OBSERVATIONS ON DEGREE OF APOSPORY IN THREE MEMBERS OF *ANDROPOGONEAE*

IN most of the agamic complexes in grasses and particularly in *Andropogoneæ*, diploids are sexual, tetraploids are facultative apomicts while pentaploids and hexaploids are obligate apomicts with some exceptions. For studies of apomixis in this tribe, essentially two different methods have been used in the past: (1) Hybridization between apomicts and sexual plants, taking maternal inheritance as a proof of apomixis, and (2) Embryological methods using microtome sections or smear techniques.

In the present study, apomixis in three tetraploid members of *Andropogoneæ*: namely *Bothriochloa pertusa* (L.) A. Camus, *Dichanthium annulatum* (Forssk.) Stapf, and *Heteropogon contortus* (L.) Beauv., was studied using embryological methods. All these three grasses are excellent fodder grasses and therefore apomixis can be economically exploited. Flowering material at different stages of development was killed and fixed in navaschin. Ovaries were sectioned at 8–12 μ and stained in safranin fast green combination.

In the three materials studied, the development of the female gametophyte followed two distinctly different patterns, one of them resulting in 8-nucleate sexual embryo-sac and the other resulting in 4-nucleate aposporic embryo-sac.

Sexual Embryo-Sac.—The megaspore mother cell divided by meiotic division and gave rise to a linear quartet (Figs. 1, 2), of which only chalazal megaspore was functional (Fig. 3). The functional megaspore nucleus divided by a mitotic division and the resulting two nuclei separated to two poles (Fig. 4). Each of these nuclei divided by two successive divisions, giving rise to an 8-nucleate embryo-sac with three antipodals, two polars, one egg and two synergids. The antipodals further divided by many divisions (Fig. 5). In *Heteropogon contortus* the development of sexual sac did not proceed beyond meiosis and therefore no mature sexual embryo-sacs were observed in this species.

Aposporic Embryo-Sac.—One or more nucellar cells enlarged and functioned as aposporic embryo-sac initials (Figs. 6, 7). The nucleus which remained restricted to one pole by a big vacuole, divided twice and the resulting four nuclei differentiated into two synergids, one egg and one polar (Fig. 8). Aposporic sac or sacs were found accompanied more regularly by a single, but rarely by two, sexual sacs (Fig. 9) in the same ovule.

The frequency of aposporic and sexual embryo-sacs is given in Table I. It is evident that the relative frequency of the two types of embryo-sacs differed in the three species.

TABLE I

Frequency of aposporic and sexual embryo-sacs in three species

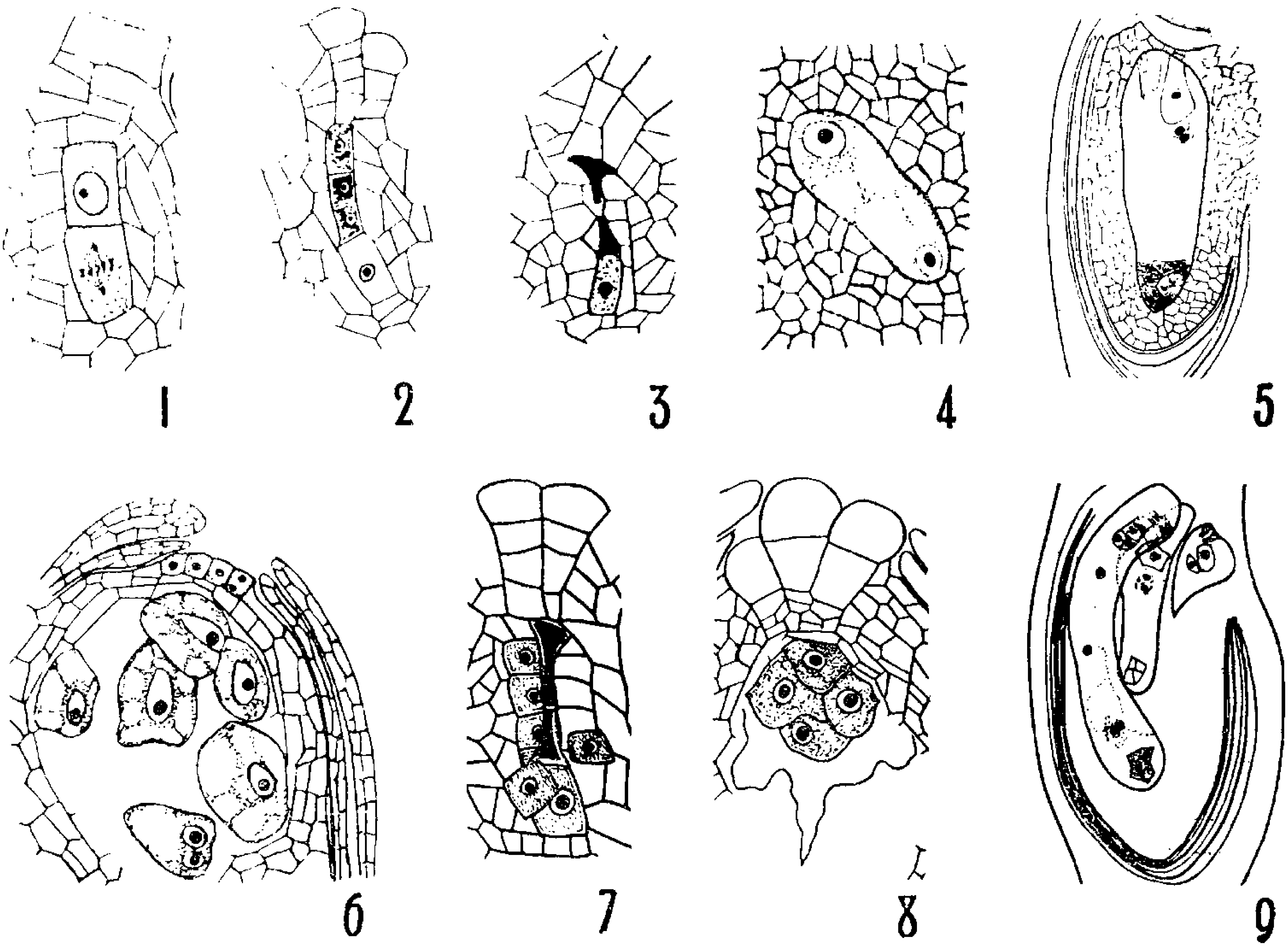
Species	Aposporic embryo-sacs	Sexual embryo-sacs	Total
(1) *Bothriochloa pertusa*	22 (36·1%)	39 (63·9%)	61
(2) *Dichanthium annulatum*	157 (67·1%)	77 (32·9%)	234
(3) *Heteropogon contortus*	203 (100%)	..	203

Measured in terms of univalents, multivalents, laggards, bridges and fragments, the results for which will be published elsewhere, the three materials used showed different degrees of meiotic irregularities. Meiosis in *B. pertusa* was least abnormal, while in *H. contortus* it was highly disturbed. The condition in *D. annulatum* was, however, intermediate. When these results are compared with those presented in Table I, a correlation between the relative frequency of aposporic embryo-sacs and the degree of meiotic irregularities is obvious.

using embryological methods. All these three grasses are excellent fodder grasses and therefore apomixis can be economically exploited. Flowering material at different stages of development was killed and fixed in navaschin. Ovaries were sectioned at 8–12 μ and stained in safranin fast green combination.

In the three materials studied, the development of the female gametophyte followed two distinctly different patterns, one of them resulting in 8-nucleate sexual embryo-sac and the other resulting in 4-nucleate aposporic embryo-sac.

Measured in terms of univalents, multivalents, laggards, bridges and fragments, the results for which will be published elsewhere, the three materials used showed different degrees of meiotic irregularities. Meiosis in *B. pertusa* was least abnormal, while in *H. contortus* it was highly disturbed. The condition in *D. annulatum* was, however, intermediate. When these results are compared with those presented in Table I, a correlation between the relative frequency of aposporic embryo-sacs and the degree of meiotic irregularities is obvious.



FIGS. 1–9. Figs. 1–5, 9. *Bothriochloa pertusa*; Fig. 6. *Heteropogon contortus*; Figs. 7, 8. *Dichanthium annulatum*. Figs. 1–3. Formation of linear quartet. Fig. 4. 2-nucleate sexual sac. Fig. 5. Mature sexual embryo-sac. Fig. 6. Many aposporic initials, one with 2 nuclei at one pole. Fig. 7. 2 overlapping linear quartets with 2 aposporic initials. Fig. 8. Mature aposporic embryo-sac. Fig. 9. 2 sexual embryo-sacs, an aposporic embryo-sac in the same ovule. (Figs. 1–4, 6–8, × 500; Figs. 5, 9, × 300).

The three species selected for the present study belonged to the sub-tribe *Andropogoninæ* of the tribe *Andropogoneæ* and were related to each other as evident from base chromosome number ($x = 10$), spike morphology and spikelets arrangement, etc. On the basis of recorded introgression Harlan *et al.* even suggested that *Dichanthium*, *Bothriochloa* and *Capillipedium* should be lumped together as one genus. It is natural therefore to expect that apomixis followed the same evolutionary path in these three species. As evident from the degree of apospory recorded in the present study, the three materials represented three stages of evolution of apomixis. The material of *H. contortus* represented the last stage, while that of *B. pertusa* represented a very early stage of such an evolution. However, the degree of apospory recorded in the three materials was not characteristic of the respective species, and one could expect to find the different stages in the same species in materials collected from different geographical regions. A species thus becomes more and more agamospermous, as the number of unreduced embryo-sacs increases and as the haploid products (pollens, embryo-sacs or egg cells) become lethal.

The author wishes to express his thanks to Prof. R. P. Roy, who initially suggested the problem and to Prof. K. S. Bhargava for providing the facilities.

Department of Botany, P. K. GUPTA.
University of Gorakhpur,
Gorakhpur, U.P., *December* 18, 1967.

---

1. Harlan, J. R., de Wet, J. M. J., Richardson, W. L and Chheda, H. R., *Okla. Agr. Exp. Sta. Tech. Bul.*, T-92, October 1961, p. 5.