Cytologia **39**: 499–505, 1974

Cytology of Some *Digitaria* Species

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Received January 9, 1973

Digitaria Rich is an important genus of the tribe Paniceae of the family Gramineae and consists of more than 325 species distributed all over the world. Only about 60 species have been cytologically examined so far and only two recent reports on the cytological studies of the genus *Digitaria* are available from India (Gupta and Srivastava 1969, Mary and Malik 1971). Besides these two recent reports, scattered chromosome counts on Indian species of *Digitaria* are available (Nath and Swaminathan 1956, Mulay and Leelamma 1960, Sharma and Jhuri 1959). The chromosome number in the genus varies from 2n=18 to 2n=108 indicating that polyploidy has played a significant role in the evolution of this genus. This information suggests that there is a necessity for undertaking detailed study in the genus *Digitaria*. Keeping this in view, a cytogenetic study in the genus was initiated in this laboratory. This report is the second in the series on the cytological studies in the genus *Digitaria*.

Material and methods

The following four species were used for the study in the present investigation:

1. *Digitaria bicornis* (Lamk.) Roem et Schult
2. *Digitaria eriostachya* Mez
3. *Digitaria glauca* Stent
4. *Digitaria swazilandensis* Stent

The seed of these four species along with that of other species was obtained through the courtesy of U.S. Plant Introduction Division. The seeds were sown and the plants raised in pots in Meerut University Botanical Gardens. The material for pollen mother cells squash preparations was collected from these plants and fixed in freshly prepared solution of ethyl alcohol: chloroform: acetic acid (6:3:1). Meiosis was studied within a week of fixation and the remaining material was stored in 70% ethyl alcohol in the refrigerator. Camera lucida drawings were made from the temporary preparations. Photomicrographs were also obtained from such temporary slides. A drop of solution of 45% acetic acid: glycerine (10:1) was allowed to pass under the cover glass in order to avoid drying.

Observations

Meiosis was studied in four species of *Digitaria*, namely *D. bicornis*, *D. eriostachya*, *D. swazilandensis* and *D. glauca*. The first three species showed normal

meiotic behaviour. An analysis of chromosome associations in these species is given in Table 1. The two taxa of *D. glauca* studied showed abnormal meiotic behaviour. The details of meiosis in the four species will be separately dealt with in the following text.

Digitaria bicornis (Lamk.) Roem et Schult

Two collections of this species were studied and both were octoploid (2n=72). At metaphase I, 36 bivalents were observed (Fig.1). At anaphase I, regular disjunction of 36 chromosomes to each pole was observed. Analysis of chromosome associations was conducted in one collection only and is presented in Table 1.

Digitaria eriostachya Mez

A solitary collection belonging to this species was found to be hexaploid (2n=54). At diakinesis and metaphase I, 27 bivalents were observed (Fig. 2). Analysis of chromosome associations is presented in Table 1. At anaphase I regular disjunction of 27 chromosomes to each pole was observed.

Table 1. Chromosome associations at metaphase I in three *Digitaria* species

Species		No. of PMCs studied	Bivalents*			Xta* per cell	Xta per bivalent
			Ring	Rod	Total		
D. bicornis	(2n=72)	25	32–35	1–4	36	68–71	1.95
			(34.2)	(1.80)		(70.20)	
D. eriostachya	(2n=54)	25	22–25	2–5	27	49–52	1.88
			(23.73)	(3.27)		(50.73)	
D. swazilandensis	(2n=54)	25	22–26	1–5	27	47–53	1.83
			(23.93)	(3.07)		(49.47)	

* upper rows range; lower rows values in parentheses means.

Digitaria swazilandensis Stent

Only one collection of this species was studied and was found to be hexaploid (2n=54). At diakinesis and metaphase I, 27 bivalents were invariably observed (Fig. 3). Analysis of chromosome associations is given in Table 1. At anaphase I, regular disjunction of 27 chromosomes to each pole was observed.

Digitaria glauca Stent

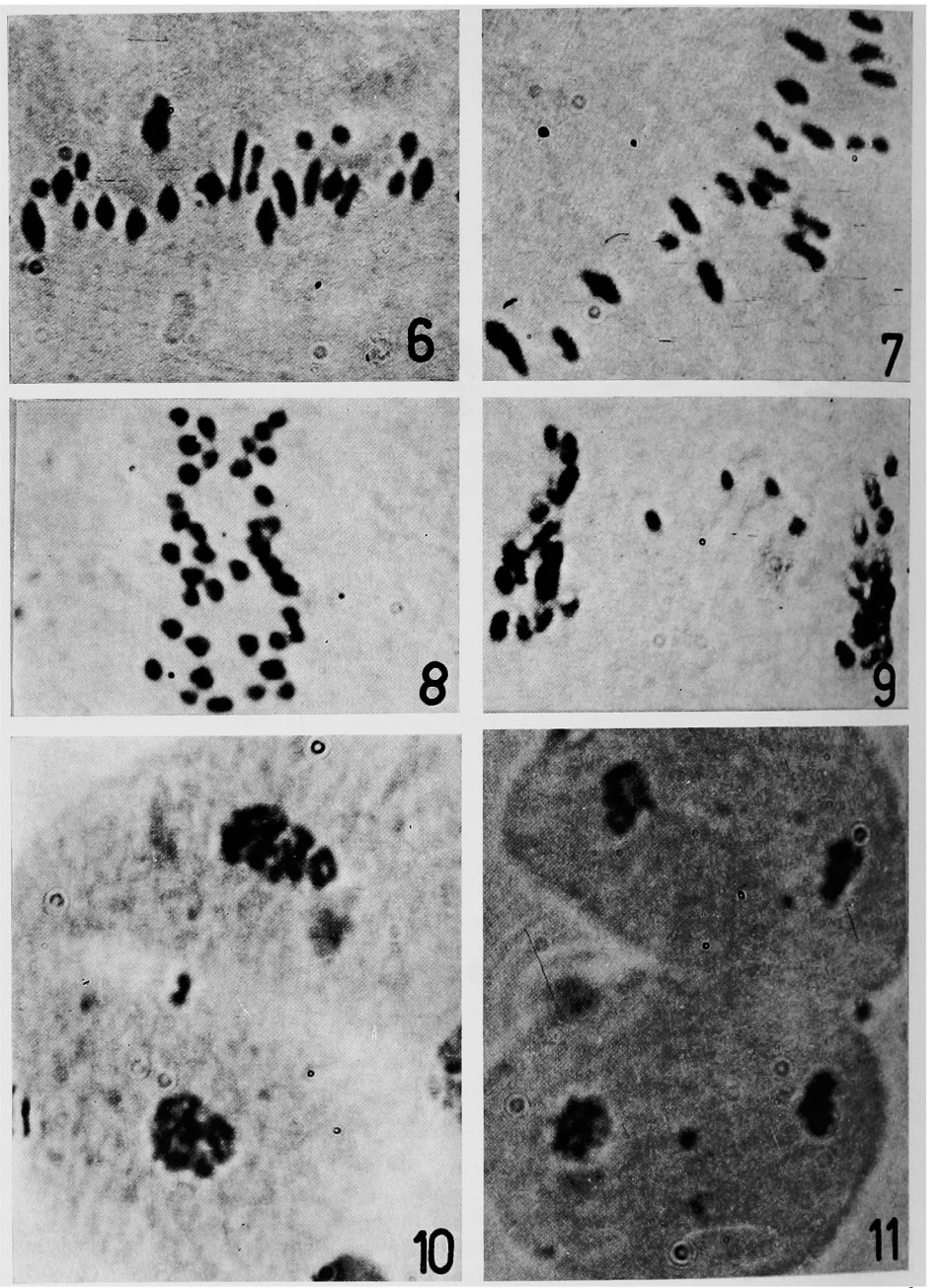
Two different accessions of *Digitaria glauca* were studied. Both of them exhibited abnormal meiotic behaviour. Meiosis in both these taxa will be discussed separately.

D. glauca (2n=45): This taxon was a pentaploid with X=9 and 2n=45. During meiosis at diakinesis and metaphase I, 45 chromosomes could be counted. The analysis of chromosome associations in this taxon is presented in Table 2. In many cells, $18^{II}+9^{I}$ could be observed (Fig. 4). Other associations like $1^{III}+17^{II}+8^{I}$ (Fig. 5) and $2^{III}+16^{II}+7^{I}$ could also be observed.

D. glauca (2n=39): This taxon was an aneuploid with a chromosome number of 2n=39. In many cells, the chromosome associations showed $18^{II}+3^{I}$ (Fig. 6). In some cases $19^{II}+1^{I}$ (Fig. 7) could also be observed. An analysis of chromosome associations in this taxon is presented in Table 3. Due to the presence of

Figs. 1–5. 1, *Digitaria bicornis*, metaphase I, showing 36^{II}. 2, *Digitaria eriostachya*, metaphase I showing 27^{II}. 3, *Digitaria swazilandensis*, metaphase I showing 27^{II}. 4, *Digitaria glauca* (2n=45), metaphase I showing $18^{II}+9^{I}$. 5, *Digitaria glauca* (2n=45), metaphase I showing $1^{III}+17^{II}+8^{I}$.

univalents at metaphase I, laggards were observed both at anaphase I and anaphase II (Figs. 8-11). Analysis of the frequency of laggards at anaphase I and anaphase II are given in Table 4 and Table 5 respectively. Similarly distributions of micronuclei at dyads and quartets are given in Table 6 and Table 7 respectively.



Figs. 6–11. Meiosis in *Digitaria glauca* (2n=39). 6, metaphase I showing 18 bivalents and 3 univalents. 7, metaphase I showing 19 bivalents and 1 univalent. 8, early anaphase I showing 39 chromosomes. 9, anaphase I showing lagging chromosomes. 10, a dyad with a lagging chromosome. 11, anaphase II showing lagging chromosomes.

Table 2. Chromosome associations at metaphase I, *Digitaria glauca* (2n=45)

No. of PMCs studied		Trivalents	Bivalents		Univalents	Xta per cell	Xta per II
			Ring	Rod			
25	Range	1–2	2–7	10–15	7–9	24–27	1.09
	Mean	0.6	4.6	12.8	8.4	24.67	

Table 3. Chromosome associations at metaphase I (*D. glauca*, 2n=39)

No. of PMCs studied		Bivalents		Univalents	Xta per cell	Xta per bivalents
		Ring	Rod			
25	Range	5–12	6–14	1–3	23–30	1.43
	Mean	7.32	11.08	2.20	25.76	

Table 4. Frequency distribution of laggards at anaphase I (*Digitaria glauca*, 2n=39)

No. of PMCs studied	Frequency of PMCs with laggards					Mean no. of laggards/PMC
	0	1	2	3	more than 3	
124	87	16	6	13	1	0.59
	70.16%	12.90%	4.83%	10.48%	0.81%	

Table 5. Frequency distribution of laggards at anaphase II (*Digitaria glauca*, 2n=39)

No. of dyad cells studied	Frequency of dyad cells with laggards				Mean no. of lagg. per cell
	0	1	2	3	
232	167	41	19	5	0.41
	71.98%	17.23%	8.18%	2.15%	

Table 6. Frequency distribution of micronuclei at the dyad stage (*Digitaria glauca*, 2n=39)

No. of cells studied	Frequency of cells with micronuclei			Mean no. of micronuclei per cell
	0	1	2	
74	64	8	2	0.16
	86.48%	10.81%	2.70%	

Table 7. Frequency distribution of micronuclei at the quartet stage (*Digitaria glauca*, 2n=39)

No. of cells studied	Frequency of cells with micronuclei			Mean no. of micronuclei per cell
	0	1	2	
74	52	21	1	0.31
	70.27%	28.37%	1.35%	

Discussion

As indicated earlier in the text, there are a large number of *Digitaria* species which have never been examined cytologically so far. Among the four species used in the present study, two species namely *Digitaria eriostachya* and *D. glauca* were cytologically examined for the first time and no earlier cytological record is available for these two species. A third species namely, *D. swazilandensis* gave a new chromosome count. The earlier chromosome count known for this species was 2n=18 (Moffett and Hurcombe 1949). The present study gave a chromosome count of 2n=54, which is a new count for this species. For *D. bicornis,* three chromosome counts were available from earlier work. These earlier counts are 2n=36 (Chen and Hsu 1964), 2n=54 (Azam *et al.* 1954, Mary and Malik 1971) and 2n=72 (Mary and Malik 1971). The present study confirmed the earlier hexaploid count (2n=72).

From the available cytological information in the genus *Digitaria,* it is obvious that the main basic chromosome number in the genus is x=9. However, there are other reports like 2n=60 in *D. adscendens* (Mulay and Leelamma 1956), 2n=30 in *D. decumbens* (Pritchard and Gould 1964) and 2n=40 in *D. diplachne* (Gould 1960) and *Digitaria eriatntha* (de Wet 1954). These reports suggest that x=10 is another basic number in the genus. It is interesting to note that basic numbers like x=7 and x=8 have also been suggested (Mary and Malik 1971). In still other cases x=15 and x=17 are also known. These variations clearly suggest that dysploid changes in the chromosome numbers have played a significant role in the evolution of the genus *Digitaria.* However, it can be argued that the primary basic number in the genus may be x=9 and all other basic numbers are secondarily derived by the ascending or descending dysploid changes at the diploid or at the polyploid levels.

In the present study, all collections except an aneuploid accession of *D. glauca* (2n=39) conform to the basic number x=9. However, a chromosome count of 2n=39 in a taxon of *D. glauca* can not be explained on the basis of the basic number x=9. It could not be a hypertetraploid, because no multivalents were ever observed. However, $19^{II}+1^{I}$ were observed in some cases. These chromosome associations suggest that this plant is perhaps a hypoploid derived from 2n=40 (x=10) situation.

In none of the collections except pentaploid *Digitaria glauca* (2n=45), multivalents formation was ever observed. This suggests that they are all allopolyploids or else they had a very efficient diploidizing system like that found in case of wheat. In case of pentaploid *D. glauca* (2n=45), multivalents though present, but rather rare and only a mean of 0.6 trivalents per cell could be observed. However, the univalents ranging from 7 to 9 per cell could be observed in the pollen mother cells studied. This suggests that the pentaploid should have originated by a cross between an allotetraploid (AABB) and allohexaploid (AABBCC), the latter having two genomes which are present in the former. The derivations of the pentaploid from the tetraploid and hexaploid can be represented as follows:

AABB × AABBCC
(18 bivalents) ↓ (27 bivalents)
AABBC
(18 bivalents, 9 univalents)

Summary

Meiosis was studied in six collections belonging to four different species of the genus *Digitaria*. Two of these four species were studied for the first time. In another species, a new chromosome number was recorded. In the remaining fourth species an earlier known chromosome count was confirmed.

Two collections belonging to *D. glauca* were studied and both showed abnormal meiosis (2n=45; 2n=39). The details of meiosis in these two collections are presented and the implications of 2n=39 on the basic number in the genus were also discussed.

Acknowledgements

Thanks are due to U.S. Plant Introduction Division for supplying the seed material and to the Head of the Botany Department, Meerut University for providing laboratory facilities.

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