CYTOLOGICAL STUDIES OF SUGARCANE AND ITS RELATIVES

XVI. Further studies of basic chromosome number of *Saccharum officinarum* L.: F_1 hybrid of Vellai and *Sclerostachya fusca* A. Camus.[1]

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In our previous study, detailed cytological examination was made of the first, second, and third back-cross generation plants of the cross *S. officinarum* var. Vellai and *Sclerostachya fusca.* The initial cross as well as the first and second back-crosses were performed in India (Parthasarathy 1948 and personal correspondence). However, the third back-cross was done in Taiwan. Instead of *S. fusca, Narenga porphyrocoma* was used. From these studies, it was concluded that the ten sugarcane chromosomes are probably made up of two sets of five. One of these sets is again partially homologous with five chromosomes of both *Selerostachya* and *Narenga.* (Li *et al*, in press). The F_1 hybrid clone of the initial cross made by Dr. Parthasarathy was introduced along with the back-crossed clones. However, it died out soon after its introduction. When Dr. H. W. Li came back from the Genetics Congress held in Montreal in 1958, he happened to come across the F_1 clone of this cross (G 3662) when Dr. A. J. Mangelsdorf showed him around in his breeding garden in Hawaii. Kind permission was then granted by his host and some sporocytes-material was collected and brought back to Taiwan. A brief report of the cytological studies of the F_1 hybrid is made here in this paper.

Observations

The aceto-carmine smear method was used throughout this study.

Since Vellai had 80 somatic chromosomes and *S. fusca* 30, naturally, the F_1 should have 55 somatic chromosomes. We found this to be true as did Parthasarathy (Parthasarathy 1948). Of these 55 chromosomes, 40 came from *S. officinarum,* leaving the remaining 15 to be donated by the male parent. In

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Dr. Parthasarathy's paper (1948), he stated that the pairing of the chromosomes in F_1 would be 20^{II} (O)+5^{II} (S)+5^{I} (S) (O and S denote *S. officinarum* and *S. fusca* respectively). However, we found the chromosome association to be very much different from Dr. Parthasarathy's generalized statement. This is shown in Table 1.

Table 1. Chromosomal association at MI of the F_1 of Vellai X *S. fusca*.

Chromosomal association				
IV	III	II	I	Frequency
		15	25	2
		16	23	2
		17	21	9
		18	19	10
		19	17	20
		20	15	20
		21	13	6
		22	11	2
	1	14	24	1
	1	17	18	4
	1	18	16	7
	1	19	14	3
	2	18	13	1
1		14	23	1
1		16	19	2
1		17	17	2
1		18	15	4
1		19	13	2
1	1	15	18	1
1	1	17	14	1
				100

From Table 1, it can be seen that the modal class is 20^{II} 15^{I}, singnifying that autosyndesis has taken place among the sugarcane chromosomes, leaving the 15 chromosomes contributed from *S. fusca* unpaired (Fig. 1 and 2). It can be here stated in passing as inference only that there seems to have a distinct difference in size between the bivalents and univalents. This is more apparent in Fig. 6 where the chromosomes are shown in idiograms. Most of the univalents of *Sclerostachya* origin are decidedly larger than those bivalents of sugarcane origin. Conversely, when *S. fusca* chromosomes are in form of bivalents and those of sugarcane univalents, as in BC_3, 15^{II} (S)+10^{I} (O), most of the bivalents are much larger in size than those univalents (Li *et al*, in press).

Some of the sugarcane bivalents failed to pair and existed as univalents. Taking the case of $15^{II}+25^{I}$, it means that five sugarcane bivalents failed to pair. On the other hand, bivalents more than 20, with a correspondingly decreasing number of univalents, would indicate the pairing of *Sclerostachya* chromosomes. Of 100 cells studied, 2 had $22^{II}+11^{I}$. Many of the larger open-type bivalents found were consisted of unequal sized chromosomes as shown in Fig. 12. These were supposed to be of *Sclerostachya* origin. Few of these, however, would involve the pairing of *Sclerostachya* and sugarcane chromosomes.

Trivalents were found. As many as two were encountered in a single sporocyte. Presumably, the trivalents were consisted of two sugarcane chromosomes and one *Sclerostachya* chromosome. This was further substantiated by the fact that most of the trivalents were made up of chromosomes of unequal size (Fig. 11). Should this assumption be correct, it would mean that two of the fifteen *Sclerostachya* chromosomes are homologous with two of the twenty sugarcane bivalents. In BC_3, as in our previous study, the chromosomal constitution was 10^{I} (O)+15^{II} (S). In this case, four of the ten sugarcane chromosomes were able to form trivalents with four of the fifteen *Sclerostachya* bivalents (Li *et al*, in press). Only 100 sporocytes were studied in F_1. Whereas in BC_3, 400 sporocytes were investigated. Perhaps this might offer part of the explanation for the discrepancy so observed.

Tetravalents were encountered. In any one sporocyte only one tetravalent was observed. Presumably, on account of the similarity in size of the chromosomes that made up a tetravalent, these tetravalents were of sugarcane origin. We found tetravalents in BC_1 (42 (O)+30 (S)), and in BC_2 (10^{II} (O)+15^{II} (S)) (Li *et al*, in press). Presumably, they were also of sugarcane origin.

In first anaphase, these *Sclerostachya* univalents might be included randomly in the daughter nuclei only to divide in the second division. Or else, they might form laggards in AI (Fig. 13 and 14), or divided later. As a result of these, frequently, they would be excluded from the daughter nuclei in TII to remain either as microcytes or micronuclei. This is shown in Table 2.

Table 2. Frequency of microcytes and micronuclei at second telophase of F_1.

Micronuclei \ Microcytes	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
0	2	8	12	11	11	10	18	9	8	4	1	3	1	3				1	1	1	104
1		1	1		1	1		1				1									6
																					110

Pollen fertility was not studied, because no tassels of advanced stage were collected then in Hawaii.

Discussion

From our observation, it is clear that the pairing condition of the fifteen chromosomes of *Sclerostachya* in F_1 differs widely from the statement made by Dr. Parthasarathy (Parthasarathy 1948). Besides the complete autosyndesis of the 40 sugarcane chromosomes, Dr. Parthasarathy figured that the fifteen chromosomes of *Sclerostachya* would be made up of 3 sets of five chromosomes. Two of these 3 sets would be homologous, forming 5 bivalents. Of 100 sporocytes studied, from zero to as many as two bivalents were found. This shows that pairing is very infrequent in this haploid set of *Sclerostachya* chromosomes.

In our previous paper (Li *et al*, in press), as many as four sugarcane chromosomes are partially homologous with 4 of *Sclerotachya*. Here, we found two trivalents as the highest number. As mentioned before, too few sporocytes studied would offer part of the explanation for the discrepancy from expectation.

Summary

F_1 hybrid of Vellai×*Sclerostachya fusca* had 55 chromosomes.

Complete autosyndesis was observed from the 40 chromosomes contributed by sugarcane.

Frequently, some of the sugarcane bivalents failed to pair up and existed as univalents.

The fifteen *Sclerostachya* chromosomes existed mostly as univalents. As many as two bivalents were observed to be of *Sclerostachya* origin.

This was very infrequent. These bivalents were of open type and sometimes were unequal in size.

Tetravalents were found and they were attributed to be of sugarcane origin.

甘蔗基本染色體數的繼續研究—甘蔗栽培品種 Vellai 與 Sclerostachya fusca A. Camus 的第一代雜種

項公傳　瞿樹時　翁登山　李先聞

甘蔗栽培品種 Vellai (2n=80) 與 *Sclerostachya fusca* (2n=30) 的第一代雜種 (F_1) 共有 55 個染色體；其中 40 個來自甘蔗，另外 15 個來自 *Sclerostachya*。

來自甘蔗的 40 個染色體能够自源配對 (Autosyndesis)，少數的有時配對不完全，出現爲單價體 (Univalent)。

來自 *Sclerostachya* 的 15 個染色體大多數是單價體。有時，不是同一對的染色體亦

行配對，但每一細胞中，這種配對，平均還不到一對，有時亦可到達兩對，但爲數不多。這種的雙價體 (Bivalent)，通常爲展開式 (Open type)，這與其他合閉式 (Closed type) 的顯有不同。展開式雙價體的兩個染色體往往大小不等 (Unequal in size)。

四價體 (Tetravalent) 有時亦發現，它們的來源似乎都是來自甘蔗。(摘要)

Literature Cited.

LI, H. W., K. C. SHANG, Y. Y. HSIAO and P. C. YANG. Cytological studies of sugarcane and its relatives. XV. Basic chromosome number of *S. officinarum* L. Cytologia. 24: 220-236, 1959.

Parthasarathy, N. Origin of noble canes (*S. officinarum* L.) Nature 161: 608-611, 1948.

Explanation of plate figures.

Fig. 1. Microphotograph of MI. chromosome association 20^{II} 15^{I} (940×).

Fig. 2. Camera lucida drawing of the same as in Fig. 1. (Camera lucida drawings all 1060×).

Fig. 3. MI. Chromosome association 1^{III} 18^{II} 16^{I}.

Fig. 4. MI. Chromosome association 20^{II} 15^{II}.

Fig. 5. MI. Chromosome association 2^{III} 18^{II} 13^{I}.

Fig. 6–9. Idiograms of the chromosomes.
The univalents in outline are presumably of *Sclerostachya* origin.

Fig. 6. Same as Fig. 2.

Fig. 7. Same as Fig. 3.

Fig. 8. Same as Fig. 4.

Fig. 9. Same as Fig. 5.

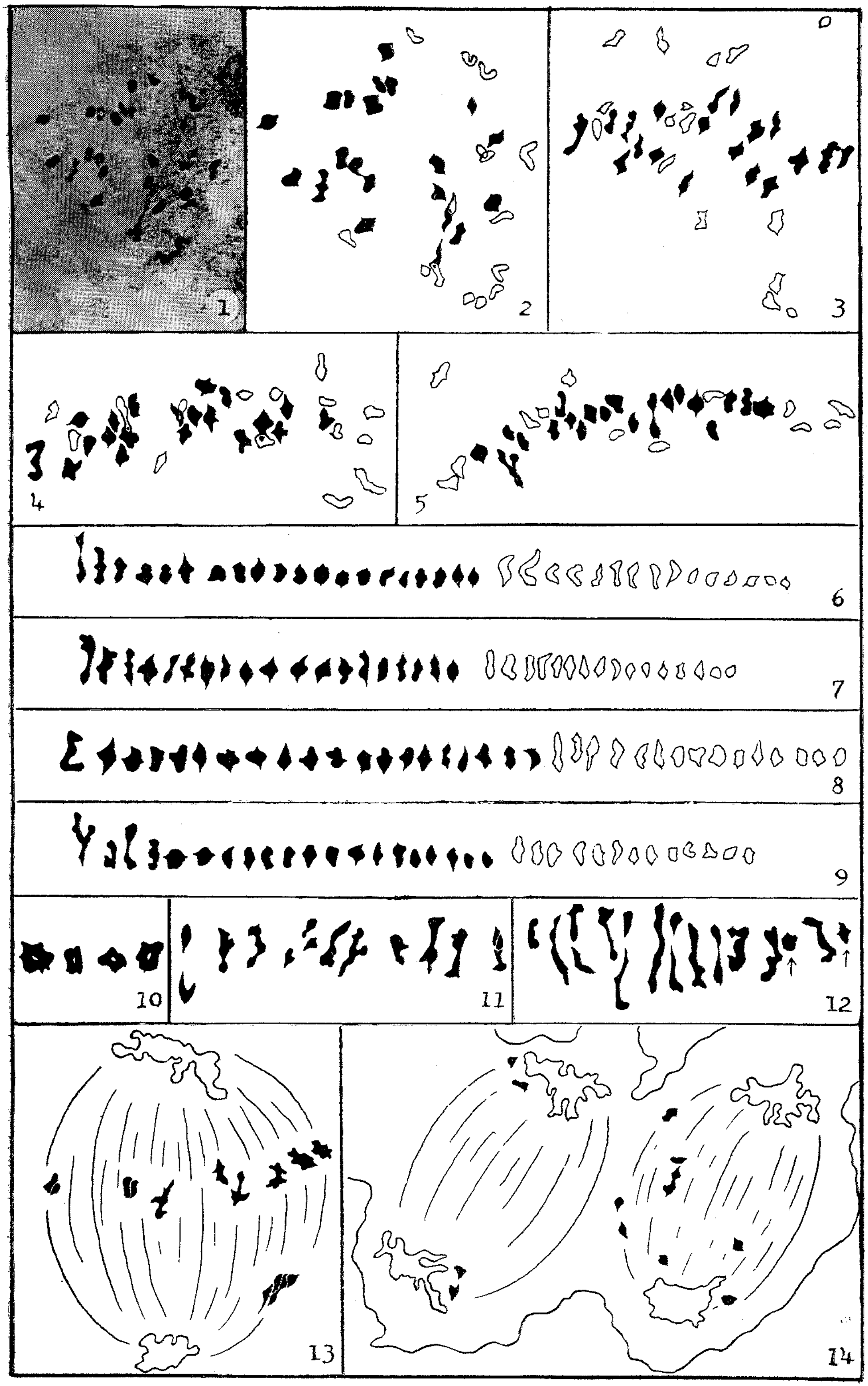
Fig. 10. Tetravalents formed in different cells.

Fig. 11. Trivalents formed in different cells.

Fig. 12. Unequal bivalents formed in different cells. Presumably they are *Sclerostachya* origin as manifested by their size as compared with the bivalents of sugarcane origin (pointed by arrows).

Fig. 13. AI. Showing the lagging univalents (presumably of *Sclerostachya* origin). Some are dividing.

Fig. 14. AII. Showing the lagging univalents presumably of *Sclerostachya* origin.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