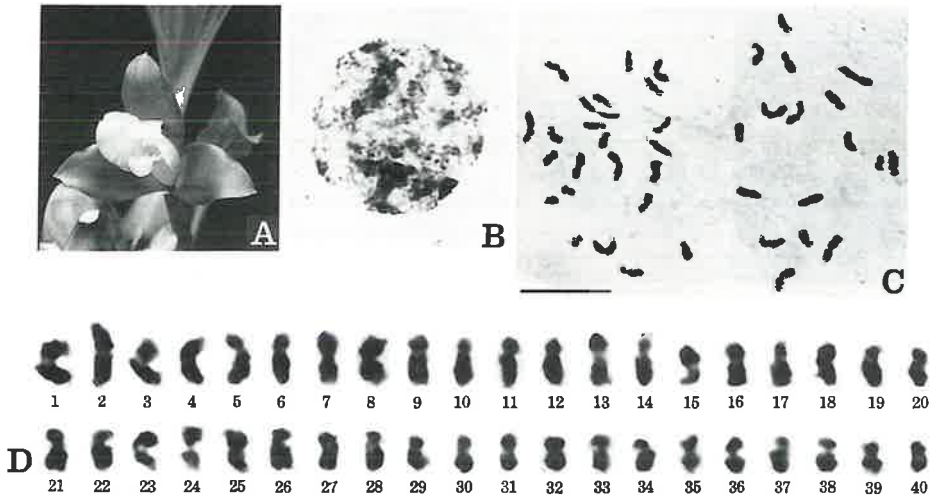

Fig. 8. *Lycaste dowiana*, 2n = 40. A, a flower. B, chromosomes at resting stage. C and D, chromosomes at mitotic metaphase. Bar indicates 28 mm for A, 10 μm for B–C and 5 μm for D.

9. *Lycaste virginalis* (Scheid.) Linden, 2n=40, Tables 1 and 10, Fig. 9.

Two plants were obtained from Guatemala. Flowers were 12 cm wide across. Petals and sepals were pale pink in color. Lips were pinkish purple.

The chromosome number of two plants of this species was 2n=40 at mitotic metaphase, and confirmed the previous report of Kojima *et al.* (1987).

The chromosomes at resting stage and mitotic prophase were similar in morphology to those of *L. brevispatha* described above. The chromosome features at resting stage were of the complex chromocenter type.

In the 2n=40 chromosomes at mitotic metaphase a gradual decrease in length from the longest (2.70 μm) to the shortest (1.05 μm) chromosomes was observed. Among the 40 chromosomes, 26 were median with arm ratios between 1.0 and 1.6, and ten (Nos. 11–12, 21–22, 25–26, 29, 33, 36–37) were submedian with arm ratios between 1.8 and 2.8. The other four chromosomes (Nos. 19–20, 31–32) were subterminal with arm ratios between 3.1 and 6.6.

The karyotype of this species was homogeneous and gradual in length and symmetric in arm ratio.

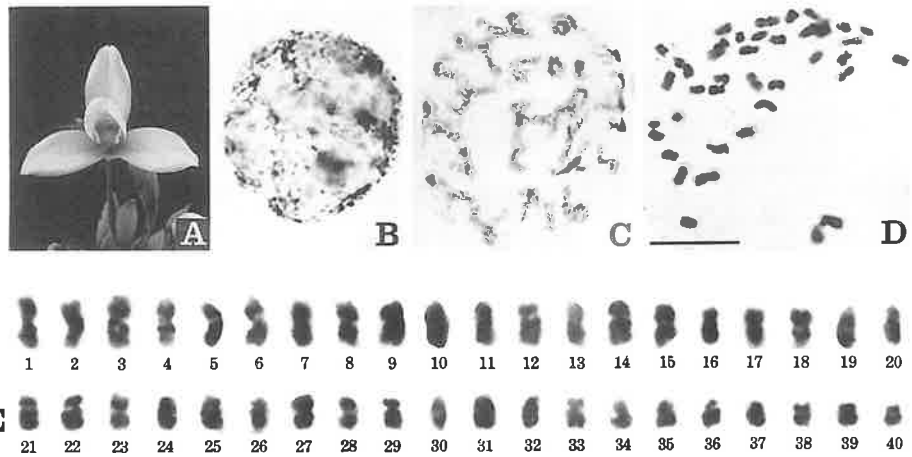

Fig. 9. *Lycaste virginalis*, 2n=40. A, a flower. B, chromosomes at resting stage. C. chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bar indicates 70 mm for A, 10 μm for B–D and 5 μm for E.

10. *Lycaste macrophylla* (Poepping et Endlicher) Lindl., 2n=40, Tables 1 and 11, Fig. 10.

Two plants were obtained from Costa Rica. Flowers were 8 cm wide across. Petals were coppery brown in color. Sepals were creamy white. Lips were creamy white with reddish purple spots.

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

The chromosomes at resting stage and mitotic prophase were similar in morphology to those of *L. brevispatha* described above. The chromosome features at resting stage were of the complex chromocenter type.

The length of 2n=40 chromosomes at mitotic metaphase gradually decreased from the longest (2.45 μm) to the shortest (1.00 μm) chromosomes. Among the 40 chromosomes, 27 were median with arm ratios between 1.0 and 1.7. The other 13 chromosomes (Nos. 1–2, 11–12, 15–16, 22–26, 31–32) were submedian with arm ratios between 1.8 and 3.0.

The karyotype of this species was homogeneous and gradual in length and symmetric in arm ratio.

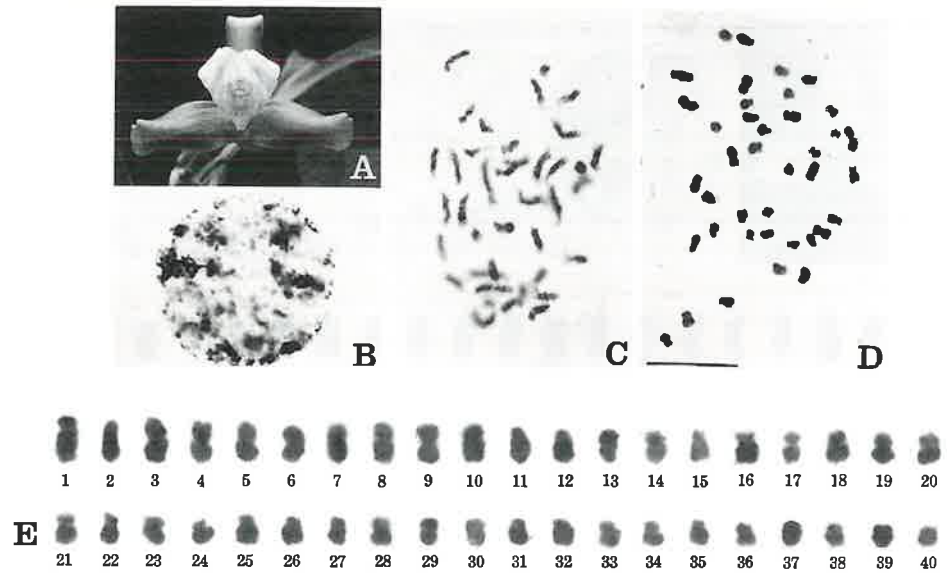

Fig. 10. *Lycaste macrophylla*, 2n=40. A, a flower. B, chromosomes at resting stage. C. chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bar indicates 36 mm for A, 10 μm for B–D and 5 μm for E.

III. Section FIMBRIATAE

11. *Lycaste linguella* Rchb.f., 2n=48, Tables 1 and 12, Fig. 11.

One plant was obtained from Peru. Flowers were 5 cm wide across. Petals were pale green in color. Sepals and lips were creamy white. Lips had a broad callus.

The chromosome number of the plant of this species was 2n=48 at mitotic metaphase, which was recorded here for the first time.

The chromosomes at resting stage and mitotic prophase were similar in morphology to those of *L. brevispatha* described above. The chromosome features at resting stage were of the complex chromocenter type.

The 2n=48 chromosome complement at mitotic metaphase in this species consisted of two groups of chromosomes; two large chromosomes of 4.75 μm and 4.35 μm and 46 small chromosomes which showed a gradual decrease in chromosome length from 3.15 to 1.50 μm. Among the 48 chromosomes, 14 were median with arm ratios between 1.1 and 1.6, 29 submedian with arm ratios between 1.8 and 2.9, and three (Nos. 4, 25–26) subterminal with arm ratios between 3.3 and 6.6. The centromeres of rest two chromosomes were not observed. Two chromosomes (Nos. 33–34) had a secondary constriction on their short arms, and formed small satellites.

The karyotype of this species was heterogeneous and bimodal in length and symmetric in arm ratio.

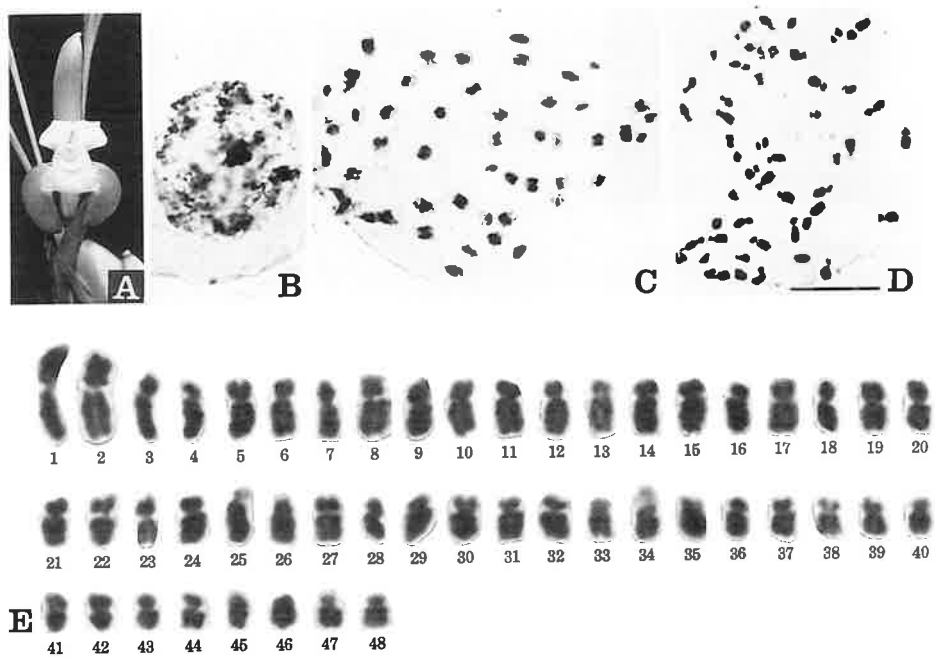

Fig. 11. *Lycaste linguella*, 2n=48. A, a flower. B, chromosomes at resting stage. C. chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bar indicates 31 mm for A, 10 μm for B–D and 5 μm for E.

12. *Lycaste locusta* Rchb. f., 2n=48, Tables 1 and 13, Fig. 12.

One plant was obtained from Peru. Flowers were 8 cm wide across. Petals and sepals were pale green in color. Lips were dark green with a white bearded margin.

The chromosome number of the plant of this species was 2n=48 at mitotic metaphase, which was recorded here for the first time.

The chromosomes at resting stage and mitotic prophase were similar in morphology to those of *L. brevispatha* described above. The chromosome features at resting stage were of the complex chromocenter type.

The chromosomes of 2n=48 at mitotic metaphase showed a gradual decrease in length from the longest (1.95 μm) to the shortest (0.95 μm) chromosomes. Among the 48 chromosomes, 27 were median with arm ratios between 1.0 and 1.7, seven (Nos. 1, 4, 7–8, 12, 21, 32) submedian with arm ratios between 1.9 and 2.8, and ten (Nos. 3, 9–11, 19–20, 27–30) subterminal with arm ratios between 3.2 and 5.2. The centromeres of rest four chromosomes were not observed.

The karyotype of this species was homogeneous and gradual in length and symmetric in arm ratio.

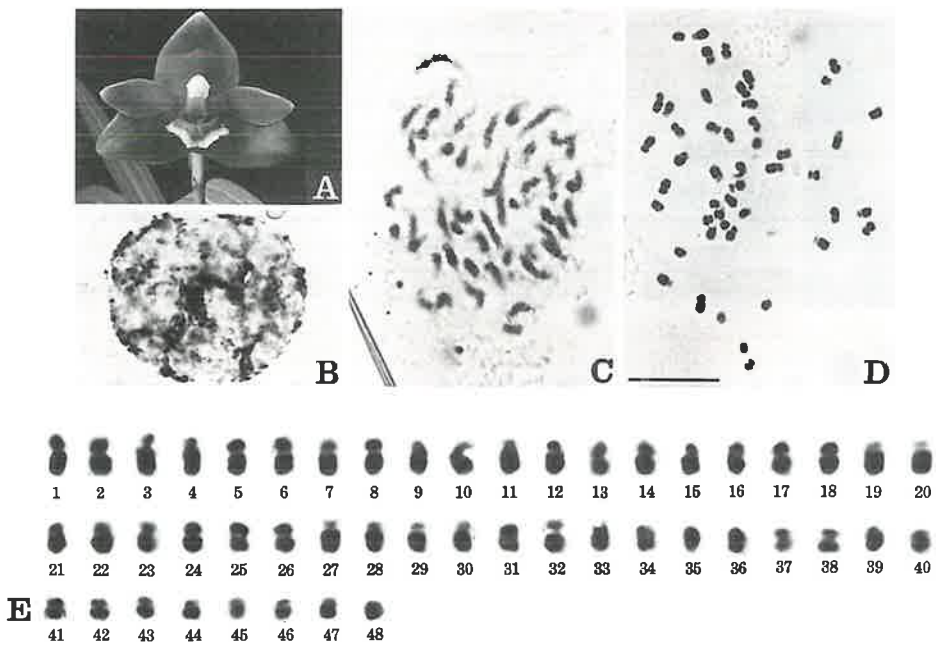

Fig. 12. *Lycaste locusta*, 2n = 48. A, a flower. B, chromosomes at resting stage. C. chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bar indicates 37 mm for A, 10 μm for B–D and 5 μm for E.

13. *Lycaste denningiana* Rchb.f., 2n=50, Tables 1 and 14, Fig. 13.

Two plants were obtained from Peru. The plants have not yet bloomed in our garden.

The chromosome number of two plants of this species was 2n=50 at mitotic metaphase, which was recorded here for the first time.

The chromosomes at resting stage and mitotic prophase were similar in morphology to those of *L. brevispatha* described above. The chromosome features at resting stage were of the complex chromocenter type.

The 2n = 50 chromosomes at mitotic metaphase gradually decreased in length from the longest (2.60 μm) to the shortest (1.20 μm) chromosomes. Among the 50 chromosomes in the complement, 22 were median with arm ratios between 1.0 and 1.7, nine (Nos. 3–4, 11–12, 15–16, 21, 31–32) submedian with arm ratios between 1.9 and 2.6, and three (Nos. 7–8, 33) subterminal with arm ratios between 3.4 and 3.8. The centromeres of other 16 chromosomes were not observed.

The karyotype of this species was homogeneous and gradual in length and symmetric in arm ratio.

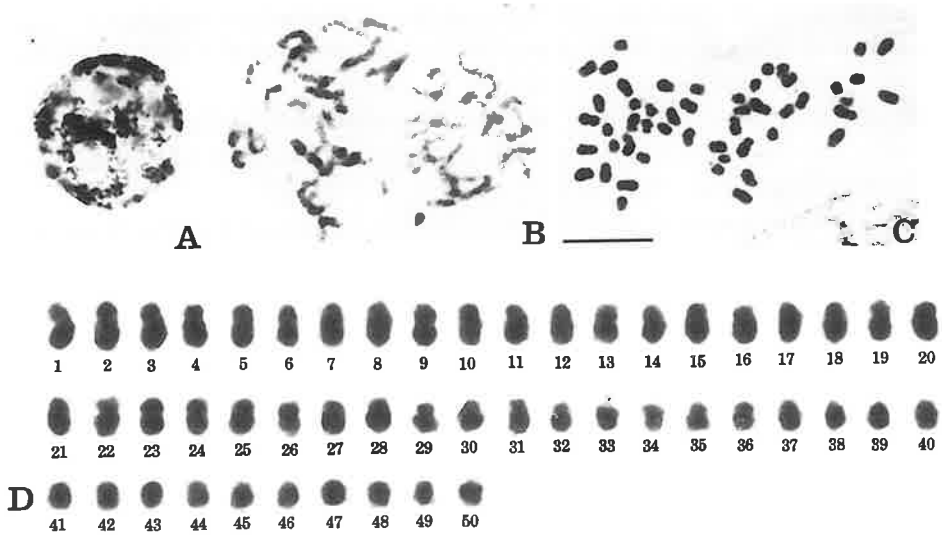

Fig. 13. *Lycaste denningiana*, 2n = 50. A, chromosomes at resting stage. B, chromosomes at mitotic prophase. C and D, chromosomes at mitotic metaphase. Bar indicates 10 μm for A–C and 5 μm for D.

14. *Lycaste barringtoniae* (Smith) Lindl., 2n=44, Tables 1 and 15, Fig. 14.

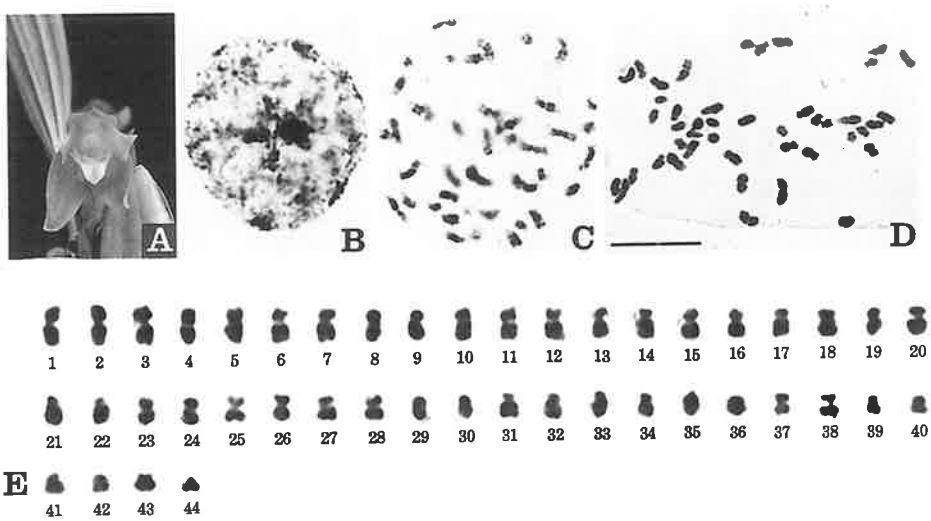

Fig. 14. *Lycaste barringtoniae*, 2n=44. A, a flower. B, chromosomes at resting stage. C. chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bar indicates 26 mm for A, 10 μm for B–D and 5 μm for E.

One plant was obtained from Jamaica. Flowers were 6 cm wide across. Petals and sepals were pale yellowish green in color. Lips were pale brown with bearded margin.

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

The chromosomes at resting stage and mitotic prophase were similar in morphology to those of *L. brevispatha* described above. The chromosome features at resting stage were of the complex chromocenter type.

The 2n=44 chromosomes at mitotic metaphase in this species gradually decreased in length from the longest (2.25 μm) to the shortest (0.80 μm) chromosomes. Among the 44 chromosomes, 36 were median with arm ratios between 1.1 and 1.7, and four (Nos. 21–22, 31–32) submedian with arm ratios between 2.1 and 2.6. The centromeres of rest four chromosomes were not observed.

The karyotype of this species was homogeneous and gradual in length and symmetric in arm ratio.

15. *Lycaste ciliata* (Ruiz et Pavon) Lindl. ex Rchb.f., 2n=44, Tables 1 and 16, Fig. 15.

One plant was obtained from Peru. Flowers were 7 cm wide across. Petals and sepals were pale brown in color. Bearded lips were creamy white.

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

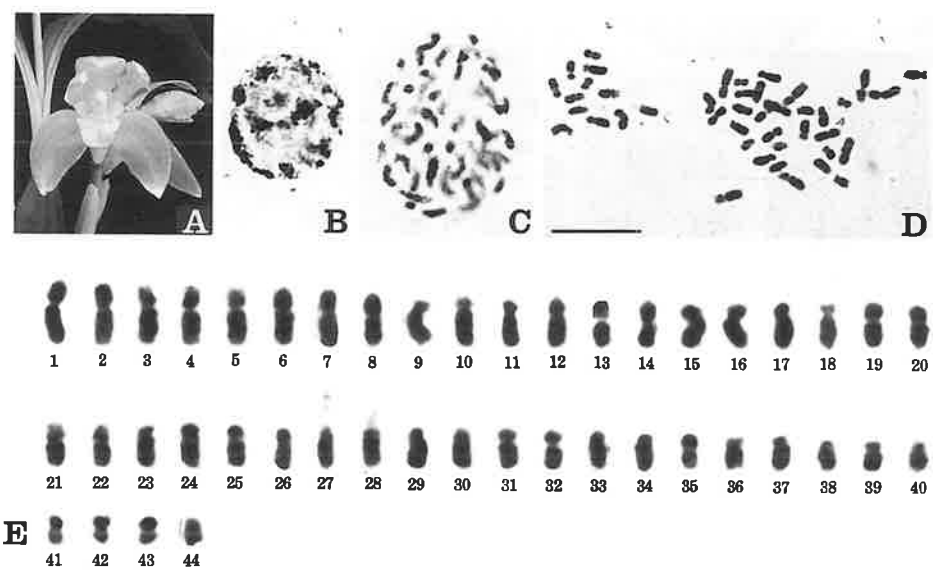

Fig. 15. *Lycaste ciliata*, 2n=44. A, a flower. B, chromosomes at resting stage. C. chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bar indicates 41 mm for A, 10 μm for B–D and 5 μm for E.

The chromosomes at resting stage and mitotic prophase were similar in morphology to those of *L. brevispatha* described above. The chromosome features at resting stage were of the complex chromocenter type.

The 2n = 44 chromosomes at mitotic metaphase gradually decreased in length from the longest (3.40 μm) to the shortest (1.35 μm) chromosomes. Among the 44 chromosomes, 16 were median with arm ratios between 1.0 and 1.7, 19 (Nos. 2–5, 11–12, 15–17, 25–26, 29–31, 33–34, 38–40) submedian with arm ratios between 1.8 and 2.8, and nine (Nos. 9–10, 18, 23–24, 27–28, 36–37) subterminal with arm ratios between 3.2 and 5.0. Two chromosomes (Nos. 27–28) had a secondary constriction on their short arms, and formed small satellites.

The karyotype of this species was homogeneous and gradual in length and symmetric in arm ratio.

16. *Lycaste dyeriana* Sander ex Rolfe, 2n = 48, Tables 1 and 17, Fig. 16.

One plant was obtained from Peru. Flowers were pendulous and 5 cm wide across. Petals and sepals were green in color. Lips were pale green with ciliated margin.

The chromosome number of the plant of this species was 2n = 48 at mitotic metaphase, which was recorded here for the first time.

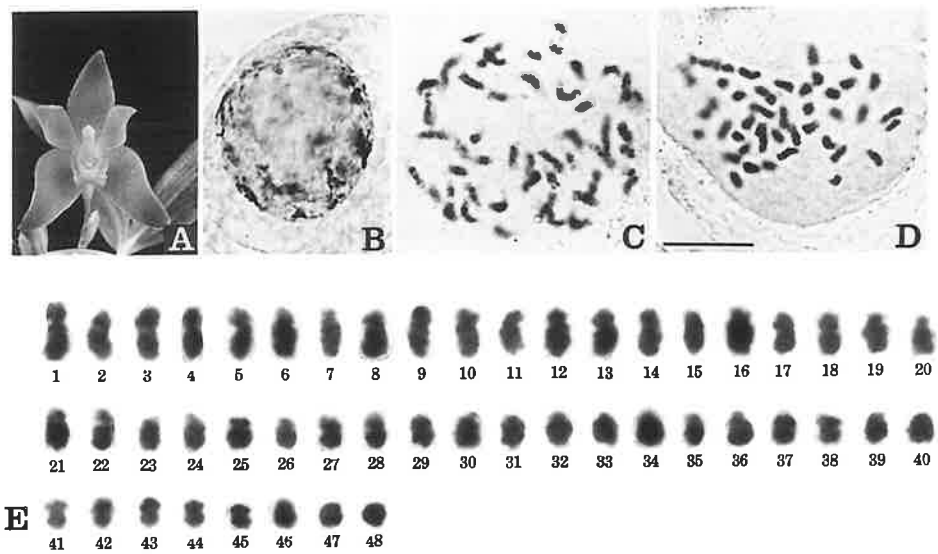

Fig. 16. *Lycaste dyeriana*, 2n = 48. A, a flower. B, chromosomes at resting stage. C. chromosomes at mitotic prophase. D and E, chromosomes at mitotic metaphase. Bar indicates 36 mm for A, 10 μm for B–D and 5 μm for E.

The chromosomes at resting stage and mitotic prophase were similar in morphology to those of *L. brevispatha* described above. The chromosome features at resting stage were of the complex chromocenter type.

The 2n = 48 chromosomes at mitotic metaphase gradually decreased in length from the longest (3.00 μm) to the shortest (1.20 μm) chromosomes. Among the 48 chromosomes, 17 were median with arm ratios between 1.0 and 1.7, 17 (Nos. 1–2, 6, 9–16, 19–22, 25–26) submedian with arm ratios between 1.8 and 3.0, and seven (Nos. 7–8, 32–36) subterminal with arm ratios between 3.2 and 4.0. The centromeres of rest seven chromosomes were not observed.

The karyotype of this species was homogeneous and gradual in length and symmetric in arm ratio.

Discussion

1. Karyomorphological characteristics of the genus *Lycaste*

In the present observations, resting chromosomes of 16 species of *Lycaste* studied contained chromomeric granules, fibrous threads and chromatin blocks which varied in number from 15 to 20 per nucleus. Those chromosome features at resting stage were of the complex chromocenter type proposed by Tanaka (1971). The chromosomes at mitotic prophase of 16 species formed early condensed segments at the interstitial regions of both arms. The late condensed segments were located in the distal and proximal regions of the chromosomes.

The chromosome numbers of 14 species studied were recorded here for the first time; 2n = 40 for *L. brevispatha, L. tricolor, L. deppei, L. cruenta, L. campbellii, L.bradeorum, L. dowiana* and *L. macrophylla*; 2n = 44 for *L. barringtoniae* and *L. ciliata*; 2n = 48 for *L. linguella, L. locusta* and *L. dyeriana*; 2n = 50 for *L. denningiana*, and those of 2n = 40 in *L. aromatica* and *L. virginalis* were reexamined.

According to the degrees of condensation of metaphase chromosomes, the average chromosome lengths were varied from 3.0 μm in *L. campbellii* to 1.3 μm in *L. brevispatha*. Among the 16 species studied, only *L. linguella* had two distinguishably large chromosomes and exhibited heterogenous and bimodal karyotype. The other 15 species showed homogeneous and gradual karyotype.

In five species, the centromeres of some chromosomes were not observed. Excepting those chromosomes, the average arm ratios in the complements at mitotic metaphase of *Lycaste* studied was 1.8. The average arm ratios of each species ranged from 2.3 in *L. ciliata* to 1.4 in *L. cruenta*. Thus, the 16 species showed a symmetric karyotype.

Secondary constrictions were observed in three species of *L. aromatica, L. linguella* and *L. ciliata*. They located near the distal regions of short arms, and their satellites were small in size. Light-stained satellites were observed on two prophase chromosomes of *L. dowiana*, however, they were not observed at metaphase. Thus, it is considered that the satellites of *Lycaste* were hardly observed at mitotic metaphase.

2. Cytotaxonomical investigations of the genus *Lycaste*

The genus *Lycaste* has been classified into four sections by Fowlie (1970); Deciduosae, Macrophyllae, Longisepalae and Fimbriatae. Then, he proposed that the former three sections were closely related with the genus *Anguloa*, while section Fimbriatae were more distantly related with *Anguloa* than the other three sections. Moreover, he proposed that *L. dyeriana* should be situated in the genus *Bifrenaria*.

All of the seven species belonging to the section Deciduosae studied had the $2n=40$ chromosome number and their karyotypes were gradual and homogeneous in length and symmetric in arm ratio.

Three species belonging to the section Macrophyllae also had the $2n=40$ chromosomes number and their karyotypes were gradual and homogeneous in length and symmetric in arm ratio.

The chromosome numbers of five species belonging to the section Fimbriatae were difference from those of former two sections. In this studies, the chromosome number of $2n=44$ was observed in *L. barringtoniae* and *L. ciliata*, $2n=48$ in *L.linguella* and *L. locusta* and $2n=50$ in *L. denningiana*. The centromeres of some chromosomes of four species of the section Fimbriatae were not observed. If those chromosomes were terminal in centromeric position, it was seemed that the aneuploidy of this section was caused by the centric fission of median chromosomes. Moreover, the existance of the large chromosomes in *L. linguella* suggested the structural changes of chromosomes.

The chromosome number of $2n=48$ and karyotypes at resting stage, mitotic prophase and metaphase of *L. dyeriana* which was treated as being the genus *Bifrenaria* by Fowlie (1970) were closely similar to those of two species of the section Fimbriatae. The chromosome number of *B. harrisoniae* was reported to be $2n=38$ (Tanaka 1962, Aoyama and Tanaka 1980), and other three species of *Bifrenaria* had same chromosome number of $2n=38$ (Aoyama unpublished). Thus, *L. dyeriana* should be treated as being the section Fimbriatae of the genus *Lycaste*.

The karyomorphological features of 16 species studied were corresponded to the sectional classification by Fowlie (1970), allthougt the section Longisepalae was not observed in the present study. Particularly, the section Fimbriatae was characterized by hyperploidy, and regarded as being monophyletic group differentiated by centric fission and structural changes of chromosomes.

Summary

1. Karyomorphological investigations were carried out in 16 species of the genus *Lycaste*.
2. The chromosome numbers of 14 species were newly reported; $2n=40$ for *L. brevispatha, L. tricolor, L. deppei, L. cruenta, L. campbellii, L. bradeorum, L. dowiana* and *L. macrophylla*; $2n=44$ for *L. barringtoniae* and *L. ciliata*; $2n=48$ for *L. linguella, L. locusta* and *L. dyeriana*; $2n=50$ for *L. denningiana*, and those of $2n=40$ in *L. aromatica* and *L. virginalis* were reexamined.

3. The chromosomes of all species studied at resting stage were the complex chromocenter type (Tanaka 1971).
4. At mitotic metaphase, karyotypes of 15 species were homogeneous and gradual in length and symmetric in arm ratio, while that of *L. linguella* had two large chromosomes and was heterogeneous and bimodal in length and symmetric in arm ratio.
5. Most species with the chromosome numbers of 2n = 44, 48 and 50 had some chromosomes of which position of centromere was not determined and considered to be terminal in centromeric position. Therefore, it is seemed that the aneuploidy of *Lycaste* was caused by the centric fission and structural changes of chromosomes.
6. The karyomorphological features of 16 species of *Lycaste* studied corresponded to each sections classified by Fowlie (1970). *L. dyeriana* which was placed in the genus *Bifrenaria* by Fowlie was closely similar to the section Fimbriatae of the genus *Lycaste* karyomorphologically.

Acknowledgements

The authors wish to express their cordinal thanks to Mr. Masatsugu Yokota, Department of Biology, University of the Ryukyus, for his valuable criticism during the preparation of this manuscript.

Literature Cited

Aoyama, M. & R. Tanaka 1980. Cytological and morphological studies on an intergeneric hybrid of *Bifrenaria* × *Cymbidium*. Bull. Hiroshima Bot. Gard. 3: 59–68.

Fowlie, J.A. 1970. The genus Lycaste. Pomona: Azul Quinta Press.

Hawkes, A.D. 1965. Encyclopaedia of cultivated orchids. Faber and Faber Limited, London 602 pp.

Hoffmann, K.M. 1929. Zytologische Studien der Orchidaceen. (Vorläufige Mitteilung.) Ber. deutschen Bot. Gesell. 47: 321–326.

Hoffmann, K.M. 1930. Beiträge zur Cytologie der Orchidaceen. Planta 10: 523–595.

Kojima, K., R. Tanaka, S. Takaki and M. Aoyama 1987. Introduction of genes into *Cymbidium* from other genera by wide crossing. *In* K. Kondo & K. Hashimoto (eds.), Proc. World Orchid Hiroshima Symposium, pp. 85–94. Executive Committee of the World Orchid Hiroshima Symposium, Hiroshima.

Levan, A., K. Fredge and A.A. Stanberg 1964. Nomenclature for centromeric position of chromosomes. Hereditas 52: 201–220.

Tanaka, R. 1959. On the speciation and karyotypes in diploid and tetraploid species of *Chrysanthemum* I, Karyotypes in *Chrysanthemum boreale* (2n = 18). Jour. Sci. Hiroshima Univ. Ser. B, Div. 2, 9: 1–16.

Tanaka, R. 1962. Chromosome count of orchids in Japan, I. Japan Orchid Soc. Bull. 8: 1–4.

Tanaka, R. 1971. Types of resting nuclei in Orchidaceae. Bot. Mag. Tokyo 84: 118–122.

Tanaka, R. 1980. The karyotype. *In* H. Kihara (ed.), Plant Genetics, I, pp. 335–358. Shokabo Co. Tokyo.

The Royal Horticultural Society. 1987. Sander's list of orchid hybrids. Addendum 1981–1985.

Table 2. Measurements of somatic chromosomes of *Lycaste brevispatha*, 2n=40 at metaphase

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.00+1.05=2.05	2.8	1.0	m
2	0.95+1.10=2.05	2.8	1.1	m
3	0.95+1.00=1.95	2.7	1.0	m
4	0.95+0.95=1.90	2.6	1.0	m
5	0.90+0.90=1.80	2.5	1.0	m
6	0.80+0.95=1.75	2.4	1.1	m
7	0.80+0.95=1.75	2.4	1.1	m
8	0.80+0.90=1.70	2.3	1.1	m
9	0.70+0.90=1.60	2.2	1.2	m
10	0.70+0.85=1.55	2.1	1.2	m
11	0.55+0.95=1.50	2.1	1.7	m
12	0.55+0.95=1.50	2.1	1.7	m
13	0.65+0.80=1.45	2.0	1.2	m
14	0.65+0.75=1.40	1.9	1.1	m
15	0.70+0.70=1.40	1.9	1.0	m
16	0.60+0.70=1.30	1.8	1.1	m
17	0.45+0.80=1.25	1.7	1.7	m
18	0.45+0.80=1.25	1.7	1.7	m
19	0.45+0.80=1.25	1.7	1.7	m
20	0.45+0.80=1.25	1.7	1.7	m
21	0.45+0.80=1.25	1.7	1.7	m
22	0.45+0.80=1.25	1.7	1.7	m
23	0.40+0.80=1.20	1.6	2.0	sm
24	0.40+0.80=1.20	1.6	2.0	sm
25	0.50+0.70=1.20	1.6	1.4	m
26	0.50+0.70=1.20	1.6	1.4	m
27	0.50+0.70=1.20	1.6	1.4	m
28	0.50+0.70=1.20	1.6	1.4	m
29	0.45+0.70=1.15	1.6	1.5	m
30	0.45+0.70=1.15	1.6	1.5	m
31	0.40+0.70=1.10	1.5	1.7	m
32	0.40+0.70=1.10	1.5	1.7	m
33	0.35+0.75=1.10	1.5	2.1	sm
34	0.35+0.75=1.10	1.5	2.1	sm
35	0.30+0.75=1.05	1.4	2.5	sm
36	0.30+0.75=1.05	1.4	2.5	sm
37	0.40+0.45=0.85	1.2	1.1	m
38	0.40+0.45=0.85	1.2	1.1	m
39	0.35+0.35=0.70	1.0	1.0	m
40	0.30+0.40=0.70	1.0	1.3	m

Table 3. Measurements of somatic chromosomes of *Lycaste tricolor*, 2n=40 at metaphase

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	0.85+1.50=2.35	3.6	1.7	m
2	0.80+1.45=2.25	3.4	1.8	sm
3	1.05+1.20=2.25	3.4	1.1	m
4	1.00+1.20=2.20	3.4	1.2	m
5	0.95+1.20=2.15	3.3	1.2	m
6	1.00+1.15=2.15	3.3	1.1	m
7	0.80+1.20=2.00	3.1	1.5	m
8	0.80+1.20=2.00	3.1	1.5	m
9	0.60+1.35=1.95	3.0	2.2	sm
10	0.55+1.40=1.95	3.0	2.5	sm
11	0.50+1.30=1.80	2.7	2.6	sm
12	0.45+1.35=1.80	2.7	3.0	sm
13	0.85+0.95=1.80	2.7	1.0	m
14	0.75+1.05=1.80	2.7	1.4	m
15	0.35+1.35=1.70	2.6	3.8	st
16	0.35+1.35=1.70	2.6	3.8	st
17	0.70+1.00=1.70	2.6	1.4	m
18	0.60+1.10=1.70	2.6	1.8	sm
19	0.80+0.90=1.70	2.6	1.1	m
20	0.75+0.90=1.65	2.5	1.2	m
21	0.60+1.05=1.65	2.5	1.7	m
22	0.60+1.00=1.60	2.4	1.6	m
23	0.75+0.75=1.50	2.3	1.0	m
24	0.70+0.80=1.50	2.3	1.1	m
25	0.50+1.00=1.50	2.3	2.0	sm
26	0.45+1.00=1.45	2.2	2.2	sm
27	0.45+0.95=1.40	2.1	2.1	sm
28	0.45+0.95=1.40	2.1	2.1	sm
29	0.50+0.90=1.40	2.1	1.8	sm
30	0.55+0.85=1.40	2.1	1.5	m
31	0.55+0.80=1.35	2.1	1.4	m
32	0.55+0.80=1.35	2.1	1.4	m
33	0.45+0.90=1.35	2.1	2.0	sm
34	0.40+0.95=1.35	2.1	2.3	sm
35	0.55+0.65=1.20	1.8	1.1	m
36	0.55+0.65=1.20	1.8	1.1	m
37	0.50+0.65=1.15	1.8	1.3	m
38	0.50+0.65=1.15	1.8	1.3	m
39	0.45+0.60=1.05	1.6	1.3	m
40	0.35+0.65=1.00	1.5	1.8	sm

Table 4. Measurements of somatic chromosomes of *Lycaste deppei*, 2n=40 at metaphase

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.35+1.40=2.75	3.3	1.0	m
2	1.35+1.40=2.75	3.3	1.0	m
3	1.25+1.50=2.75	3.3	1.2	m
4	1.25+1.35=2.60	3.1	1.0	m
5	1.25+1.35=2.60	3.1	1.0	m
6	1.25+1.35=2.60	3.1	1.0	m
7	1.25+1.35=2.60	3.1	1.0	m
8	1.15+1.45=2.60	3.1	1.2	m
9	1.25+1.30=2.55	3.0	1.0	m
10	1.25+1.30=2.55	3.0	1.0	m
11	1.15+1.35=2.50	3.0	1.1	m
12	1.15+1.35=2.50	3.0	1.1	m
13	0.85+1.50=2.35	2.8	1.7	m
14	0.80+1.50=2.30	2.7	1.8	sm
15	0.55+1.60=2.15	2.6	2.9	sm
16	0.50+1.60=2.10	2.5	3.2	st
17	0.60+1.45=2.05	2.4	2.4	sm
18	0.60+1.45=2.05	2.4	2.4	sm
19	0.60+1.45=2.05	2.4	2.4	sm
20	0.65+1.40=2.05	2.4	2.1	sm
21	0.90+1.15=2.05	2.4	1.2	m
22	0.85+1.20=2.05	2.4	1.4	m
23	0.80+1.20=2.00	2.4	1.5	m
24	0.75+1.25=2.00	2.4	1.6	m
25	0.80+1.20=2.00	2.4	1.5	m
26	0.80+1.15=1.95	2.3	1.4	m
27	0.85+1.05=1.90	2.3	1.2	m
28	0.90+0.95=1.85	2.2	1.0	m
29	0.45+1.40=1.85	2.2	3.1	st
30	0.45+1.40=1.85	2.2	3.1	st
31	0.55+1.30=1.85	2.2	2.3	sm
32	0.55+1.30=1.85	2.2	2.3	sm
33	0.70+1.15=1.85	2.2	1.6	m
34	0.70+1.15=1.85	2.2	1.6	m
35	0.75+0.95=1.70	2.0	1.2	m
36	0.70+0.90=1.60	1.9	1.2	m
37	0.55+0.85=1.40	1.7	1.5	m
38	0.50+0.85=1.35	1.6	1.7	m
39	0.60+0.70=1.30	1.5	1.1	m
40	0.55+0.65=1.20	1.2	1.1	m

Table 5. Measurements of somatic chromosomes of *Lycaste cruenta*, 2n=40 at metaphase

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.15+1.50=2.65	3.8	1.3	m
2	1.15+1.45=2.60	3.7	1.2	m
3	1.10+1.35=2.45	3.5	1.2	m
4	1.10+1.30=2.40	3.4	1.1	m
5	1.05+1.30=2.35	3.3	1.2	m
6	1.05+1.25=2.30	3.3	1.1	m
7	1.05+1.15=2.20	3.1	1.0	m
8	1.00+1.15=2.15	3.1	1.1	m
9	1.00+1.15=2.15	3.1	1.1	m
10	0.80+1.35=2.15	3.1	1.6	m
11	0.90+1.10=2.00	2.8	1.2	m
12	0.85+1.05=1.90	2.7	1.2	m
13	0.80+1.05=1.85	2.6	1.3	m
14	0.85+0.95=1.80	2.6	1.1	m
15	0.80+1.00=1.80	2.6	1.2	m
16	0.85+0.95=1.80	2.6	1.1	m
17	0.65+1.15=1.80	2.6	1.7	m
18	0.65+1.15=1.80	2.6	1.7	m
19	0.60+1.10=1.70	2.4	1.8	sm
20	0.65+1.05=1.70	2.4	1.6	m
21	0.60+1.10=1.70	2.4	1.8	sm
22	0.55+1.10=1.65	2.3	2.0	sm
23	0.80+0.85=1.65	2.3	1.0	m
24	0.75+0.85=1.60	2.3	1.1	m
25	0.55+1.00=1.55	2.2	1.8	sm
26	0.55+1.00=1.55	2.2	1.8	sm
27	0.45+1.00=1.45	2.1	2.2	sm
28	0.45+1.00=1.45	2.1	2.2	sm
29	0.55+0.90=1.45	2.1	1.6	m
30	0.50+0.95=1.45	2.1	1.9	sm
31	0.50+0.95=1.45	2.1	1.9	sm
32	0.50+0.95=1.45	2.1	1.9	sm
33	0.60+0.85=1.45	2.1	1.4	m
34	0.60+0.85=1.45	2.1	1.4	m
35	0.50+0.90=1.40	2.0	1.8	sm
36	0.45+0.90=1.35	1.9	2.0	sm
37	0.65+0.65=1.30	1.8	1.0	m
38	0.60+0.65=1.25	1.8	1.0	m
39	0.55+0.60=1.15	1.6	1.0	m
40	0.50+0.60=1.10	1.6	1.2	m

Table 6. Measurements of somatic chromosomes of *Lycaste campbellii*, 2n=40 at metaphase

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.75+2.50=4.25	3.5	1.4	m
2	1.80+2.35=4.15	3.4	1.3	m
3	1.75+2.10=3.85	3.2	1.2	m
4	1.70+2.10=3.80	3.2	1.2	m
5	1.65+2.10=3.75	3.1	1.2	m
6	1.70+2.00=3.70	3.1	1.1	m
7	1.25+2.30=3.55	2.9	1.8	sm
8	1.40+2.15=3.55	2.9	1.5	m
9	1.50+2.00=3.50	2.9	1.3	m
10	1.50+2.00=3.50	2.9	1.3	m
11	1.50+2.00=3.50	2.9	1.3	m
12	1.50+2.00=3.50	2.9	1.3	m
13	1.30+2.15=3.45	2.9	1.6	m
14	1.40+2.05=3.45	2.9	1.4	m
15	1.55+1.80=3.35	2.8	1.1	m
16	1.50+1.80=3.30	2.7	1.2	m
17	1.30+1.80=3.10	2.6	1.3	m
18	1.30+1.75=3.05	2.5	1.3	m
19	1.25+1.75=3.00	2.5	1.4	m
20	1.25+1.75=3.00	2.5	1.4	m
21	1.15+1.75=2.90	2.4	1.5	m
22	1.10+1.80=2.90	2.4	1.6	m
23	0.70+2.15=2.85	2.4	3.0	sm
24	0.75+2.10=2.85	2.4	2.8	sm
25	0.70+2.10=2.80	2.3	3.0	sm
26	0.75+2.05=2.80	2.3	2.7	sm
27	0.90+1.85=2.75	2.3	2.0	sm
28	1.15+1.60=2.75	2.3	1.3	m
29	1.05+1.65=2.70	2.2	1.5	m
30	1.05+1.65=2.70	2.2	1.5	m
31	0.85+1.55=2.40	2.0	1.8	sm
32	0.80+1.60=2.40	2.0	2.0	sm
33	0.90+1.50=2.40	2.0	1.6	m
34	0.75+1.60=2.35	2.0	2.1	sm
35	1.50+1.25=2.30	1.9	1.1	m
36	0.85+1.40=2.25	1.9	1.6	m
37	0.85+1.20=2.05	1.7	1.4	m
38	0.85+1.20=2.05	1.7	1.4	m
39	0.85+1.20=2.05	1.7	1.4	m
40	0.75+1.10=1.85	1.5	1.4	m

Table 7. Measurements of somatic chromosomes of *Lycaste aromatica*, 2n=40 at metaphase

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.55+1.85=3.40	3.8	1.1	m
2	1.45+1.85=3.30	3.7	1.2	m
3	1.50+1.60=3.10	3.5	1.0	m
4	1.55+1.55=3.10	3.5	1.0	m
5	1.35+1.75=3.10	3.5	1.2	m
6	1.40+1.65=3.05	3.4	1.1	m
7	1.15+1.90=3.05	3.4	1.6	m
8	1.40+1.60=3.00	3.3	1.1	m
9	1.35+1.55=2.90	3.2	1.1	m
10	1.40+1.45=2.85	3.2	1.0	m
11	1.30+1.50=2.80	3.1	1.1	m
12	1.15+1.50=2.65	3.0	1.3	m
13	0.10+0.55+2.00=2.65*	3.0	3.0	sm
14	0.10+0.50+2.00=2.60*	2.9	3.3	st
15	1.25+1.35=2.60	2.9	1.0	m
16	1.00+1.35=2.35	2.6	1.3	m
17	0.85+1.45=2.30	2.6	1.7	m
18	0.45+1.85=2.30	2.6	4.1	st
19	0.65+1.55=2.20	2.5	2.3	sm
20	0.65+1.55=2.20	2.5	2.3	sm
21	0.55+1.55=2.10	2.3	2.8	sm
22	0.60+1.50=2.10	2.3	2.5	sm
23	0.55+1.50=2.05	2.3	2.7	sm
24	0.55+1.50=2.05	2.3	2.7	sm
25	0.55+1.40=1.95	2.2	2.5	sm
26	0.50+1.40=1.90	2.1	2.8	sm
27	0.75+1.15=1.90	2.1	1.5	m
28	0.85+1.00=1.85	2.1	1.1	m
29	0.65+1.10=1.75	2.0	1.6	m
30	0.70+1.00=1.70	1.9	1.4	m
31	0.70+1.00=1.70	1.9	1.4	m
32	0.60+1.05=1.65	1.8	1.7	m
33	0.60+1.05=1.65	1.8	1.7	m
34	0.60+1.00=1.60	1.8	1.6	m
35	0.35+1.25=1.60	1.8	3.5	st
36	0.30+1.20=1.50	1.7	4.0	st
37	0.55+0.80=1.35	1.5	1.4	m
38	0.55+0.75=1.30	1.5	1.3	m
39	0.50+0.75=1.25	1.4	1.5	m
40	0.50+0.70=1.20	1.3	1.4	m

* Chromosome with secondary constriction

Table 8. Measurements of somatic chromosomes of *Lycaste bradeorum*, 2n=40 at metaphase

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.15+1.65=2.80	3.8	1.4	m
2	1.25+1.55=2.80	3.8	1.2	m
3	1.25+1.40=2.65	3.6	1.1	m
4	1.25+1.30=2.55	3.5	1.0	m
5	0.80+1.60=2.40	3.3	2.0	sm
6	0.75+1.50=2.25	3.1	2.0	sm
7	1.05+1.10=2.15	3.0	1.0	m
8	1.05+1.10=2.15	3.0	1.0	m
9	0.75+1.20=1.95	2.7	1.6	m
10	0.65+1.30=1.95	2.7	2.0	sm
11	0.65+1.30=1.95	2.7	2.0	sm
12	0.65+1.30=1.95	2.7	2.0	sm
13	0.95+1.00=1.95	2.7	1.0	m
14	0.95+1.00=1.95	2.7	1.0	m
15	0.90+1.00=1.90	2.6	1.1	m
16	0.90+1.00=1.90	2.6	1.1	m
17	0.80+1.10=1.90	2.6	1.3	m
18	0.70+1.15=1.85	2.5	1.6	m
19	0.60+1.20=1.80	2.5	2.0	sm
20	0.65+1.15=1.80	2.5	1.7	m
21	0.70+1.05=1.75	2.4	1.5	m
22	0.70+1.00=1.70	2.3	1.4	m
23	0.45+1.25=1.70	2.3	2.7	sm
24	0.45+1.25=1.70	2.3	2.7	sm
25	0.75+0.90=1.65	2.3	1.2	m
26	0.75+0.90=1.65	2.3	1.2	m
27	0.65+0.95=1.60	2.2	1.4	m
28	0.75+0.80=1.55	2.1	1.0	m
29	0.75+0.80=1.55	2.1	1.0	m
30	0.75+0.80=1.55	2.1	1.0	m
31	0.70+0.80=1.50	2.1	1.1	m
32	0.70+0.80=1.50	2.1	1.1	m
33	0.45+1.05=1.50	2.1	2.3	sm
34	0.40+1.10=1.50	2.1	2.7	sm
35	0.70+0.80=1.50	2.1	1.1	m
36	0.55+0.85=1.40	1.9	1.5	m
37	0.45+0.85=1.30	1.8	1.8	sm
38	0.35+0.95=1.30	1.8	2.7	sm
39	0.50+0.65=1.15	1.6	1.3	m
40	0.50+0.60=1.10	1.5	1.2	m

Table 9. Measurements of somatic chromosomes of *Lycaste dowiana*, 2n=40 at metaphase

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.55+1.90=3.45	4.0	1.2	m
2	1.60+1.80=3.40	3.9	1.1	m
3	1.10+1.75=2.85	3.3	1.5	m
4	1.35+1.50=2.85	3.3	1.1	m
5	0.95+1.85=2.80	3.3	1.9	sm
6	0.80+1.80=2.60	3.0	2.2	sm
7	1.25+1.30=2.55	3.0	1.0	m
8	1.25+1.30=2.55	3.0	1.0	m
9	0.85+1.60=2.45	2.8	1.8	sm
10	0.75+1.70=2.45	2.8	2.2	sm
11	0.80+1.65=2.45	2.8	2.0	sm
12	0.75+1.60=2.35	2.7	2.1	sm
13	0.85+1.50=2.35	2.7	1.7	m
14	0.75+1.55=2.30	2.7	2.0	sm
15	1.00+1.25=2.25	2.6	1.2	m
16	0.95+1.25=2.20	2.6	1.3	m
17	0.80+1.40=2.20	2.6	1.7	m
18	0.85+1.25=2.10	2.4	1.4	m
19	0.65+1.40=2.05	2.4	2.1	sm
20	0.65+1.35=2.00	2.3	2.0	sm
21	0.75+1.25=2.00	2.3	1.6	m
22	0.65+1.30=1.95	2.3	2.0	sm
23	0.90+1.05=1.95	2.3	1.1	m
24	0.95+1.00=1.95	2.3	1.0	m
25	0.90+1.05=1.95	2.3	1.1	m
26	0.65+1.30=1.95	2.3	2.0	sm
27	0.65+1.30=1.95	2.3	2.0	sm
28	0.60+1.30=1.90	2.2	2.1	sm
29	0.65+1.20=1.85	2.1	1.8	sm
30	0.80+1.05=1.85	2.1	1.3	m
31	0.80+1.00=1.80	2.1	1.2	m
32	0.75+1.00=1.75	2.0	1.3	m
33	0.70+1.05=1.75	2.0	1.5	m
34	0.55+1.15=1.70	2.0	2.0	sm
35	0.75+0.90=1.65	1.9	1.2	m
36	0.75+0.90=1.65	1.9	1.2	m
37	0.50+1.15=1.65	1.9	2.3	sm
38	0.55+1.05=1.60	1.9	1.9	sm
39	0.65+0.90=1.55	1.8	1.3	m
40	0.65+0.85=1.50	1.7	1.3	m

Table 10. Measurements of somatic chromosomes of *Lycaste virginalis*, 2n=40 at metaphase

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.20+1.50=2.70	3.7	1.2	m
2	1.05+1.60=2.65	3.6	1.5	m
3	1.10+1.50=2.60	3.5	1.3	m
4	1.15+1.35=2.50	3.4	1.1	m
5	1.05+1.40=2.45	3.3	1.3	m
6	1.00+1.40=2.40	3.3	1.4	m
7	1.00+1.30=2.30	3.1	1.3	m
8	1.05+1.15=2.20	3.0	1.0	m
9	1.00+1.20=2.20	3.0	1.2	m
10	0.95+1.25=2.20	3.0	1.3	m
11	0.75+1.35=2.10	2.8	1.8	sm
12	0.65+1.40=2.05	2.8	2.1	sm
13	0.75+1.25=2.00	2.7	1.6	m
14	0.75+1.25=2.00	2.7	1.6	m
15	1.00+1.00=2.00	2.7	1.0	m
16	0.75+1.20=1.95	2.6	1.6	m
17	0.90+1.05=1.95	2.6	1.1	m
18	0.90+1.00=1.90	2.6	1.1	m
19	0.25+1.65=1.90	2.6	6.6	st
20	0.45+1.40=1.85	2.5	3.1	st
21	0.60+1.20=1.80	2.4	2.0	sm
22	0.55+1.20=1.75	2.4	2.1	sm
23	0.85+0.90=1.75	2.4	1.0	m
24	0.80+0.90=1.70	2.3	1.1	m
25	0.50+1.15=1.65	2.2	2.3	sm
26	0.50+1.10=1.60	2.2	2.2	sm
27	0.75+0.85=1.60	2.2	1.1	m
28	0.75+0.80=1.55	2.1	1.0	m
29	0.55+1.00=1.55	2.1	1.8	sm
30	0.60+0.95=1.55	2.1	1.5	m
31	0.35+1.20=1.55	2.1	3.4	st
32	0.35+1.20=1.55	2.1	3.4	st
33	0.45+1.05=1.50	2.0	2.3	sm
34	0.55+0.85=1.40	1.9	1.5	m
35	0.55+0.85=1.40	1.9	1.5	m
36	0.35+1.00=1.35	1.8	2.8	sm
37	0.35+0.90=1.25	1.7	2.5	sm
38	0.55+0.65=1.20	1.6	1.1	m
39	0.50+0.60=1.10	1.5	1.2	m
40	0.45+0.60=1.05	1.4	1.3	m

Table 11. Measurements of somatic chromosomes of *Lycaste macrophylla*, 2n=40 at metaphase

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	0.60+1.85=2.45	3.7	3.0	sm
2	0.55+1.70=2.25	3.4	3.0	sm
3	1.05+1.20=2.25	3.4	1.1	m
4	1.10+1.15=2.25	3.4	1.0	m
5	1.10+1.10=2.20	3.4	1.0	m
6	1.05+1.10=2.15	3.3	1.0	m
7	0.85+1.25=2.10	3.2	1.4	m
8	0.85+1.25=2.10	3.2	1.4	m
9	1.05+1.05=2.10	3.2	1.0	m
10	0.90+1.20=2.10	3.2	1.3	m
11	0.55+1.35=1.90	2.9	2.4	sm
12	0.55+1.25=1.80	2.7	2.2	sm
13	0.65+1.15=1.80	2.7	1.7	m
14	0.65+1.10=1.75	2.7	1.6	m
15	0.50+1.15=1.65	2.5	2.3	sm
16	0.45+1.20=1.65	2.5	2.6	sm
17	0.70+0.90=1.60	2.4	1.2	m
18	0.65+0.90=1.55	2.4	1.3	m
19	0.70+0.85=1.55	2.4	1.2	m
20	0.70+0.85=1.55	2.4	1.2	m
21	0.60+0.95=1.55	2.4	1.5	m
22	0.55+1.00=1.55	2.4	1.8	sm
23	0.55+1.00=1.55	2.4	1.8	sm
24	0.50+1.05=1.55	2.4	2.1	sm
25	0.45+1.05=1.50	2.3	2.3	sm
26	0.45+1.00=1.45	2.2	2.2	sm
27	0.55+0.85=1.40	2.1	1.5	m
28	0.55+0.85=1.40	2.1	1.5	m
29	0.60+0.80=1.40	2.1	1.3	m
30	0.60+0.80=1.40	2.1	1.3	m
31	0.45+0.90=1.35	2.1	2.0	sm
32	0.35+0.95=1.30	2.0	2.7	sm
33	0.50+0.80=1.30	2.0	1.6	m
34	0.60+0.70=1.30	2.0	1.4	m
35	0.50+0.75=1.25	1.9	1.5	m
36	0.50+0.65=1.15	1.8	1.3	m
37	0.50+0.65=1.15	1.8	1.3	m
38	0.50+0.65=1.15	1.8	1.3	m
39	0.45+0.65=1.10	1.7	1.4	m
40	0.45+0.55=1.00	1.5	1.2	m

Table 12. Measurements of somatic chromosomes of *Lycaste linguella*, 2n=48 at metaphase

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	2.05+2.70=4.75	2.4	1.3	m
2	1.85+2.50=4.35	2.2	1.3	m
3	0.85+2.30=3.15	1.6	2.7	sm
4	0.65+2.15=2.80	1.4	3.3	st
5	0.85+1.95=2.80	1.4	2.2	sm
6	0.85+1.95=2.80	1.4	2.2	sm
7	1.00+1.80=2.80	1.4	1.8	sm
8	0.90+1.85=2.75	1.4	2.0	sm
9	0.90+1.75=2.65	1.3	1.9	sm
10	0.90+1.75=2.65	1.3	1.9	sm
11	0.70+1.90=2.60	1.3	2.7	sm
12	0.70+1.90=2.60	1.3	2.7	sm
13	0.65+1.85=2.50	1.3	2.8	sm
14	0.65+1.85=2.50	1.3	2.8	sm
15	0.65+1.85=2.50	1.3	2.8	sm
16	0.65+1.80=2.45	1.2	2.7	sm
17	1.00+1.45=2.45	1.2	1.4	m
18	1.05+1.40=2.45	1.2	1.3	m
19	1.05+1.35=2.40	1.2	1.2	m
20	1.10+1.30=2.40	1.2	1.1	m
21	0.80+1.50=2.30	1.2	1.8	sm
22	0.80+1.50=2.30	1.2	1.8	sm
23	0.95+1.35=2.30	1.2	1.4	m
24	0.75+1.55=2.30	1.2	2.0	sm
25	0.30+2.00=2.30	1.2	6.6	st
26	0.35+1.90=2.25	1.1	5.4	st
27	0.70+1.45=2.15	1.1	2.0	sm
28	0.85+1.30=2.15	1.1	1.5	m
29	0.60+1.45=2.05	1.0	2.4	sm
30	0.60+1.45=2.05	1.0	2.4	sm
31	0.55+1.45=2.00	1.0	2.6	sm
32	0.50+1.45=1.95	1.0	2.9	sm
33	0.70+1.15=1.85*	0.9	1.6	m
34	0.70+1.15=1.85*	0.9	1.6	m
35	0.65+1.20=1.85	0.9	1.8	sm
36	0.65+1.20=1.85	0.9	1.8	sm
37	0.55+1.25=1.80	0.9	2.2	sm
38	0.55+1.20=1.75	0.9	2.1	sm
39	0.60+1.15=1.75	0.9	1.9	sm
40	0.60+1.15=1.75	0.9	1.9	sm
41	0.75+1.00=1.75	0.9	1.3	m
42	0.75+1.00=1.75	0.9	1.3	m

Table 12. (continued)

43	0.70+1.00=1.70	0.9	1.4	m
44	0.60+1.00=1.60	0.8	1.6	m
45**	1.60	0.8		
46**	1.60	0.8		
47	0.55+1.00=1.55	0.8	1.8	sm
48	0.50+1.00=1.50	0.8	2.0	sm

* Chromosome with secondary constriction
** The centromere was not observed.

Table 13. Measurements of somatic chromosomes of *Lycaste locusta*, 2n=48 at metaphase

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	0.65+1.30=1.95	2.8	2.0	sm
2	0.80+1.10=1.90	2.7	1.3	m
3	0.45+1.45=1.90	2.7	3.2	st
4	0.50+1.40=1.90	2.7	2.8	sm
5	0.70+1.15=1.85	2.6	1.6	m
6	0.75+1.10=1.85	2.6	1.4	m
7	0.55+1.20=1.75	2.5	2.1	sm
8	0.60+1.15=1.75	2.5	1.9	sm
9	0.35+1.40=1.75	2.5	4.0	st
10	0.35+1.40=1.75	2.5	4.0	st
11	0.35+1.40=1.75	2.5	4.0	st
12	0.50+1.20=1.70	2.4	2.4	sm
13	0.75+0.90=1.65	2.3	1.2	m
14	0.70+0.90=1.60	2.3	1.2	m
15	0.60+0.95=1.55	2.2	1.5	m
16	0.65+0.90=1.55	2.2	1.3	m
17	0.65+0.90=1.55	2.2	1.3	m
18	0.60+0.95=1.55	2.2	1.5	m
19	0.25+1.30=1.55	2.2	5.2	st
20	0.25+1.25=1.50	2.1	5.0	st
21	0.50+1.00=1.50	2.1	2.0	sm
22	0.55+0.95=1.50	2.1	1.7	m
23	0.55+0.95=1.50	2.1	1.7	m
24	0.65+0.85=1.50	2.1	1.3	m
25	0.70+0.80=1.50	2.1	1.1	m
26	0.65+0.85=1.50	2.1	1.3	m
27	0.30+1.20=1.50	2.1	4.0	st

Table 13. (continued)

28	0.30+1.20=1.50	2.1	4.0	st
29	0.35+1.15=1.50	2.1	3.2	st
30	0.30+1.15=1.45	2.1	3.8	st
31	0.65+0.75=1.40	2.0	1.1	m
32	0.40+1.00=1.40	2.0	2.5	sm
33	0.55+0.75=1.30	1.8	1.3	m
34	0.55+0.75=1.30	1.8	1.3	m
35*	1.25	1.8		
36*	1.25	1.8		
37	0.60+0.65=1.25	1.8	1.0	m
38	0.55+0.70=1.25	1.8	1.2	m
39	0.55+0.70=1.25	1.8	1.2	m
40	0.55+0.65=1.20	1.7	1.1	m
41	0.55+0.60=1.15	1.6	1.0	m
42	0.50+0.60=1.10	1.6	1.2	m
43	0.50+0.60=1.10	1.6	1.2	m
44	0.45+0.60=1.05	1.5	1.3	m
45	0.40+0.60=1.00	1.4	1.5	m
46	0.40+0.60=1.00	1.4	1.5	m
47*	1.00	1.4		
48*	0.95	1.3		

* The centromere was not observed.

Table 14. Measurements of somatic chromosomes of *Lycaste denningiana*, 2n=50 at metaphase

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.00+1.60=2.60	2.9	1.6	m
2	0.95+1.65=2.60	2.9	1.7	m
3	0.75+1.65=2.40	2.7	2.2	sm
4	0.75+1.55=2.30	2.6	2.0	sm
5	0.85+1.35=2.20	2.5	1.5	m
6	1.00+1.20=2.20	2.5	1.2	m
7	0.50+1.70=2.20	2.5	3.4	st
8	0.50+1.70=2.20	2.5	3.4	st
9	1.05+1.15=2.20	2.5	1.0	m
10	0.95+1.20=2.15	2.4	1.2	m
11	0.65+1.45=2.10	2.4	2.2	sm
12	0.70+1.35=2.05	2.3	1.9	sm
13	0.95+1.10=2.05	2.3	1.1	m
14	0.90+1.15=2.05	2.3	1.2	m

Table 14. (continued)

15	0.70+1.35=2.05	2.3	1.9	sm
16	0.55+1.45=2.00	2.3	2.6	sm
17*	2.00	2.3		
18*	2.00	2.3		
19	0.85+1.15=2.00	2.3	1.3	m
20	0.80+1.20=2.00	2.3	1.5	m
21	0.65+1.30=1.95	2.2	2.0	sm
22	0.70+1.25=1.95	2.2	1.7	m
23	0.90+1.05=1.95	2.2	1.1	m
24	0.85+1.05=1.90	2.1	1.2	m
25	0.85+1.00=1.85	2.1	1.1	m
26	0.85+0.90=1.75	2.0	1.0	m
27	0.75+0.95=1.70	1.9	1.2	m
28	0.70+1.00=1.70	1.9	1.4	m
29	0.70+0.95=1.65	1.9	1.3	m
30	0.65+0.95=1.60	1.8	1.4	m
31	0.55+1.05=1.60	1.8	1.9	sm
32	0.50+1.00=1.50	1.7	2.0	sm
33	0.30+1.15=1.45	1.6	3.8	st
34	0.60+0.80=1.40	1.6	1.3	m
35	0.60+0.80=1.40	1.6	1.3	m
36	0.60+0.80=1.40	1.6	1.3	m
37*	1.40	1.6		
38*	1.40	1.6		
39*	1.40	1.6		
40*	1.40	1.6		
41*	1.35	1.5		
42*	1.35	1.5		
43*	1.35	1.5		
44*	1.30	1.5		
45*	1.30	1.5		
46*	1.30	1.5		
47*	1.25	1.4		
48*	1.25	1.4		
49*	1.20	1.6		
50*	1.20	1.6		

* The centromere was not observed.

Table 15. Measurements of somatic chromosomes of *Lycaste barringtoniae*, 2n=44 at metaphase

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.00+1.25=2.25	3.6	1.2	m
2	0.95+1.20=2.15	3.5	1.2	m
3	0.85+1.10=1.95	3.2	1.2	m
4	0.90+1.00=1.90	3.1	1.1	m
5	0.70+1.10=1.80	2.9	1.5	m
6	0.65+1.05=1.70	2.8	1.6	m
7	0.65+1.05=1.70	2.8	1.6	m
8	0.70+1.00=1.70	2.8	1.4	m
9	0.65+1.00=1.65	2.7	1.5	m
10	0.65+1.00=1.65	2.7	1.5	m
11	0.60+0.95=1.55	2.5	1.5	m
12	0.60+0.95=1.55	2.5	1.5	m
13	0.55+0.95=1.50	2.4	1.7	m
14	0.55+0.95=1.50	2.4	1.7	m
15	0.60+0.90=1.50	2.4	1.5	m
16	0.65+0.85=1.50	2.4	1.3	m
17	0.55+0.95=1.50	2.4	1.7	m
18	0.55+0.95=1.50	2.4	1.7	m
19	0.60+0.85=1.45	2.3	1.4	m
20	0.55+0.90=1.45	2.3	1.6	m
21	0.45+1.00=1.45	2.3	2.2	sm
22	0.40+1.05=1.45	2.3	2.6	sm
23	0.65+0.80=1.45	2.3	1.2	m
24	0.60+0.80=1.40	2.3	1.3	m
25	0.60+0.80=1.40	2.3	1.3	m
26	0.55+0.80=1.35	2.2	1.4	m
27	0.55+0.75=1.30	2.1	1.3	m
28	0.50+0.75=1.25	2.0	1.5	m
29	0.55+0.70=1.25	2.0	1.2	m
30	0.55+0.70=1.25	2.0	1.2	m
31	0.40+0.85=1.25	2.0	2.1	sm
32	0.40+0.85=1.25	2.0	2.1	sm
33	0.45+0.80=1.25	2.0	1.7	m
34	0.45+0.75=1.20	1.9	1.6	m
35*	1.15	1.9		
36*	1.10	1.8		
37	0.50+0.55=1.05	1.7	1.1	m
38	0.50+0.55=1.05	1.7	1.1	m
39	0.45+0.50=0.95	1.5	1.1	m
40	0.45+0.50=0.95	1.5	1.1	m
41	0.45+0.50=0.95	1.5	1.1	m
42	0.45+0.50=0.95	1.5	1.1	m

Table 15. (continued)

43*	0.85	1.4
44*	0.80	1.3

* The centromere was not observed.

Table 16. Measurements of somatic chromosomes of *Lycaste ciliata*, 2n=44 at metaphase

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.25+2.15=3.40	3.5	1.7	m
2	1.15+2.15=3.30	3.4	1.8	sm
3	1.05+1.90=2.95	3.0	1.8	sm
4	1.05+1.90=2.95	3.0	1.8	sm
5	1.00+1.90=2.90	3.0	1.9	sm
6	1.05+1.85=2.90	3.0	1.7	m
7	1.15+1.75=2.90	3.0	1.5	m
8	1.15+1.65=2.80	2.9	1.4	m
9	0.50+2.10=2.60	2.7	4.2	st
10	0.50+2.10=2.60	2.7	4.2	st
11	0.70+1.80=2.50	2.6	2.5	sm
12	0.75+1.75=2.50	2.6	2.3	sm
13	1.00+1.40=2.40	2.5	1.4	m
14	1.05+1.35=2.40	2.5	1.2	m
15	0.75+1.65=2.40	2.5	2.2	sm
16	0.75+1.65=2.40	2.5	2.2	sm
17	0.65+1.70=2.35	2.4	2.6	sm
18	0.55+1.80=2.35	2.4	3.2	st
19	0.90+1.40=2.30	2.4	1.5	m
20	0.90+1.40=2.30	2.4	1.5	m
21	0.90+1.35=2.25	2.3	1.5	m
22	0.90+1.35=2.25	2.3	1.5	m
23	0.50+1.70=2.20	2.2	3.4	st
24	0.50+1.70=2.20	2.2	3.4	st
25	0.65+1.50=2.15	2.2	2.3	sm
26	0.65+1.50=2.15	2.2	2.3	sm
27	0.10+0.25+1.75=2.10*	2.1	5.0	st
28	0.10+0.25+1.75=2.10*	2.1	5.0	st
29	0.55+1.55=2.10	2.1	2.8	sm
30	0.60+1.40=2.00	2.0	2.3	sm
31	0.65+1.35=2.00	2.0	2.0	sm
32	0.75+1.25=2.00	2.0	1.6	m

Table 16. (continued)

33	0.55+1.40=1.95	2.0	2.5	sm
34	0.50+1.40=1.90	1.9	2.8	sm
35	0.85+1.00=1.85	1.9	1.1	m
36	0.40+1.35=1.75	1.8	3.3	st
37	0.40+1.35=1.75	1.8	3.3	st
38	0.40+1.15=1.55	1.6	2.8	sm
39	0.45+1.05=1.50	1.5	2.3	sm
40	0.45+1.00=1.45	1.5	2.2	sm
41	0.70+0.75=1.45	1.5	1.0	m
42	0.65+0.75=1.40	1.4	1.1	m
43	0.70+0.70=1.40	1.4	1.0	m
44	0.60+0.75=1.35	1.4	1.2	m

* Chromosome with secondary constriction

Table 17. Measurements of somatic chromosomes of *Lycaste dyeriana*, 2n=48 at metaphase.

Chromosome	Length(μm)	Relative length	Arm ratio	Form
1	1.00+2.00=3.00	3.3	2.0	sm
2	1.00+1.80=2.80	3.1	1.8	sm
3	1.20+1.55=2.75	3.0	1.2	m
4	1.05+1.65=2.70	3.0	1.5	m
5	0.95+1.70=2.65	2.9	1.7	m
6	0.80+1.75=2.55	2.8	2.1	sm
7	0.50+2.00=2.50	2.7	4.0	st
8	0.55+1.95=2.50	2.7	3.5	st
9	0.75+1.75=2.50	2.7	2.3	sm
10	0.65+1.80=2.45	2.7	2.7	sm
11	0.60+1.80=2.40	2.6	3.0	sm
12	0.60+1.80=2.40	2.6	3.0	sm
13	0.75+1.65=2.40	2.6	2.2	sm
14	0.70+1.70=2.40	2.6	2.4	sm
15	0.60+1.65=2.25	2.5	2.7	sm
16	0.55+1.70=2.25	2.5	3.0	sm
17	0.90+1.25=2.15	2.4	1.3	m
18	1.00+1.15=2.15	2.4	1.1	m
19	0.50+1.50=2.00	2.2	3.0	sm
20	0.50+1.50=2.00	2.2	3.0	sm

Table 17. (continued)

21	0.55+1.45=2.00	2.2	2.6	sm
22	0.60+1.30=1.90	2.1	2.1	sm
23*	1.80	2.0		
24*	1.80	2.0		
25	0.60+1.15=1.75	1.9	1.9	sm
26	0.55+1.15=1.70	1.9	2.0	sm
27	0.70+0.95=1.65	1.8	1.3	m
28	0.65+1.00=1.65	1.8	1.5	m
29	0.65+0.90=1.55	1.7	1.3	m
30	0.65+0.85=1.50	1.6	1.3	m
31	0.65+0.85=1.50	1.6	1.3	m
32	0.35+1.15=1.50	1.6	3.2	st
33	0.35+1.15=1.50	1.6	3.2	st
34	0.35+1.15=1.50	1.6	3.2	st
35	0.35+1.15=1.50	1.6	3.2	st
36	0.30+1.20=1.50	1.6	4.0	st
37	0.65+0.80=1.45	1.6	1.2	m
38	0.60+0.80=1.40	1.5	1.3	m
39*	1.40	1.5		
40*	1.40	1.5		
41	0.55+0.85=1.40	1.5	1.5	m
42	0.60+0.80=1.40	1.5	1.3	m
43	0.65+0.75=1.40	1.5	1.1	m
44	0.65+0.70=1.35	1.5	1.0	m
45	0.65+0.65=1.30	1.4	1.0	m
46*	1.30	1.4		
47*	1.25	1.4		
48*	1.20	1.3		

* The centromere was not observed.