PRELIMINARY CHROMOSOME STUDIES ON THE VASCULAR PLANTS OF TAIWAN (V). CYTOTAXONOMY ON SOME MONOCOTYLEDONS[2]

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Abstract: Chromosome counts of 64 taxa belonging to 47 genera and 12 families are reported in this study. The tribe Ophiopogoneae of the lily family, Liliaceae, and the genus *Dendrobium* of the orchid family, Orchidaceae, have been studied intensively using living materials cultivated in Taipei. Some effort has been made to make a cyto-taxonomical study of the plants from Lanhsü Island (Botel Tobago) where the flora is not yet completely known. A total of 21 taxa have been investigated. A brief synopsis for the tribe Ophiopogoneae of the lily family is proposed for Taiwan species, and a new basic number of X=9 is suggested. In the genus *Dendrobium*, it seems there are three groups of plants that can be recognized based on the characters of the pseudobulbs and the leaves, and on their different basic chromosome numbers, i.e. X=10, X=19, and X=15. Of the chromosome studies made, 29 taxa are reported here for the first time. Most of these are of the endemic members of the orchid family.

INTRODUCTION

This is an extension of our studies on the Monocotyledons of Taiwan from a systematic point of view.[3] During the past two years, extensive collections have been made on liliaceous and orchidaceous species. They were collected from different localities and then brought back to Taipei and either cultivated in our experimental gardens or in a shade house. An attempt has been made to make a general survey of the genus *Dendrobium* (Orchidaceae), and of some of the liliaceous plants, especially, *Liriope*, and *Ophiopogon*. In addition, as many as possible of other monocots have been gathered so as to make a comparative study on these rather difficult taxa.

Due to the extremely similar appearence between the genus *Liriope* and *Ophiopogon*, a lot of our herbarium sheets were very much confused in their determination. These plants are widely distributed in temperate and subtropical regions where they grow as an undergrowth in moist woods, or in the littoral grasslands. The vegetative parts of these plants look so much like that even an expert in the regional flora feels reluctant to name them. We have found three species of *Liriope* in Taiwan, namely: *L. angustissima*, *L. platyphylla* and *L. spicata*. *Liriope minor* has also been recorded, but the author has failed to find a single specimen of it either in the field or herbaria. A new record of a species of *Ophiopogon*, *O. jaburan*, has been found in the course of this study. This plant grows at Lanhsü (Botel Tobago)

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(2) This study is supported in part by a grant sponsored by the Biological Center of Academia Sinica.

(3) Preliminary chromosome Studies on the Vascular Plants of Taiwan (IV). Counts and Systematic notes on some Monocotyledons. Taiwania **16**: 123-136 (1971).

only. The other species of *Ophiopogon* are: *O. formosanum, O. japonicum, O. planiscapus* and *O. scaber*. These two genera are included in a tribe, Ophiopogoneae, or by some in an independent family, Ophiopogonaceae. The *Liriope* species have their pollen sacs elliptical, rounded at the apex, with filaments of nearly equal length to the anthers, while in the *Ophiopogon* species, the anthers are acuminate at the apex, and have elongate deltoid pollen sacs with very short filaments.

No previous cytological studies have been made on the Taiwan species of the tribe Ophiopogoneae. The present study is based on critically examined samples, therefore, a thorough investigation on the cytotaxonomy of this group of plants, combined with systematic data of these cytological observations is given here.

More than two-thirds of the *Dendrobium* species studied cytologically in this paper are native taxa. An attempt has been made to investigate the cytology of the orchid family, however, this is only a part of that study. A limited number of taxa have been identified but most of the collections are waiting until they bloom before critical studies can be made. The basic number of the genus *Dendrobium* has been considered to be X=10, and X=19. Many of the chromosome counts on the orchid family appear here for the first time.

MATERIALS AND METHODS

All plants studied in this study, were collected from their native habitats. In the case of the genera *Liriope, Ophiopogon*, and other herbaceous monocots, the floral buds were usually fixed in the field, and the root tips were fixed from plants which had been transplanted to claypots and kept in our shade house. In the genus *Dendrobium* and other epiphytic species of the orchidaceous plants, the root tips were pretreated in a 0.002 mol 8-hydro-oxyquinolin aqueous solution for 4 hours at around 20°C. A list of the collections are shown in Table 2. A complete set of the voucher specimens are preserved in the Herbarium of the National Taiwan University (TAI) and some of the living materials are being cultivated in the experimental gardens of the Department of Botany, NTU.

The standard 3:1 alcohol-glacial acetic acid fixative was applied both for floral buds and root-tips. The materials were then subsequently transferred into 70% alcohol and stored in a 5°C refrigerator until time permitted their cytological investigations. 1N hydrochloric acid was used to decompose the middle lamella and the aceto-carmine or aceto-orcein (2%) squash techniques were universally applied for preparing slides.

RESULTS AND DISCUSSIONS

Table 1 is a brief summary of the results of the present cytological study of the Taiwan monocots. The systematic notes together with the cytological informations are discussed for each taxon. The families are arranged according to the Hutchinson system (1959). Following the family name is the Hutchinson's family number, and the number in parenthesis is the family number proposed by Dalla Torre & Harms (1908), with additions from Engler & Diels, ed. 11, (1936) this is also followed in the Cave's Index (1958–1965) and the Ornduff's Index (1967, 1968). The genera and species are arranged alphabetically after the families. An asterisk(*) indicates the first time a count has been reported as far as is known.

Table 1. Chromosome Counts in Some Taiwan Monocots

Fig.	Taxon	Voucher	*n*	2*n*	Locality	Previous counts & authority
	ALISMATACEAE 345(16)					
	Sagittaria X=11(10)					
1	trifolia Linn.	4569	11		Taipei	2*n*=22, Morinaga & F. ('31). *n*=11, 2*n*=22, Hsu ('67).
	COMMELINACEAE 358(34)					
	Commelina X=11, ?12, ?15					
2	auriculata Blume	3415		22	Tawu	*
	auriculata Blume	C253	11		Tawu (cult. Taipei)	
3	communis Linn.	3481		22	Wulai	2*n*=48. 90, Mitsukuri ('47). *n*=23, 44; 2*n*=46. 88, Fukumoto ('65)
4	communis Linn.	4956		44	Lanhsü	2*n*=c. 84, Smith ('64). *n*=11, Hsu ('67). *n*=10 Hsu ('67).
	communis Linn.	9915		44	Lanhsü	
	Forrestia X=10					
	chinensis Br.	4848		20	Lanhsü	
	Pollia X=5, 19					
5	sorzogonensis H. Mey.	4044	10		Chihpen	*
	FLAGELLARIACEAE 360(26)					
	Flagellaria X=?					
	indica Linn.	4978		38	Lanhsü	*n*=19, Chuang *et al.* ('62); Shetly & Sub. ('64). 2*n*=38, Briggs ('66).
	MUSACEAE 366(46)					
	Musa X=10, 11					
6	formosana Hay.	6432		20	Tatfing-shan	*
	ZINGIBERACEAE 369(47)					
	Alpinia X=12					
7	intermedia Gagnep.	4989		28	Lanhsü	*n*=12, Hsu ('67)
	LILIACEAE 372(39)					
	Aletris X=13					
8	spicata Fr.	4460	13		Chihsing-shan	*
	Dianella X=8					
9	nemorosa Lam.	4996	16		Lanhsü	2*n*=16, 64, 76, 80, 84, Curtis ('52). *n*=16, Sato ('42); Chuang *et al.* ('62); Hsu ('67) as D. ensifolia.
	Disporum X=6, 8, 9, 11					
10	kawakamii Hay.	4467		16	Chihsing-shan	*n*=8, Chuang *et al.* ('62) 2*n*=16, Chao *et al.* ('63)

Table 1. (Continued)

Fig.	Taxon	Voucher	n	$2n$	Locality	Previous counts & authority
	Liriope X=18					
11	angustissima Ohwi	3880		36	Chinshan	*
	angustissima Ohwi	C245	18		Yehliu (cult. Taipei)	
	Ophiopogon X=18					
12	formosana Ohwi	C216		18	Chihpen	*
13	jaburan (Kunth) Lodd.	4864		18	Lanhsü	$2n$=36, Matsura & Suto ('35); Sato ('43); Hasegawa ('68). n=18, $2n$=72, Sato ('43). $2n$=36, 72, Oinuma ('44, '46, '49). $2n$=36, Hasegawa ('68).
	planiscapus Nakai	C016		18	Kueihu	
	planiscapus Nakai	C158		18	Chiti	
	planiscapus Nakai	C197		18	Lanshan	
	planiscapus Nakai	C206		18	Chushuipo	
	planiscapus Nakai	C217		18	Chihpen	
	planiscapus Nakai	C218		18	Chihpen	
	planiscapus Nakai	C219		18	Chihpen	
	planiscapus Nakai	C220		18	Chihpen	
	planiscapus Nakai	C221		18	Chihpen	
	planiscapus Nakai	C222		18	Chihpen	
14	planiscapus Nakai	C223		18	Chihpen	
	planiscapus Nakai	C224		18	Chihpen	
15	planiscapus Nakai	C309	9		Chushuipo	
16	scaber Ohwi	C306		36	Yushan-chien-shan	*
	Tricyrtis X=13					
17	formosana Bak.	3273	26		Kueihu	$2n$=25, 26, Sato ('39).
	ARACEAE 381(24)					
	Acorus X=9, 11, 12					
	gramineus Soland	5220	12		Nankang	$2n$=24, Löve & L. ('57)
	Alocasis X=14(?13)					
18	macrorrhiza(L.) Schott.	4843		28	Lanhsü	n=28, Pfitzer ('57).
	Colocasia X=12, 14					
19	esculentum Schott.	4991		28	Lanhsü	$2n$=28, Asana & S. ('39).
	TYPHACEAE 384(9)					
	Typha X=15					
20	orientalis Presl	4927		30	Lanhsü	*
	PALMAE 393(22)					
	Arenga X=16					

Table 1. (Continued)

Fig.	Taxon	Voucher	*n*	2*n*	Locality	Previous counts & authority
21	engleri Beccari	4163		32	Lanhsü	*
	CYPERACEAE 410(21)					
22	Cyperus X=7, 8					
	sp.	4042		16	Chihpen	
	Fimbrystylis X=5, 6, 8, 11					
	dichotoma (L.) Vahl	3866		12	Paishawan	2*n*=10, Sharma & Bal ('56). 2*n*=12, Hsu ('67).
	ORCHIDACEAE 405(51)					
	Bletilla X=16, 18					
23	formosana (Hay.) Schltr.	3557		16	Lanshan	*
	Calanthe X=20					
24	longicalcarata Hay.	6101		20	Chitou	*
25	yushuni Mori et Yam.	6411		20	Tatung-shan	*
	sp.	3350		20	Kueihu	*
	Dendrobium X=10, 19					
26	fimbriatolabellum Hay.	9912		18	Chinshui-ying	*
27	flaviflorum Hay.	9917		38	Tawushan	*
28	heishanaense Hay.	9913		38	Alishan	*
29	kwashotense Hay.	9916		38	Lutao	*
30	longicaratum Hay.	6919		38	Chinshui-ying	*
31	miyakei Schltr.	9918		38	Lanhsü	*
32	moniliforme Sw.	6511		38	Chitou	*
33	nakaharai Schltr.	9920		30	Chinshui-ying	*
34	ventricosum Kränzl.	9921		20	Lanhsü	*
	Dendrochilum X=?					
35	formosanum Masamune	9909		30	Lanhsü	*
	Diploprora X=?					
36	uraiense Hay.	9907		16	Chihtan-shan	*
	Gastrochilus X=?					
37	somai Hay.	9908		30	Liukuei	*
	Gastrodia X=12					
38	elata Blume	3286	12		Kueihu	*
	Habenaria X=(7), 14, 21					
39	longitentaculata Hay.	6423		42	Tatung-shan	*
	Liparis X=15 16, 21					
40	keitaoensis Hay.	9914		30	Chitou	*

Table 1. (Continued)

Fig.	Taxon	Voucher	n	$2n$	Locality	Previous counts & authority
	Microstylis X=?					
41	latifolia J. J. Smith	3429		26	Chushuipo	*
	Saccolabium X=?					
42	kotoense (Yam.) Yam.	9910		30	Lanhsü	*
	Sarcanthus X=?					
43	micranthus Amus	9911		36	Lanhsü	*
	Spatholottis X=?					
44	plicata Bl.	4977		18	Lanhsü	*
	GRAMINEAE 411(20)					
	Bambusa X=12					
45	oldhamii Munro	4438	12		Hsinhu-atien	*
46	stenostachya Hackel	6420		24	Tatung-shan	*
	Brachiaria X=7, 9					
	subquadripara (Trin.) Hitchc.	4916	36		Lanhsü	n=36, Chen & Hsu ('61), as B. distachya.
	Calamagrostis X=7					
47	arundinacea (L.) Roth.	3792		21	Hohuan-shan	$2n$=42, Tateoka ('54). n=14, $2n$=c. 28, Sorsa ('62).
	Capillipedium X=(5)10					
48	kwashotensis (Hay.) Hsu	4876	20		Lanhsü	*
	Cenchrus X=9, 17					
49	calyculatus Cavan	4186	34		Kenting	n=34, Chen & Hsu ('61); Cavan ('61).
	Chloris X=10					
50	barbata Sw.	4100	20		Kenting	n=20, Chen & Hsu ('61).
	Digitaria X=9, 15, 17					
51	adscendens Henr.	4967	9		Lanhsü	n=27, Ono & Tateoka ('53); Chen & Hsu ('61). $2n$=60, Mulay & Leelamma ('56). n=18, Nath & Swaminalhan ('57). $2n$=24, Gould ('63); Larsen ('63).
	leptalea Ohwi					
52	var. recticulmis Ohwi	4975	18		Lanhsü	n=18, Chen & Hsu ('61).
	microbachne (Presl) Henr.	4910	36		Lanhsü	n=36, Chen & Hsu ('61).
53	violascens Link.	4403	18		Tanshui	n=18, Chen & Hsu ('61).
	Eleusine X=9					
54	indica (L.) Gartn.	4954		18	Lanhsü	n=9, Chen & Hsu ('61). $2n$=18, Avdulov ('31); Sharma & D. ('56); O'Byrne ('59); Sharma &

Table 1. (Continued)

Fig.	Taxon	Voucher	*n*	2*n*	Locality	Previous counts & authority
						Thuri ('59); Gould ('60); Singh & Godward ('60).
	Eriochloa X=9					
55	procera (Retz.) C. E. Hubb.	4107	18		Fengkang	*n*=18, Raman *et al.* ('59); Chen & Hsu ('61).
	Ichnanthus X=10					
56	vicinus (F. M. Bail.) Merr.	3474	20		Huoshao-chang	*n*=20, Chen & Hsu ('61).
	vicinus	6430	10		Tatung-shan	
	Isachne X=10					
57	schmidii Hack.	3436	10		Chusuipo	*
	Leptures X=7					
58	repens (Forst. f.) R. Br.	4933	21		Lanhsü	2*n*=54 ('58).
	Panicum X=7, 9, 10					
59	notatum Retze	4140		18	Kenting	*n*=18, Chen & Hsu ('61), as P. incomtum.
	Paspalum X=10, 12					
60	distichum Linn.	4926	20		Lanhsü	2*n*=60, Parodi ('46). 2*n*=48, Burton ('42). *n*=20, 30, Chen & Hsu ('61).
	Setaria X=9, 19					
61	geniculata (Lamk.) P. Beauv.	4911	36		Lanhsü	2*n*=72, Brown ('48); Gould ('66); Platzer ('62). *n*=18, 36, Gould ('60).
	geniculata	6409	36		Tatung-shan	*n*=36, Chen & Hsu ('61). 2*n*=36, 72, Gould ('65).
	Trisetum X=7, ?12					
62	bifidum (Thunb.) Ohwi	6304	42		Paiyun-shan-chuang	2*n*=28, Moriya & Kondo ('50); Ono & Tateoka ('53).
	spicatum (L.) Richter					
63	var. formosanum (Honda) Ohwi	3834	14		Hohuan-shan	*n*=14, Chen & Hsu ('62). 2*n*=28, Bowden ('60); Sekolovskaya & Strelkova ('60); Mosquin & Hayley ('66), on T. spicata.

Table 2. A List of Collections

Alisan (阿里山)—CHIAYI CO.: 23°32′-120°47′, alt. 2,230 m.
Cultivated in Taipei—9913.

Chihpen (知本)—TAITUNG CO.: 22°42′-121°01′, collected from a secondary forest along a stream.
Oct. 1, 1967—4044.
Cultivated in Taipei—C216, C217, C218, C219, C220, C221, C222, C223, C224.

Chihtanshan (直潭山)—TAIPEI CO.: ca. 24°57′-121°31′, Alt. 700 m, collected from a moist primary forest.
Cultivated in Taipei—9907 (B043E).

Chinshan (金山)—TAIPEI CO.: 25°57′-121°31′, littoral region.
Sept. 10, 1967—3880.

Chihsingshan (七星山)—TAIPEI CO.: 25°10′-121°33′, collected from elevation of about 900 m, in sulphur spring area.
May 11, 1968—4460, 4467.

Chinshuiying (浸水營)—TAITUNG CO.: 22°22′-120°46′, in a primitive forest. Alt. 700 m.
Cultivated in Taipei—9912 (F096E); 9919 (F105E); 9920 (B033E).

Chiti (溪底)—NANTOU CO.: ca. 23°36′-20°38′, alt. about 1,000 m.
Cultivated in Taipei—C158.

Chitou (溪頭)—NANTOU CO.: ca. 23°38′-120°37′, alt. 950 m., location of Experimental Forest Station of National Taiwan University.
Sept. 2, 1969—6101, 6511.
Cultivated in Taipei—9914 (B014T).

Chusuipo (出水坡)—TAITUNG CO.: 22°23′-120°49′, collected from elevation about 400 m to 550 m., in a primary forest.
July 31, 1967—3429, 3436.
Cultivated in Taipei—C206, C309.

Fengkang (楓港)—PINGTUNG CO.: 22°12′-120°41′, collected from a riverbed.
Oct. 2, 1967—4100, 4107.

Hohuanshan (合歡山)—NANTOU CO.: 24°04′-121°16′, collected from elevation of about 3,100 m.
Aug. 22, 1967—3792, 3834.

Hsinhuatien (興化店)—TAIPEI CO.: 25°13′-121°27′, collected from the sandy coastal region.
Apr. 28, 1968—4338.

Hushaochang (火燒崙)—TAIPEI CO.: 24°55′-121°35′, collected from elevation of about 200 m, olong a stream.
Aug. 5, 1967—3474.

Kenting (墾丁)—PINGTUNG CO.: 21°57′-120°47′, collected from the coastal region.
Oct. 4, 1967—4140, 4163.
Oct. 5, 1967—4186.

Kueihu (魁湖)—TAITUNG CO.: ca. 22°46′-120°53′, collected from elevation of about 1,600 m., in a primary forest.
July 27, 1967—3273, 3286.
July 29, 1967—3350.
Cultivated in Taipei—C016.

Lanhsü (蘭嶼)—TAITUNG CO.: 22°00′06″-20°05′07″—121°29′58″-121°36′12″, an Island called also Botel Tobago, or Orchid Island.
Aug. 26, 1968—4843, 4848.
Aug. 27, 1968—4868, 4876.
Aug. 28, 1968—4910, 4911, 4926.
Aug. 29, 1968—4927.
Aug. 30, 1968—4633, 4954.

Table 2. (Continued)

Aug. 31, 1968—4956, 4969.
Sept. 1, 1968—4975, 4977.
Sept. 2, 1968—4978.
Sept. 3, 1968—4989, 4991, 4996.
Cultivated in Taipei—9909 (B048E), 9910 (F261E), 9911 (F228E), 9915 (K. Hsu), 9918 (F20E), 9921 (F234E).

Lanshan (嵐山)—HUALIEN CO.: ca. 23°55′-121°26′, collected from elevation of about 1,800 m.
Cultivated in Taipei—C197.

Liukuei (六龜)—23°00′-120°38′, collected from a ***Cryptomeria*** plantation, Alt. about 700 m.
Cultivated in Taipei—9908 (F262E).

Lutao (綠島)—TAITUNG CO.: 22°39′-121°29′, a small Island.
Cultivated in Taipei—9916 (F213E).

Nankang (南港)—TAIPEI CO.: 25°03′-121°36′, alt. ca. 100 m.
March 23, 1969.

Paishawan (白沙灣)—TAIPEI CO.: ca. 25°14′-121°14′, collected from a sandy coastal region.
Sept. 10, 1967—3866.

Paiyunshanchuang (排雲山莊)—CHIAYI CO.: ca. 23°28′-120°26′ alt. 3,550 m in ***Abies*** primary forest.
Sept. 8, 1969—6304.

Taipei (臺北)—TAIPEI CITY: 25°03′-121°31′, collected around the University Campus, NTU.
July 7, 1968—4569.

Tanshui (淡水)—TAIPEI CO.: 25°11′-121°26′, collected from south side, of Tanshui River.
Apr. 9, 1968—4569.

Tatungshan (大桶山)—TAIPEI CO.: ca. 24°48′-121°21′, alt. about 500 m, collected in moist primary forest along a stream.
Oct. 10, 1969—6409, 6411, 6420, 6423, 6430, 6432.

Tawu (大武)—TAITUNG CO.: 22°22′-120°54′, collected from the coastal region.
July 31, 1967—3415.
Cultivated in Taipei—C253.

Tawushan (大武山)—TAITUNG CO.: 22°30′-120°41′, alt. 1,800 m, collected in a primary forest.
Cultivated in Taipei—9917 (F182R).

Wulai (烏來)—TAIPEI CO.: 24°52′-121°33′, alt. 145 m.
Aug. 13, 1957—3481

Yehliu (野柳)—TAIPEI CO.: 25°13′-121°42′, collected from the coastal region.
Cultivated in Taipei—C245.

Yushanchienshan (玉山前山)—CHIAYI CO.
Sept. 29, 1969—C306.

Alismataceae

One species, *Sagittaria trifolia*, was used for chromosome studies. This is a very common aquatic weed found in the paddy fields. In the meiotic cells $n=11$ was counted, a number which confirms the previous count (Hsu, '67).

Commelinaceae

Three genera were studied cytologically, namely *Commelina*, *Forrestia* and *Pollia*. *Commelina auriculata*, a species growing in gravel river beds, shows a diploid nature, which is a first time record for the species. In *C. communis* different counts were obtained from Wulai and Lanhsü. The former is a diploid which confirms the former count (Hsu, '67), while from the latter locality a tetraploid was discovered.

Forrestia chinensis, an undergrowth in moist forests at low altitudes, is a diploid species, the same chromosome counts of $n=10$ has previously been found by the present author, who proposed a basic number of $X=10$ (Hsu, '67). The chromosomes are fairly large in this species. A first time chromosome number of $n=10$ was obtained for *Pollia sorzogonensis*.

Flagellariaceae

Only one species, *Flagellaria indica*, is known from southern Taiwan in this family. This is a woody vine with a scandent stem and climbs by its circinate leaf tips. The somatic cells of $2n=38$ was counted from Lansü material, the count confirms the previous chromosome number.

Musaceae

The somatic count of $2n=20$ was found for *Musa formosana*. This is a first time count. The chromosomes are medium sized and fairly short at the anaphase configuration.

Zingiberaceae

A small flowered taxon, *Alpinia intermedia*, was found for cytological investigation. The somatic cells were counted with $2n=24$ chromosomes. It confirms the previous count made on meiotic cells, $n=12$, by the present author (Hsu '67). The chromosomes are unequal in size, and fairly large in this species.

Liliaceae

Six genera, *Aletris*, *Dianella*, *Disporum*, *Liriope*, *Ophiopogon*, and *Tricyrtis* were studied for their chromosomes. *Aletris spicata* has a meiotic count of $n=13$ which is a new addition to the chromosome atlas. It has medium sized chromosomes. *Dianella nemorosa* of Lanhsü Island has $n=16$ chromosomes, the same chromosome number as was found for plants collected on Taiwan. Medium sized chromosomes were found in this species. The karyotype of *Disporum kawakamii* was studied by Chao *et al.* ('63). The present study confirms the previous results (Chuang *et al.*, '62; Chao *et al.* '63). It has large chromosomes. The lowland *Liriope* species, *L. angustissima*, is found with a haploid chromosome number of $n=18$. In *Ophiopogon*, *O. jaburan* grows on coastal regions of Lanhsü Island, while *O. planiscapus* is commonly found at low to medium altitudes. All of them are diploid with $2n=36$ for somatic chromosomes. *O. scaber*, a tetraploid, is found only at higher elevations. The tribe Ophiopogoneae was studied thoroughly. The species can be identified by the following key:

Key to the Taiwan genera and species of tribe Ophiopogoneae

1(8) Pollen sacs elliptical, rounded at the apex, with a distinct filament ..... *Liriope*

2(3) Leaves 8-12 mm wide, apex usually obtuse, suddenly acute; inflorescences 5-17 cm long, very densely flowered; plant estoloniferous... *L. platyphylla* Wang et Tang

3(2) Leaves less than 5 mm wide; inflorescences loosely flowered:
4(5) Plants less than 15 cm high; inflorescences less than 4 cm long; 5-10 flowered; leaves 1-2 mm wide; plant stoloniferous.....*L. minor*
5(4) Plants more than 20 cm high; inflorescences 15-20-flowered; leaves 3-5 mm wide:
6(7) Inflorescences more than 10 cm long; plants stoloniferous; grows in mountainous regions.....*L. laxispicata* Hay. (*L. spicata*)
7(6) Inflorescence 5-10 cm long; plants estoloniferous, grows on lowlands and coastal regions.....*L. angustissima* Ohwi
8(1) Pollen sacs deltoid, acuminate at the apex, with very short filaments.....*Ophipogon*
9(10) Leaves 7-13 mm wide; pedicels long, plants estoloniferous.....*O. jaburan* (Kunth) Lodd
10(9) Leaves less than 6 mm wide; pedicels shorter; plants stoloniferous:
11(12) Leaves 4-6 mm wide, apex usually obtuse; margins obscurely serrulate, teeth far apart; scapes $\frac{1}{2}$ as long as the leaves.....*O. planiscapus* Nakai
12(11) Leaves 2-3 mm wide; margins distinctly serrulate, teeth dense:
13(14) Flowers 5-8 in a scape, the scape nearly as long as the leaves; perianth-segments oblong, obtuse at apex, flat, 5-8 mm long.....*O. formosanum* Ohwi
14(13) Flowers 2-4 in a scape, the scape 4-18 cm long:
15(16) Perianth-segments acute at the apex, lanceolate, reflexed, 4-5 mm long.....*O. japonicum* Ker
16(15) Perianth-segments oblong, obtuse at the apex, flat, 3-5 mm long .....*O. scaber* Ohwi

The Formosan species of *Tricyrtis* were studied by Simizu ('62) from the view point of gross morphology. The present count on chromosomes of the meiotic cells agrees with Sato ('39) $n=26$, however, $2n=25$ has also been reported by Sato.

Araceae

Three genera, *Acorus*, *Alocasia* and *Colocasia*, were investigated. *Ac. gramineus* is a petrophilus grass-like plant with small meiotic chromosomes of $n=12$. *Al. macrorhiza* and *C. esculentum* from the Lanhsü Island show somatic counts of $2n=28$. All of them are diploid.

Typhaceae

A shallow water aquatic species, *Typha orientalis*, was found in Taiwan. It's count was $2n=60$, on the Lanhsü material. It grows in marshy places close to the seashore.

Palmae

One of the most common native palms is *Arenga engleri*. This species has $2n=32$. It has small somatic chromosomes. This is a first time count.

Cyperaceae

Small chromosomes of somatic cells $2n=12$ were counted for *Fimbrystylis dichotoma*. It agrees with the previous observation (Hsu, '67), but $2n=10$ was reported by Sharma & Bol ('56).

Orchidaceae

The chromosomes of thirteen genera were studied. All of the species are reported for the first time. A petrophilus grass-like orchid on sunny hillside, *Bletilla formosana*, has somatic chromosomes of $2n=16$. It grows commonly at medium altitudes. One of the terrestrial orchids, a broad-leaved and shade-loving genus, is the genus *Calanthe*. The purple flowered *C. longicalcarata* and the yellow flowered *C. yushuni* have the same somatic count of $2n=40$.

The genus *Dendrobium* of Taiwan, is an epiphytic genus. So far as our materials are concerned, there seems to be at least three groups of plants classified on their chromosome numbers. The first group with basic number of X=19, has the pseudo-bulbs terete and erect and leaves lorate, *D. fimbriatolabellum*, *D. flaviflorum*, *D.*

heishanaense, D. kwashotense, D. longicalcaratum, D. miyakei, and, *D. moniliforme* fall in this first group which are diploid with $2n=38$ somatic chromosomes. The second group has $X=10$ basic number and these pseudobulbs are erect and flattened and have flat acicular leaves. This is represented by a diploid species, $2n=20$, *D. ventricosum* from the Lanhsü Island. The third group represented by *D. nakaharai* has a $2n=30$ somatic number, this has creeping, deeply jointed pseudobulbs and small elliptical leaves. It seems the basic number of $X=15$ should be added to the already known numbers of $X=10$, and $X=19$.

A small yellow flowered handsome epiphyte is the *Dendrochilum formosanum.* It has somatic chromosomes of $2n=30$, and has a slender and pendent inflorescence.

Diploprora uraiense has been found in moist primitive forests and on mossy rocks along streams. Its somatic chromosome number is $2n=16$.

The somatic count of $2n=30$ was observed for the *Gastrochilus somai* and the meiotic count of $n=12$ was found for a parasitic giant species, *Gastrodia elata.*

Habenaria longitentaculata grows in dark primitive forests where considerable humus has been deposited. The fringed margin of the lip is the outstanding feature of the species. It has $2n=42$ chromosomes.

The somatic count of $2n=30$ and $2n=26$ were observed for *Liparis keitaoensis* and for *Microstylis latifolia* respectively.

Root tip materials of three Lanhsü Island plants were studied. The flower of *Saccolubium kotoense* smells like *Cinnamomum zeylanicum.* The vegetative part of this plant looks like *Phalenopsis,* but the inflorescences are axillary with a stout and pendent axis. A somatic number of $2n=30$ was counted. In *Sarcanthus micranthus* and *Spathoglottis plicata.* $2n=36$ and $2n=18$ was observed.

Gramineae

Two kinds of bamboo, *Bambusa oldhamii,* and *B. stenostachya,* are very common in Taiwan. The former has meiotic cells of $n=12$. This bamboo is edible and extensively cultivated for its young shoots, while in the latter the somatic cells are $2n=24$. These are planted to form natural giant hedges.

Among the grasses examined, most of the counts agree with the previous counts of Chen & Hsu (1961, '62). *Capillipedium kwashotensis* and *Isachne schmidii* are the first time counts on record. The former species has meiotic cells of $n=20$, while the latter has $n=10$ chromosomes. *Calamagrostis arundinaceas* has a somatic count of $2n=28$ which confirms Sorsa's observation. The result of Tateoka on *Lepturus repens* is recognized in the meiotic count of $n=27$ by Lanhsü plant, and the haploid number of $n=28$ is added to the Formosan *Trisetum bifidum.*

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EXPLANATION OF PLATE FIGURES*

Plate I.

Fig. 1.* *Sagittaria trifolia* Linn., early metaphase I with 11 bivalents.
Fig. 2. *Commelina auriculata* Blume, diakinesis with 11 bivalents.
Fig. 3.* *Commelina communis* Linn., somatic early metaphase with 22 chromosomes; magnification reduced to 2/5.
Fig. 4. *Commelina communis* Linn., somatic early metaphase with 44 chromosomes.
Fig. 5.* *Pollia sorzogonensis* H. Mey., early metaphase I with 10 bivalents.
Fig. 6. *Musa formosana* Hay., somatic anaphase showing 20: 20 distribution of chromosomes.
Fig. 7.* *Alpinia intermedia* Gagnep., somatic metaphase with 28 chromosomes; magnification reduced to 2/5.
Fig. 8. *Aletris spicata* Fr., diakinesis with 13 bivalents.
Fig. 9.* *Dianella nemorosa* Lam., diakinesis with 16 bivalents.
Fig. 10. *Disporum kawakamii* Hay., somatic early metaphase with 16 chromosomes.
Fig. 11.* *Liriope angustissima* Ohwi, somatic early metaphase with 36 chromosomes.
Fig. 12. *Ophiopogon formosana* Ohwi, somatic early metaphase with 18 chromosomes.
Fig. 13. *Ophiopogon jaburan* (Kunth) Lodd., somatic metaphase with 18 chromosomes.
Fig. 14. *Ophiopogon planiscapus* Nakai, somatic metaphase with 18 chromosomes.
Fig. 15. *Ophiopogon planiscapus* Nakai, diakinesis with 9 bivalents.
Fig. 16. *Ophiopogon scaber* Ohwi, somatic metaphase with 36 chromosomes.
Fig. 17. *Tricyrtis formosana* Bak., diakinesis with 26 bivalents; magnification reduced to 2/5.
Fig. 18. *Alocasia macrorrhiza* (L.) Schott., somatic metaphase with 28 chromosomes.
Fig. 19.* *Colocasia esculentum* Schottl, somatic metaphase with 28 chromosomes.
Fig. 20. *Typha orientalis* Pers., somatic early metaphase with 60 chromosomes.
Fig. 21. *Arenga engleri* Beccari, somatic metaphase with 32 chromosomes.
Fig. 22.* *Cyperus* sp., somatic metaphase with 16 chromosomes.

EXPLANATION OF PLATE FIGURES*

Plate II.

Fig. 23.* *Bletilla formosana* (Hay.) Schltr., somatic metaphase with 16 chromosomes.
Fig. 24. *Calanthe longicalcarata* Hay., somatic metaphase with 40 chromosomes.
Fig. 25. *Calanthe yushuni* Mori et Yam., somatic metaphase with 40 chromosomes.
Fig. 26. *Dendrobium fimbriatolabellum* Hay., somatic metaphase with 38 chromosomes.
Fig. 27. *Dendrobium flaviflorum* Hay., somatic metaphase with 38 chromosomes.
Fig. 28. *Dendrobium heishanaense* Hay., somatic metaphase with 38 chromosomes.
Fig. 29. *Dendrobium kwashotense* Hay., somatic metaphase with 38 chromosomes.
Fig. 30. *Dendrobium longicalcaratum* Hay., somatic metaphase with 38 chromosomes.
Fig. 31. *Dendrobium miyakei* Schltr., somatic metaphase with 38 chromosomes.
Fig. 32. *Dendrobium moniforme* Sw., somatic metaphase with 38 chromosomes.
Fig. 33. *Dendrobium nakaharai* Schltr., somatic metaphase with 30 chromosomes.
Fig. 34. *Dendrobium ventricosum* Kränzl., somatic metaphase with 20 chromosomes.
Fig. 35. *Dendrochilum formosanum* Masamune, somatic metaphase with 30 chromosomes.
Fig. 36. *Diploprora uraiense* Hay., somatic metaphase with 16 chromosomes.
Fig. 37. *Gastrochilus somai* Hay., somatic metaphase with 30 chromosomes.
Fig. 38. *Gastrodia elata* Blume, diakinesis with 24 bivalents.

EXPLANATION OF PLATE FIGURES*

Plate III.

Fig. 39. *Habenaria longitentaculata* Hay., somatic metaphase with 28 chromosomes.
Fig. 40. *Liparis keitaoensis* Hay., somatic metaphase with 30 chromosomes.
Fig. 41.* *Microstylis latifolia* J. J. Smith, somatic metaphase with 40 chromosomes.
Fig. 42. *Saccolabium kotoense* (Yam.) Yam., somatic metaphase with 30 chromosomes.
Fig. 43. *Sarcanthus micranthus* Ames, somatic metaphase with 36 chromosomes.
Fig. 44.* *Spathoglottis plicata* Bl., somatic metaphase with 18 chromosomes.
Fig. 45. *Bambusa oldhamii* Munro, diakinesis with 12 bivalents.
Fig. 46. *Bambusa stenostachya* Hackel, somatic metaphase with 24 chromosomes.
Fig. 47.* *Calamagrostis arundinacea* (L.) Roth., somatic early metaphase with 28 chromosomes.
Fig. 48. *Capillipedium kwashotensis* (Hay.) Hsu, diakinesis with 20 bivalents.
Fig. 49. *Cenchrus calyculatus* Cavan, diakinesis with 34 bivalents.
Fig. 50. *Chloris barbata* Sw., diakinesis with 20 bivalents.
Fig. 51. *Digitaria adscendens* Henr., diakinesis with 27 bivalents.
Fig. 52. *Digitaria leptalea* Ohwi var. *recticulmis* Ohwi, diakinesis with 18 bivalents.
Fig. 53. *Digitaria violascens* Link., diakinesis with 18 bivalents.
Fig. 54. *Eleusine indica* (L.) Gartn., somatic metaphase with 18 chromosomes.
Fig. 55. *Eriochloa procera* (Retz.) C. E. Hubb., diakinesis with 18 bivalents.
Fig. 56.* *Ichnanthus vicinus* (F. M. Bail.) Merr., diakinesis with 20 bivalents.
Fig. 57. *Isachne schmidii* Hack., diakinesis with 10 bivalents.
Fig. 58. *Lepturus repens* (Forst. f.) R. Br., diakinesis with 27 bivalensts.
Fig. 59. *Panicum notatum* Retz., somatic metaphase with 18 chromosomes.
Fig. 60. *Paspalum distichum* Linn., diakinesis with 20 bivalents.
Fig. 61. *Setaria geniculata* (Lam.) P. Beauv., diakinesis with 36 bivalents.
Fig. 62. *Trisetum bifidum* (Thunb.) Ohwi, diakinesis with 28 bivalents.
Fis. 63.* *Trisetum spicatum* (L.) Richter var. *formosanum* (Honda) Ohwi, late diakinesis with 14 bivalents

* The magnification scale used in this article is the same with the previous report.

Plate I

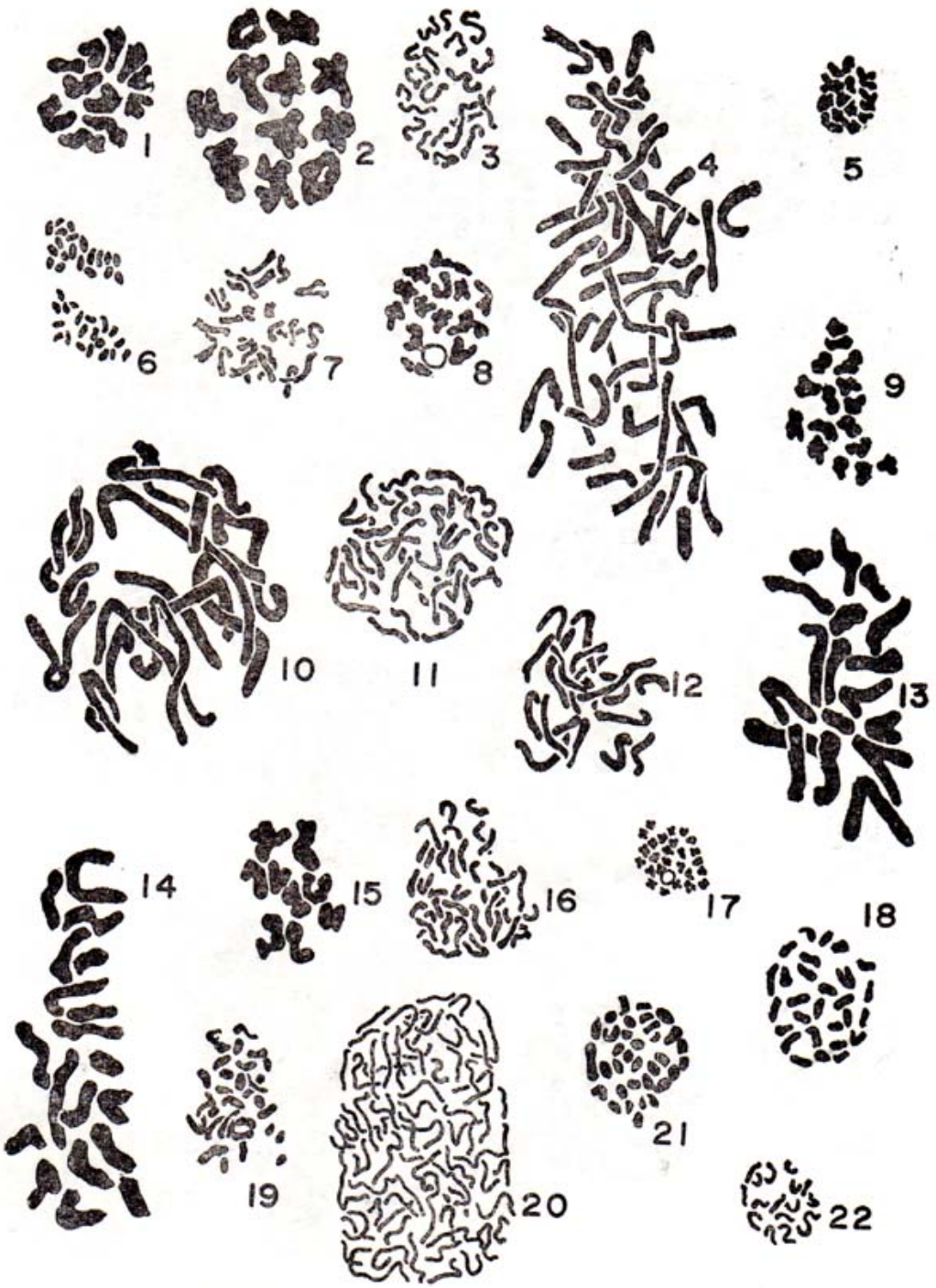


Plate II

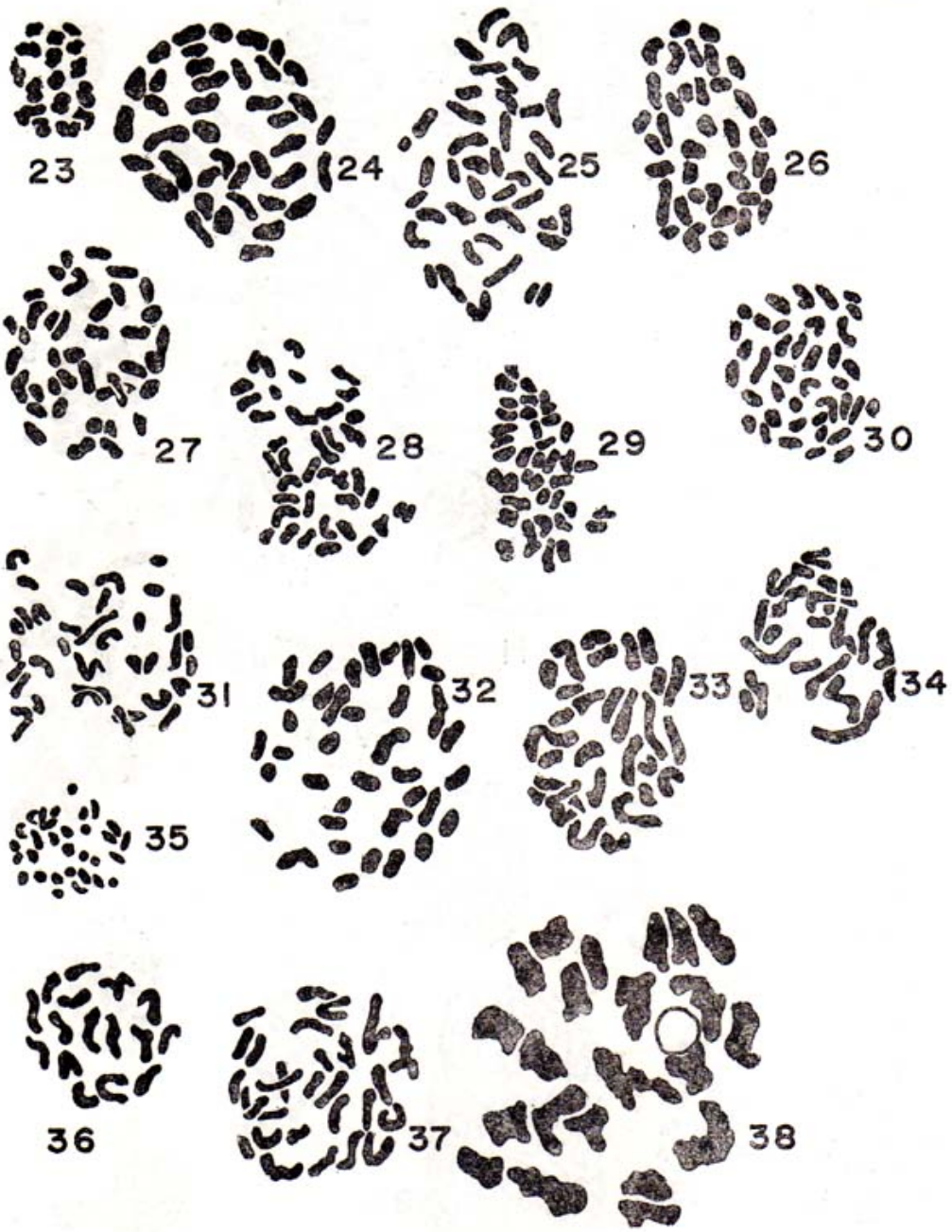
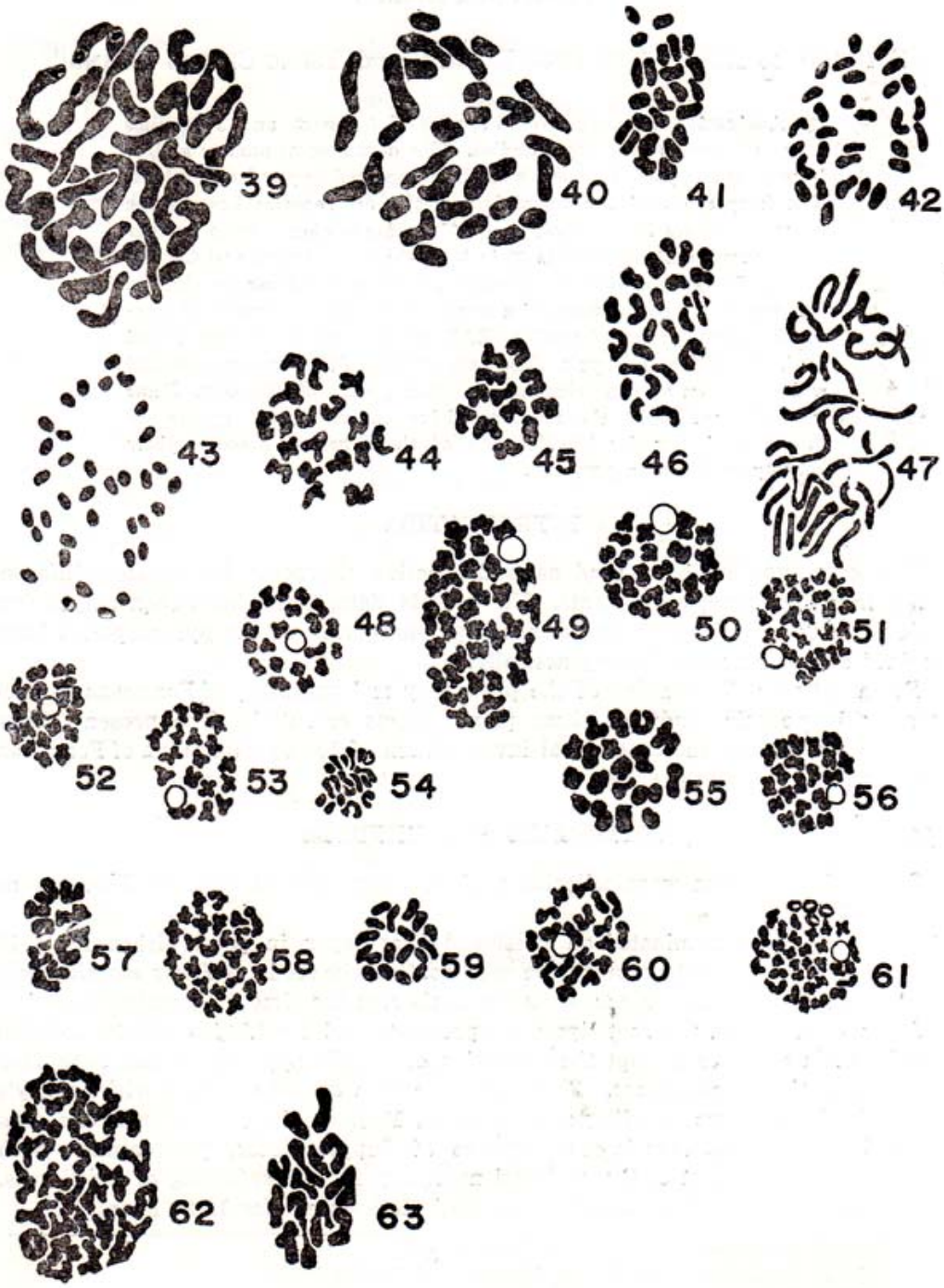


Plate III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