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水蔗草胚珠附器的研究①

[1,2]马三梅 [2]王永飞 [1]叶秀麟 [1]梁承邺 [1]赵南先
[1]（中国科学院华南植物研究所 广州 510650）
[2]（暨南大学生物工程学系 广州 510632）

摘要 本文对水蔗草的胚珠附器进行研究，结果表明：在功能大孢子时期，珠孔端的1～3个珠心细胞开始特化，发育成胚珠附器；胚珠附器发生时，有些胚珠同时出现无孢子生殖原始细胞；有性生殖和无孢子生殖的胚囊中均有胚珠附器存在；但在无孢子生殖的胚囊中，胚珠附器一般很大，长约是宽的1～3倍；而有性生殖胚囊的胚珠附器的长约是宽的1～2倍；和有性生殖胚囊相比，无孢子生殖胚囊的胚珠附器更加发达；存在发达的胚珠附器是水蔗草无孢子生殖胚囊的特点之一。

关键词 水蔗草，胚珠附器，无孢子生殖

The Embellum in *Apluda mutica*

[1,2]MA San-Mei [2]WANG Yong-Fei [1]YE Xiu-Lin [1]LIANG Cheng-Ye [1]ZHAO Nan-Xian
[1]（*South China Institute of Botany*, *The Chinese Academy of Sciences*, Guangzhou 510650）
[2]（*Department of Bioengineering*, *Jinan University*, Guangzhou 510632）

Abstract Embellum of *Apluda mutica* was studied by light microscope. It was demonstrated that outer layer of 1-3 nucellar cells which enlarge in size and often protrude into the micropyle to form embellum at the functional megaspore stage. Both polygonum type and panicum type embryo sac have embellum. The length of embellum is about one to three times of its width in mature aposporous embryo sac, while its length is one to two times of its width in mature sexual embryo sac. The mature embellum cells in aposporous embryo sac were larger than that in sexual embryo sac. The larger embellum could be used as a secondary screening indicator for identifying aposporous embryo sac in *Apluda mutica*.

Key words *Apluda mutica*, Embellum, Apospory

The monotypic genus *Apluda* belongs to the sub-family Andropogoninae of Gramineae. *Apluda mutica* L. is a perennial grass. Murty (1973) did the first embryological study in *Apluda mutica* var. *aristita*. After three megaspores at the micropylar end had degenerated, and only the chalazal megaspore existed in the nucellus, a nucellar cell adjacent to the megaspore differentiated into aposporous initial cell. The latter developed into a panicum-type embryo sac. It was an aposporous 4-nucleate embryo sac without chromosome reduction composed of an egg, a single synergid and a central cell with 2 polar nuclei. Before the onset of the division in the aposporous initial cell, the chalazal megaspore degenerated (Ma *et al*, 2002). Embellum cell was first found by Narayanaswami (1953). However, the term embellum was first used by Busri (1993). It means nucellus cells

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作者简介：马三梅，女，博士，副教授，1971年生，河南平顶山人，从事植物生殖生物学方面的研究。
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which enlarge and may even protrude through the integuments to provide a frill of cells encircling the micropyle.

This paper reports the presence of embellum in *A. mutica* and presents light microscope evidence for their difference in aposporous and sexual embryo sac. The possible significance of embellum is considered.

1 Material and Methods

The material of *A. mutica* was obtained from a population in South China Institute of Botany, Guangzhou, China. Inflorescences in different stages were collected from plants and fixed wholly in formalin-glacial acetic acid-ethanol (FAA) solution. The fixed materials were transferred and stored in 70% alcohol at 4 ℃. 200 ovaries at different stages were taken out from the flowers by fine-tipped needles. The ovaries were stained in Ehrlich hematoxylin, dehydrated through a graded alcohol series and embedded in paraffin. The paraffin blocks were trimmed, and serially sectioned at 5 ~ 8 μm, observed and photographed by Nikon UFX-II microscope.

2 Results

2.1 Formation of micropyle

The inner integument is usually initiated first at the time of archesporial cell. The outer integument originates after the inner integument starts its development. By the embryo sac has become mature, the ovule has curved and is completely inverted, so that the nucellus and integuments lie alongside the funiculus. The inner integument is annular, while the outer integument is a semiannular outgrowth interrupted on the concawe side of the funiculus. Micropyle is formed by inner integument.

2.2 Time and location of embellum

1 ~ 3 nucellar cells at the outer layer begin to grow considerably in size when there is only one functional megaspore existed in nucellus. Such cells function as the initial of embellum. The number of the cells under consideration is variable. Sometimes there is one cell that develops into embellum; other times 2 or 3 enlarged cells were observed at the end-point of the inner integuments around the micropylar area (Figs. a,b). They are much larger than the neighbouring cells.

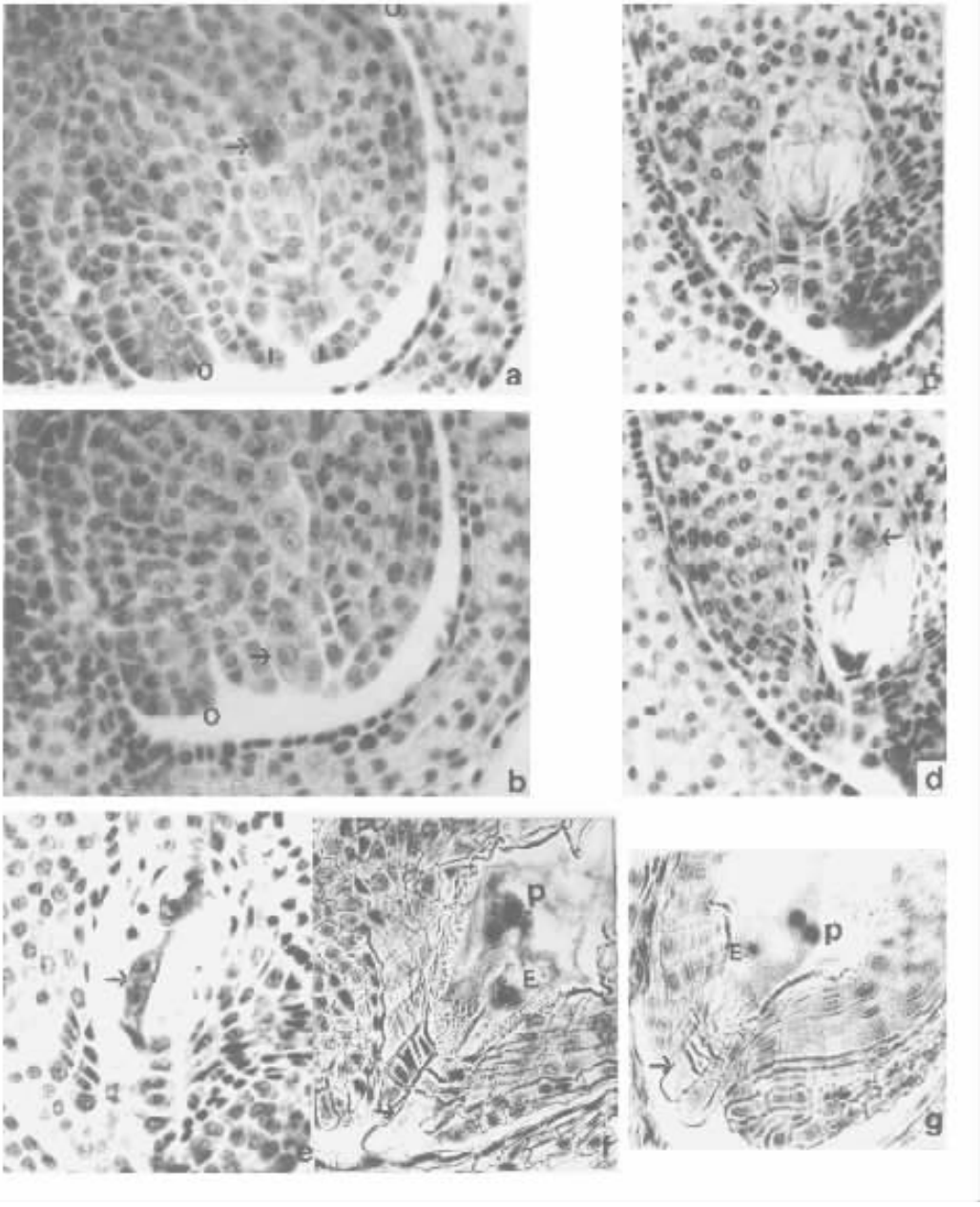
2.3 Difference of embellum in aposporous and sexual embryo sac

The embellum goes on enlarging and protruding from 2-nucleate to 8-nucleate embryo sac stage in sexual embryo sac. It protrudes into micropyle at the mature embryo sac stage. Its length ranges from 0.01 to 0.02 mm, and width about 0.01 mm. The length of the largest embellum is about 1 ~ 2 times of its width in sexual embryo sac (Figs. c, d, e), while in apomictic embryo sac, embellum varied in length from 0.01 to 0.03 mm with its width about 0.01 mm. Therefore, the length of embellum may be 1 ~ 3 times of its width (Figs. f,g). In general, the embelllum in aposporous embryo sac is more conspicuous than that in sexual embryo sac at the mature stage of embryo sac.

3 Discussion

The number of plants with embellum includes 15 species. Embellum is found in either sexual embryo sac or aposporous embryo sac. The size and the length/width ratio of embellum are reported variable in different species. The ratio is 1 in sexual reproductive *Pennisetum typhoideum* and *Echinochloa frumentacea* (Narayanaswami, 1953; 1955). There is a beaked embellum without enlargement in sexual reproductive *Oryza sativa* and *Buchloe dactyloides* (Busri *et al*, 1993). The ratio is 3 in obligate apomictic *Pennisetum squamulatum* (Liu *et al*, 2000). This also is the case in

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Figs. a, b Functional megaspore stage. Fig. a. Functional megaspore cell in first section (arrow). Fig. b. Elongation of a nucellar epidermal cell in second section (arrow) ×500. Figs. c,d,e Embellum in mature sexual embryo sac, showing an embellum (arrow) ×400. Fig. c. Embellum in the first section (arrow) ×400. Fig. d. Antipodal cell in second section (arrow) ×400. Fig. e. A central cell in third section (arrow) ×400. Figs. f,g Embellum in aposporous embryo sac (arrow), an egg cell and two polar nuclei in the aposporous embryo sac, one synergid degenerated in the embryo sac, ×500. Fig. f One embellum in aposporous embryo sac (arrow) ×500. Fig. g Two embellums in aposporous embryo sac (arrow) ×500.

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Abbreviations: E, Egg cell; P, Polar nucleus; O, Outer integument; I, Inner integument.

tetraploid *Brachiaria ruziziensis*（Gobbe *et al*，1982）. In our study，the length of embellum is about one to three times of its width in mature apomictic embryo sac，while its length is one to two times of its width in mature sexual embryo sac in *A. mutica*. It seems that the mature embellum cells in aposporic embryo sac were larger than that in sexual embryo sac in the so far observed plants. The more conspicuous embellum as a secondary characteristic of aposporous embryo sac may be used for screening apomictic embryo sac in *A. mutica*.

The hypertrophy of a pair of nucellar cells abutting the micropyle is also observed in Setaria. There is evidence that occasionally three megaspores of tetrad are functional. This would indicate the possibility of the development of twin or triplet seedlings from supernumerary embryo sacs within the ovule. Embellum may be related to the development of twin or triplet seedlings（Narayanaswami，1955）. A pair of cells abutting the micropyle appears hypertrophied and richly protoplasmic，but they disorganize prior to the entry of the pollen tube in *Echinochloa frumentacea*. It showed that embellum may not be related to the double fertilization of plant（Narayanaswami，1955）. A characteristic of the aborted ovules was the development of enlarged cells with dark staining nuclei in the micropyle region. Similar cell development has been reported previously for aborted ovules of pearl millet X napiergrass hybrids，but the function of these cells is unknown（Hanna，1981；Hanna and Dujardin，1986）. In short，the function of embellum is not clear to date.

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