

## APOMIXIS AND POLYEMBRYONY IN SOME ANDROPOGONEAE FROM PAKISTAN

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### Abstract

The species *Chrysopogon serrulatus*, *Cymbopogon parkeri*, *Dichanthium annulatum* and *Themeda anathera* were studied embryologically. Apomixis was found in all the four species. Tetranucleate apomictic embryo sacs were observed in *C. serrulatus*, *D. annulatum* and *T. anathera*, whereas polyembryony was recorded in *C. parkeri* and *T. anathera*. Morphological and cytological polymorphism as present in these species is related to the apomictic form of reproduction.

### Introduction

The species *Chrysopogon serrulatus*, *Cymbopogon parkeri*, *Dichanthium annulatum* and *Themeda anathera* constitute a highly variable group of grasses. These species are high polyploids with varying number of chromosomes. In *T. anathera* however, polyploidy is superimposed with aneuploidy. Although *D. annulatum* is known to be an apomict (Celarier & Harlan, 1957; Brooks, 1958), reproductive mechanism in the remaining three species is not yet known.

A study of the embryology of these species was carried out with a view to find out whether the reproductive mechanism would provide an explanation for the morphological and cytological polymorphism. *Dichanthium annulatum* was included in this study to confirm earlier findings.

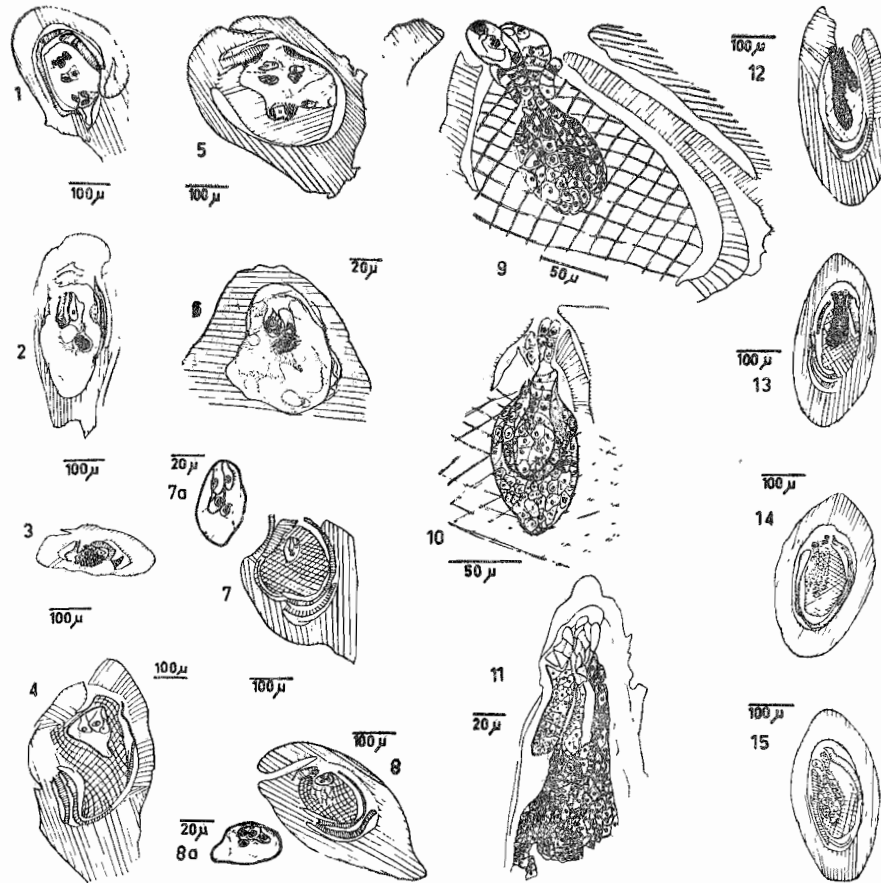
### Material and Methods

Material was collected from the Andropogoneae nursery of the Department of Genetics, University of Karachi. Ovaries from unopened florets, lying just below the already opened florets were dissected out and were fixed in Carnoy's fixative in 3:1:1 ratio of alcohol: acetic acid: chloroform. After dehydration in T.B.A. series, serial sections were cut at 14, 20 and 25  $\mu$ m and stained with safranin and aniline blue or iron alum hematoxylin.

### Results

Embryological studies in *Chrysopogon serrulatus*, *Cymbopogon parkeri*, *Dichanthium annulatum* and *Themeda anathera* showed apomixis in each of the four species. Although 8-nucleate sexual embryo sacs were observed in certain cases, the species more commonly showed either tetranucleate embryo sacs or, polyembryos or both.

In *C. serrulatus* tetranucleate embryo sacs with single polar nucleus were observed which showed diplosporous type of development, (Fig. 6).



**Legend to the figures**

- Fig. 1. 8-nucleate sexual embryo sac of *Cymbopogon parkeri*.
- Fig. 2. 4-nucleate embryo sac from apomictic *Dichanthium annulatum*.
- Fig. 3. Ovule of *Cymbopogon parkeri* showing zygote and endosperm at an early stage of development.
- Fig. 4. Tetranucleate apomictic embryo sac of *Themeda anathera*.
- Fig. 5. Binucleate embryo sacs of *Dichanthium annulatum* produced from the nucellar cells.
- Fig. 6. Diplosporous development of Tetranucleate embryo sac in *Chrysopogon serrulatus*, with the egg, Two synergids and a polar nucleus.
- Fig. 7-8. Tetranucleate apomictic embryo sac of *Themeda anathera*.
- Fig. 9-14. L.S. of ovary of *Cymbopogon parkeri* showing polyembryony.
- Fig. 15. L.S. of ovary of *Themeda anathera* showing polyembryony.

Embryo-sacs in *D. annulatum* were found arising from nucellar cells of the ovule. Although most of the developing embryo-sacs were binucleate, but 4-nucleate and 6-nucleate embryo sacs were also visible (Fig. 5). The 4-nucleate embryo sacs were regarded as apomictic, since one egg, 2 synergids and a single polar nucleus were distinctly visible. In one case a male gamete was seen lying very close to a single polar nucleus. It indicated the presence of pseudogamy. In this particular embryo sac the egg nucleus was undergoing mitotic division and the anaphase was quite clear indicating the parthenogenetic development of the egg (Fig. 2).

Tetranucleate embryo sacs each with one egg, two synergids and one polar nucleus were visible in *T. anathera* as well (Figs. 7-8). Polyembryos were also observed in some of the ovules of this species. The endosperm was well developed, with prominent nuclei in its cells. This indicated that the embryos were either apogametic or perthenogenetic and not of adventitious type (Fig. 15).

An 8-nucleate embryo sac was seen in *C. parkeri* indicating the presence of sexual reproduction (Fig. 1). In addition, 2-4 embryos per ovule were observed in a number of sections of this species. Four nucleate embryo sacs were not found in *C. parkeri* but ovules showed polyembryony and the embryos had well developed endosperm. This again indicated that these embryos developed either from the egg or from the synergids (Figs. 9-14).

## Discussion

Among the members of to Andropogoneae, Nygren (1954) found only one species with apomictic mode of reproduction. Later, this number was raised to 17 by Brown & Emery (1958). These authors in the study of apomixis in panicoid grasses established that in Andropogoneae the sexual embryo sacs are 8-nucleate while the apomictic ones are 4-nucleate. Since then 4 and 8 nucleate embryo sacs have been used for determining apomixis and sexuality in Andropogoneae by various authors (Brooks, 1958. Knox & Heslop-Harrison; 1963. Saran & De Wet 1969).

Brooks, 1958 and Celarier & Harlan (1957) following Brown & Emery (1958) found both sexual and apomictic embryo sacs in *D. annulatum*. But pollination was found necessary for the development of endosperm. Our own studies in *D. annulatum* showed mostly 4-nucleate aposporous embryo sacs.

Presence of sexual embryo sacs as well as polyembryos in *C. parkeri* point out that in this species both sexual and apomictic forms of reproduction go together. *Cymbopogon parkeri* is a polyploid species complex with varying chromosome numbers ( $2n=40,50,60$ ), morphological diversity and suspected interspecific hybridization. (to be reported elsewhere). These characteristics of *C. parkeri* seem to be promoted by the dual reproductive mechanisms as suggested for certain other taxa belonging to Andropogoneae (Celarier & Harlan, 1957; Faruqi, 1961, 1963, 1964, 1969, 1971).

Tetranucleate embryo sacs were found also in *C. serrulatus* but polyembryony and sexual embryo sacs could not be seen. Brown & Emery (1958) have reported sexual mode of reproduction in the related species *C. montanus*. He has also

reported sexual mode of reproduction in *Cymbopogon martini* and *C. nervatus*. Apomixis as pointed out in this study for the genera *Chrysopogon* and *Cymbopogon* is new.

Brown & Emery (1958) reported apomixis in *Themeda quadrivalvis* and *T. triandra* and sexual reproduction in *T. anathera*. In the present study, however, both tetranucleate embryo sacs as well as polyembryos were found in *T. anathera* which clearly demonstrated the phenomenon of apomixis. Pienaar (1955) and Hayman (1960) reported both euploidy and aneuploidy in certain other species of *Themeda*. These cytological features were also present in our collection of *T. anathera*. It seems that prevalence of euploidy, aneuploidy and morphological polymorphism in this species is also promoted by the apomictic mode of reproduction. Although sexual embryo sacs were not recorded, cytological and morphological features strongly suggest facultative apomixis for this species.

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