# Palynotaxonomy and Phylogeny of Ranunculaceae*

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Pollen morphological data have helped to understand the taxonomy and phylogeny of Ranunculaceae. Palynology supports the segregation of Paeoniaceae from Ranunculaceae, but does not envisage further splitting of the family. Occurrence of various apertural types within the family suggests that Ranunculaceae is eurypalynous.

**Key-words** - Palynotaxonomy, Phylogeny, Ranunculaceae.

## INTRODUCTION

Ranunculaceae is cosmopolitan in distribution, with about 50 genera and 2,000 species. About 30 genera and 300 species occur in India. The plants, mostly annual or perenial herbs with a few climbers, are distributed in geographically distant and climatically different zones.

The present study is based on pollen morphological data gathered from the publications of Kumazawa (1936), Wodehouse (1936), Selling (1947), Erdtman (1952), Bakker (1956), Ikuse (1956), Nair (1965a, 1965b, 1974), Huynh (1970), Skvarla and Nowicke (1979), Petrov and Borrisova-Ivanova (1981), Nowicke and Skvarla (1983), Gupta and Sharma (1986), Al-Eisawi (1987), Clarke *et al.* (1991). Vishnu-Mittre and Sharma (1963) and Khan (1969, 1976).

The study is aimed to correlate the results with other available palynodata to understand the systematic position and evolution of the family. Fiftyone species distributed over 16 genera have been investigated and the rest of the information is taken from published literature.

## DISCUSSION

Ranunculaceae has been placed under Ranales and is classified under several tribes, viz., Clematideae, Anemoneae, Ranunculeae, Helleboreae and Paeonieae by Hooker (1872-1897). But Engler and Prantl placed *Clematis* under the tribe Anemoneae and the genus *Callianthemum* under Helleboreae.

Ranunculaceae has got the primitive characters as far the flowers, woods and pollen are concerned. It has diverse pollen types, generally 3-zonocolpate, but 3-zonocolporate *(Paeonia, Delphinium* and *Actaea alba),* pantoporate and spiraparturate (*Anemone* sp.). Pantocolpate, spiraperturate and pantoporate *(Pulsatilla)* are also present. It is typified by *Ranunculus* type pollen grains, having three broad, long tenuimarginate colpi with tapering ends arranged meridionally. On the basis of apertural forms Kumazawa (1936) distinguished three artificial groups, namely, (1) pollen with pores,(2) pollen with parallel colpi, and (3) pollen with unparallel colpi. Inaperturate pollen are also reported in *Souliea* (Kumazawa, 1936; Erdtman, 1952) and *Anemone sellowii* (Huynh, 1970). The apertures are often weakly defined and have crustate aperture membrane. The pollen evolution in the family has been studied in detail by Wodehouse (1936) who considered that the 3-colpate forms are the basic types and from which the pollen with other apertural forms have evolved. It was also noted that the colpus of the type found in the family is best suited for hormomegathic function.Huynh (1970) reported 3-colpate pollen type (*Hepatica* and *Anemone*) to be the original type and considered other types to be their derivatives.

Jensen (1968) on the basis of serological study of 20 genera of the family has found high correlation of *Helleborus* with *Aconitum, Caltha* and *Delphinium* and a slight correlation with *Adonis, Coptis, Trollius, Myosurus* and *Clematis. Aconitum* has high correlation with other seven genera, *Caltha* has a high correlation with nine genera and *Delphinium* with nine genera. *Helleborus* has

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a little similarity with *Eranthes*. All these genera generally have colpate pollen type with different sexine patterns. In Ranunculaceae more than 135 species of 41 genera have exine spinulose and punctate or perforate tectum but the exception to this type is found in *Helleborus*, *Paeonia*, *Hydrostis* and *Trollius*. Having striate ornamentation, *Trollius* comes close to *Caltha*.

The pollen types of all the five tribes of the Indian Ranunculaceae are 3-colpate (Table 1). The grains are pantoporate in the species of *Naravelia*, *Thalictrum*, *Anemone*, *Ranunculus* and *Caltha palustris* var. *alba*, pantocolpate in *Clematis patens* and some species of *Anemone*, and 3-zonocolporate in *Actaea alba*, *Delphinium* and a species of *Paeonia*.

The tribe Paeonieae has been elevated to a separate family (Worsdell, 1908; Kapil & Jalan, 1962) which has a palynological support (Wodehouse, 1936). However, it may be pointed out that 3-zonocolpate type and 3-zoncolporate types are found in *Paeonia* (Ikuse, 1956) as in *Actaea* (Kumazawa, 1936). Boissier (1867) on gross morphology puts *Actaea* under Paeoniaceae which is also supported by pollen based classification. Paeoniaceae has been placed close to Dilleniaceae (Corner, 1949) rather than to Magnoliaceae (Worsdell, 1908) and this has the palynological support also. Hutchinson (1926) placed the Paeoniaceae between the Helleboraceae and the Ranunculaceae though in both these taxa 3-zonocolporate pollen are absent. Pollen morphological evidences suggest that *Paeonia* is possibly a direct offshoot of Ranunculaceae having 3-zonocolporate pollen and stands higher in the scale of evolution.

On the basis of tectum structure Nowicke and Skvarla (1983) placed *Circaeaster* and *Kingdonia* under a ditypic family Circaeasteraceae supporting the treatment of Cronquist (1968). They further separated *Sargentodoxa* from the Ranunculaceae and placed under Sargentodoxaceae as proposed by Takhtajan (1980) but palynological evidence does not support large scale splitting of the family.

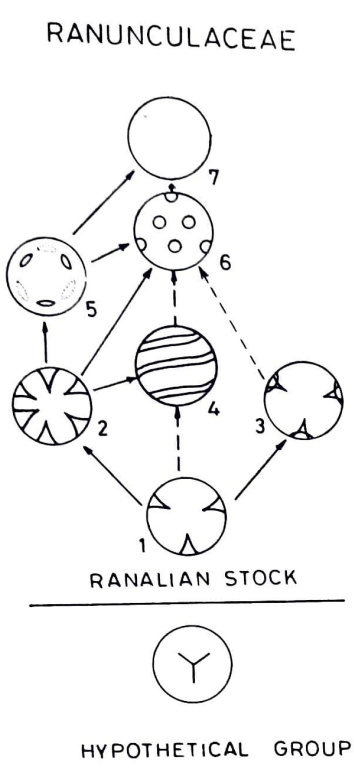
A scheme of the possible evolution of the apertural forms in Ranunculaceae is presented in text figure I. Owing to the fact that the majority of the taxa in the family produce 3-zonocolpate pollen, it is envisaged that this character has possibly given rise to the other apertural types.

It is of particular importance that the Ranunculaceae is devoid of one colpate type of pollen which is characteristic of the Annonaceae, to some extent the Magnoliaceae and Nymphaeaceae. The occurrence of 1-colpate pollen grains in some Ranalian families, is an evidence of pollen evolution from the Bennettitalian group as suggested by Wodehouse (1936) but such a primitive pollen type is absent in the Ranunculaceae. It is important to note that

**Table 1. Aperture and exine ornamentation in the genera of Ranunculaceae (After Khan, 1969)**

| Tribes | Genera | Aperature types | | | | Exine ornamentation types | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 3-zono-colpate | Panto-colpate | Panto-porate | 3-zono-colporate | Psilate | Granulose | Foveo-late | Reti-culate | Striate | spin-ulose |
| I. Clema-tideae | *Clematis* | P | P | A | A | P | P | A | A | A | A |
| | *Naravelia* | A | A | P | A | A | P | A | Negatively Reticulate | A | A |
| II. Anemo-neae | *Adonis* | P | A | A | A | A | A | P | A | A | A |
| | *Anemone* | P | P | P | A | A | P | A | Areolate | A | A |
| | *Callianthemum* | P | (spiraperturate) | A | A | P | P | A | A | A | A |
| | *Thalictrum* | A | A | P | A | P | A | A | A | A | A |
| III. Ranun-culaeae | *Ranunculus* | P | P | P | A | A | P | A | P | P | P |
| IV. Helle-boreae | *Aconitum* | P | A | A | A | P | A | P | A | A | A |
| | *Actaea* | P | A | A | P | A | P | A | A | A | P |
| | *Aquilegia* | P | A | A | A | A | P | A | A | A | A |
| | *Caltha* | P | A | P | A | A | A | A | A | P | A |
| | *Cimicifuga* | P | A | A | A | P | A | A | A | A | A |
| | *Delphinium* | P | A | A | P | P | A | A | A | A | A |
| | *Nigella* | P | A | A | A | P | P | A | A | P | A |
| | *Trollius* | P | A | A | A | A | A | A | A | | |
| V. Paeo-nieae | *Paeonia* | P | A | A | P | A | A | P | P | A | A |

P = Present, A = Absent




**Text-figure 1.** Diagramatic representation of pollen apertural groups and their probable evolution in the family Ranunculaceae.

1- 3-colpate (Ranuncul s group)
2- Stephanocolpate (Clematis group)
3- 3-colporate (Paeonia group)
4- Spiraperturate (Anemone group)
5- Pantocolpate (Pulsatella group)
6- Pantoporate (Thalictrum group)
7- Inaperturate (Soulia group)

almost all the apertural types except 1-colpate found in angiosperms occur in Ranunculaceae.

The affinity of Ranunculaceae with the Alismataceae has been discussed by Maheshwari ( 1962). Owing to the occurrence of pantoporate types of pollen both in Alismataceae and Ranunculaceae, Wodehouse (1936) supported the derivation of Alismataceae from Ranunculaceae. There is evidence of the evolution of the pantoporate type from the pantocolpate type in both families (Wodehouse, 1936) which further suggest the phylogeny of the two, but having possibly evolved along parallel lines from a common ancestor.

Van Campo (1976) has placed Ranunculaceae close to Caryophyllaceae and Papaverales on the basis of successiformy within *Anemone* and *Caltha*. Walker (1976) discussed the evolutionary significance of the exine in the pollen of primitive angiosperms and suggested 4 grades in the evolution of dicotylendons and monocotyledons. The evolution in dicotyledons has been traced from Magnoliidae of grade I to Ranunculiidae along with Hamamelidiidae and Caryophylliidae of Grade. II. The Ranunculiidae appears to have completed evolution at this grade II as at grade I their closest Magnoliid relatives in Winteraceae and Aristolochiaceae. The order Piperales also have some characters that indicate relationship with members of the Ranunculiidae. These studies have supported the view that Ranales may be considered to form a comprehensive group of dicotyledons. So is the case of Ranunculaceae. It represents a Ranalian stock of 3-zonocolpate and their derivative types.

Khan (1976) on the basis of pollen morphology of Thalamiflorae, proposed that magnoranalian dicots (protodicots) have given rise to Proto-magnolian and Proto-ranalian dicots. Ranunculaceae has evolved from the Proto-ranalian dicots having 3-colpate basic pollen type. Later polycolpate, spiraperturate, eu-pantocolpate and pantoporate types have evolved. The inaperturate pollen type has acquired the climax position in the evolutionary heirarchy as found in *Soulia* and *Anemone sellowii* (Text-fig.1). It is evident with these facts that Ranunculaceae has primitive, moderate to most evolved genera.

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## REFERENCES

Al-Eisawi, D.M. 1987. Pollen morphology of Ranunculaceae in Jordon. *Pollen spore* **28** : 311-328.

Bakker, Von Z.E.M. 1956. *South African pollen grains and spores-II*. A.A. Balkema, Amsterdem.

Boissier, E. 1867. *Flora Orientalis*. Apud H. Georg. Biblio polam, Genevae.

Clarke. G.C.S., Punt, W. & Hoen. P.P. 1991. The Northwest European Pollen Flora - 51-Ranunculaceae. *Rev. Palaeobot. Palynol.* 69 : 117-271.

Corner, E. J.H. 1949. The annonaceous seed and its four integuments. *New Phytol.* **48** : 522-564.

Cronquist, A. 1968. *The Evolution and Classification of Flowering Plants*. Nelson & Sons, London.

Erdtman, G. 1952. *Pollen morphology and plant taxonomy-Angiosperms*. Waltham Mass; U.S.A.

Gupta, H.P. & Sharma, C. 1986. *Pollen Flora of North-West Himalaya*. Indian Association of Palynostratigraphers, Lucknow.

Hooker, J.D. 1872-1897. *Flora of British India*. L. Reeve & Co., London.

Hutchinson, J. 1926. *The families of flowering plants*. Pt. I. Dicotyledons. Oxford Uni. Press. London.

Huynh, K.L. 1970. Le pollen du genre *Anemone* et du genre *Hepatica* (Ranunculaceae) et leur taxonomie. *Pollen Spore* **12** (3) : 329-364.

Ikuse, M. 1956. *Pollen grains of Japan*, Hirokowa, Tokyo.

Jensen, U. 1968. Serologische Beitrage zur systematik der Ranunculaceae, *Bot. Jahrb.* **88** (3) : 269-310.

Kapil, R.N. & Jalan, S. 1962.Studies in the family Ranunculaceae-I, The embryology of *Caltha palustris*. Symp. Plant Embryology, P.L.A.,

C.S.I.R., 205-213.

Khan, H.A. 1969. *Pollen grains of some Indian Thalamiflorae*. Ph.D. Thesis, Aligarh Muslim University, Aligarh.

Khan, H.A. 1976. The Thalamiflorae - An analysis of pollen morphology. *Aspects Plant Science* **1** : 53-72.

Kumazawa, M. 1936. Pollen grains morphology in Ranunculaceae, Lardizabalaceae and Berberidaceae, *Japan J. Bot.* **8** : 19-47.

Maheshwari, P. 1962. The over powering role of morphology in taxonomy. *Bull. Bot. Surv. India*. **4** : 85-94.

Nair, P.K.K. 1965a. Trends in the morphological evolution of pollen and spores. *J. Indian bot. Soc.* **44 (4)** : 468-478.

Nair, P.K.K. 1965b. *Pollen grains of Western Himalayan Plants*. Asia Publishing House, Bombay.

Nair, P.K.K. 1974. Primitive argiosperms - A preliminary assessment. *Advances Pollen - spore Res.* **1** : 21-30.

Nowicke, J.W. & Skvarla, J.J. 1983. A palynological study of the genus *Helleborus* (Ranunculaceae). *Grana* **22** : 129-140.

Petrov, S. & Borrisova - Ivanova, O. 1981. Palynomorphological characteristics of Bulgarian representatives of the family Ranunculaceae Juss. VII. *Ceratocephalus* Pers and *Adonis L.* on the family Ranunculaceae Juss. *Fitologia Sofic* **17** : 3-32.

Selling, O.H. 1947. *Studies in Hawaiian pollen statistics. pt. II The Pollens of Hawaiian phenerogams*. Bishop Museum, Honolulu, Hawaii.

Skvarla, J.J. and Nowicke, J.W. 1979. The morphology of the exine in *Nigella* (Renunculaceae) Amer. J. Bot. **66** (2) : 162-165.

Takhtajan, A.L. 1980. Outline of the classification of flowering plants (Magnoliophyta). *Bot. Rev.* **46** (3) : 225-359.

Van Campo, M. 1976. *Patterns of pollen morphological variation with in taxa -The evolutionary significance of the exine. Linn. Soc. Symp Ser* **1** : 125-137

Vishnu-Mittre and Sharma, B.D. 1963. Studies of Indian pollen grains-II. Ranunculaceae, *Pollen. Spore*. **5** (2) : 285-296.

Walker, J.W. 1976. *Evolutionary significance of the exine in the pollen of primitive angiosperms. In* : Ferguson, I.K. & Muller, J. (eds)- The Evolutionary significance of the Exine. Academic Press, London : 251-308.

Wodehouse, R.P. 1936. Pollen grains in the identification and classification of plants-VII. The Ranunculaceae. *Bull Torrey bot. Club*. 63 495-514.

Worsdell, W.C. 1908. The affinities of *Paeonia. J. Bot.* 46 : 114-116.