TOWARDS EVOLVING A TRISOMIC SERIES IN JUTE

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THE utility of aneuploid analysis in applied plant breeding and fundamental genetic work is well recognised. The contribution of Sears[1] in establishing the breadwheat monosomics is an outstanding example of the value of aneuploids, not only for the precise elucidation of the genetic architecture of the wheat plant but also for evolving superior plant types, through the systematic incorporation of desired chromosomes. Thus, the Chinese Spring wheat monosomics are now used the world over by wheat breeders for the location and transfer of rust-resistance genes in their otherwise superior varieties. In a diploid such as jute (*Corchorus olitorius* and *C. capsularis* : $2n = 14$), since it cannot tolerate loss of whole chromosomes, the addition lines provided by trisomics would be of great value, both for fundamental genetic and applied breeding work. This is of particular significance in a crop like jute where further advance in breeding is now seriously hampered by a lack of adequate genetic data.

The first report of a trisomic jute plant was by Nandi[2] who recorded its spontaneous occurrence in *C. capsularis*. No further report is available until that of Swaminathan and Iyer[3] who isolated two trisomic individuals from the F_2 generation of the cross *C. olitorius* × *C. capsularis*, where the male parent used was grafted on *C. olitorius*. Subsequently, a larger number of trisomics were recorded in the F_2 of the second such hybrid obtained by them using grafted *C. olitorius* as female parent and irradiated pollen of *C. capsularis*. These trisomics as well as others obtained from diploid × autotetraploid crosses and from irradiated populations and their subsequent progenies have been carefully maintained and screened year after year, and subjected to detailed cytological and genetic analyses. The results of this study, obtained so far, are summarised in this paper.

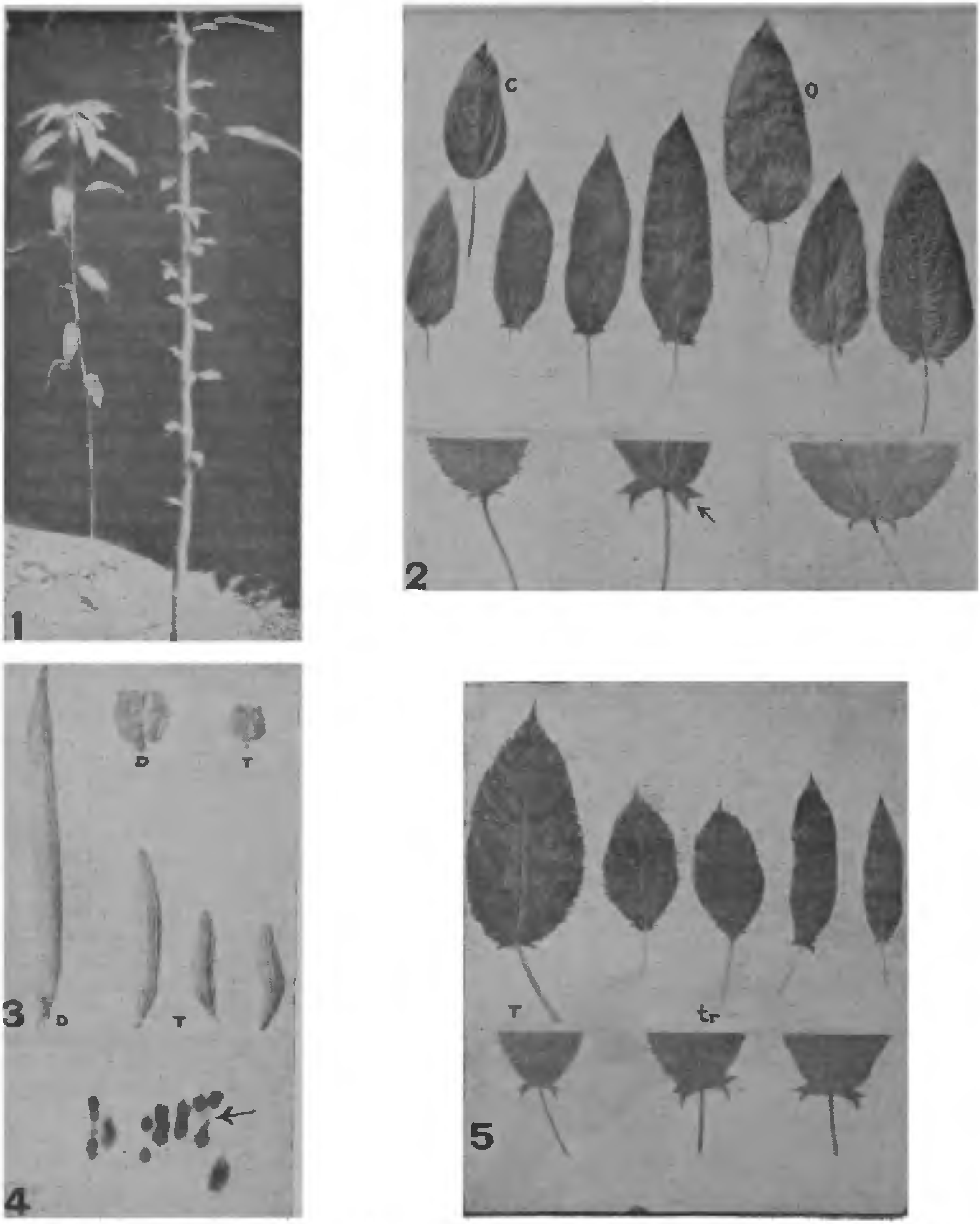
Sources of Occurrence.—The trisomic population built up in jute arose from the following sources : (*i*) F_2 and subsequent progenies of the interspecific cross, *C. olitorius* × *C. capsularis* made by Swaminathan *et al.*[4] and the backcrosses of these trisomics with the two parents, and of crosses between themselves, (*ii*) progenies of diploid × autotetraploid and subsequently triploid × diploid crosses in *C. olitorius*, and (*iii*) M_2 and subsequent generations of fast-neutron and gamma-irradiated *C. olitorius* and *C. capsularis* varieties.

The varieties of *C. olitorius* used in this study were, C.G., JRO 632, JRO 620 and KT-1, and of *C. capsularis* were, JRC 321, JRC 412 and JRC 212. The standard method adopted for screening trisomics was the location of the suspected trisomic individuals at the time of thinning the crop (3-4 weeks after sowing), labelling them and subsequently confirming as many as possible by cytological examination of the microsporocytes at meiosis, and then collecting single-plant seeds after bagging. Since many of these plants had poor seed-set, they were sown in pans and the seedlings after identification were transplanted either to pots or in the field. Since mortality was generally higher under field conditions, particularly following heavy rains, a very large population had to be transplanted to pots, from the field.

DIAGNOSTIC FEATURES OF TRISOMICS

Seedling Characters.—At the time of thinning, the jute plants are about 3-6 inches tall with 3 to 5 leaves. The trisomic plants could easily be spotted out by the characteristic glossiness of the adaxial leaf surface and a slight dorsiventral curvature of the lamina. In most cases, the leaves were oblong-ovate but the extra shine of the upper surface was the chief marker at this stage.

Adult Plant Characters.—As the plants grew taller, the trisomics were initially slow-growing, unbranched, generally weaker than the corresponding diploid sister-plants (Fig. 1). The most interesting feature was in the doubled nature of the filiform appendages at the base of the leaf-margin, which in the normal diploids was single on either side. Instead of one marginal tooth on each side being extended, the two last pairs of teeth became extended to varying lengths, thus furnishing a very distinctive marker phenotype (Fig. 2). In addition, there was segregation for intensity of anthocyanin pigmentation in different trisomic lines.



FIGS. 1–5. Fig. 1. A trisomic F_2 (left) from the cross *Corchorus olitorius* × *C. capsularis*, at the onset of flowering, with the more vigorous diploid segregant alongside. Fig. 2. Leaves from six different types of trisomic hybrids (F_7), compared with those of the two parents, *C. capsularis* (*c*) and *C. olitorius* (*o*); note the prominent double nature of the filiform appendages (arrow). Fig. 3. Fruits of the diploid (D) parents with their corresponding trisomics (T), showing the characteristic stunting; the sub-globose capsules are those of *capsularis*. Fig. 4. Metaphase plate from meiosis I of microsporocytes, showing a distinct trivalent (arrow), and six bivalents, taken from the original slide of F_1 meiosis prepared in 1960, proving the trisomic nature of the interspecific hybrid. Fig. 5. Leaves from four different trisomic plants (*tr*) derived from the diploid × autotetraploid crosses in *C. olitorius*, compared with that of the tetraploid parent (T); note the large double appendages (enlarged below).

Flower and Fruit Characters.—The trisomics were early to flower but produced fewer flowers since those formed first usually dropped of Stamens were fewer in number than in the normal diploid *C. olitorius*, and pollen fertility ranged between 50–70%. Meiosis in microsporocytes revealed the occurrence of either 7 bivalents and a univalent or 6 bivalents and a trivalent, thus providing two groups of trisomics. The most distinctive feature of trisomics in jute was the stunting of the capsules in both *C. olitorius* and *C. capsularis* (Fig. 3). In fact, the former group of trisomics was quite reminiscent of the short-capsuled F_1 plant isolated by Swaminathan *et al.*,[4] from the *olitorius* × *capsularis* cross. The close resemblance in fruit-shape, leaf type, plant habit and even meiotic behaviour prompts this author to believe that the F_1 hybrids obtained by us earlier were most probably trisomics by themselves. A re-examination of the original slides of F_1 meiosis did show a few cells with 6 bivalents *plus* 1 trivalent clearly (Fig. 4).

Our earlier observation[3] of the occurrence of capsules in bunches in the first two trisomics isolated by us, and the suggested possibility of the extra chromosome being from the *capsularis* genome, did not find support in the subsequent generation of these trisomics. Hence, bunching of capsules cannot be considered as a stable marker, nor as any influence of *capsularis* chromosome.

It is interesting to recall that these two trisomics obtained from the F_2 progeny of the first hybrid between *C. olitorius* var. C.G. × *C. capsularis* var. JRC-13 (grafted on the former) proved inviable in F_4 and subsequent generations, whereas the 15 trisomics isolated from the F_2 of the second hybrid between grafted *C. olitorius* var. JRO-620 × *C. capsularis* var. JRC-412 (2,000 *r* X-rayed pollen) have proved more viable and a very large population of trisomics has now been built up from this material at I.A.R.I. The trisomics from the latter source have been back-crossed to the two parental species and a whole gamut of recombinant trisomics have resulted from this. An interesting observation is the recovery of a greater percentage of trisomic individuals in the progeny of the cross between a trisomic and *C. capsularis* than that with *C. olitorius* although the seed-set was much higher in the latter cross.

A new set of trisomics is now in the assembly line following crosses between diploid *vs.* autotetraploid and triploid *vs.* diploid *C. olitorius* vars. JRO-620 and JRO-632. The leaf-shape in these trisomics is a distinct departure from the earlier set of hybrid trisomics, in being more thick, ovoid, with larger dentations and showing the characteristic larger double appendages (Fig. 5). The third series of trisomics obtained in fast-neutron (2 Kr) and gamma-ray (20 to 50 Kr) treated progenies, again constituted a class of their own. There were vigorous types with profuse branching habit and with typical stunted fruits, and at the other extreme were the drastic mutants with poor seed-setting but with miniature fruits. Two plants of *C. capsularis* with miniature fruits have also been isolated from gamma-irradiated M_2 and M_3 progenies. One interesting mutant of *C. olitorius* var. KT-1 in the fast-neutron-treated material, which proved to be a trisomic, showed hastate leaves (nearly tri-palmate) which is a rare shape for jute, but this mutant could not be recovered in subsequent generations owing to heavy seedling mortality.

Thus, in our present collection of over 1,000 lines of trisomic jute, now under intensive cytogenetic analysis we have been able to recognise at least five distinct phenotypic groups. These have been classified on the basis of habit and vigour, leaf-shape, size and texture, and the nature of filiform appendages, pigmentation (whether fully green, light red or only stipules red), meiotic behaviour and fruit characters. While the detailed analysis of each type is being published elsewhere, suffice it to say here that it is hoped that within the next year or two, a whole set of primary trisomics for the seven linkage groups of jute (*C. olitorius*) would become available for use in genetic analysis and for possible utilisation in building up chromosome addition lines in this important bast-fibre crop.

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