Karyomorphological studies of six species of subtribe Catasetinae, Orchidaceae

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Abstruct

The karyomorphological observations were carried out on six species in three genera (*Catasetum*, *Cycnoches* and *Mormodes*) of subtribe Catasetinae, Orchidaceae cultivated in the Hiroshima Botanical Garden.

In the all six species, the nuclei at resting stage were observed as the complex chromocenter type, and the karyotypes at mitotic prophase were observed as the interstitial type.

The chromosome numbers of *Catasetum tenebrosum* (2n=54) and *Mormodes sinuata* (2n=54) were reported here for the first time, and *Catasetum cernuum* (2n=54), *C. integerrinum* (2n=54), *C. viridiflavum* (2n=54) and *Cycnoches ventricosum* (2n=68) were redocumented. It was suggested that the five species with chromosome number of 2n=54 had basic chromosome number of x=27 and the one species with chromosome number of 2n=68 had basic chromosome number of x=34.

The karyotypes at mitotic metaphase were symmetrical due to the centromeric position on the all six species studied. The karyotypes of four species of *Catasetum* and *Cycnoches ventricosum* were gradual, though that of *Mormodes sinuata* was bimodal due to the chromosome length.

Introduction

The subtribe Catasetinae, tribe Cymbidieae, the Orchidaceae consists of 194 species in five genera (*Catasetum*, *Clowesia*, *Cycnoches*, *Dressleria* and *Mormodes*) in which the most species are distributed in tropical America (Dressler 1993).

The chromosome numbers of 30 species in the subtribe Catasetinae were indicated as 2n=54, 56, 64, 68, ca.108 and ca.162 (Blumenschein 1960, Jones and Daker1967, Nakata and Hashimoto 1990, Félix and Guerra 2000).

The authors have already studied about the chromosomes of tribe Cymbidieae (Aoyama 1989). In this study, karyomorphological observations of six species of subtribe Catasetinae cultivated in the Hiroshima Botanical Garden were held for enhancing the information about chromosomes.

Materials and Methods

The six species observed in this study were listed in Table 1. They were in three genera in the subtribe Catasetinae and cultivated in the Hiroshima Botanical Garden.

The observation of chromosomes was made by the aceto-orcein squash method. The active root tips were immersed in 0.002M 8-hydroxyquinoline at 15℃ for four hours. Then, they were fixed in acetic alcohol (1:3) at 5℃ for 24 hours. The fixed materials were hydrolyzed in a 1:2 mixture of 45% acetic acid and 1N HCl at 60℃ for 30 seconds. Finally, the materials were squashed and stained in 2% aceto-orcein.

The observations on chromosome morphology were made in nuclei at resting stage, and chromosomes at mitotic prophase and metaphase stages. The types of nuclei at resting stage and chromosomes at mitotic prophase were classified according to Tanaka (1971, 1980), and at mitotic metaphase, they were classified according to Levan *et al.*

*Contribution from the Hiroshima Botanical Garden No.96
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Bulletin of the Hiroshima Botanical Garden, No.30 : 15-30, 2012

(1964).

Results

The pictures of the nuclei at resting stage, the chromosomes at mitotic prophase and metaphase, the drawing of the chromosomes at mitotic metaphase and the chromosomes arrangement according to their length and pairing of each species were organized into one figure (Fig. 1-6). The chromosome numbers of all species studied were shown in Table 1. The measurements of chromosome length were described in Table 2-7.

Table 1. Chromosome numbers of the six species of Catasetinae studied

Species	HBG* accession number	Chromosome numbers		References
		Present count (2n)	Previous count (2n)	
Catasetum				
cernuum (Lindl.) Rchb.f.	2533	54	54	Jones & Daker 1967
			56	Blumenschein 1960
integerrimum Hook.	2539	54	54	Jones & Daker 1967
tenebrosum Kranzl.	1467	54		
viridiflavum Hook.	3149	54	54	Jones & Daker 1967
Cycnoches				
ventricosum Batem.	3148	68	68	Jones & Daker 1967
Mormodes				
sinuata Rchb.f. & Warm.	3618	54		

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1) *Catasetum cernuum* (Lindl.) Rchb.f., HBG2533, Tables 1 and 2, Fig. 1.

The nuclei at resting stage were observed as the complex chromocenter type (Fig. 1A).

The karyotype at mitotic prophase were observed as the interstitial type (Fig. 1B).

The chromosome number of 2n=54 was counted at mitotic metaphase (Table 1, Fig. 1C-E). This number was correspondent to the previous report by Jones and Daker (1967).

The chromosomes at mitotic metaphase varied in length from 2.23 to 0.85 μm (Table 2). In the chromosome complement, 54 chromosomes showed a gradual decrease in length. Among the complement of the 54 chromosomes, 49 chromosomes had their centromeres at the median regions (m) and five chromosomes (Nos. 6, 10, 11, 23 and 24) had their centromeres at the submedian regions (sm).

Thus, this species showed a gradual and symmetric karyotype.

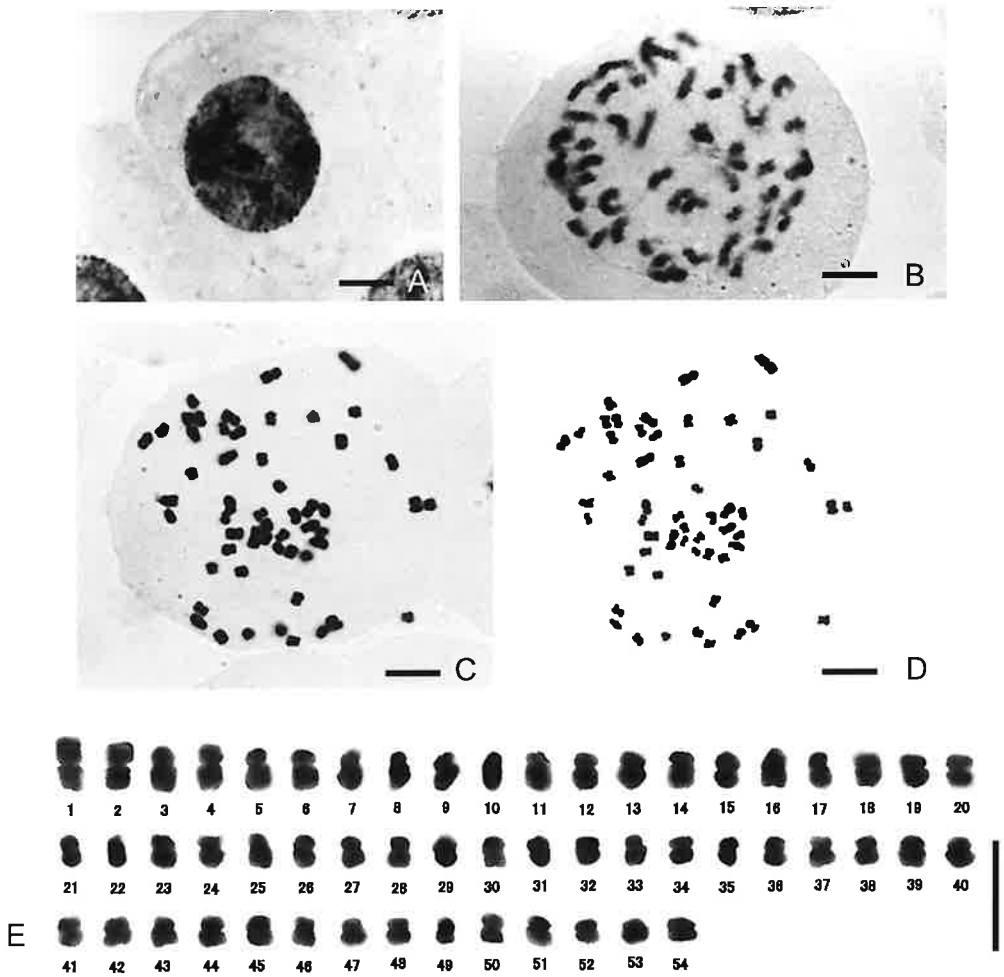

Fig. 1. *Catasetum cernuum* (Lindl.) Rchb.f., HBG2533, 2n=54.

A: resting stage, B: mitotic prophase, C and E: mitotic metaphase, D: drawing of mitotic metaphase.

Bars indicate 5μm.

2) *Catasetum integerrimum* Hook., HBG2539, Tables 1 and 3, Fig. 2.

The nuclei at resting stage were observed as the complex chromocenter type (Fig. 2A).

The karyotype at mitotic prophase were observed as the interstitial type (Fig. 2B).

The chromosome number of 2n=54 was counted at mitotic metaphase (Table 1, Fig. 2C-E). This number was correspondent to the previous report by Jones and Daker (1967).

The chromosomes at mitotic metaphase varied in length from 2.79 to 0.87 μm (Table 3). In the chromosome complement, 54 chromosomes showed a gradual decrease in length. Two chromosomes (Nos. 9 and 10) had satellites at the terminal regions of their long arms. Among the complement of the 54 chromosomes, one chromosome (No. 47) had its centromere at the median point (M), 23 chromosomes (Nos. 1-4, 7-9, 13-16, 25-28, 31, 32, 37-40, 44 and 45) had their centromeres at the median regions, 21 chromosomes (Nos. 5, 6, 10-12, 17-20, 22-24, 29, 30, 33-36 and 41-43) had their centromeres at the submedian regions and one chromosome (No. 21) had its centromere at the subterminal region (st), and in eight chromosomes (Nos. 46 and 48-54), centromeres did not observed in this study.

Thus, this species showed a gradual and symmetric karyotype.

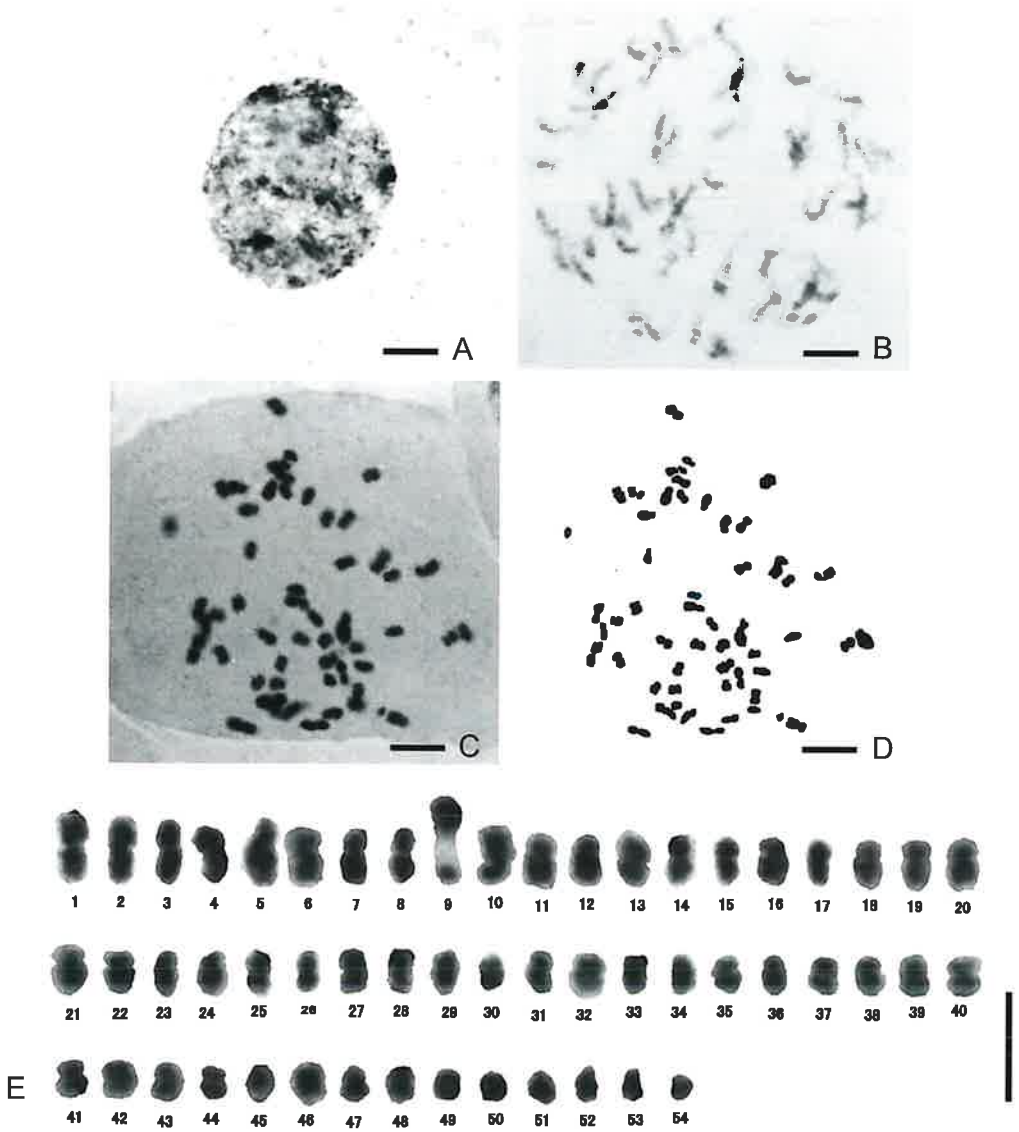

Fig. 2. *Catasetum integerrimum* Hook., HBG2539, 2n=54.

A: resting stage, B: mitotic prophase, C and E: mitotic metaphase, D: drawing of mitotic metaphase. Bars indicate 5μm.

3) *Catasetum tenebrosum* Kranzl., HBG 1467, Tables 1 and 4, Fig. 3.

The nuclei at resting stage were observed as the complex chromocenter type (Fig. 3A).

The karyotype at mitotic prophase were observed as the interstitial type (Fig. 3B).

The chromosome number of 2n=54 was counted at mitotic metaphase (Table 1, Fig. 3C-E). This was reported here for the first time.

The chromosomes at mitotic metaphase varied in length from 3.24 to 1.15 μm (Table 4). In the chromosome complement, 54 chromosomes showed a gradual decrease in length. Among the complement of the 54 chromosomes, 28 chromosomes had their centromeres at the median regions, 23 chromosomes (Nos. 5, 7-10, 13, 19, 20, 23-26, 29, 30, 37, 38, 41, 42, 45-48 and 54) had their centromeres at the submedian regions and three chromosome (Nos. 14-16) had their centromeres at the subterminal regions.

Thus, this species showed a gradual and symmetric karyotype.

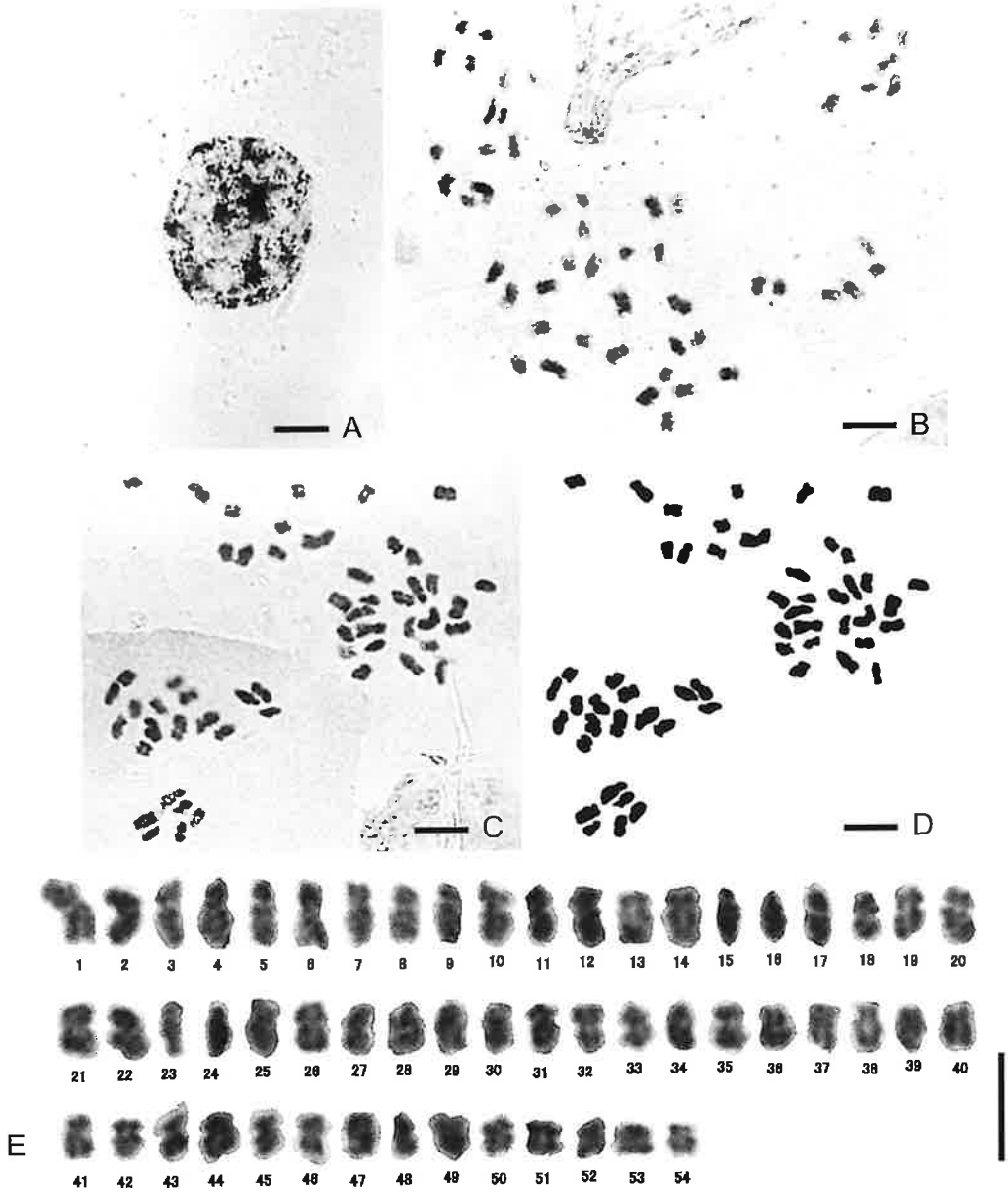

Fig. 3. *Catasetum tenebrosum* Kraenzl., HBG1467, 2n=54.

A: resting stage, B: mitotic prophase, C and E: mitotic metaphase, D: drawing of mitotic metaphase.

Bars indicate 5μm.

4) *Catasetum viridiflavum* Hook., HBG3149, Tables 1 and 5, Fig. 4.

The nuclei at resting stage were observed as the complex chromocenter type (Fig. 4A).

The karyotype at mitotic prophase were observed as the interstitial type (Fig. 4B).

The chromosome number of 2n=54 was counted at mitotic metaphase (Table 1, Fig. 4C-E). This number was correspondent to the previous report by Jones and Daker (1967).

The chromosomes at mitotic metaphase varied in length from 2.56 to 0.85 μm (Table 5). In the chromosome complement, 54 chromosomes showed a gradual decrease in length. Among the complement of the 54 chromosomes, 31 chromosomes had their centromeres at the median regions and 19 chromosomes (Nos. 5, 6, 10, 19-22, 30, 31, 35-40, 43, 44, 51 and 52) had their centromeres at the submedian regions, and in four chromosomes (Nos.49, 50, 53 and 54), centromeres did not observed in this study.

Thus, this species showed a gradual and symmetric karyotype.

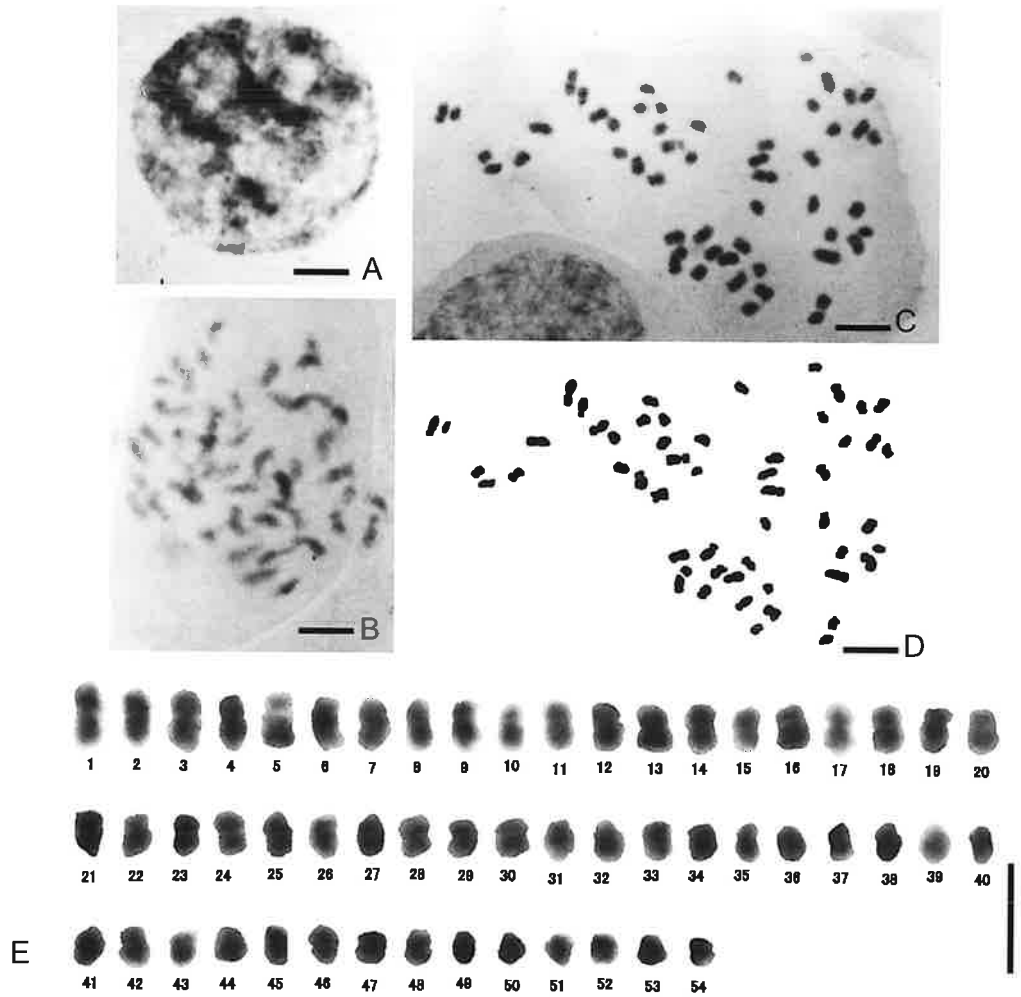

Fig. 4. *Catasetum viridiflavum* Hook., HBG3149, 2n=54.

A: resting stage, B: mitotic prophase, C and E: mitotic metaphase, D: drawing of mitotic metaphase. Bars indicate 5μm.

5) *Cycnoches ventricosum* Batem., HBG3148, Tables 1 and 6, Fig.5.

The nuclei at resting stage were observed as the complex chromocenter type (Fig. 5A).

The karyotype at mitotic prophase were observed as the interstitial type (Fig. 5B).

The chromosome number of 2n=68 was counted at mitotic metaphase (Table 1, Fig. 5C-E). This number was correspondent to the previous report by Jones and Daker (1967).

The chromosomes at mitotic metaphase varied in length from 2.65 to 0.74 μm (Table 6). In the chromosome complement, 68 chromosomes showed a gradual decrease in length. Among the complement of the 68 chromosomes, 11 chromosomes (Nos. 3, 4, 37, 38, 41, 42, 47, 48, 54, 57 and 58) had their centromeres at the median regions, 40 chromosomes had their centromeres at the submedian regions and three chromosomes (Nos. 1, 5 and 14) had their centromeres at the subterminal regions, and in 14 chromosomes (Nos. 39, 45, 49, 50, 53, 56, 59, 60 and 63-68), centromeres did not observed in this study.

Thus, this species showed a gradual and symmetric karyotype.

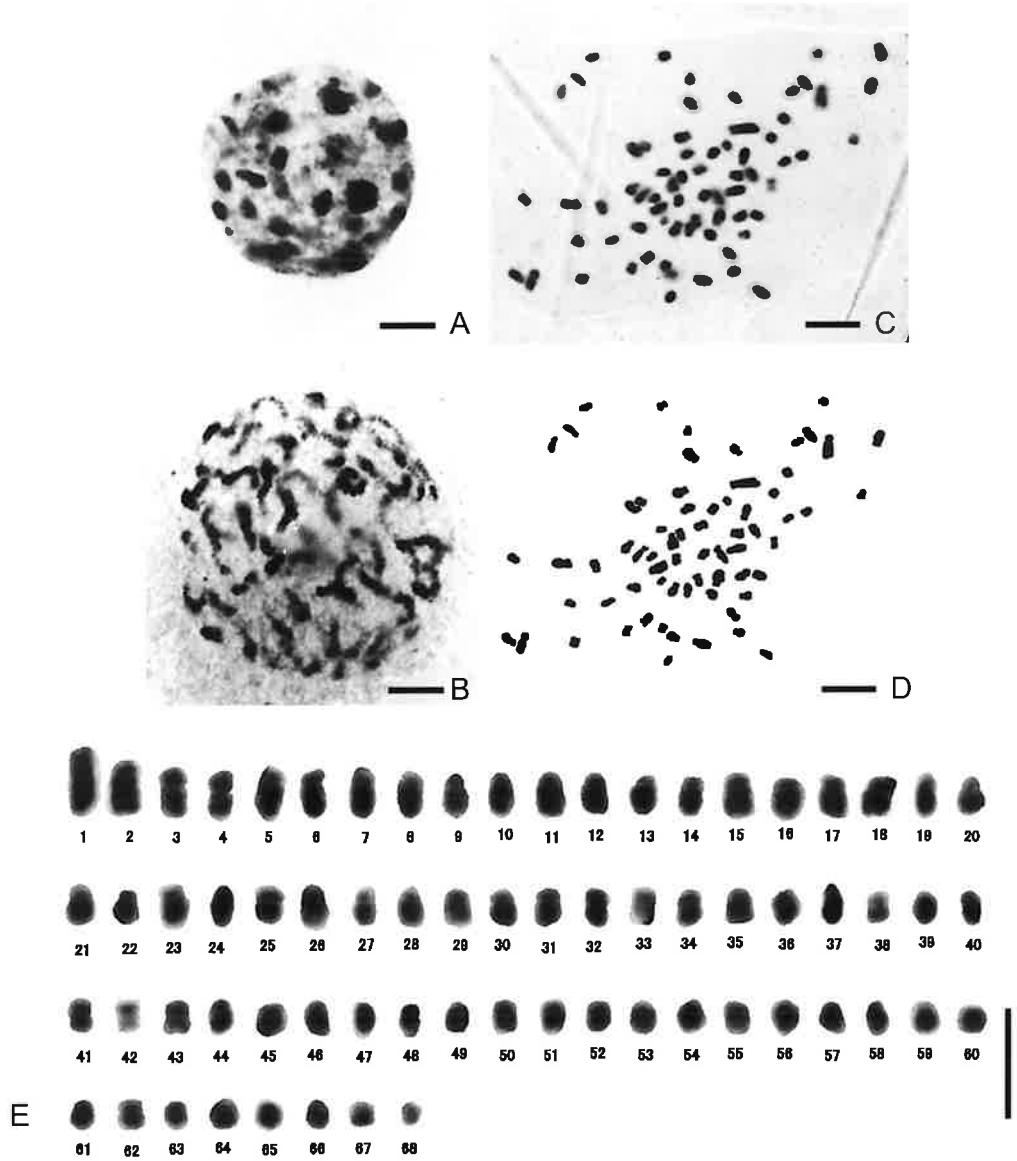

Fig. 5. *Cycnoches ventricosum* Batem, HBG3148, 2n=68.

A: resting stage, B: mitotic prophase, C and E: mitotic metaphase, D: drawing of mitotic metaphase.

Bars indicate 5μm.

6) *Mormodes sinuata* Rchb.f. & Warm., HBG3618, Tables 1 and 7, Fig. 6.

The nuclei at resting stage were observed as the complex chromocenter type (Fig. 6A).

The karyotype at mitotic prophase were observed as the interstitial type (Fig. 6B).

The chromosome number of 2n=54 was counted at mitotic metaphase (Table 1, Fig. 6C-E). This was reported here for the first time.

The chromosomes at mitotic metaphase varied in length from 2.76 to 1.00 μm (Table 7). In the chromosome complement, the two longest chromosomes (Nos. 1 and 2) were distinguished and the other 52 chromosomes showed a gradual decrease in length. Among the complement of the 54 chromosomes, 29 chromosomes had their centromeres at the median regions, 23 chromosomes (Nos. 3, 4, 8, 11, 12, 19-22, 24-26, 31-35, 37-40, 53 and 54) had their centromeres at the submedian regions and the longest two chromosomes (Nos.1 and 2) had their centromeres at the subterminal regions.

Thus, this species showed a bimodal and symmetric karyotype.

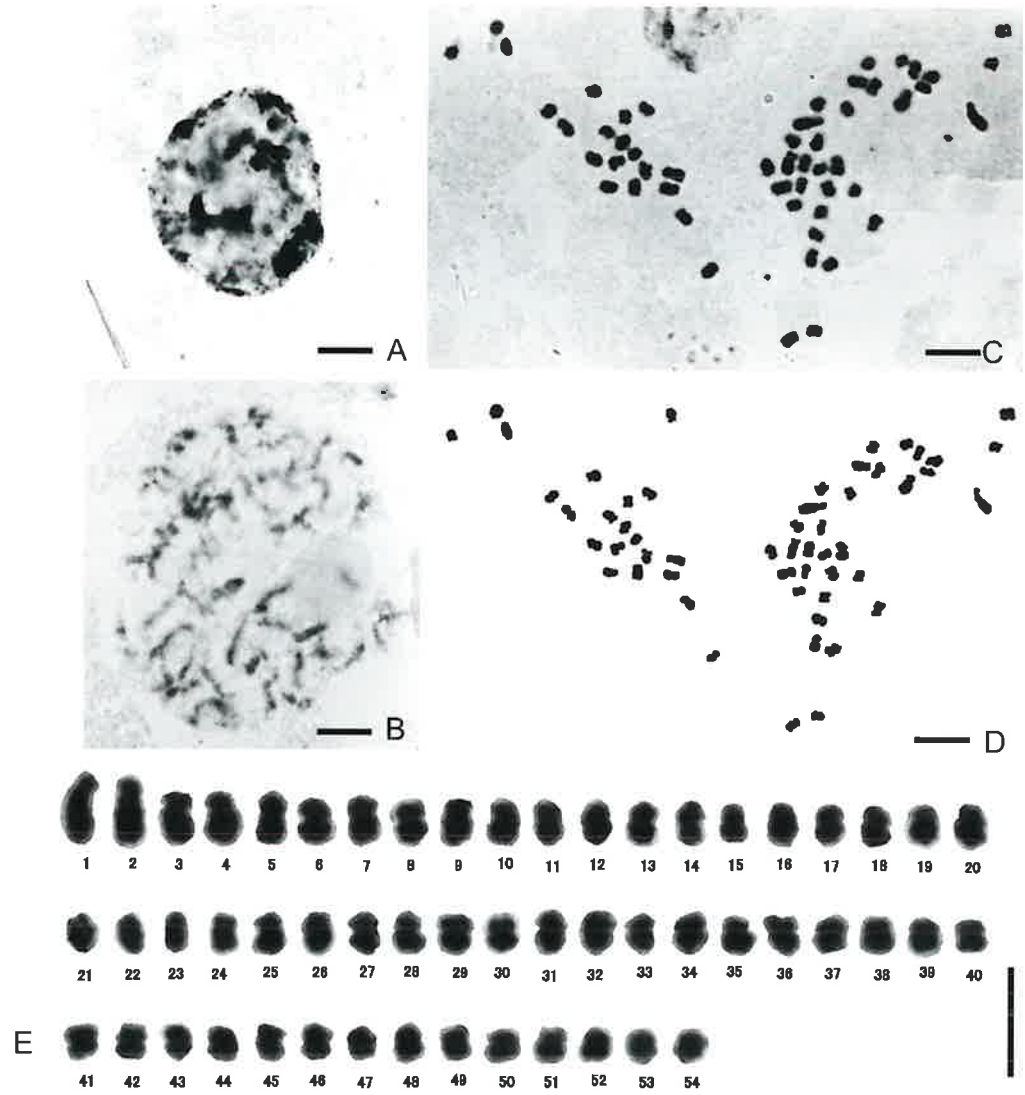

Fig. 6. *Mormodes sinuata* Rchb.f. & Warm., HBG3168, 2n=54.

A: resting stage, B: mitotic prophase, C and E: mitotic metaphase, D: drawing of mitotic metaphase. Bars indicate 5μm.

Discussions

In this study, the chromosome numbers of *Catasetum tenebrosum* (2n=54) and *Mormodes sinuata* (2n=54) were new reports. Those of the other four species supported previous counts.

All four species of genus *Catasetum* showed similar karyotypes of the complex chromocenter type at resting stage and the interstitial type at mitotic prophase. They were consistent each other on their chromosome number of 2n=54 and the gradual and symmetric karyotypes at mitotic metaphase. Eight chromosomes of *C. integerrimum* and four chromosomes of *C. viridiflavum* did not show their centromeres, it was speculated that it was caused by the unclear pictures of the small chromosomes.

The chromosome numbers of 2n=54, 56, ca.108 and ca.162 were counted from 18 species of *Catasetum* (Blumenschein 1960, Jones and Daker1967, Félix and Guerra 2000). Jones and Daker (1967), and Félix and Guerra (2000) mentioned that Catasetum showed basic chromosome number of x=27, and the results of this study supported it.

Mormodes sinuata showed similar characters of the chromosomes with *Catasetum* species in this study, i.e. the complex chromocenter type at resting stage, the interstitial type at mitotic prophase, the symmetric karyotype at mitotic metaphase and the chromosome number of 2n=54. The chromosome number of 2n=54 were previously counted from three species of *Mormodes* (Jones and Daker 1967, Nakata and Hashimoto 1990). Jones and Daker (1967), and Félix and Guerra (2000) noticed that *Mormodes* showed the basic chromosome number of x=27 and the results of this study supported it. Besides, *Mormodes* showed a bimodal karyotype at mitotic metaphase though *Catasetum* showed a gradual karyotype. It would be one of the points to distinguish between two genera.

Cycnoches ventricosum showed different features from other five species of two genera in this study. The chromocenters of *Cycnoches* at resting nuclei were relatively observed more clear and larger than those of *Catasetum* and *Mormodes*. The chromosome number of 2n=68 was different from other five species. The average of arm ratios of this species was higher than those of other five species. The chromosome numbers of 2n=64 and 68 were previously counted in four species of *Cycnoches* (Jones and Daker1967). Jones and Daker suggested that the basic chromosome number of *Cycnoches* was x=32 or 34 and there were karyomorphologically distinctions between *Cycnoches* and *Catasetum*. Present report did not show contradictory results for the previous reports.

In the recent molecular studies, it was advocated that subtribe Catasetinae took in more three genera of *Cyrtopodium*, *Galeandra* and *Grobya* (Chase 2012). Many species still remain to be cytological studies in subtribe Catasetinae. It is necessary to research on the species of subtribe Catasetinae including new genera not only by molecular studies but also cytotaxonomical studies.

Acknowledgement

We thank to Mr. Daizo Araki for reading the manuscripts and giving us advices.

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カタセタム亜族（ラン科）６種の核形態学的研究

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要　約

広島市植物公園で栽培しているラン科カタセタム亜族に含まれる３属（*Catasetum*, *Cycnoches*, *Mormodes*）の６種について核形態学的観察を行った.

調査した６種全てにおいて，静止期核は複雑染色中央粒型，体細胞分裂前期の核型は介在型として観察された.

Catasetum tenebrosum と *Mormodes sinuata* の染色体数 2n=54 は初の報告だった. *Catasetum cernuum*, *C. integerrinum*, *C. viridiflavum* の 2n=54, *Cycnoches ventricosum* の 2n=68 は過去の報告を裏付けるものであった. 染色体数 2n=54 を示した５種は染色体基本数 x=27，2n=68 の１種は染色体基本数 x=34 と示唆された.

調査した全６種において，体細胞分裂中期の核型は動原体の位置に基づく表現は対称的とされた. また，染色体長に基づく表現では *Catasetum* の４種と *Cycnoches ventricosum* は漸減的，*Mormodes sinuata* は二相的とすることができた.

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２）広島大学技術センター附属植物園

Table 2. Measurements of somatic chromosomes at mitotic metaphase in *Catasetum cernuum*, 2n=54

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	1.08+1.15=2.23	3.3	1.06	m
2	1.01+1.07=2.08	3.1	1.06	m
3	0.91+1.02=1.93	2.8	1.12	m
4	0.91+1.02=1.93	2.8	1.12	m
5	0.66+1.07=1.67	2.6	1.62	m
6	0.60+1.07=1.67	2.5	1.78	sm
7	0.68+0.98=1.66	2.4	1.44	m
8	0.56+0.95=1.51	2.2	1.65	m
9	0.57+0.93=1.50	2.2	1.63	m
10	0.42+1.05=1.47	2.2	2.50	sm
11	0.47+1.01=1.48	2.2	2.15	sm
12	0.55+0.91=1.46	2.2	1.65	m
13	0.57+0.86=1.43	2.1	1.51	m
14	0.57+0.86=1.43	2.1	1.51	m
15	0.64+0.77=1.41	2.1	1.20	m
16	0.57+0.82=1.39	2.0	1.44	m
17	0.52+0.85=1.37	2.0	1.63	m
18	0.47+0.77=1.24	1.8	1.64	m
19	0.56+0.74=1.30	1.9	1.32	m
20	0.52+0.68=1.20	1.8	1.31	m
21	0.51+0.78=1.29	1.9	1.53	m
22	0.53+0.68=1.21	1.8	1.28	m
23	0.45+0.78=1.23	1.8	1.73	sm
24	0.45+0.77=1.22	1.8	1.71	sm
25	0.48+0.74=1.22	1.8	1.54	m
26	0.43+0.72=1.15	1.7	1.67	m
27	0.49+0.72=1.21	1.8	1.47	m
28	0.46+0.67=1.13	1.7	1.46	m
29	0.54+0.66=1.20	1.8	1.22	m
30	0.51+0.66=1.17	1.7	1.29	m
31	0.45+0.73=1.18	1.7	1.62	m
32	0.45+0.72=1.17	1.7	1.60	m
33	0.42+0.68=1.10	1.6	1.62	m
34	0.40+0.64=1.04	1.5	1.60	m
35	0.46+0.64=1.10	1.6	1.39	m
36	0.44+0.58=1.02	1.5	1.32	m
37	0.48+0.60=1.08	1.6	1.25	m
38	0.46+0.59=1.05	1.5	1.28	m
39	0.43+0.64=1.07	1.6	1.49	m
40	0.43+0.59=1.02	1.5	1.37	m
41	0.46+0.58=1.04	1.5	1.26	m
42	0.42+0.52=0.94	1.4	1.24	m
43	0.42+0.62=1.04	1.5	1.48	m
44	0.45+0.58=1.03	1.5	1.29	m
45	0.46+0.57=1.03	1.5	1.24	m
46	0.46+0.54=1.00	1.5	1.17	m
47	0.41+0.59=1.00	1.5	1.44	m
48	0.40+0.57=0.97	1.4	1.43	m
49	0.40+0.60=1.00	1.5	1.50	m
50	0.45+0.48=0.93	1.4	1.07	m
51	0.40+0.57=0.97	1.4	1.43	m
52	0.36+0.53=0.89	1.3	1.47	m
53	0.37+0.49=0.86	1.3	1.32	m
54	0.36+0.49=0.85	1.3	1.36	m

m: The centromere observed at the median region.
sm: The centromere observed at the submedian region.

Table 3. Measurements of somatic chromosomes at mitotic metaphase in *Catasetum integerrimum*, 2n=54

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	1.25 + 1.54=2.79	3.3	1.23	m
2	1.16+1.33=2.49	3.0	1.15	m
3	1.03+1.41=2.44	2.9	1.37	m
4	0.90+1.31=2.21	2.6	1.46	m
5	0.70+1.46=2.16	2.6	2.07	sm
6	0.67+1.42=2.09	2.5	2.12	sm
7	0.83+1.31=2.14	2.6	1.58	m
8	0.82+1.23=2.05	2.5	1.50	m
9	*0.57+0.80+0.46=1.83	2.2	1.29	m
10	*0.56+0.47+0.77=1.80	2.2	2.84	sm
11	0.63+1.18=1.81	2.2	1.87	sm
12	0.65+1.12=1.77	2.1	1.72	sm
13	0.79+1.00=1.79	2.1	1.27	m
14	0.74+1.03=1.77	2.1	1.39	m
15	0.67+1.08=1.75	2.1	1.61	m
16	0.57+0.91=1.48	1.8	1.60	m
17	0.59+1.16=1.75	2.1	1.97	sm
18	0.55+1.07=1.62	1.9	1.95	sm
19	0.53+1.11=1.64	2.0	2.09	sm
20	0.54+1.05=1.59	1.9	1.94	sm
21	0.40+1.22=1.62	1.9	3.05	st
22	0.46+1.02=1.48	1.8	2.22	sm
23	0.45+1.16=1.61	1.9	2.58	sm
24	0.50+1.06=1.56	1.9	2.12	sm
25	0.71+0.90=1.61	1.9	1.27	m
26	0.71+0.88=1.59	1.9	1.24	m
27	0.70+0.85=1.55	1.9	1.21	m
28	0.61+0.91=1.52	1.8	1.49	m
29	0.51+1.03=1.54	1.8	2.02	sm
30	0.44+0.91=1.35	1.6	2.07	sm
31	0.59+0.87=1.46	1.7	1.47	m
32	0.51+0.86=1.37	1.6	1.69	m
33	0.46+0.99=1.45	1.7	2.15	sm
34	0.43+0.98=1.41	1.7	2.28	sm
35	0.46+0.95=1.41	1.7	2.07	sm
36	0.50+0.87=1.37	1.6	1.74	sm
37	0.55+0.84=1.39	1.7	1.53	m
38	0.50+0.77=1.27	1.5	1.54	m
39	0.58+0.79=1.37	1.6	1.36	m
40	0.56+0.77=1.33	1.6	1.38	m
41	0.47+0.85=1.32	1.6	1.81	sm
42	0.39+0.76=1.15	1.4	1.95	sm
43	0.46+0.80=1.26	1.5	1.74	sm
44	0.46+0.76=1.22	1.5	1.65	m
45	0.47+0.77=1.24	1.5	1.64	m
**46	1.20	1.4		
47	0.56+0.58=1.14	1.4	1.04	M
**48	1.10	1.3		
**49	1.05	1.3		
**50	0.96	1.1		
**51	0.96	1.1		
**52	0.96	1.1		
**53	0.96	1.1		
**54	0.87	1.0		

*: Chromosome with secondary constriction

**: The centromere was not observed.

M: The centromere observed at the median point.

st: The centromere observed at the subterminal region.

See Table 2 for explanation of the other symbols.

Table 4. Measurements of somatic chromosomes at mitotic metaphase in *Catasetum tenebrosum*, 2n=54

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	1.54+1.70=3.24	2.9	1.10	m
2	1.22+1.82=3.04	2.8	1.05	m
3	1.22+1.82=3.04	2.8	1.49	m
4	1.13+1.57=2.70	2.4	1.39	m
5	0.88+1.91=2.79	2.5	2.17	sm
6	1.11+1.60=2.71	2.5	1.44	m
7	0.92+1.76=2.68	2.4	1.91	sm
8	0.75+1.54=2.29	2.1	2.05	sm
9	0.69+1.88=2.57	2.3	2.72	sm
10	0.68+1.72=2.40	2.2	2.53	sm
11	1.00+1.48=2.48	2.2	1.48	m
12	0.92+1.54=2.46	2.2	1.67	m
13	0.63+1.78=2.41	2.2	2.83	sm
14	0.58+1.77=2.35	2.1	3.05	st
15	0.57+1.81=2.38	2.2	3.18	st
16	0.52+1.59=2.11	1.9	3.06	st
17	1.00+1.36=2.36	2.1	1.36	m
18	0.95+1.08=2.03	1.8	1.14	m
19	0.78+1.52=2.30	2.1	1.95	sm
20	0.77+1.45=2.22	2.0	1.88	sm
21	0.93+1.36=2.29	2.1	1.46	m
22	0.94+1.15=2.09	1.9	1.22	m
23	0.60+1.60=2.20	2.0	2.67	sm
24	0.74+1.42=2.16	2.0	1.92	sm
25	0.71+1.42=2.13	1.9	2.00	sm
26	0.76+1.34=2.10	1.9	1.76	sm
27	0.90+1.16=2.06	1.9	1.29	m
28	0.84+1.14=1.98	1.8	1.36	m
29	0.75+1.28=2.03	1.8	1.71	sm
30	0.70+1.24=1.94	1.8	1.77	sm
31	0.76+1.23=1.99	1.8	1.62	m
32	0.70+1.12=1.82	1.6	1.60	m
33	0.78+1.06=1.84	1.7	1.36	m
34	0.83+1.01=1.84	1.7	1.22	m
35	0.68+1.14=1.82	1.6	1.68	m
36	0.59+1.00=1.59	1.4	1.69	m
37	0.53+1.28=1.81	1.6	2.42	sm
38	0.50+1.22=1.72	1.6	2.44	sm
39	0.68+1.10=1.78	1.6	1.62	m
40	0.61+1.03=1.64	1.5	1.69	m
41	0.63+1.14=1.77	1.6	1.81	sm
42	0.54+1.02=1.56	1.4	1.89	sm
43	0.70+1.05=1.75	1.6	1.50	m
44	0.66+1.01=1.67	1.5	1.53	m
45	0.57+1.05=1.62	1.5	1.84	sm
46	0.54+1.05=1.59	1.4	1.94	sm
47	0.52+1.06=1.58	1.4	2.04	sm
48	0.54+0.99=1.53	1.4	1.83	sm
49	0.55+0.93=1.48	1.3	1.69	m
50	0.58+0.88=1.46	1.3	1.52	m
51	0.52+0.85=1.37	1.2	1.63	m
52	0.50+0.84=1.34	1.2	1.68	m
53	0.54+0.64=1.18	1.1	1.19	m
54	0.38+0.77=1.15	1.0	2.03	sm

See Table 3 for explanation of symbols.

Table 5. Measurements of somatic chromosomes at mitotic metaphase in *Catasetum viridiflavum*, 2n=54

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	1.15+1.41=2.56	3.2	1.23	m
2	0.96+1.48=2.44	3.0	1.54	m
3	1.06+1.34=2.40	3.0	1.26	m
4	0.98+1.26=2.24	2.8	1.29	m
5	0.74+1.40=2.14	2.6	1.89	sm
6	0.52+1.37=1.89	2.3	2.63	sm
7	0.93+1.09=2.02	2.5	1.17	m
8	0.82+1.10=1.92	2.4	1.34	m
9	0.81+1.10=1.91	2.4	1.36	m
10	0.65+1.18=1.83	2.3	1.82	sm
11	0.70+1.10=1.80	2.2	1.57	m
12	0.71+1.06=1.77	2.2	1.49	m
13	0.81+0.94=1.75	2.2	1.16	m
14	0.81+0.94=1.75	2.2	1.16	m
15	0.73+0.97=1.70	2.1	1.32	m
16	0.68+0.90=1.58	2.0	1.32	m
17	0.75+0.97=1.72	2.1	1.29	m
18	0.78+0.87=1.65	2.0	1.12	m
19	0.58+1.09=1.67	2.1	1.88	sm
20	0.58+1.06=1.64	2.0	1.83	sm
21	0.49+1.13=1.63	2.0	2.30	sm
22	0.41+0.97=1.38	1.7	2.34	sm
23	0.73+0.82=1.55	1.9	1.11	m
24	0.71+0.81=1.52	1.9	1.14	m
25	0.54+0.90=1.44	1.8	1.66	m
26	0.57+0.84=1.41	1.7	1.46	m
27	0.65+0.78=1.43	1.8	1.21	m
28	0.61+0.69=1.30	1.6	1.14	m
29	0.60+0.81=1.41	1.7	1.35	m
30	0.59+0.81=1.39	1.7	1.37	m
31	0.48+0.83=1.31	1.6	1.74	sm
32	0.45+0.83=1.28	1.6	1.83	sm
33	0.53+0.76=1.29	1.6	1.42	m
34	0.53+0.74=1.27	1.6	1.40	m
35	0.39+0.89=1.28	1.6	2.26	sm
36	0.43+0.82=1.25	1.5	1.91	sm
37	0.44+0.81=1.25	1.5	1.84	sm
38	0.40+0.81=1.21	1.5	2.00	sm
39	0.40+0.84=1.25	1.5	2.09	sm
40	0.41+0.84=1.25	1.5	2.07	sm
41	0.53+0.72=1.25	1.5	1.37	m
42	0.53+0.73=1.25	1.5	1.37	m
43	0.36+0.87=1.23	1.5	2.42	sm
44	0.37+0.63=1.00	1.2	1.70	sm
45	0.58+0.63=1.21	1.5	1.08	m
46	0.53+0.62=1.15	1.4	1.16	m
47	0.48+0.71=1.19	1.5	1.49	m
48	0.49+0.68=1.17	1.4	1.39	m
**49	1.08	1.3		
**50	0.99	1.2		
51	0.29+0.70=0.99	1.2	2.42	sm
52	0.32+0.65=0.97	1.2	1.99	sm
**53	0.96	1.2		
**54	0.85	1.1		

See Table 3 for explanation of symbols.

Table 6. Measurements of somatic chromosomes at mitotic metaphase in *Cycnoches ventricosum*, 2n=68

Chromosome	Length (μm)	Relative length	Arm rati	Form
1	0.63+2.02=2.65	3.0	3.23	st
2	0.55+1.55=2.10	2.4	2.80	sm
3	0.80+1.20=2.00	2.3	1.49	m
4	0.82+1.01=1.83	2.1	1.23	m
5	0.46+1.41=1.87	2.1	3.09	st
6	0.54+1.30=1.84	2.1	2.40	sm
7	0.56+1.27=1.83	2.1	2.26	sm
8	0.57+1.16=1.73	2.0	2.03	sm
9	0.59+1.13=1.72	2.0	1.92	sm
10	0.44+1.15=1.59	1.8	2.60	sm
11	0.44+1.17=1.61	1.8	2.66	sm
12	0.46+1.12=1.58	1.8	2.42	sm
13	.041+1.15=1.56	1.8	2.82	sm
14	0.36+1.08=1.44	1.6	3.01	st
15	0.46+1.07=1.54	1.7	2.31	sm
16	0.41+1.05=1.46	1.7	2.56	sm
17	0.55+0.97=1.52	1.7	1.78	sm
18	0.44+1.00=1.60	1.6	2.26	sm
19	0.50+0.92=1.43	1.6	1.83	sm
20	0.52+0.89=1.41	1.6	1.73	sm
21	0.43+0.98=1.41	1.6	2.25	sm
22	0.39+0.99=1.38	1.6	2.54	sm
23	0.39+0.97=1.36	1.5	2.51	sm
24	0.40+0.93=1.34	1.5	2.31	sm
25	0.49+0.86=1.35	1.5	1.74	sm
26	0.49+0.85=1.34	1.5	1.75	sm
27	0.40+0.89=1.30	1.5	2.21	sm
28	0.35+0.87=1.22	1.4	2.48	sm
29	0.35+0.94=1.29	1.5	2.73	sm
30	0.36+0.92=1.28	1.5	2.58	sm
31	0.41+0.86=1.27	1.4	2.10	sm
32	0.42+0.85=1.27	1.4	2.01	sm
33	0.45+0.78=1.23	1.4	1.75	sm
34	0.44+0.77=1.21	1.4	1.75	sm
35	0.38+0.85=1.23	1.4	2.25	sm
36	0.30+0.84=1.15	1.3	2.78	sm
37	0.54+0.65=1.19	1.4	1.21	m
38	0.49+0.62=1.11	1.3	1.28	m
**39	1.18	1.3		
40	0.40+0.76=1.16	1.3	1.91	sm
41	0.48+0.69=1.17	1.3	1.45	m
42	0.45+0.71=1.16	1.3	1.59	m
43	0.39+0.77=1.16	1.3	1.95	sm
44	0.39+0.76=1.15	1.3	1.93	sm
**45	1.16	1.3		
46	0.36+0.79=1.15	1.3	2.20	sm
47	0.42+0.69=1.11	1.3	1.66	m
48	0.42+0.65=1.06	1.2	1.55	m
**49	1.10	1.3		
**50	1.06	1.2		
51	0.36+0.70=1.06	1.2	1.97	sm
52	0.36+0.70=1.06	1.2	1.97	sm
**53	1.04	1.2		
54	0.39+0.65=1.04	1.2	1.65	m
55	0.27+0.76=1.03	1.2	2.77	sm
**56	1.05	1.2		
57	0.38+0.60=0.98	1.1	1.59	m
58	0.36+0.60=0.96	1.1	1.65	m
**59	0.98	1.1		
**60	0.94	1.1		
61	0.32+0.65=0.97	1.1	2.01	sm
62	0.34+0.62=0.96	1.1	1.84	sm
**63	0.94	1.1		
**64	0.93	1.1		
**65	0.92	1.0		
**66	0.82	0.9		
**67	0.80	0.9		
**68	0.74	0.8		

See Table 3 for explanation of symbols.

Table 7. Measurements of somatic chromosomes at mitotic metaphase in *Mormodes sinuata*, 2n=54

Chromosome	Length (μm)	Relative length	Arm ratio	Form
1	0.64+2.12=2.76	3.4	3.31	st
2	0.59+2.11=2.70	3.3	3.55	st
3	0.65+1.49=2.14	2.6	2.31	sm
4	0.58+1.41=1.99	2.5	2.43	sm
5	0.82+1.26=2.09	2.6	1.53	m
6	0.77+1.13=1.90	2.3	1.47	m
7	0.72+1.17=1.89	2.3	1.61	m
8	0.61+1.04=1.65	2.0	1.71	sm
9	0.72+1.16=1.87	2.3	1.61	m
10	0.63+0.98=1.61	2.0	1.56	m
11	0.57+1.09=1.66	2.0	1.92	sm
12	0.60+1.03=1.63	2.0	1.70	sm
13	0.73+0.88=1.60	2.0	1.21	m
14	0.70+0.89=1.59	2.0	1.26	m
15	0.74+0.84=1.58	1.9	1.14	m
16	0.64+0.89=1.53	1.9	1.39	m
17	0.60+0.97=1.57	1.9	1.60	m
18	0.58+0.93=1.51	1.9	1.59	m
19	0.48+1.09=1.57	1.9	2.26	sm
20	0.48+1.01=1.49	1.8	2.11	sm
21	0.55+1.01=1.56	1.9	1.82	sm
22	0.55+0.96=1.51	1.9	1.73	sm
23	0.59+0.95=1.54	1.9	1.62	m
24	0.56+0.95=1.52	1.9	1.70	sm
25	0.56+0.96=1.52	1.9	1.70	sm
26	0.53+0.95=1.48	1.8	1.78	sm
27	0.62+0.90=1.52	1.9	1.45	m
28	0.57+0.83=1.40	1.7	1.44	m
29	0.57+0.92=1.49	1.8	1.61	m
30	0.58+0.89=1.47	1.8	1.55	m
31	0.54+0.94=1.48	1.8	1.74	sm
32	0.53+0.93=1.46	1.8	1.76	sm
33	0.46+0.97=1.43	1.8	2.09	sm
34	0.51+0.86=1.37	1.7	1.70	sm
35	0.51+0.90=1.41	1.7	1.76	sm
36	0.52+0.84=1.36	1.7	1.62	m
37	0.49+0.85=1.34	1.6	1.74	sm
38	0.46+0.80=1.26	1.6	1.75	sm
39	0.37+0.90=1.27	1.6	2.42	sm
40	0.39+0.74=1.13	1.4	1.89	sm
41	0.56+0.68=1.24	1.5	1.21	m
42	0.54+0.68=1.22	1.5	1.25	m
43	0.54+0.70=1.24	1.5	1.30	m
44	0.47+0.73=1.21	1.5	1.56	m
45	0.48+0.75=1.23	1.5	1.58	m
46	0.48+0.74=1.23	1.5	1.54	m
47	0.47+0.72=1.19	1.5	1.55	m
48	0.45+0.73=1.18	1.5	1.64	m
49	0.52+0.64=1.16	1.4	1.24	m
50	0.54+0.61=1.15	1.4	1.13	m
51	0.45+0.71=1.15	1.4	1.58	m
52	0.43+0.70=1.13	1.4	1.64	m
53	0.33+0.73=1.05	1.3	2.21	sm
54	0.28+0.72=1.00	1.2	2.57	sm

See Table 2 for explanation of symbols.