

## A Monosome in Rice

by

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**Introduction :** Cytogenetics of rice and rice hybrids has not been fully studied inspite of its economic importance. One field of study is hybrid sterility. It is well established that hybrids between *indica* and *japonica* sub-species of rice show varying degrees of sterility and also that by normal selection fertile types can be secured in the progeny. The occurrence of semi-sterility in hybrids between plants of the same species namely *O. sativa* L. is of theoretical interest and hence a detailed study of the nature of this sterility has been undertaken at the Central Rice Research Institute. During such a study it was found that the hybrids between *indica* and *japonica* varieties are a good source of chromosome variability and an instance of such a variant-secured from hybrid progenies is given below. The mode of origin of such variants is inferred to be caused by the cryptic chromosomal structural differences present in the sub-species affecting the meiotic mechanism thus resulting in chromosome variability in later generations. A study of such chromosome variations would be of use in interpreting differences between the *indica* and *japonica* sub-species and also in tracing the evolution of cultivated rice. The variants may also have use in rice breeding, for it is well known that aneuploids have been successfully used in other crop plants like wheat (Sears 1953 and Sikka *et al.*, 1956) and tobacco (Cluusen and Cameron 1944).

**Material and Methods :** For the study of the genetics of semi-sterility a series of hybrids between *indica* and *japonica* rices were grown and from these cultures highly sterile plants were selected. One such plant from the  $F_5$  generation of the cross. T. 1145. (Orissa) and Taihoku (Japan) was found to have reduced spikelets, non-dehiscent anthers and sterile pollen. This plant was maintained by vegetative propagation. Initially there was no grain setting in the second crop season, but however, after continued vegetative propagation a quantity of seeds could be collected in the main season (July to October) when the sterility was only 72%. On sowing these seeds about 28% germinated and a population of 45 plants was grown in the following second crop season. This progeny and its above mentioned parent were studied cytologically.

For meiotic studies, spikelets in suitable stage were collected and fixed in propionic alcohol (3:1) between 10 a. m. and 12 noon. Spikelet tips were cut off before fixing to allow the fixative to penetrate well into the material. Propiono-Carmine was used for staining. For studying mitosis root tips were fixed in Bouin's fixative after pretreatment with alpha-bromo-naphthalene and passed through chloroform series. Sections were cut at a thickness of 10 microns and stained in Heidenhain's haematoxylin. Camera lucida drawings were made at bench level using oil immersion objective (100 X).

**Experimental Results :** Cytological studies of the root tips showed that the parent plant (Culture No. 159-32-4-15) was a monosome having 23 chromosomes (Fig. 1), one less than the normal complement of 24. This number was confirmed also subsequently after vegetative propagation. It is inferred that this plant originated by the union of a 11 chromosomed gamete with a normal one having 12 chromosomes. The chromosome deficiency could have arisen by the non-disjunction of one bivalent, an inference supported by the observation of Sampath and Mohanty (1954), who found the occurrence of anaphase bridges and laggards in the M. I. stage of P. M. C. in *indica* x *japonica* hybrids.

Normally a monosome is expected to segregate for normal and sterile plants, just as there would be segregation for chromosome number. This expectation was not confirmed in the population of the progeny. On the contrary the progeny showed uniformity for medium height, high sterility, slightly reduced spikelet size (comparatively larger than the spikelets of monosome) narrow leaf (slightly broader than the leaves of monosome) and flowering duration. The cytological studies also revealed a uniformity in chromosome number in the samples studied, all of them possessing 12 bivalents (Fig. 2) as observed in the diakinetik as well as metaphase stage of meiotic division of P. M. C. This number was confirmed by studying the root tips where 24 chromosomes were counted in the somatic metaphase. The probable explanation for the prevalence of only normal diploids in the progeny is that union occurs only between gametes possessing the full complement of 12 chromosomes, the chromosome deficient gametes being eliminated on selfing. Such a 24 chromosomed plant should ordinarily be fully fertile. Since the monosome was obtained from the *indica* x *japonica* cross, the genic balance in the progeny will control fertility and the high sterility is attributable to genic factors.



FIG. 1

R. T.; Monosome-Somatic metaphase  
( $2n = 23$ ); X 2200

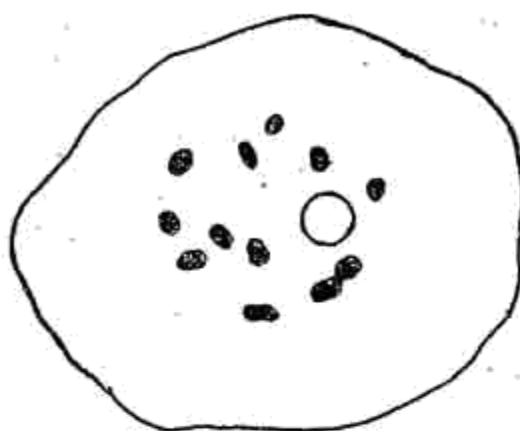


FIG. 2

P. M. C.; Progeny of Monosome  
(10 II + 1 IV), X 2200

The cytology of sterile diploid progeny derived from the monosome showed the following interesting feature. Six plants, in all, were used for study of meiosis in the P. M. C. Frequently in these cells from all the six samples, one quadrivalent was observed in proximity to the nucleolus. The cytogenetics of this progeny is being studied further. Since they are completely sterile in the second crop season, crossing with normal pollen in the main season is to be done.

**Discussion:** Both the monosome and its progeny are of interest because they can be used to locate the genes carried by the missing chromosome, thus to identify a linkage group with a particular chromosome and also to trace the differentiation of *indica* and *japonica* sub-species. Previous work by Venkataswamy (1957) had shown that highly sterile true-breeding cultures can be obtained from progeny of *indica* × *japonica* crosses and also that occasional quadrivalents are present in such cultures. Since the monosome also produces such a progeny, explanation for this behaviour can be elucidated from a study of hybrid sterility in *indica* × *japonica* crosses.

One other instance of monosomy in rice has been previously reported by Sampath and Krishnaswamy (1948) and the same was studied further by Chandrasekharan (1952). Their material was strikingly different from the present instance for that monosome was completely fertile, extremely alike to the normal 24 chromosomed plant. The cause of high sterility of the present example could be due to its hybrid origin as mentioned before, as well as to identity of the missing chromosome.

In addition to the monosome, haploids, tetraploids, chromosome structural variants, as well as mutants, having narrow leaves, increased lemma size etc. have been isolated from the progeny of

*indica* × *japonica* hybrids. All these variants support the inference that chromosome structural differences exist between the species as originally postulated by Terao and Mizushima (1939) and Kuang (1951). The present work stresses the importance of looking for the very small number of mutants and chromosome variants which are likely to be present in the hybrid populations.

**Summary:** A highly sterile plant selected from the  $F_2$  generation of a cross between the rice varieties T. 1145 (Orissa) and Taihoku (Japan) proved to be a monosome having the somatic chromosome number 23. From seeds of this plant a progeny of 45 plants was raised which were uniform in appearance and completely sterile. A sample study showed the progeny to be normal diploids. It is inferred that the monosome arose by non-disjunction of a bivalent in the  $F_1$  generation. The semi-sterility of the monosome and the diploid progeny is attributed to genic unbalance arising from inter-racial hybridization. The *indica* × *japonica* hybrid progenies were observed to be a source of chromosome variants.

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