Chromosome Studies on *Hosta* I. The Chromosome Numbers in Various Species of *Hosta*

By

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(With 18 Text-figures)

Since the classic works of STRASBURGER, the cytology of the genus *Hosta* has been the subject of study by a number of authors. In *Hosta Sieboldiana,* 24 meiotic or 48 somatic chromosomes have been reported by STRASBURGER (1882, 1900, 1905), MIYAKE (1905), SYKES (1908 a, b), INARIYAMA (1928) and IMAI and KANNA (1934). The same number has been also described in *H. coerulea* and *H. ventricosa*[1] by SYKES (1908 a, b) and by SATÔ (1935 a). IMAI and KANNA (1934), however, examining the meiotic and somatic chromosomes of three types of *H. coerulea,* have stated that they make a polyploid series ($2x$, $3x$ and $4x$) with the basic number of 12, the cultivated form with 48 somatic chromosomes being tetraploid. They also counted 24 haploid chromosomes in *H. japonica.* SAKAI (1934) described the somatic chromosomes of *H. atropurpurea,* reporting ca. 48 as the somatic number. Besides these investigators, LEWITSKY (1931) counted ca. 62 somatic chromosomes in *H. Sieboldiana* and WHITAKER (1934) reported 30 meiotic chromosomes in *H. coerulea* suggesting that this plant belongs to the *Yucca-Agava* group which was established from the karyological point of view.

The present author has been engaging in cytological studies on the various species of Japanese *Hosta,* and has ascertained that the basic number of this genus is not 12 or 24 but 30, confirming WHITAKER's results. A part of his data was reported at the Annual Congress of the Botanical Society of Japan held in Kyôto in April, 1935.

Later, SATÔ (1935 b) revised his previous report and agreed that the chromosome numbers are just the same as the author's counting, i.e., 30 meiotic and 60 somatic chromosomes in *H. ventricosa, H. japonica* var.

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1) Presumably synonymous with *H. coerulea.*

TABLE I

Scientific names, Japanese names, sources and chromosome numbers of the species studied. In the species asterisked the processes of meiosis of the pollen mother-cells are aberrant.

Scientific names	Japanese names	Sources	*n*	2*n*	Text-figures
H. japonica	Koba-gibôsi	Tomakomai, Hokkaidô	30	—	1
H. japonica var. *aestivalis*	Natuno-sazi-gibôsi	Tôkyô Bot. Garden	30	—	2
var. *albomarginata*	Hukurin-gibôsi	cultivated[1]	30	—	3
var. *angustifolia*(?)	Sazi-gibôsi	Tôkyô Bot. Garden	30	—	4,14 15,16
H. rectifolia	Tati-gibôsi	Sapporo, Hokkaidô	30	—	5
H. rupifraga	Hatidyô-gibôsi	Tôkyô Bot. Garden	30	—	6
H. Sieboldiana	Tô-gibôsi	cultivated	30	—	7,13
H. Sieboldiana var. *nigrescens*	Kuro-gibôsi	cultivated	30	—	8
*H. undulata**	Suzi-gibôsi	cultivated	30	60	9,17
*H. ventricosa**	Gibôsi	Tôkyô Bot. Garden	30	—	
H. sp.[2]		cultivated	30	—	10
H. sp.[2]		Mt. Gassan, Yamagata Prefecture	30	60	11,18
H. sp.[2]		Mt. Hakkôda, Aomori Prefecture	30	—	12

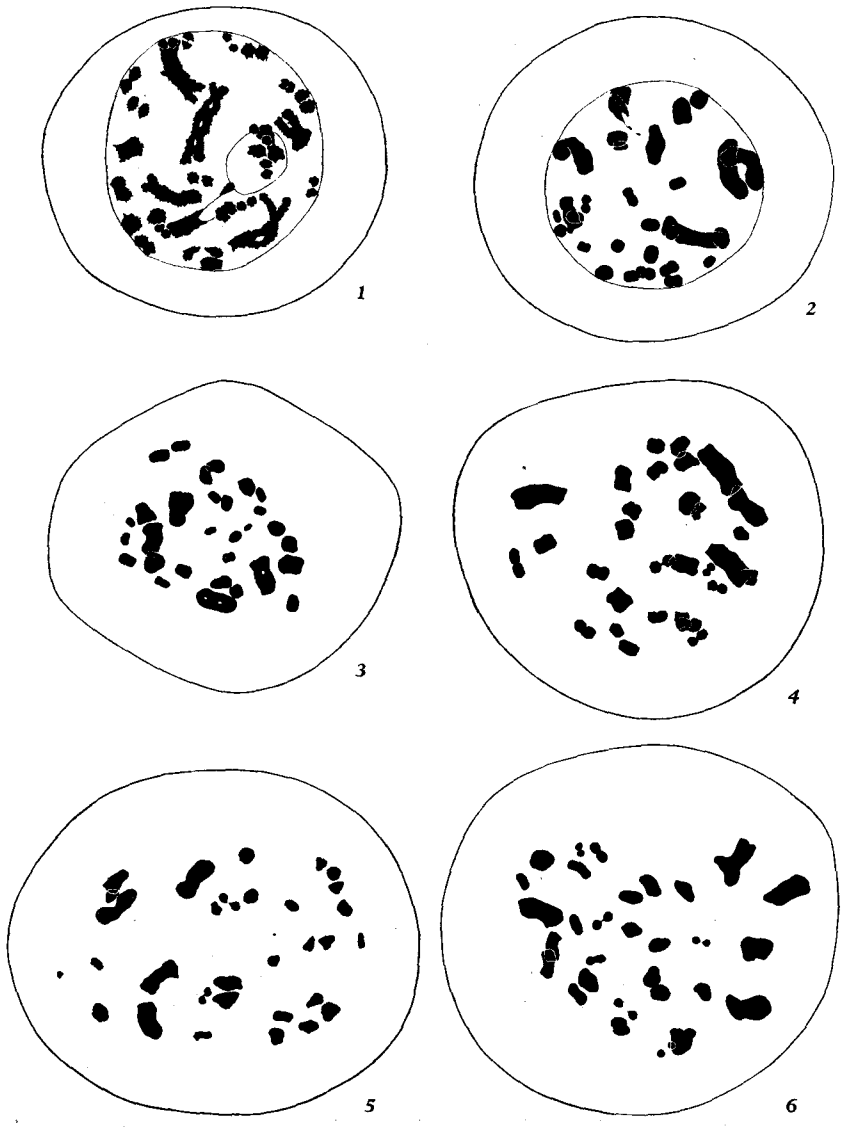
1) Material cultivated in our experimental gardens and of unknown sources.
2) The specific names of these materials have not been determined.

albo-marginata, *H. lacifolia* var. *tardiflora* and *H. rupifraga*.

Of the author's data previously reported, only those concerning the chromosomes numbers will be reported in the present paper.

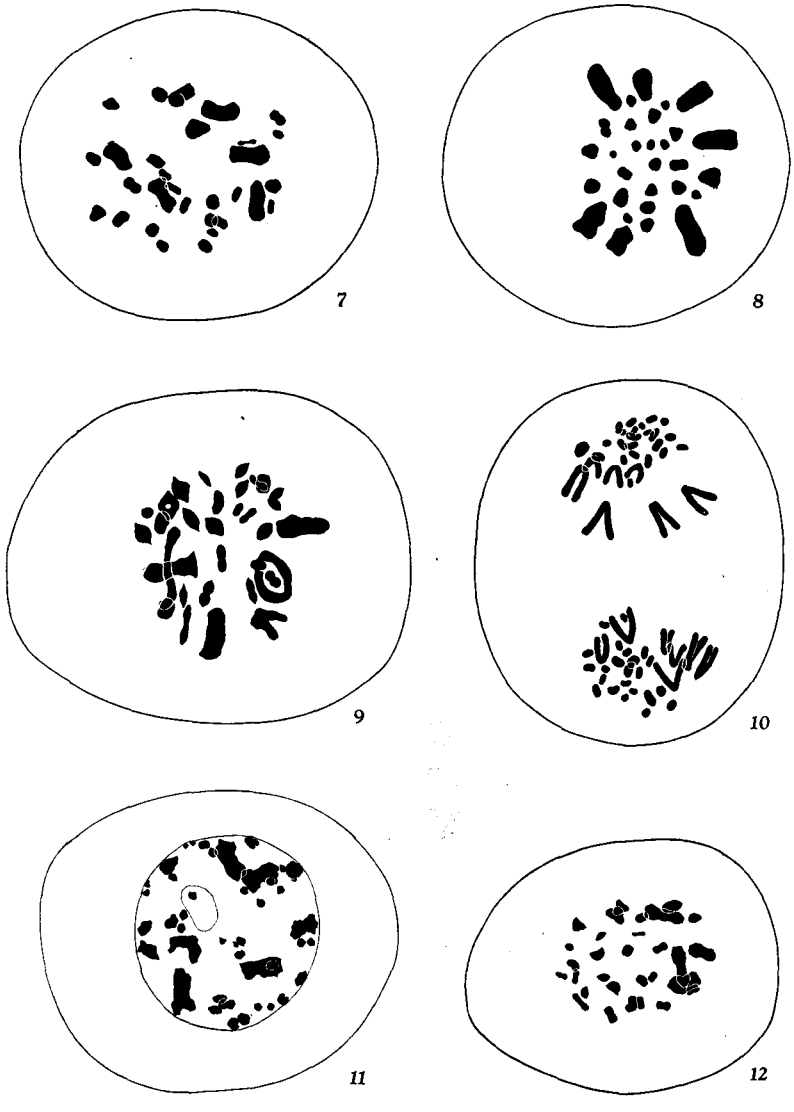
The materials were collected from various sources, as indicated in the third column of Table I. They were transplanted from their habitats to our experimental garden and used as the materials for the present studies.

Though the permanent smear methods and the paraffin methods were sometimes employed in order to observe the pollen mother-cells, iron aceto-carmine preparations were mainly resorted to which revealed the best



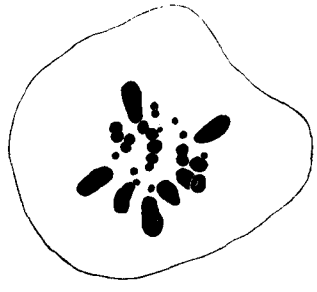
Text-figs. 1–6. The meiotic complements in pollen mother-cells of several species of *Hosta*; from iron aceto-carmine preparations. (See right hand column of Table I for key.) ×1750×½

figures for observation. The figures of the somatic chromosomes were obtained from the paraffin sections of the root tips, fixed in NAVASHIN's or LA COUR 2BE fixatives and stained after the schedule of NEWTON's gentian



Text-figs. 7–12. The meiotic complements in pollen mother-cells in several species of *Hosta;* 7–11, from iron aceto-carmine preparations; 12. from a permanent smear preparation. (See right hand column of Table I for key). ×1750×½

violet staining. The materials fixed in the comparatively low temperature appear to give good results. The species subjected to observation are listed in Table I. In consequence of the observation of the microsporogenesis, all species investigated proved to bear 30 reduced chromosomes essentially (Text-figs. 1–12), though in some of them univalents or fragments of chromosomes often appeared and aberrant processes took place. Neither polyploid species nor 12 or 24 chromosomal species were observed. The meiotic complements in the various species appear to show little differences to one another. Of thirty bivalents, four are comparatively larger and can be easily distinguished from the others. Of these largest four, however, one has a somewhat submedian fiber attachment while the other three have quite a subterminal one as shown in the anaphase figures. The remaining 26 consist of various sized gemini, indicating that these species should never be of polyploid constitution. That all species have similar chromosome sets may suggest the possibility of interspecific or intervarietal hybridization. The polymorphism in this genus which has bewildered the taxonimists may presumably attributed to the results of the hybridization which had taken place between its various species. In fact, some interspecific hybrids have been secured in the author's experiments.

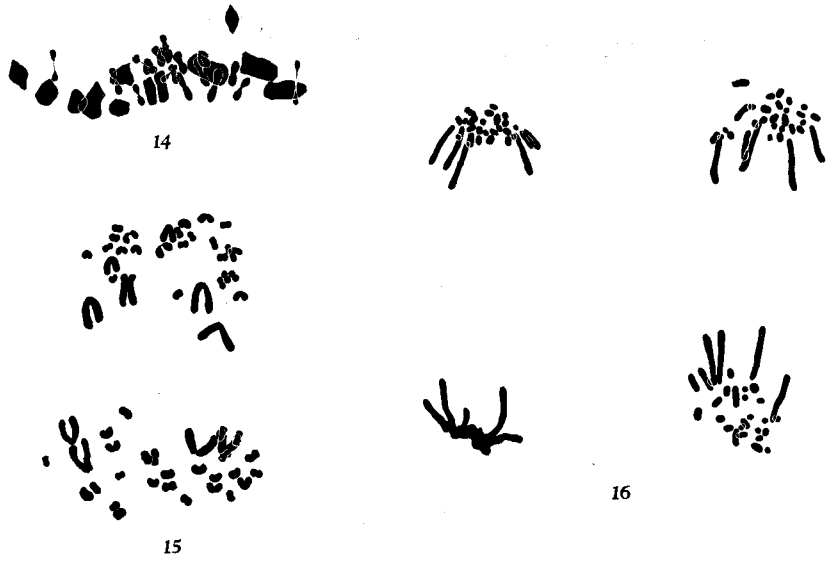


Text-fig. 13.
The first metaphase plate of the pollen mother-cell of *H. Sieboldiana*; from a permanent smear preparation. Five pairs of associated bivalents are shown. ×1750×$\frac{2}{3}$

In the fixed materials there have been observed to exist some tendencies between the bivalents of the same size and shape to lie in proximity to each other in prometaphase and metaphase, though it was obscure whether this phenemenon is caused by the effect of fixatives or whether it suggests the sign of so-called secondary association (Text-fig. 13). One may be allowed to imagine that the previous authors might have miscounted two associated bivalents as one resulting in the reports of a lower number than there really is.

The meiotic processes proceed quite normally in the majority of the materials (Text-figs. 14–16), in which the fertility of pollen grains is of high degree. Some species, however, show high percentage of abortive pollen grains and are almost completely sterile, namely *H. undulata*[2] and

2) Synonymous with *H. japonica* var. *albo variegatis.*



Text-figs. 14–16. The process of microsporogenesis of *H. japonica* var. *angustifolia*(?); from the aceto-carmine preparations; 14, first metaphase; 15, first anaphase; 16, second telophase. ×1750×½

H. ventricosa. In Table II are presented the percentage of good pollen grains examined in the iron aceto-carmine preparations and the percentage of germinated pollen grains on 1% agar-agar soil, with 1% of saccharose added.

In these pollen sterile plants, there were observed to take place aberrant processes of meiosis such as fragmentation of chromosomes, bridge

TABLE II

The percentage of normal pollen grains and germinated pollen grains.

Species	Number of pollen grains counted	Percentage of normal pollen grains	Number of pollen grains tested	Percentage of germinated pollen grains
H. japonica	1122	96.9	1363	78.2
H. japonica var. *angustifolia*(?)	1320	98.7	—	—
H. rectifolia	547	98.9	865	76.2
H. rupifraga	391	94.3	—	—
H. Sieboldiana	521	95.8	542	72.0
H. Sieboldiana var. *nigrescens*	1000	95.2	—	—
H. undulata	1417	26.5	1184	0.08
„	444	10.4	542	0
„	549	21.0	760	0
H. ventricosa	1726	17.9	1065	0
H. sp. (from Mt. Gassan)	1109	97.8	1368	88.4

formation and occurrence of univalents etc., which apparently give rise to the pollen sterility of these plants. The detailed investigations in progress at present will be reported in later papers.

Somatic complements were observed in only two species, namely, *H. undulata* (Text-fig. 17), and one specie of uncertain identity (Text-fig. 18). In the two cases sixty chromosomes corresponding to the gemini which emerged in the meiotic complements were clearly observed on the equatorial plates. Owing to the large number and the small size of the chromosomes, it is difficult to study the karyotype of each species.

17 18

Text-figs. 17–18. The somatic complements of two species of *Hosta*; 17, *H. undulata*; 18, *H.* sp. (from Mt. Gassan). ×3500×$\frac{2}{3}$

Summary

The meiotic processes have been studied in several species of *Hosta*. All species studied have proved to bear 30 meiotic chromosomes, which are the basic number of this genus. These observations go against the descriptions of many previous authors, who counted 24 meiotic or 48 somatic chromosomes. It is the author's view that they may have miscounted two associated bivalents as one. No polyploid species have been observed.

The present studies have been carried out under the guidance of Professor H. MATSUURA, to whom the author wishes to express his heartiest thanks for the kind suggestions and criticism. He is also indebted to many gentlemen who kindly rendered assistance in collecting the materials for the present studies.

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