

A contribution to the embryology of *Alysicarpus monilifer* D.C.

V SESHAVATHARAM

Department of Botany, Andhra University, Waltair 530 003, India

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Abstract. Embryology of *Alysicarpus monilifer* D.C. is described. The anther wall comprises the epidermis, the fibrous endothecium, two middle layers and uniseriate glandular tapetum. Pollen is shed at the 2-celled stage. The ana-campylotropous ovule is crassinucellate and bitegmic. The archesporium in the ovule is hypodermal and cuts off a parietal cell. Embryo sac development conforms to the Polygonum type. Endosperm development is nuclear. A chalazal part of the endosperm remains free nuclear and is haustorial in function. Embryogeny conforms to Period I Megarchetype IV and Series B₂. The embryogenic classification of the tribe is discussed in the light of the present observation and earlier reports.

Keywords. Embryology ; *Alysicarpus*.

1. Introduction

The tribe Hedysaraceae of the Papilionaceae includes 47 genera and 7000 species distributed in the tropical and subtropical regions of the world (Rendle 1925). Of these only 14 genera are known embryologically. The researches of Souèges (1947, 1953a, 1953b, 1955, 1956), Johansen (1950), Rau (1951, 1953, 1954), Smith (1956), Goursat (1961), Kapuskar (1964) and Deshpande *et al* (1976) reveal the embryogeny of 15 species belonging to 11 genera of this tribe. The embryology of *Alysicarpus monilifer* D.C. is described here.

2. Material and methods

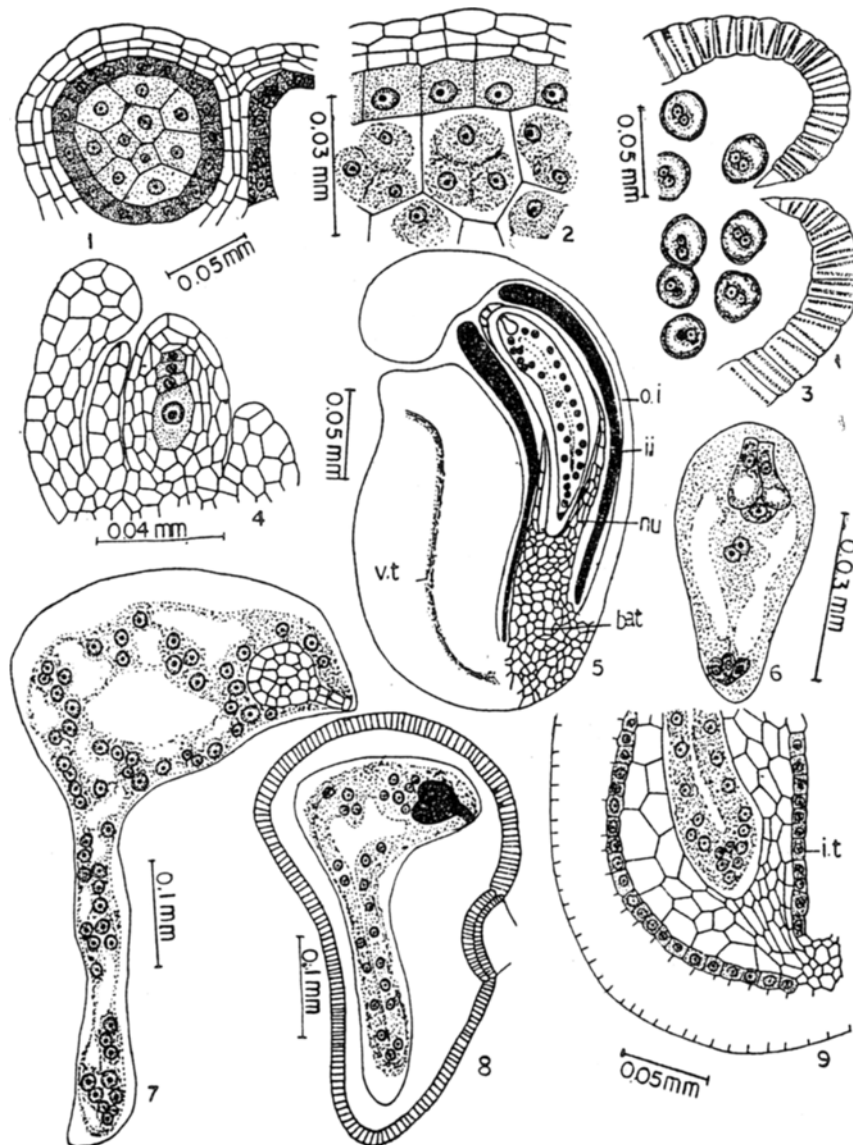
Buds, flowers and fruits of varying ages were collected from the plants growing in the university campus, during the rainy season and were fixed in FAA. Customary methods of dehydration and embedding, etc. were followed. Sections cut between 8 and 10 microns thick were stained with safranin and fastgreen. The endosperm was observed in whole mounts after making suitable dissections.

3. Observations

3.1. *Microsporogenesis and the development of pollen*

The archesporium in the anther is hypodermal represented by a single row of 4-5 cells. The primary parietal layer by further divisions forms 2-3 parietal layers of which the innermost forms the secretory tapetum (figure 1). The tapetal cells remain uninucleate throughout. Some of the cells on the connective side adjoining

the tapetum also behave like the tapetal cells in assuming a dense cytoplasm and deeply stained nuclei. The hypodermal parietal layer forms the fibrous endothecium (figure 3). The two middle layers are crushed in the mature anther. Division of the microspore mother cell is simultaneous and cytokinesis takes place by furrowing (figure 2). The pollen is shed at the 2-celled stage.



Figures 1-9. 1. T.S. anther lobe showing wall layers and sporogenous tissue ; 2. Same showing cytokinesis in pollen mother cells ; 3. Same showing fibrous endothecium and two celled pollen grains ; 4. L.S. portion of ovule showing a linear tetrad of megaspores ; 5. LS ovule showing the integuments endosperm and barrier tissue at the globular stage of embryo ; 6. Mature embryo sac ; 7. Nuclear endosperm showing chalazal elongation ; 8. LS young seed showing the embryo and endosperm ; 9. LS portion of the ovule at the chalazal regions showing the incipient integumentary tapetum and thick walled barrier tissue.

3.2. *Megasporogenesis and female gametophyte*

The ovule at maturity is campylotropous bitegmic and crassinucellate (figure 5). The single celled archesporium in the ovule is hypodermal and cuts off a parietal cell. The megaspore mother cell undergoes the usual meiotic divisions resulting in a linear tetrad of megaspores of which the chalazal is functional (figure 4). The development of the mature embryo sac conforms to the *Polygonum* type. The mature megagametophyte is 8-nucleate with an egg apparatus, two polar nuclei and three antipodal cells (figure 6). The antipodal cells are ephemeral and degenerate prior to fertilization.

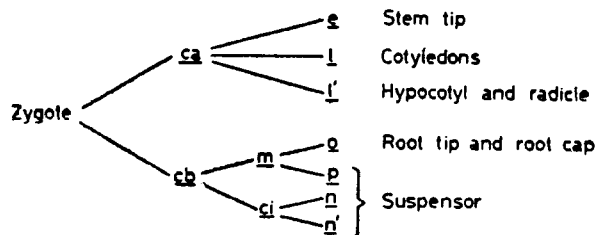
3.3. *Endosperm*

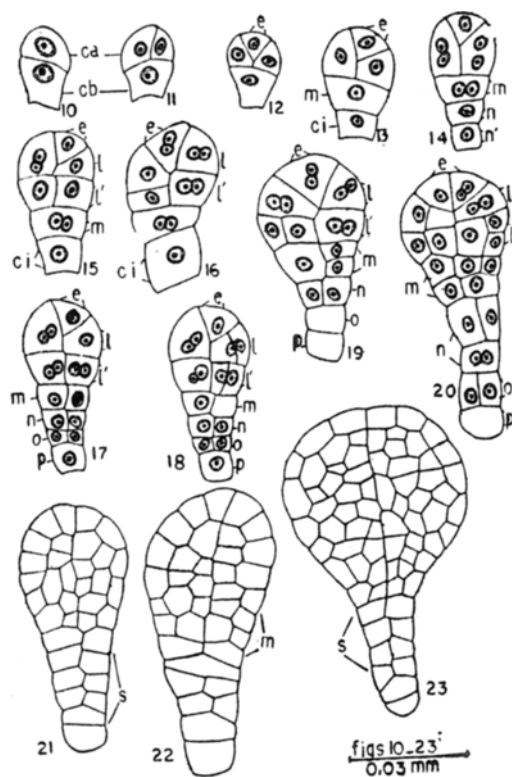
The primary endosperm nucleus divides much earlier than the zygote and the development of the endosperm is of the nuclear type. The endosperm remains free nuclear until the embryo reaches the early dicotyledonous stage (figure 8). During the course of its development the embryo sac enlarges enormously and encroaches on the surrounding nucellar tissue. This is more prominent at the micropylar region where it comes in direct contact with the innermost layer of the inner integument. At the chalazal region the tubular free nuclear part assumes a haustorial role (figure 7). The active growth of the endosperm haustorium at the chalazal end is arrested by the development of thick walled barrier tissue (figure 5). The cells of the innermost layer of the inner integument have dense contents and are prominent (figure 9).

3.4. *Embryo*

The developmental sequence in the embryogeny is illustrated in figures 10 to 23. The zygote divides transversely resulting in a two celled proembryo. The apical cell (*ca*) divides by an obliquely vertical wall resulting in two unequal cells (figure 11). Another oblique division in the larger derivative cell of the tier (*cal*) cuts off an epiphyseal initial (*e*) (figure 12). The basal cell (*cb*) undergoes a transverse division resulting in *m* and *ci*. Further divisions in the apical quadrant demarcate the tiers *l* and *l'*. Periclinal divisions in both the tiers differentiate the dermatogen. The epiphyseal initial undergoes a vertical division and by further divisions contributes to the stem tip in the mature embryo.

The cell *m* divides by a vertical wall and both the cells divide transversely. Their upper derivatives contribute to the root tip and the root cap, while the derivatives of the lower cells together with those of tiers *n* and *n'* contribute to the long and massive suspensor. A schematic representation of the zygote derivatives and their destinations in the mature embryo is given below :





Figures 10-23. Stages in the development of embryo.

Thus the embryogeny according to Souèges scheme (Crété 1963) falls under Period I, Megarchetype IV and Series B₂.

4. Discussion

The archesporium in the ovule is hypodermal in all the species investigated so far in the tribe the sole exception being *Desmodium paniculatum* where a subhypodermal archesporium was reported by Rembert (1969). However, this needs verification in view of its rare occurrence in the family Papilionaceae.

In *Alysicarpus momilifer* wall formation in the endosperm is initiated after the differentiation of the cotyledonary lobes in the embryo and is further restricted to the upper half of the embryo sac, while the chalazal part functions as the haustorium. A similar feature has earlier been reported by Rau (1953) in *Desmodium triflorum*, *D. tortulosum*, *D. pulchellum*, *Eleiotis soraria* and *Aeschynomene indica*; by Kapuskar (1964) in *Aeschynomene aspera* and by Deshpande *et al* (1976) in *Zornia diphylla*. *Stylosanthes mucronata* (Rau 1953) is so far the only member of the tribe where a cellular endosperm is not organised at all in the developing seed.

The tribe Hedysareae shows considerable variation in the mode of embryo development and in the nature and organisation of the suspensor. The variation met with in the embryogeny of the tribe is summarized in table 1.

Table 1. Variation in the embryo development among the members of the tribe Hedysareae.

Species investigated	Author	Embryo type, after Johansen 1950	Embryo type, after Souéges 1948
<i>Coronilla minima</i>	Souéges 1947	Coronilla variation of the Onograd type	Period I, Megarchetype VI, series A
<i>Desmodium catescens</i>	Rau 1954	do.	do.
<i>D. canadense</i>	Rau 1954	do.	do.
<i>Hedysarum coronarium</i>	Souéges 1956	do.	do.
<i>Hippocrepis comosa</i>	Souéges 1955	do.	do.
<i>Lespedeza violacea</i>	Rau 1954	do.	do.
<i>Ornithopus perpusillus</i>	Souéges 1953a	do.	do.
<i>Onobrychis sativa</i>	Souéges 1953b	do.	do.
<i>Scorpiurus vermiculata</i>	Goursat 1961	do.	do.
<i>Zornia diphylla</i>	Deshpande and Bhasin 1976	do.	do.
<i>Aeschynomene indica</i>	Rau 1951	do.	do.
<i>A. aspera</i>	Kapuskar 1964	do.	do.
<i>Desmodium laevigatum</i>	Rau 1954	do.	Period I, Megarchetype VI, Series B
<i>Alysicarpus monilifer</i>	Present study	Alysicarpus variation of the Onograd type	Period I, Megarchetype IV, Series B
<i>Arachis hypogea</i>	Smith 1956	Solanad type	Period I, Megarchetype V, Series C
<i>Hedysarum nutans</i>	Johansen 1950	Caryophyllad type	Period II, Megarchetype IV, Series A

The embryogeny in a majority of the species follows a more or less uniform pattern agreeing with that originally described by Souéges (1947) in *Coronilla minima* and belongs to the first embryogenic group under Period I, Megarchetype VI and Series A. According to the system of Johansen (1950) the embryogeny in all these species conforms to the Onograd type, but does not fit into any of the variations proposed by him. Hence it is now proposed to erect a new variation designated as 'Coronilla variation' under the Onograd type to accommodate all these genera of the tribe Hedysareae, belonging to Period I, Megarchetype VI and Series A, where $cb = s$.

Rau (1954) observed that *Desmodium laevigatum* differs in its embryogeny from the rest of the members of the tribe which necessitates further investigations to evaluate the significance of this variation.

Alysicarpus monilifer shows further deviation from the fundamental type, where the embryogeny falls under the second group along with *Desmodium laevigatum* but belongs to the fourth megarchetype in period I where $cb = iec + co + s$. In this respect *Alysicarpus* differs from the rest of the Hedysareae and resembles members of Phaseoleae and Galegeae.

According to Johansen's system, the embryogeny in *Alysicarpus monilifer* conforms to the Onagrad type but does not fit into any of the variations proposed under that type. The embryogeny shows resemblance to the Trifolium variation of the Onagrad type in the possession of the epiphyseal initial, but differs in the destination of the derivatives of the basal cell cb . In Trifolium variation, based on the embryogeny in *Trifolium minus* (Souèges 1927) the entire basal cell cb contributes to the suspensor ($cb = s$) whereas in *Alysicarpus* the derivatives of the basal cell contribute to the root tip and root cap in addition to suspensor ($cb = iec + co + s$).

Hence, a new variation designated as *Alysicarpus* variation is proposed to accommodate the type, having an epiphyseal initial and where the derivatives of the tier cb contribute to the root tip and root cap in addition to the suspensor. *Alysicarpus* is so far the only genus in this tribe where an epiphyseal initial is demarcated in the tier ca and $cb = iec + co + s$. In this respect it resembles *Rhynchosia suaveolens* of Phaseoleae, and *Tephrosia strigosa* of Galegeae (Seshavatharam 1969) suggesting a relationship between these tribes and Hedysareae embryogenically.

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