THE CYTOGENETICAL STUDIES ON SOME WEEDS OF MEGHALAYA

Abstract

BY

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I certify that the thesis entitled "The cytogenetical studies on some weeds of Meghalaya" submitted by miss Adelin Khongjee, for the degree of Doctor of Philosophy of the North-Eastern Hill University, Shillong embodies the record of original investigation carried out by her under the supervision of Late Dr. A. Singh. She has been duly registered and the thesis presented is worthy of being considered for the award of the Ph.D. degree. This work has not been submitted for any degree of any other University.

Dated Shillong,

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ABSTRACT

In the present study 23 weeds of Meghalaya belonging to the families Compositae, Poaceae, Verbenaceae and Oxalidaceae have been cytologically investigated. The study was undertaken to bring out the cytogenetic mechanisms which have provided versatility to these weedy species enabling them to colonise vast areas of Meghalaya in only a few decades.

Of the 23 species, nine have been mitotically analysed and their karyotypes have been prepared. These have been utilised to understand their inter-relationship and to correlate their morphological features with the primitive/advanced status on the basis of symmetry/asymmetry of karyotypes.

1. In the genus Eupatorium, 3 species - E. odoratum, E. adenophorum and E. riparium, were collected. E. odoratum grows upto 975 m altitude, whereas, the other two species are restricted upto 1706 m and 1956 m. The somatic number in E. adenophorum and E. riparium is $2n = 51$ and in E. odoratum $2n = 60$. E. odoratum has longer chromosomes than the other two species. The three species possess symmetrical karyotype which is in contrast to other species in the family. The somatic number indicates polyploidy; triploidy in those with $2n = 51$ and hexaploidy with $2n = 60$. It indicates

that the genus is polyphyletic and polybasic with x = 10 and 17. Evolution in the genus appears to have proceeded more through polyploidy than through asymmetry of the karyotype.

2. The other weed, Mikania micrantha, has $2n = 36$. Its karyotype is also symmetrical. However, there is polysomaty with $2n = 34$, 38 and 40 in the species. The variation in the number of somatic complements may be the means for quick and successful adaptation of the species as weed in the varied ecological niches. The cytological study of this species is the first report.

3. Two species of Galinsoga, G. parviflora and G. ciliata have $2n = 16$ and 32 respectively. Although the chromosome number in one is just half of the other, yet there is wide variation in total chromatin length, being 29.86 μ in the diploid species and 68.58 μ in the tetraploid species. The tetraploid species, G. ciliata, has also asymmetrical karyotype. The karyotype and the total chromatin length evidently reflect that G. ciliata is of the allopolyploid origin.

4. Hypochoeris radicata has $2n = 8$. The plants collected from lower and higher altitudes widely differ in chromosome lengths.

5. In the family Poaceae, 2 species of the genus Echinochloa - E. stagnina and E. frumentacea, both with 2n = 36, have been analysed. Both the species have almost similar chromatin content, but E. frumentacea has more asymmetrical karyotype than E. stagnina.

Meiotic studies have been made in all the 23 species collected from almost the whole range of their distribution in Meghalaya.

6. In the 3 species of Eupatorium meiosis displayed a number of univalents. The univalent frequency in accessions from lower altitude is much higher than in those from the higher altitude. In addition to univalents, bivalents and trivalents have been scored in sufficient number. The pairing behaviour of the chromosomes at meiosis has been critically discussed from which segmental allopolyploid nature of the three species has been inferred. Despite irregular meiosis there is high degree of seed setting which presumably means agamospermic nature of seeds. The agamospermic nature of seeds has provided stability to suitable gene combinations which have proved very successful in colonising vast areas of Meghalaya in a short span of time. Thus the successful colonisation of these species appears to be due to the agamospermic seed setting along with the means of vegetative propagation.

7. Mikania micrantha has highly irregular meiosis. The various species of the genus have an array of base numbers like 16, 17, 18, 19 and 20. Along with univalents and bivalents a few multivalents are also formed. The latter is presumably due to translocations. The occurrence of high number of univalents and chromosome mosaicism in accessions from high altitude reflect that the species is better adapted to lower altitude. A few seeds that are formed release variability which is conserved by vegetative propagation.

8. Both the species of Galinsoga, G. parviflora and G. ciliata, show regular meiosis with n = 8 and 16 respectively. The occurrence of only bivalents in the tetraploid G. ciliata confirms its allopolyploid nature which was also deduced from its karyotype. B chromosomes are found in all accessions of G. parviflora, whereas, in the tetraploid G. ciliata B's are found only in those from higher altitudes. The presence of B appears to provide some amount of fitness or superiority in colonisation of new regions.

9. Plants of H. radicata collected from high and low altitudes have a number of interesting features. It has high heterozygosity and aneuploidy, spontaneous translocations, disomic/trisomic and mixoploidy with 2x, 4x and 8x inflorescences. Such a versatile mechanism appears to confer more successful adaptive potential to the species.

10. In the genus Echinochloa, 5 species have been meiotically analysed. All of them appear to be allopolyploid as they have regular pairing with no multivalent. In one species, E. colonum, two types of cyto-types at low and high altitudes have been detected.

11. The other species, Imperata cylindrica, has shown conspicuous cytomixis. The accessions from lower and higher altitudes have significant difference in chiasmata frequency. The role of temperature in this type of chromosome pairing appears significant.

12. Six species of Panicum have been meiotically analysed of which two species, namely, P. atrosanguineum and P. khasianum. have been studied meiotically for the first time. The genus is dibasic with x = 8 in P. maximum and x = 9 in the remaining 5 species, i.e., P. paludosum, P. brevifolium, P. atrosanguineum, P. psilopodium and P. khasianum. In P. maximum 80% of the PMCs show 16 bivalents but in about 20% of them univalents to quadrivalents have been scored. The occurrence of multivalents is visualised on the basis of auto-syndetic pairing or intra-specific autopolyploidy. The speciation trend from the meiotic data appears to be directed from species with x = 9 to x = 8 due to deletion of a pair. Along with these features the species show cytomixis, but its apomictic mode of reproduction mask the deleterious effect of chromosome mosaicism.

The other 5 species have sufficient percentage of PMCs with regular and a few with irregular meiosis. Yet they have succeeded quite well in colonizing due to features mentioned in *P. maximum*.

13. *Lantana camara* with 2n = 44 is a hardy weed. It is a tetraploid showing univalents and bivalents. In spite of meiotic errors there is high degree of seed setting due to apomictic mode of reproduction. The successful genotype is thus preserved to cover large areas.

14. Three species of *Oxalis*, *O. corniculata*, *O. latifolia* and *O. corymbosa* have been meiotically studied. All the species reproduce vegetatively. There is strong incompatibility between different species. *O. corniculata*, an octaploid, forms only univalents and bivalents at meiosis and sets a few seeds. It has, therefore, more genetic potential to colonise than the other two species, *O. latifolia* and *O. corymbosa*.

Taking an overall picture of these weedy species it is evident that most of these are polyploids showing irregular meiosis leading to variation in chromosome numbers in different population. Some of them show apomixis and/or vegetative propagation. This cytogenetic mechanism confer immense breeding potential for colonization of new areas in Meghalaya.

A few of the species have been investigated electrophoretically. Protein fractions through electrophoresis have been carried out in 2 species of Galinsoga, 3 species of Eupatorium, 3 species of Oxalis and 5 species of Panicum. Comparison of similar and dissimilar bands among the various species of the genera mentioned above provide sufficient indications that cytological findings are corroborated by protein fractions. For instance, the occurrence of 4 different bands in tetraploid G. ciliata corroborates its high ploidy level as well as the fact that it has one set of dissimilar genome; in the 3 species of Eupatorium only 2 bands are similar but the other bands are species specific indicating the intermingling of genetic material. Similarly, in the 3 species of Oxalis, 2 tetraploid species have more number of similar bands indicating their closer relationship and homology than that of the octaploid O. corniculata. The five species of Panicum have very few common bands indicating their distant or remote relationship. It is thus evident that electrophoretic data can be profitably utilised in the studies of species relationship as a supporting tool to cytogenetic observations.