J. Ind. Bot. Soc. Vol.84 (2005) 17 - 20

EMBRYOLOGY OF *BRACHIARIA ERUCIFORMIS* (J.E.SMITH) GRISEB. (POACEAE)

G.N.V.FEBULAUS & T.PULLAIAH

Department of Botany, Sri Krishnadevaraya University, Anantapur 515 003(A.P.)

Anthers are tetrasporangiate and the wall development is monocotyledonous comprising endothecium, middle layer and tapetum. Tapetum is of the Glandular type with 2- or 3-nucleate cells. Endothecium develops fibrous thickenings when the pollen grains are at 2-celled stage. Meiosis is normal and successive cytokinesis leads to the formation of isobilateral microspore tetrads. Pollen grains are monocolpate and 3-clled at the time of shedding. The ovule is hemianatropous, bitegmic and pseudocrassinucellate with monosporic Polygonum type of embryo sac development. Endosperm development is of the Nuclear type. Embryo development conforms to the Asterad type.

Key words: Embryology, Poaceae, *Brachiaria cruciformis*

The genus *Brachiaria* belongs to the tribe Paniceae, sub-family Panicoideae of the family Poaceae. Very little embryological information is available on this tribe. Embryology of *Brachiaria ramosa* has been worked out by Bhanwra *et al.* (1985) while Febulaus and Pullaiah (1991) studied the embryology of *Brachiaria reptans*. The embryology of *Brachiaria cruciformis* (J.E.Smith) Griseb. has not been worked out earlier.

MATERIALS AND METHODS

The material was collected from the natural populations growing in Reddipalli farm in Anantapur district. Inflorescences at different stages of development were fixed in Formalin-AceticAcid-Alcohol (F.A.A.). The florests were dehydrated in tertiary butyl alcohol series and usual methods of infiltration, embedding and sectioning were followed. The sections were stained in Delafield's haematoxylin and mounted in Canada balsam. Voucher speciomen No. *GNVF* 5680 has been deposited in the Herbarium of Sri Krishnadevaraya University, Anantapur.

E mail: pullaiaht@yahoo.co.in
Communicated by : M. Iqbal

OBSERVATIONS

Microsporangium, microsporogenesis and male gametophyte: The anthers are tetrasporangiate. Archesporium is hypodermal consisting of a single row of 4-6 cells that undergo periclinal divisions forming primary parietal and a primary sporogenous layer (Fig. 1 A,B). The primary parietal layer undergoes one more periclinal division forming two layers of which the inner again divides periclinally to give rise to middle layer and tapetal layer (Fig. 1 C,D). This represents a monocotyledonous type of anther wall development (Davis, 1966). The epidermal cells undergo only anticlinal divisions to keep pace with the expanding anther. The sub-epidermal layer develops fibrous thickenings at about the time of formation of 2-celled pollen grains (Fig. 1 F). The middle layer is ephemeral and degenerates at 1-celled pollen grain stage (Fig. 1 E). Anther tapetum is of Glandular type and its cells become binucleate and rarely three-nucleate at 1-celled pollen grain stage (Fig. 1 E,G-I).

The pollen mother cells are arranged in two rows (Fig. 1 C,D). Meiosis is normal and successive cytokinesis leads to the formation of isobilateral microspore tetrads (Fig. 1 J-S). After seperation the microspores become more or less spherical and increase in size (Fig. 1 T-V). A vacuole appears in its cytoplasm and pushes the nucleus to a peripheral position (Fig. 1 W). Mitotic division results in the formation of a large vegetative and a small generative cell (Fig. 1 X,Y). The generative cell moves into the cytoplasm of the vegetative cell and divides to form two male gametes. The pollen grains are monocolpate and three-celled at the time of shedding (Fig. 1 Z).

Ovary and Ovule: The ovary encloses a single basal bitegmic, hemianatropous and pseudocrassinucellate

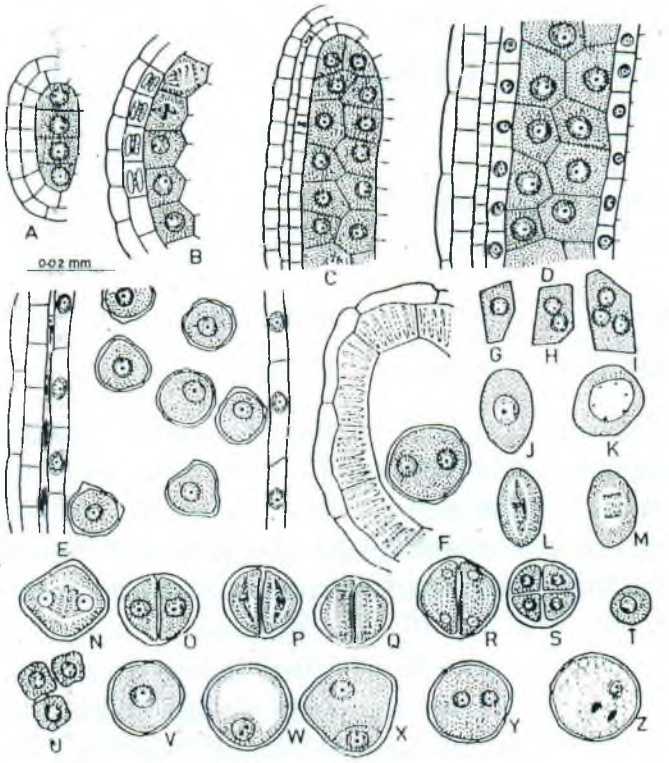

Fig. 1. A-Z. *Brachiaria eruciformis*. Microsporogenesis and male gametophyte

A-D. Longitudinal section of part of anther lobe showing wall layers and pollen mother cells; E. Anther wall showing degenerating middle layer at 1-nucleate pollen grain stage; F. Fibrous endothecium at 2-celled pollen grain stage; G-I. Tapetal cells; J-R. Meiosis in pollen mother cell; S. Isobilateral pollen tetrad; T-W. 1-nucleate pollen grains; X-Y. 2-celled pollen grains; Z. 3-celled pollen grain.

The poorly developed, 2-4-layered outer integument covers only one third of the ovule (Fig. 2 E). The 2-3-layered inner integument is formed earlier than the outer integument and alone forms micropyle (Fig. 2 E).

Megasporangium, megasporogenesis and female gametophyte: The hypodermal, single-celled archesporium (Fig. 2A) enlarges and functions directly as the megaspore mother cell. The nucellar epidermis undergoes one or two periclinal divisions to form the parietal layers (Fig. 2 B). The megaspore mother cell undergoes meiotic division and forms a

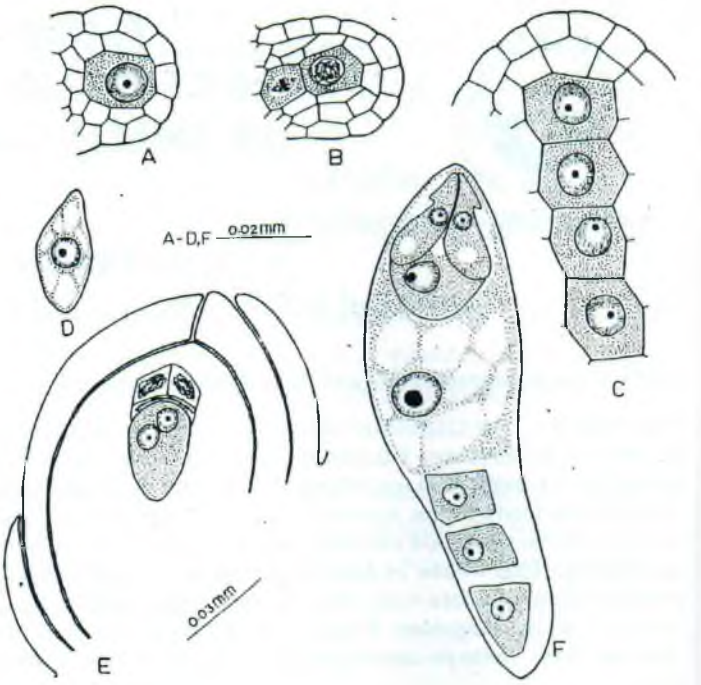

Fig. 2. A-F. *Brachiaria eruciformis*. Megasporogenesis and Female gametophyte.

A,B. Megaspore mother cell; C. Megaspore dyad; D. Megaspore tetrad; E. 1- nucleate embryo sac; F. Ovule at 2-nucleate embryo sac stage; G. Organised embryo sac.

linear or T-shaped tetrad (Fig. 2 C,E). The functional chalazal megaspore undergoes mitotic divisions to form a normal 8-nucleate Polygonum type of embryo sac (Fig. 2 D-F).

Fertilization: The actual course of pollen tube is not traced. But it appears to enter through the micropyle into one of the synergids. The syngamy and triple fusion occur simultaneously.

Endosperm and Embryo: The primary endosperm nucleus divides earlier than zygote. The divisions are free nuclear. The daughter nuclei arrange themselves along the periphery of the embryo sac (Fig. 3 A). Wall formation takes place first around the proembryo that progress towards the chalazal end. (Fig. 3 B). The endosperm becomes completely cellular.

Transverse division of zygote results in the formation of terminal cell, *ca* and basal cell, *cb*. Vertical division in the *ca* and transverse in the *cb* results in the formation of four-celled proembryo. Another vertical divcision in *ca* at right angle to the first one

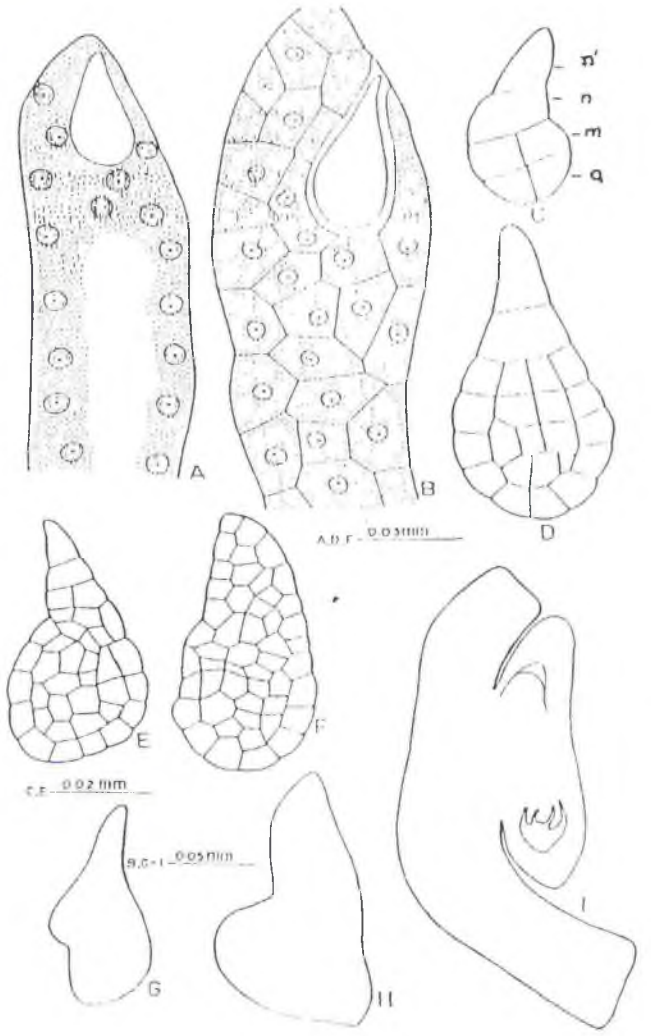

Fig. 3. A – I. *Brachiaria eruciformis*. Endosperm and Embryo. A,B. Stages in the development of endosperm, C-I, Stages in the development of embryo.

forms a quadrant. Later, transverse division in *ca* results in tier *l* and *l'* (Fig. 3 C). Further transverse and vertical divisions in the cells of *ca, m* and *ci* forms the globular embryo (Fig. 3 D-F). The organ differentiation of proembryo (Fig. 3 G) corresponds to that of rest of the members of tribe Paniceae. The mature embryo consists of the primary root ensheathed by the coleorhiza and the root cap and shoot axis bearing plumule enclosed within the coleoptile. Epiblast is absent in the mature embryo (Fig. 3 I). The developmwent of embryo conforms to the Asterad type.

DISCUSSION

The embryological features in the members of the tribe Paniceae are almost similar (Febulaus and Pullaiah, 1991, 1992, 1995, 1996). In this tribe anther tapetum is of the Glandular type and its cells to begin with are uninucleate but later become two-nucleate. In some members like *Pennisetum* (Narayanaswamy, 1953), *Panicum miliare* (Narayanaswamy, 1955a), *Echinochloa colonum, E. crusgalli* (Bhanwra and Choda, 1986), *Brachiaria ramosa* (Bhanwra *et al.*, 1985) the tapetal cells remain uninucleate. Binucleate tapetal cells are reported in *Echinochloa frumentacea* (Narayanaswamy, 1955b), *Digitaria bicornis* and *Digitaria ciliaris* (Febulaus and Pullaiah, 1996). In *Brachiaria eruciformis* (present study) two and rarely three-nulceate anther tapetal cells are observed. Successive cytokinesis leading to isobilateral microspore tetrads is a feature reported almost in all other members of the Paniceae. However, linear, T-shaped, decussate or intermediate types are reported in *Echinochloa colonum, E. frumentacea* (Narayanaswamy, 1955b) and *E. stagnina* (Muniyamma, 1978). T-shaped and linear microspore tetrads are also reported in *Urochloa panicoides* (Basavaiah and Murthy, 1989).

The ovule in the tribe Paniceae is bitegmic, pseudocrassinucellate and hemianatropous. Such type of ovules are reported in *Echinochloa colonum, E. crusgalli* (Narayanaswamy, 1955b), *E. stagnina* (Muniyamma, 1978), *Brachiaria distachya, Cenchrus biflorus, Paspalidium flavidum, Setaria verticillata, S. intermedia* (Bhanwra *et al.*, 1982), *Urochloa panicoides* (Basavaiah and Murthy, 1989), *Brachiaria reptans, Panicum repens, Cenchrus ciliaris, Digitaria bicornis, D. ciliaris* (Febulaus and Pullaiah, 1991, 1992, 1995, 1996) and also in the present study in *Brachiaria eruciformis*. However, Narayanaswamy (1953, 1954) reported campylotropous and crassinucellate ovules in *Pennisetum typhoideum* and anatropous ovules in *Paspalum scrobiculatum*. Crassinucellate ovules were also reported in *Panicum miliaceum* (Narayanaswamy, 1955b). Linear megaspore tetrads are common in *Brachiaria ramosa* (Bhanwra *et al.*, 1985), *Paspalum scrobiculatum* (Narayanaswamy, 1954), *Pennisetum typhoideum* (Narayanaswamy, 1953), *Urochloa panicoides* (Basavaiah and Murthy, 1989) and also in *Brachiaria eruciformis* (Present study). However, T-shaped tetrads are rarely reported in *Urochloa*

panicoides (Basavaiah and Murthy, 1989). Monosporic, Polygonum type of embryo sac is characteristic feature of the tribe Paniceae including *Brachiaria eruciformis* (present study).

Antipodal cells in members of the tribe Paniceae show proliferation. In *Pennisetum macrostachyum* (Shanthamma, 1979) they divide to produce 6-12 cells; 5-8 cells are reported in *Brachiaria distachya, Paspalidium flavidum, Setaria verticillata*, 22-25 cells in *Cenchrus biflorus* and 23-27 in *Setaria intermedia* (Bhawra *et al.*, 1982). In *Brachiaria eruciformis* only three antipodal cells have been observed.

In possessing the following characters *Brachiaria eruciformis* is related to some of the species in Paniceae; mature embryo sac oriented almost parallel to the long axis of the ovule, no change in the position of antipodals after fertilization and Panicoid type of embryo (Reeder, 1957). These features are also reported in *Pennisetum typhoideum, Paspalum scrobiculatum, Setaria italica* (Narayanaswamy, 1953, 1954, 1956), *Brachiaria distachya, Cenchrus biflorus, Paspalum flavidum, Setaria glauca, S. intermedia, S. verticillata* (Bhanwra *et al.*, 1982) and *Brachiaria ramosa* (Bhanwra *et al.*, 1985).

REFERENCES

Basavaiah & TCS Murthy 1989 A cytoembryological study of *Urochloa panicoides* P. Beauv. (Poaceae). *Proc Indian Acad Sci (Plant Sci)* **99** 453-458

Bhanwra R K, S P Choda & S Kumar 1982 Comparative embryology of some grassess. *Proc Indian Nat Sci Acad* B **48** 152-162.

Bhanwra R K, S P Choda & R Kumar 1985 Comparative embryology of *Brachiaria ramosa* and *Poa annua*. *Res Bull Punjab Univ Sci* **36** 245-253

Bhanwra R K & S P Choda 1986 Comparative embryology of *Echinochloa colonum* and *E. crusgalli* (Poaceae). *Proc. Indian Acad Sci. (Plant Sci)* **26** 71-78.

Davis G L 1966 *Systematic embryology of Angiosperms*. John Wiley & Sons, Inc. New York.

Febulaus G N V & T Pullaiah 1991 Embryology of *Brachiaria reptans*. In: *Botanical Research in India* (eds. N C Aery and B L Chaudhary), Himanshu Publications, Udaipur, p. 149-154.

Febulaus G N V & T Pullaiah 1992 Embryological studies in *Panicum repens* Linn. *Phytomorphology* **42** 125-131.

Febulaus G N V & T Pullaiah 1995 Apomixis in *Cenchrus ciliaris*. In: *Advances in Plant Reproductive Biology* (eds.Y S Chauhan & A K Pandey), Narendra Publishing House, Delhi, p. 153-162.

Febulaus G N V & T Pullaiah 1996. Embryology of *Digitaria* (Poaceae). *Phytomorphology* **46** 161-169

Johansen D A 1950 Plant Embryology. Waltham, Mass.

Muniyamma M 1978 Variation in microsporogenesis and development of embryo sac in *Echinochloa stagnina* (Retz.) P. Beauv. (Gramineae). *Bot Gaz* **130** 87-94.

Narayanaswamy S 1953 The structure and development of caryopsis in some Indian millets 1. *Pennisetum typhoideum*. *Phytomorphology* **3** 98-112.

Narayanaswamy S 1954 The structure and development of caryopsis in some Indian millets 2. *Paspalum scrobiculatum*. *Bull Torrey Bot Club* **61** 288-299.

Narayanaswamy S 1955a The structure and development of caryopsis in some Indian millets 3. *Panicum miliare* and *P. miliaceum*. *Lloydia* **16** 61-73.

Narayanaswamy S 1955b The structure and development of caryopsis in some Indian millets 4. *Echinochloa frumentacea*. *Phytomorphology* **5** 161-171.

Narayanaswamy S 1956 The structure and development of caryopsis in some Indian millets 6. *Setaria italica*. *Bot. Gaz*. **118** 112-122.

Reeder J 1957 Grass embryo in Systematics. *Amer J Bot* **44** 756-768.

Shanthamma C 1979 Reproductive behaviour of *Pennisetum macrostachyum* Benth. and a new basic number in genus *Pennisetum*. *Bull Torrey Bot Club* **106** 73-78.