ENVIRONMENTAL INFLUENCE ON CYTOMIXIS IN *CORCHORUS FASCICULARIS* LAMK. (TILIACEAE)

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Abstract: Cytomictic behaviour (intensity assessed from the frequency of hypo- and hyperploid meiocytes formed) is noted in a single plant (to avoid any intra plant variations) of *Corchorus fascicularis* Lamk. from the natural population under a unit location (West Bengal plains, Kalyani, Nadia; latitude 22°50′ to 24°11′ N, longitude 88°09′ to 88°48′ E, altitude 9.75 m, sandy loamy soil, pH-6.89) from early June to early July 2012. Meiosis has been studied from 6 samples under the assessed period. High temperature has intensified the phenomenon of cytomixis as evidenced from the enhanced frequency of hypo- and hyperploid PMCs formation without affecting pollen fertility. Apart from cytomixis, differential condensation of chromosomes, meiocytes with 2 nucleoli, occurrence of minute fragments, high frequency of univalent formation and irregular anaphase I separation are also observed. Results obtained have been discussed.

Keywords: *Corchorus fascicularis*, Cytomixis, Temperature effect

INTRODUCTION

The unique phenomenon cytomixis has been defined as mixing of cytoplasms in somatic and reproductive cells through cellular bridging, thereby forming a syncytia involving 2 to many cells. Sharing of cytoplasmic constitutes during cytomixis seems to be predominant in male reproductive cell lines and intercellular bridge formation is a key event during the process (Mandal *et al.* 2013). Gates (1911) first described cytomixis as migration of chromatin materials through wide cytomictic connections. The phenomenon was first reported in meiocytes of *Crocus sativus* by Körnicke (1901). Cytomixis involves intercellular transfer of the organelles and other cytoplasmic constituents during spermatogenesis of animals (Roosen-Runge 1977; Carlson and Handel 1988; Ventela *et al.* 2003; Guo and Zheng 2004) and in some lower group of plants (Carr 1976; Paolillo and Cukierski 1976; Dong and Junying 1988; Kwaitkowska *et al.* 2003; Dong *et al.* 2004; Guzicka and Wozny 2005; Heng-Chang *et al.* 2007). In flowering plants, cytomixis has been noted in a wide range of taxa (Mandal and Datta 2012) predominantly during meiosis (Datta *et al.* 2005; Boldrini *et al.* 2006; Singhal and Kumar 2008; Song and Li 2009; Li *et al.* 2009; Saggoo *et al.* 2011). The preponderance of cytomixis has been noted in cytologically imbalanced plants like haploids, polyploids, aneuploids, apomictics (Nirmala and Rao 1996; Peng *et al.* 2003) as well as in hybrids (Maity and Datta 2008; Li *et al.* 2009) and in some secondary polyploids (Mukherjee and Datta 2005; Iqbal and Datta 2007; Mandal and Datta 2011) among others.

Faulty fixation (Maheshwari 1950; Takats 1959), chemical and herbicide effects (Ajay and Sarbhoy 1987), mechanical injury (Tarkowska 1965; 1966), pathological consequences (Bobak and Herich 1978; Morisset 1978), nutritional deficiency (Miljajev 1967) and environmental stresses and pollution (Malallah and Attia 2003; Haroun *et al.* 2004; Kumar and Tripathi 2008) have been reported to be the possible causes for cytomixis. However, recent evidences suggest that it is a natural phenomenon under genetic control influenced by physiological and environmental factor(s) (Soodan and Wafai 1987; Zheng *et al.* 1987; Bellucci *et al.* 2003; Boldrini *et al.* 2006; Ghaffari 2006; Himshikha *et al.* 2010; Kaur and Singhal 2012). Soodan and Wafai (1987) presumed the involvement of specific genes for cytomixis, which express only under particular environmental conditions. Yun-sheng and Yong-ping (2006) reported that the phenomenon to be controlled by poly-gene or key-gene which exists in all three genomes of allopolyploid wheat.

Persistent cytomixis (24.33% in 2009 – Maity and Datta 2009; 14.57% in 2010 – Mandal and Datta 2011; 13.21% in 2012 – Mandal and Datta 2012) was recorded in *Corchorus fascicularis* Lamk. (Tiliaceae), a wild genetic resource of cultivated jute (Mahapatra and Saha 2008), under uniform agro-climatic conditions in an identical location in West Bengal plains. Mandal and Datta (2012) also reported inter- and intra-plant variation in cytomictic behavior of chromosomes in *C. fascicularis*. Present communication reports on the influence of environmental factor(s) on cytomixis in *C. fascicularis*. The objective of the work is to add more evidences under environmental control over the unique phenomenon.

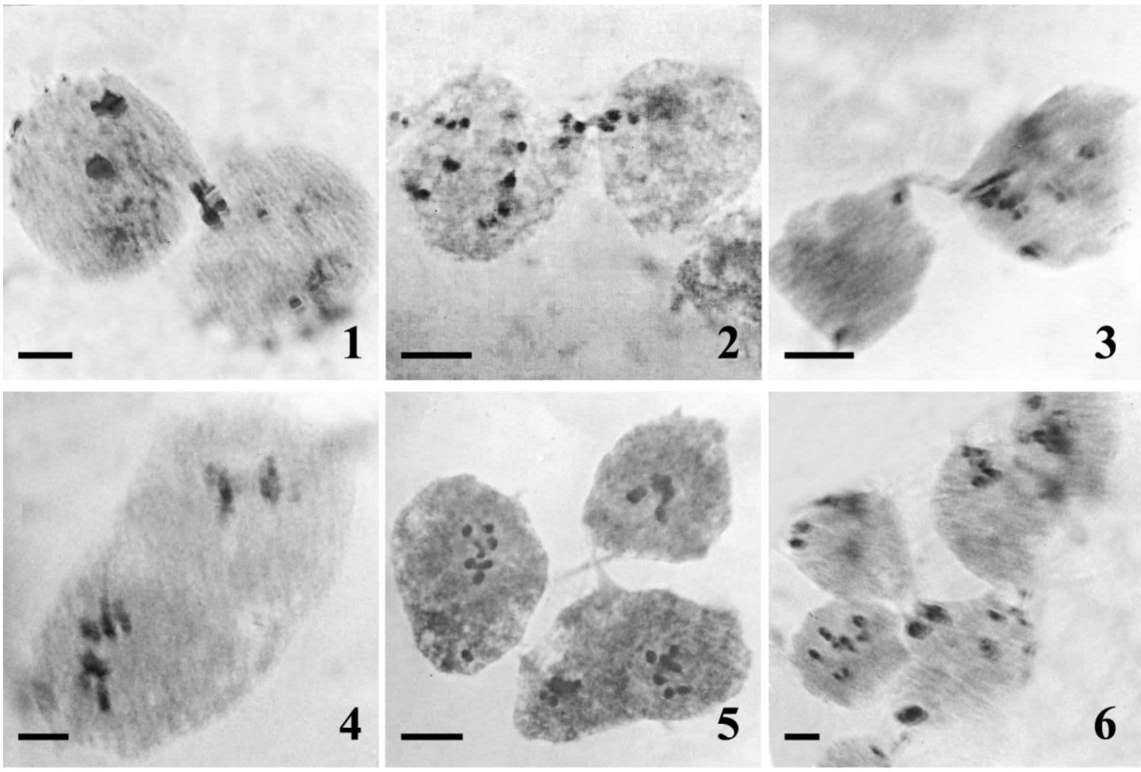

FIGURE LEGENDS

Figure plate I (1-6) showing cytomictic behavior of chromosomes in *Corchorus fascicularis*. **(1-3)** cytomixis involving 2 meiocytes; **(4)** fusion of 2 meiocytes; **(5)** sticky bridge formation between meiocytes and fusion of PMCs; **(6)** four meiocytes in a cluster. Interesting to note that aberrant meiocytes are formed and chromosomes are differentially condenced. Scale bar = 10 µm.

MATERIAL AND METHOD

A single randomly selected plant (to avoid any intra plant variation) from *C. fascicularis* (2n=14) population growing in the experimental field plots of University of Kalyani (West Bengal plain-latitude 22°50′ to 24°11′ N, longitude 88°09′ to 88°48′ E, altitude 9.75 m; sandy loamy soil, soil pH 6.85) was meiotically assessed from early days of June 2012 to early July 2012 (samples were collected in 6 different days – **Table 1**). Agro meteorological data was obtained from Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal, India. For meiotic analysis, floral buds were fixed uniformly at 6:00 AM in Carnoy's fixative in different dates of assessment (3 to 5 buds were scored in each data) and PMCs were squashed in 2% propino-carmine solution. The intensity of cytomixis was measured from the frequency of hypo- and hyperploid meiocytes scored at metaphase I (MI) and anaphase I (AI). Pollen fertility was assessed from pollen grains stanibility (Marks 1954) in 2% propinocarmine solution. Fully stained pollen grains were considered fertile. Photomicrographs were taken from temporary squash preparation and subsequently magnified.

RESULT AND DISCUSSION

Meiotic data obtained has been presented in **Table 1**. Result suggested distinctive influence of temperature on the intensity of cytomixis; although, pollen fertility was nearly similar in different observations. Mostly 2 to 4 PMCs were in a cluster **(Figs. 1-6)**. PMCs with hypo- and hyperploid chromosome numbers were formed more predominantly during enhanced temperature regime. Intercellular bridges, sticky in nature, and PMC fusions were evident **(Figs. 5-6)**. During cytomixis, transfer of chromatin materials between meiocytes showed agglutination **(Fig. 1)** and were sometimes differentially condensed. PMCs with two nucleoli were also observed during the process, thereby suggesting transmigration of nucleoli. Apart from cytomictic behavior of chromosomes, fragments of variable number (1 to 5) and sizes (0.04-0.09 µm) with possible constrictions, enhanced univalent frequency including complete lack of pairing (14I formation) and irregular AI separation are also reported. Pollen size did not show any marked variations during the assessed periods and it ranged from 36.4 µm ± 0.87 × 29.5 µm ± 0.17 to 42.80 µm ± 0.28 × 32.4 µm ± 0.91. Rare often (3 out of 7398 – 0.07%) relatively small sized (24.97 µm × 17.83 µm) pollen grains were observed but such type of pollen grains are rather not uncommon in *Corchorus* spp. where cytomixis has not been evident. Meiotic analysis in the marked plant thereafter (mid-July to early August

2012 – rainy season; temperature 26°-32°C, humidity 76-82%, rainfall 150-325 mm) showed incipient cytomixis without the formation of aneuploid and polyploid PMCs.

de Souza and Pagliarini (1997) reported that high temperature and water scarcity during summer season possibly accounted for cytomixis in *Brassica napus* and *B. campestris*, normally grown in winter. The high temperature has been also considered to be the cause of the high incidence of cytomixis in *Hemerocallis* (Narain 1979), *Ervatamia divaricata* (De and Sharma 1983), *Helicanthes elastic* (Soman and Bhavanandan 1993), Rose (Pécrix *et al.* 2011), among others. Malallah and Attia (2003) suggested that cytomixis observed in *Diplotaxis harra* may be associated with temperature and drought stress phases prevailing during the growth season in Kuwait. On the contrary, Kaur *et al.* (2010) reported cytomixis in *Poa annua* while growing wild in higher altitudes but the species depicted normal meiosis in plains. In the present investigation, cytomixis studied irrespective of its intensity did not affect pollen fertility. However, formation of heterogenous pollen grains and reduction of pollen fertility and viability due to cytomixis have been reported in plant species (De and Sharma 1983; Baptista-Giacomelli *et al.* 2000; Bellucci *et al.* 2003; Rani *et al.* 2010; Saggoo *et al.* 2011; Srivastava and Kumar 2011). Gayen and Sarkar (1996) reported enhanced pollen fertility (15 to 20 folds) in maize haploids with extensive cytomixis.

Table 1. Cytomixis and pollen fertility in different studied periods of *C. fascicularis*

Samples	Climatic factors	Number of cells scored at diplotene and MI	Frequency (%)			Number of AI cells scored	Equal (7/7) separation (%)	PMCs with aneuploid chromosome number at AI (%)		Total number of pollen grains scored	Pollen fertility (%)
			Hypoploid	Hyperploid	Total			Hypoploid	Hyperploid		
1	T: 39º-30ºC; H: 85.51%; R: 0.00 mm	123	8.94	13.82	22.76	87	88.51	0.00	3.44	1479	69.17
2	T: 39.4º-29Cº; H: 94-61%; R: 0.00 mm	93	6.45	8.60	15.05	82	86.59	0.00	4.88	1234	72.93
3	T: 32º-25Cº; H: 88-69%; R: 13.0 mm	138	2.90	3.62	6.52	68	88.24	0.00	0.00	1169	76.65
4	T: 32.2º-26Cº; H: 91-69%; R: 20.0 mm	220	1.36	5.45	6.81	111	79.28	0.00	0.00	1081	74.01
5	T: 31.6º-26ºC; H: 89-62%; R: 10.0 mm	77	0.00	6.49	6.49	73	95.89	0.00	0.00	1322	72.01
6	T: 38º-27ºC; H: 91-68%; R: 7.00 mm	147	3.40	7.48	10.88	81	88.89	0.00	3.70	1113	71.34

1=05.06.2012, 2=11.06.2012, 3=17.06.2012, 4=22.06.2012, 5= 02.07.2012, 6=09.07.2012; T= Temperature, H= Humidity, R= Rainfall

CONCLUSION

High temperature has intensified cytomictic behavior of chromosomes in *C. fascicularis*, and it is in accordance to the current concept that the phenomenon is influenced by the environmental factor(s). In the context, it would be relevant to accord the suggestion provided by Mandal and Datta (2012) that cytomixis is a natural process under gene control, and the gene(s) involved in the process may be differentially expressed or repressed under a given set of condition(s).

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