

A Review :

A fresh light on the embryology of *Phaseolus aconitifolius* Jacquin, obs.: further evidence of a criticism of P. Maheshwari (1950), Soueges and Crete's (1952), S.C. Maheshwari (1955), Johri (1963), Rembert (1967a - Ph.d. Thesis, 67b, 69, 71), Bhasin (1971) and Deshpande and Bhasin (1974)

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The embryology of the Papilionaceae is full of interest. In this family, so well characterized by the structure of its flower and fruit, the degree of homogeneity is apparently so great that the systematists hesitates in setting the limits of the various genera within the family. However, from the embryogenic point of view these genera can be as clearly distinguished as those of the Papaveraceae. The Papilionaceae has long been an object for embryological studies on account of considerable variation that exist in the mode of embryonal development so much so that even two different Megarchtypes may occur in the same species as is reported by Rau (1954) in *Desmodium laevigatum* (Hedysareae), Goursat (1969) in *Astragalus glycyphyllos* (Astragaleae) and *Baptisia australis* (Podalyrieae). However, Salgare (1973, 74a, 76d, e, 97c, 2006e) has observed three different Megarchtypes in *Phaseolus aconitifolius* (Phaseoleae), out of these three, the first two could be placed in Soueges' and Crete's (1952) embryogenic classification (category A₂ and C₂ of Soueges and Crete's, 1952; Salgare, 1973, 74a, 76d, e, 97c, 2006e), but the third could not be accommodated in their system and seems to be a type by itself (Salgare, 1973, 74a, 76d, e, 97c, 2006e). This proves that Soueges' and Crete's (1952) embryogenic system of classification is not perfect and needs it's revision. It should be pointed out that Bhasin (1971) and Deshpande and Bhasin (1974) did not trace out such embryonic developments in *P. aconitifolius*. This proves their superficial and misleading observations.

Megasporogenesis culminates with the production of megaspores. Maheshwari (1945a, b) and Cave (1953) both relate the importance of gametophyte studies in angiosperms. Since megaspore produce

megagametophytes directly, production and position of megaspore must be significant not accidental. Megasporogenesis is initiated in most Papilionaceous species by the development of an archesporium hypodermally oriented in the nucellus. In Papilionaceae archesporium, whether multi-cellular or uni-cellular, is characteristically hypodermal. Roy (1933), Samal (1936), and Rembert (1969) consider a few cases of sub-hypodermal archesporial development in Papilionaceae, but all other cases appear to be doubtful, including report of Cooper (1938) and Paul and Datta (1950). In addition to the uni-cellular male archesporium, bi-cellular archesporium was also noted by Salgare (1974a, 75c, 76e) in *P. aconitifolius*. However, Bhasin (1971) and Deshpande and Bhasin (1974) were not aware of bi-cellular male archesporium again proves their superficial and misleading observations.

The megasporocyte undergoes meiosis I to form a dyad. Meiosis II proceeds in both members, which results in the formation of a megaspore tetrad which is a general feature of Papilionaceae. A generalized or hypothetical (ancestral) pattern may be postulated as consisting of four megaspores in linear arrangement. In *P. aconitifolius* a linear megaspore tetrad, in addition to T-shaped tetrads were also present (Salgare, 1974a, 75c). However, Bhasin (1971) and Deshpande and Bhasin (1974) were unaware of a linear tetrad of megaspore again proves their superficial and misleading observations.

Any one of these megaspores has equal potential for maturing into a megagametophyte. Depending on the number of megaspore nuclei taking part in the development, the megagametophytes of angiosperms has been classified into three main types: monosporic, bisporic

and tetrasporic (Maheshwari, 1950; Johri, 1963). In the first only one of the four megaspores, in the second two megaspore nuclei, and in the third all the four megaspore nuclei take part in the development of the megagametophyte. However, in *Phaseolus aconitifolius* three of the four megaspores take part in the development, while the fourth one remained non-functional. Such a type of megagametophyte should be regarded as a class by itself – trisporic development (Salgare, 1974a, 75a, c, f, 76e, g, 80a, 97a, c, 2000, 06b, d), [Trisporic development was also recorded by Salgare in *Cyamopsis psoralioides* in 1975a, g, 76h, 80a, 97a, 2000, 06b, d and in *Sesbania aegyptiaca* in 1974b, 76a, b, i, 80a, 97a, 2000, 06b, d] since it is not, even mentioned by Maheshwari (1950) and Johri (1963) in the classification of the megagametophytes of angiosperms. This proves that Maheshwari's (1950) and Johri's (1963) system of classification of the megagametophytes of angiosperms is imperfect and misleading. Bhasin (1971) and Deshpande and Bhasin (1974) again failed to trace out trisporic development in *Phaseolus aconitifolius*. At the same time it should be pointed out that there is no place for the trisporic development in the system of megaspore tetrad patterns formulated by Rembert (1967a - Ph.D. Thesis, b, 69, 71) for Papilionaceae, further proves that an imperfect and misleading system of Rembert (1967a - Ph.D. Thesis, b, 69, 71). Indeed we can no longer afford to adhere to any theory simply because it is widely accepted, its author famous, or because the printed page impresses us.

In *Phaseolus aconitifolius* at one instance the superimposed twin megagametophytes was noted. In that case, the chalazal end two megaspores showed potentiality and each one develop up to two-nucleate megagametophyte stage (two juxtaposed megaspores of an inverted T-shaped megaspore tetrad) and two degenerating micropylar megasporae (two superposed megaspores) indicate their origin from an inverted T-shaped megaspore tetrads (Salgare, 1974, 75c-f, 76a-c, 77, 80a, b, 2003). They are supposed to act as a single unit at maturity - bisporic development. It should be noted that this bisporic development entirely differ from those of Rembert's (1969 – Patterns VIII, IX, X) and hence form type by itself. This again proves that the system of megaspore tetrad patterns formulated by Rembert (1967a - Ph.D. Thesis, b, 69, 71) for Papilionaceae is imperfect and misleading. This also proves the failure of Bhasin (1971) and Deshpande and Bhasin (1974) who could not trace out bisporic development in *P. aconitifolius*, indicating again their superficial and misleading observations. It should be pointed out that all previous

reports of bisporic development in Leguminales have been challenged by Maheshwari (1955). However, the extensive work of Salgare (1973, 74, 75b-g, 76a-c, e, 77, 80a, b, 2000, 2003) proved that bisporic development does occur in Leguminales and the challenge of Maheshwari (1955) is not justified.

At another instance in *Phaseolus aconitifolius*, the left hand side of the megagametophyte of the superimposed twin megagametophytes, developed up to the four-nucleate stage, one at the micropylar end and two at the usual position of the polar nuclei, while the fourth at the chalazal end which developed into a single antipodal cell. Eight-nuclei could be counted in the right hand side of the megagametophyte. The egg apparatus is observed at the micropylar end. However, its structure is different from the egg apparatus of the normal megagametophyte. Almost at the usual position of the polar nuclei, two nuclei were found. At the chalazal end two antipodal cells were formed which were lying side by side. The left hand side antipodal contains a single nucleus and the right hand side antipodal was with two nuclei. Further it can be stated that these superimposed twin megagametophytes may function as a single megagametophyte, bisporic development where the egg apparatus is formed by the right hand side megagametophyte alone, the combined efforts have been made by both in the formation of the three antipodals. Similarly the secondary nucleus will be formed by the fusion of the five nuclei of this superimposed twin megagametophytes and at the maturity the partition walls will be dissolved resulting into the bisporic development (Salgare, 1974, 75c-e, 76b, c, 77, 80a, b, 2000, 03, 06a, c, d). Again this proves that Bhasin (1971) and Deshpande and Bhasin (1974) could not trace out bisporic development in *P. aconitifolius* indicating their superficial and misleading observations. This again challenges the hypothetical argument of Maheshwari (1955).

Yet in another instance the micropylar megaspore remained non-functional, while the remaining, chalazal three megaspores functioned and each one developed further up to forming a bi-nucleate megagametophyte. Among them the upper megagametophyte of this multiple megagametophytes was comparatively bigger than the remaining two and both of its nuclei were lying at its two poles. The middle megagametophyte was the smallest in size and both the nuclei were found more or less in an oblique fashion. As far as the size was concerned the lower megagametophyte was intermediate between these two and both of its nuclei were in an oblique in line (Salgare, 1974a, 75c, f, 76d-e, g, 80a, 2000, 06b, d). It should be pointed out that Bhasin (1971) and Deshpande

and Bhasin (1974) could not trace out such multiple megagametophytes in their studies in *P. aconitifolius*. This further proves that Bhasin's (1971) and Deshpande's and Bhasin's (1974) observations were superficial and misleading. It should also be pointed out that there is no room for this superposed multiple megagametophytes (trisporic development) in the system of megaspore tetrad patterns formulated by Rembert (1967a - Ph.D. Thesis, b, 69, 71) for Papilionaceae.

Bhasin (1971) and Deshpande and Bhasin (1974) also failed to trace out the endosperm haustorium and the development of the barrier tissue in *Phaseolus aconitifolius* again proves their superficial and misleading observations.

REFERENCES

- Bhasin, R.K. (1971).** Embryology of *Phaseolus aconitifolius*. Proc. 58th Session of the Indian Sci. Cong., held on January 3-7, 1971 at Bangalore Univ., Bangalore, *Bot. Section*, **3**:453, Abstract No. 156.
- Cave, M.S. (1953).** Cytology and embryology in the delimitation of genera. In: Plant genera, their nature and definition. *Chronica Botanica*, **14**:140-153.
- Cooper, D.C. (1938).** Embryology of *Pisum sativum*. *Bot. Gaz.* **100**:123-132.
- Deshpande, P.K. and Bhasin, R.K. (1974).** Embryological studies in *Phaseolus aconitifolius* Jacquin, *Obs. Bot. Gaz.*, **135**: 104-113.
- Goursat, Mazie-Jose (1969).** Recherches sur L'embryogenie De Papilionaceae. Ph.D. Thesis Faculty of Pharmacy. Series E. No. 190, Univ. Dr Paris.
- Johri, B.M. (1963).** Female gametophyte, pp 69-103 In: P. Maheshwari (ed.) *Recent advances in the embryology of Angiosperms*, International Society of plant morphologists, University of Delhi.
- Maheshwari, P. (1945a).** Embryology of angiosperms as a field of research. *Nature*, **156**:354-355.
- Maheshwari, P. (1945b).** The place of angiosperm embryology in research and teaching. *J. Indian Bot. Soc.*, **24**: 25-41.
- Maheshwari, P. (1950).** An Introduction to the embryology of Angiosperms. McGraw-Hill Book Company, New York, London.
- Maheshwari, S.C. (1955).** The occurrence of bisporic embryo sacs in angiosperms – A Critical Review. *Phytomorphology*, **5**: 67-99.
- Paul, A.K. and Datta, R.M. (1950).** Structure and development of female gametophyte in *Crotalaria intermedia* Kotschy. *Phillippine J. Sci.*, **79**:59-65.
- Rau, M.A. (1954).** The development of the embryo in *Cyamopsis*, *Desmodium* and *Lespedeza*, with a discussion on the position of the Papilionaceae in the system of embryogenic classification. *Phytomorphology*, **4**: 418-430.
- Rembert, D. H. JR. (1967a).** Comparative megasporogenesis in Leguminosae – A phylogenetic tools. Ph.D. Diss. Univ. Kentucky, Lexington, U.S.A.
- Rembert, D.H.JR. (1967b).** Development of the ovule and megagametophyte in *Wisteria sinensis*. *Bot. Gaz.*, **128**: 223-229.
- Rembert, D.H.JR. (1969).** Comparative megasporogenesis in Papilionaceae. *Amer. J. Bot.*, **56**: 584-591.
- Rembert, D.H.JR. (1971).** Phylogenetic significance of megaspore tetrad patterns in Leguminosae. *Phytomorphology*, **21**: 2-9.
- Roy, B. (1933).** Studies in the development of the female gametophyte in some Leguminous crops of India. *Indian J. Agric. Sci.*, **3**:1098-1107.
- Salgare, S.A. (1973).** On the early embryogeny of *Phaseolus aconitifolius*. *Sci. and Cult.*, **39**: 315-316.
- Salgare, S.A. (1974a).** Embryology of *Phaseolus aconitifolius*, with a discussion on the position of the Phaseoleae in the system of embryogenic classification. Proc. 61st Session of the Indian Sci. Cong. Held on January 3-7, 1074 at Nagpur Univ., Nagpur, *Bot. Section*, **3**: 1-2, Abstract No. 2.
- Salgare, S.A. (1974b).** On the megagametophyte of *Sesbania aegyptiaca* Poir., II. *J. Biol. Sci.*, **17**: 111-113.
- Salgare, S.A. (1975a).** Trisporic development in *Cyamopsis psoraloides* DC. Proc. 62nd Session of the Indian Sci. Cong. held on January 3-7, 1975 at Delhi Univ., Delhi, *Bot. Section*, **3**: 78-79, Abstract No. 116.
- Salgare, S.A. (1975b).** Bisporic development in *Cyamopsis psoraloides* DC. *J. Indian Bios. Asso.*, **1**: 18-22.
- Salgare, S.A. (1975c).** Gametophytes of *Phaseolus aconitifolius* Jacquin, *Obs. J. Indian Bios. Asso.*, **1**: 35-50.
- Salgare, S.A. (1975d).** I. On the megagametophyte of *Phaseolus aconitifolius* Jacquin, *Obs. J. Indian Bios. Asso.*, **1**: 164-165.
- Salgare, S.A. (1975e).** II. On the megagametophyte of *Phaseolus aconitifolius* Jacquin, *Obs. J. Indian Bios. Asso.*, **1**:165-167.
- Salgare, S.A. (1975f).** III. On the megagametophyte of *Phaseolus aconitifolius* Jacquin, *Obs. J. Indian Bios. Asso.*, **1**:167-169.
- Salgare, S.A. (1975g).** Male and female gametophytes of *Cyamopsis psoraloides* DC. *Biovigyanam*, **1**:173-181.
- Salgare, S.A. (1976a).** Embryology of *Sesbania aegyptiaca* Poir. Proc. 63rd Session Indian Sci. Cong., held on January 3-7, 1976 at Andhra Univ., Visakhapatnam, *Bot. Section*, **3**: 81.
- Salgare, S.A. (1976b).** Gametophytes of *Sesbania aegyptiaca* Poir. *J. Indian Bios. Asso.*, **2**:14-26.
- Salgare, S.A. (1976c).** I. Superimposed twin megagametophytes in Papilionaceae. *J. Indian Bios. Asso.*, **2**: 70-78.
- Salgare, S.A. (1976d).** Development of the seed of *Phaseolus aconitifolius* Jacquin, *Obs. J. Indian Bios. Asso.*, **2**: 170-178.

- Salgare, S.A. (1976e).** Embryology of *Phaseolus aconitifolius* Jacquin, *Obs. J. Indian Bios. Asso.*, **2** : 234-238.
- Salgare, S.A. (1976f).** I. Bisporic development in *Phaseolus aconitifolius* Jacquin, *Obs. J. Indian Bios. Asso.*, **2** : 338.
- Salgare, S.A. (1976g).** I. Trisporic development in *Phaseolus aconitifolius* Jacquin, *Obs. J. Indian Bios. Asso.*, **2** : 339.
- Salgare, S.A. (1976h).** On the megasporogenesis of *Cyamopsis psoralioides*, DC. *J. Indian Bios.*, **2** : 239-243.
- Salgare, S.A. (1976i).** Embryology of *Sesbania aegyptiaca* Poir. *J. Indian Bios. Asso.*, **2** : 243-246.
- Salgare, S.A. (1977).** Superimposed twin megagametophytes in Papilionaceae. Proc. 64th Session Indian Sci. Cong., held on January 3-7, 1977 at Utkal Univ., Bhubaneswar, *Bot. Section*, **3** : 111, Abstract No.129.
- Salgare, S.A. (1980a).** A Criticism of Rembert's papers entitled, 'Comparative Megasporogenesis in Papilionaceae – 1969' and 'Phylogenetic significance of megaspore tetrad patterns in Leguminosae- 1971'. Proc. 2nd All India Symp. on Life Sci., held on March 9-11, 1980 at the Deptt. of Bot., Govt. Institute of Science, Nagpur. Abstract No. 43.
- Salgare, S.A. (1980b).** Bisporic development in Papilionaceae. – Challenge to the hypothesis of Maheshwari (1955). Proc. 2nd All India Symp. on life Sci., held on March 9-11, 1980 at the Deptt. of Bot., Govt. Institute of Science, Nagpur. Abstract No. 44.
- Salgare, S.A. (1997a).** Present status of megaspore tetrad pattern of Papilionaceae. Proc. 14th Nat. Symp. on Recent Trends in Life Sci., held on October 23-25, 1997 at the Deptt. of Zool., Punjabi Univ., Patiala. pp. 69, Abstract No.91.
- Salgare, S.A. (1997b).** A new megarchtype. Proc. 14th Nat. Symp. on Recent Trends in Life Sci., held on October 23-25, 1997 at the Deptt. of Zool., Punjabi Univ., Patiala. pp.70, Abstract No.92.
- Salgare, S.A. (1997c).** Present status of the embryology of *Phaseolus aconitifolius* Jacquin, *Obs. Proc. 14th Nat. Symp. on Recent Trends in Life Sci.*, held on October 23-25, 1997 at the Deptt. of Zool., Punjabi Univ., Patiala. pp.71-72, Abstract No.94.
- Salgare, S.A. (2000).** Megaspore tetrad patterns in Papilionaceae – A Critical Review. Proc. 87th Session of the Indian Sci. Cong., held on January 3-7, 2000 at Pune Univ., Pune, Bot. Section (3):52-54, Abstract No. 73.
- Salgare, S.A. (2003).** Bisporic development in Papilionaceae – A Critical Review, pp. 299-309 *In* : B.K.Dwivedi, S.D.Mishra and S.P.Singh, (eds.) Agriculture in New Millennium, Publication of Bioved Research and Communication Centre, Allahabad, India.
- Salgare, S.A. (2006a).** A Criticism of Maheshwari's (1955) paper entitled, 'The occurrence of bisporic embryo sacs in angiosperms – A Critical Review'*. *Internat. J. Biosci. Reporter*, **4** : 55-58.
- Salgare, S.A. (2006b).** Trisporic development in Angiosperms – A New Record and a Criticism on the Classification of the megagametophytes of Angiosperms by Maheshwari (1950)*. *Internat. J. Biosci. Reporter*, **4** : 111-114.
- Salgare, S.A. (2006c).** Bisporic development in *Phaseolus aconitifolius* Jacquin, *Obs.* and further evidence of a criticism of Maheshwari (1955), Bhasin (1971) and Deshpande and Bhasin (1974) – I*. *Internat. J. Biosci. Reporter*, **4** : 259-261.
- Salgare, S.A. (2006d).** Further evidence of a criticism of Rembert (1967a - Ph.D. Thesis, 67b, 69, 71) – I*. *Internat. J. Biosci. Reporter*, **4** : 291-292.
- Salgare, S.A. (2006e).** Is Soueges and Crete's (1952) system of embryogenic classification for Papilionaceae perfect ?* and further evidence of a criticism of Soueges and Crete's (1952), Bhasin (1971) and Deshpande and Bhasin (1974). *Internat. J. Biosci. Reporter*, **4** : 367-368.
- Samal, K.K. (1936).** The development of the embryo sac and embryo in *Crotalaria juncea*. *J. Indian Bot. Soc.*, **15** : 19-31.
- Soueges, R. and Crete, P. (1952).** Les acquisitions les plus recentes de l'embryogenie des Angiospermes. (1947-1951). *Ann. Biol.*, **28** : 9-45.

