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Cytotaxonomic Studies of Different *Corchorus* (Jute) Species II

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Datta *et al.* (1966) worked out the karyotypes of several species of *Corchorus* (jute) and summarised the relevant literature.

In this paper the same techniques were uniformly adapted and followed in working out the karyotypes of certain other species of jute in order to come to an uniform conclusion.

Materials and methods

Seeds were soaked in conc. H_2SO_4 for ten minutes, washed thoroughly in running water and kept over a moist blotting paper inside the covered sterilized petri-dishes to enhance early germination. When root-tips were 2–3 mm, in length, they were pretreated in saturated aesculine solution at 8–10°C for about 2–3 hours. After pretreatment they were taken out and fixed in acetic-alcohol (1: 1) for 30 minutes and then taken out in a mixture of 2% aceto-orcein + 1 N/HCl in the proportion of 9: 1 and slightly warmed over a flame and kept over night.

Next day they were washed in 45% acetic acid and squashed in the same solution. Slides were microscopically examined under a Zeiss phase contrast microscope. Metaphase plates were drawn under a camera lucida.

Observations

Chromosomes of these jute species have been classified on a criterion which relates to their lengths, irrespective of their constrictions. Then they are described according to the positions of their constrictions present.

Chromosomes above 2.5 μ and upto 3.0 μ have been named as A; above 2.0 μ upto 2.5 μ as B; above 1.5 μ upto 2.0 μ as C and above 1.0 μ upto 1.5 μ as D; and below 1.0 μ as E. On this basis chromosomes are critically classified and their karyotype formulae are based (cf. Datta *et al.* 1966).

In general the A type has two constrictions at most of which one is median or nearly median and another is subterminal in position. Other A types have subterminal constriction only. The B type has two constrictions at most of which one is nearly median and another is subterminal. Other B types have subterminal constrictions only. C type of chromosomes are median to submedian only. D type of chromosomes has primary constriction which is median or submedian. E type has median primary constriction.

Diploid chromosome numbers of *C. olitorius* and *C. capsularis*, the cultivated jute species and those of other four wild species of *Corchorus* (*urticaefolius*, *siamensis*, *aestuans* and an unidentified new species from Mozambique) are 14. Those of hybrids of 2n×4n *C. olitorius* are variable, though 21 is also recorded (by Datta and Panda 1960).

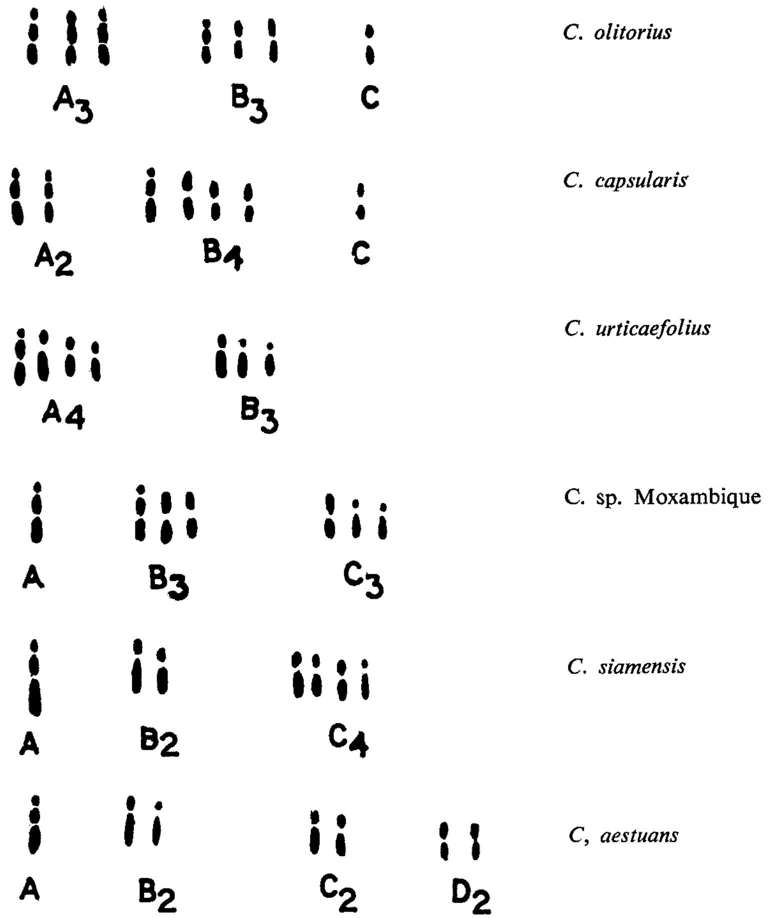

Fig. 1. Karyotypes of different wild jute species. ×2400.

Table 1 shows the frequencies of variation in the chromosome numbers observed in the somatic tissues of *C. olitorius*. Amongst 10 metaphase plates observed,

Table 1.

Metaphase plates observed	No. of 2n chromosomes
9	14
1	13
Total 10	

Table 2.

Species	Chromo-somes	Length (μ)	Av. length (μ)	"R" length	Centro-mere	No. of chromo-somes with secondary constric-tion	Chromatin content (μ)
C. olitorius	A	3.30	2.48	100.0	M	8	34.30
	A	2.75		83.8	M		
	A	2.75		83.3	M		
	B	2.20		66.6	M		
	B	2.20		66.6	Sm		
	B	2.20		66.6	Sm		
	C	1.95		59.9	M		
C. capsularies	A	3.10	2.44	100.0	M	6	32.48
	A	2.57		82.9	M		
	B	2.48		80.0	M		
	B	2.48		80.0	M		
	B	2.48		80.0	M		
	B	2.48		80.0	M		
	C	1.65		53.2	M		
C. urticaefolius	A	3.00	2.39	100.00	Sm	2	33.50
	A	2.75		91.66	St		
	A	2.50		83.33	Sm		
	A	2.50		83.33	St		
	B	2.00		66.66	Sm		
	B	2.00		66.66	Sm		
	B	2.00		66.66	Sm		
C. siamensis	A	2.50	1.86	100.00	Sm	2	26.00
	B	2.00		80.00	St		
	B	2.00		80.00	Sm		
	C	1.75		69.92	Sm		
	C	1.75		69.92	Sm		
	C	1.50		60.00	Sm		
	C	1.50		60.00	Sm		
C. aestuans =(*C. acutangulus*)	A	2.50	1.68	100.00	Sm	2	23.50
	B	2.00		80.00	St		
	B	2.00		80.00	St		
	C	1.75		69.92	Sm		
	C	1.50		60.00	Sm		
	D	1.00		40.00	M		
	D	1.00		40.00	M		
Corchorus species, wild from Mozambique	A	2.50	1.89	100.00	St	4	26.50
	B	2.25		90.00	St		
	B	2.00		80.00	M		
	B	2.00		80.00	M		
	C	1.50		60.00	M		
	C	1.50		60.00	M		
	C	1.50		60.00	M		

one was found with 13 and the rest with 14 chromosomes (by Datta and Mukhopadhaya in 1965).

Previously Datta *et al.* (1966) reported variations in the somatic chromosome numbers in *C. pascuorum* and *C. asplenifolius*.

Length, average length, "R" length, centromere etc. can be noted in Table 2.

Fig. 2. shows the total amount of chromatin content in these species. Lengths of bar diagrams are given in μ. Fig. 1. shows the karyotypes of these species.

In 1960 Datta and Panda observed a wide range of variations in chromosome numbers in the root tip cells of different hybrid population of 2n $\times$ 4n *C. olitorius* (strain C. G.). Range of variations recorded was from 12–56. 28 had the highest frequency of 12, whereas several complements has the lowest frequency of 1. In a later study (1965) on the same material Datta and Mukhopadhaya recorded certain above mentioned variations in addition to 2n=10 in the frequency of 1, not recorded before (vide: Table 3).

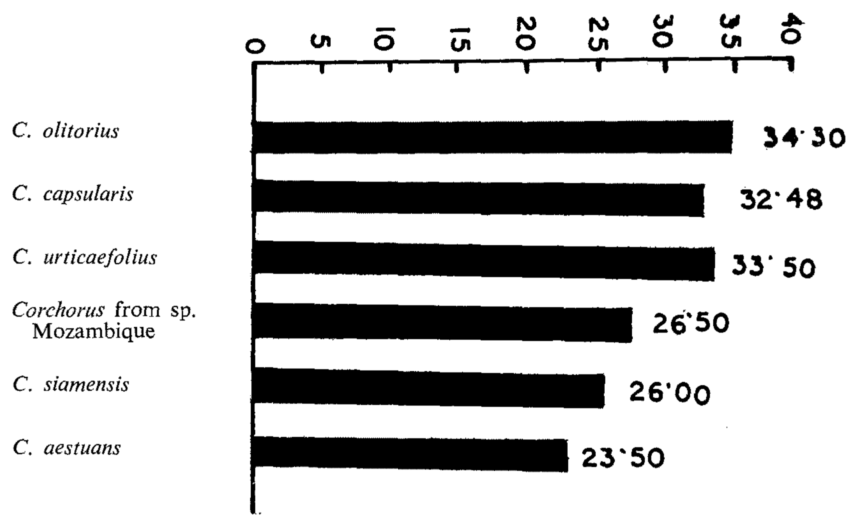

Fig. 2. Histogram showing the relative chromatin contents of these jute species.

Occurrence of 28 chromosomes in the highest frequency might be due to fertilization of an unreduced triploid gamete with one normal gamete.

Studied seedlings were composed of 2.22% hypoploids, 35.54% euploids and 62.18% hyperploids in 1969.

Studied seedlings were composed of 16.66% hypoploids, 50.00% triploids and 33.33% tetraploids in 1965.

Table 4 shows the karyotypic formulae and world distribution of these species.

Discussion

Sharma and Ray (1958) described the karyotype formulae of *C. olitorius* as $AB_2C_2D_2$ and of *C. capsularis* as AB_2CD_3 following a different technique and a different type of fixative. Datta *et al.* (1966) followed a different technique uni-

Table 3. Somatic chromosome numbers in different seedlings (root tips) of 2n×4n hybrid population of *C. olitorius* strain C. G.

Chromosome no.	10	12	14	15	16	18
Frequencies (1960)		1 (2.22%)	1 (2.22%)	1 (2.22%)	1 (2.22%)	1 (2.22%)
Percentages* (1965)	1 (16.66%)					

Chromosome no.	21	22	23	24	25	26
Frequencies (1960)	2 (4.44%)	1 (2.22%)	2 (4.44%)	3 (6.66%)	1 (2.22%)	9 (20.00%)
Percentages (1965)	3 (50.00%)					

Chromosome no.	27	28	29	30	36	45
Frequencies (1960)	3 (6.66%)	12 (26.66%)	1 (2.22%)	1 (2.22%)	1 (2.22%)	1 (2.22%)
Percentages (1965)		2 (33.33%)				

Chromosome no.	48	54	56	Total	Mean±S.E.	S
Frequencies (1960)	1 (2.22%)	1 (2.22%)	1 (2.22%)	99.94=100	27.13±1.14	8.72
Percentages (1965)				99.99=100	21.5±2.70	6.59

* Percentages (given in brackets below each frequency).

Table 4. Karyotype formulae

Serial no.	Species	Haploid karyotype	Distribution
1.	*C. olitorius*	A_3B_3C	Portugal, Africa, Madagascar, Arbia, Persia, Afghanistan, Pakistan, India, Burma, Malaysia, Siam, Formosa, Loochoo Islands, China, Philippines, Australia.
2.	*C. capsularis*	A_2B_4C	India, Bangladesh (formerly E. Pakistan) Burma, Malaysia, Siam, Cochin-China, Formosa, Loochoo Islands, China, Philippines.
3.	*C. urticaefolius*	A_4B_3	Africa, India, Sri Lanka (Ceylon), Siam.
4.	*C. siamensis*	AB_2C_4	Siam
5.	*C. aestuans* (Syn=*C. acutangulus*)	AB_2C_2D	South and North America, Africa, Pakistan, India, Bangladesh, Malaysia, The East Indies, Siam, Formosa, Loochoo Islands, China, Australia
6.	*Corchorus* species (Wild, from Mozambique)	AB_3C_3	Mozambique (Africa)

formly on several species of *Corchorus* and published their results. Following the same method as enunciated by Datta and his co-workers (1966), the karyotype formulae of *C. olitorius* and *C. capsularis* stand as A_3B_3C and A_2B_4C respectively. Further, Sharma and Ray (1958) did not give detailed measurements against each class of chromosome and concluded (p 12), "Karyotype differences between species and another suggest further the role of chromosomal alterations in structure, in speciation. This also serves to emphasize the idea that in genera, having uniform chromosome number in their species, karyotype data are useful criteria for identification of their species".

Corchorus species (wild, from Mozambique) was regarded as a form of *C. trilocularis* by the experts of the Royal Botanic Gardens at Kew, England (in a communication to Datta). Morphologically it does not show any resemblance to *C. trilocularis* except in the shape and size of flowers. Rather, in other morphological peculiarities, it shows resemblance to *C. olitorius*. Karyologically also it does not fully tally with *C. olitorius* nor with *C. trilocularis* (3M+4 Sm+0 St) (Cf. Datta *et al.* 1966, Datta 1968). Chromosomes of this species are a little smaller than those of *C. olitorius*. Most likely the present one may be a new valid species or it may be a

Table 5. Showing the presence of median, submedian and subterminal centromeres in the species studied showing comparative primitiveness of the respective species in the scale of evolution

Species	Nature of centromere			Inference
	Median	Submedian	Subterminal	
1. *C. capsularis*	7	0	0	Most primitive
2. *C. olitorius*	5	2	0	Primitive
3. *C. siamensis*	0	6	1	More advanced than 4, 5 and 6
4. *C. urticaefolius*	0	5	2	Less advanced than 3
5. *C. aestuans*	2	3	2	Less advanced than 3 and 4.
6. *Corchorus* species (wild from Mozambeque)*	5	0	2	More primitive than 3, 4 and 5

* This species is still not identified properly.

variant form of a certain species complex. Thorough systematic study and genome analysis are not yet done. In Africa there occurs maximum speciation of the genus *Corchorus*. A number of variations of each jute species also is noted due to climatic and edaphic factors. Intensive researches are needed to unravel the intricate mysteries of Nature.

C. urticaefolius and *C. aestuans* (=*C. acutangulus*) are morphologically similar in outward appearance. Karyologically they are different, though anatomically both these two species show certain similarities (Cf. Datta and Saha 1960, Datta and Miss Chatterjee in press). Morphology and anatomy also show phylogenetic similarities. They may be nearly related but genetical experiments are needed to come to a definite conclusion in this respect.

C. siamensis is an endemic species of Siam. Karyologically it is an advanced species. But it shows certain morphological similarities with those of *C. olitorius*. Further researches are going on in this laboratory on this species to come to a definite conclusion.

Huziwara (1958) remarked that there is a remarkable similarity of chromosome morphology between complements of closely related species. This has been demonstrated in many different kinds of plants. In addition, the importance of the study of karyomorphology is being highly appreciated in determining phylogeny, evolution and differentiation of species. Lewitsky's (1931) and Delauney's (1926) hypotheses have been taken into consideration in order to come to a tentative conclusion.

In the hybrid population of 2n×4n *C. olitorius*, a wide range of variations in chromosome number is noted. Studied seedlings were found to be hypoploids, euploids, hyperploids in addition to normal triploids. Ising (1966) also recorded variations in chromosome number in 4n×2n hybrids of *Cyrtanthus*. In case of actual triploids in jute the karyotype was studied and the karyotype formula stands as $A_9B_9C_3$.

It is evident from the present study and the previous one (Cf. Datta *et al.* 1966) that evolution in this genus is not only divaricate but intricate also.

Summary

1. Karyotypes of 6 jute (*Corchorus*) species are worked out. Detailed measurements of chromosomes are given. Karyotype formula for each species is given on the basis of measurements in this genus.

2. Evolution seems to be divaricate but intricate also.

References

Datta, R. M., Panda, B. S., Roy, K., Bose, M. M. and De, T. K. 1966. Cytotaxonomic studies of different *Corchorus* (Jute) species I. Bot. Mag. Tokyo **79**: 467–73.

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Delaunay, L. S. 1926. Phylogenetische Chromosomenverkürzung. Z. Zellforschg. und mikrosk. Anatom. **4**: 338–364.

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Lewitsky, G. A. 1931. The karyotype of systematics. Bull. Appl. Bot. **27**: 187–240.

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Note added to proof:

In 1968 Basak, S. L. and Biswas, P. K. published the following: Basak, S. L. and Biswas, P. K.–(1968) Pairing behaviour of chromosomes in autotetraploid of jute (*Corchorus olitorius* L.). Cytologia Vol **33**: 50–53.

In 1974, Ghosh, P. L., Paria, P. and Basak, S. L. again published the following:

Ghosh, P. L., Paria, P. and Basak, S. L.–1974 Pairing behaviour of chromosomes in autotetraploid of jute (*Corchorus capsularis* L.).–Cytologia Vol **39**: 91–96.

In both these references these learned authors missed to refer to earlier reference published in 1963:

Datta, R. M.-(1963) Investigations on the autotetraploids of the cultivated and the wild types of jute (*Corchorus olitorius* Linn. and *C. capsularis* Linn.).-Züchter, Bd. **33** (H. 1): 17–33.

In the above reference pairing behaviour of these two jute species with other details are exhaustively dealt with.

In a subsequent contribution I along with my student Dr. B. S. Panda added further details in case of 4n *C. capsularis*. For sake of reference I am quoting below:

Datta, R. M. and Panda, B. S.-(1963) Further studies on meiotic chromosome pairing and sporad analysis in the population of 4n cultivated *Corchorus capsularis* L. (Strain: D 154)-Ind. Agric. **7**: 128–132.

Ghosh, Paria and Basak in their last contribution (1974) had criticised our findings at p. 94–95 in this manner:

"Both the species of cultivated jute, *C. capsularis* and *C. olitorius* are strictly diploid as revealed from their diploid pairing behaviour. Hence a pentavalent and that too in the form of ring as reported by Datta and Panda (1963) seems to be highly doubtful as it is not possible to form a pentavalent ring by five homologous chromosomes unless one of them is an isochromosome".

It appears they have based their criticisms on our figs. 1 and 2 published in Ind. Agric. Vol 7: 128–132. In my Fig. f (p. 22) of my paper in Züchter, 33 Band, 1963 I also recorded a ring pentavalent in 4n *Corchorus olitorius*. In the population of 2n×4n *C. olitorius* (Cytogenetical studies on an autotriploid (2n×4n) *olitorius* jute (*Corchorus olitorius* Linn. Strain; Chinsurah Green)—Züchter. Bd. **34** (8): 335–340. 1964) I have noted rings of six chromosomes also. In case of six types of quadrivalents noted in 4n *C. olitorius* and *C. capsularis* I recorded that the simple ring type is 61.8% and the simple chain is 29.4%. Rest were of the remaining last four types. The wide variation in the shapes of quadrivalents indicates that there are fundamental differences in the groups of chromosomes. This further suggests that the original diploids from which the tetraploids have been produced are themselves secondary polyploids (Cf. p. 23, Züchter 1963) or these diploids might have involved homologous segments in apparently non-homologous chromosomes. It appears to me that observations of Basak and others are based on meagre data, hence leading to erroneous conclusions.

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