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Review Article of the *Papaveracea* Adans. and Status of the Egyptian and Saudi Genera

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Abstract. This work deals with the systematic relations of family *Papaveraceae* according to the new data derived from molecular analysis. An overall view has been given to elucidate the taxonomic position of the family within the basal eudicots. Characteristic features of all the group has been given with clear view of the general features of the family and its taxonomic divisions according to the different systems of classifications, with short account of its distribution. Relations between the three families *Papaveraceae, Fumariaceae* and *Hypecoaceae* has been clarified, with new list of the genera, as listed by Royal Botanical Gardens of Kew, according to recent consideration of the family, also, it has been added with summary of the phylogenetic relationships of the family and its genera. List of the Saudi and Egyptian wild genera and species is given, with complete description of their morphological variations and their position according to the new classification of the family.

Keywords: Eudicots – Magnoliopsida- *Papaveraceae*- Phylogeny – Ranunculales.

Introduction

Family *Papaveraceae* is one of the most interesting families which took the attention of many scientists to understand the relation between its members and the nearby families. In the same time the position of this family remained a matter of discussion, whether it is monophyletic or polyphyletic. The new concepts in the systematic position of the family within the Eudicots have been faced with many opinions, as well as the relation between the three families *Papaveraceae, Fumariaceae* and *Hypocoaceae* are still a matter of discussion. For that the general features

of the family is clarified with a survey of the most recent works dealing with the position and relations of the family has been given to elucidate the new classification of the recent *Papaveraceae* members, and its status within the related families.

Taxonomic Status of the Family

The taxonomic status of family *Papaveraceae* s.l. has been faced with numerous opinions. Before the tremendous ribosomal and DNA sequences researches concerning the phylogeny of the taxonomic taxa, the family has been considered by Wettstein[1] as one of the *Rhoeadales* families. Later on, Melchior[2], Tamura[3], Benson[4] and Tutin *et al.*[5] renamed the order *Rhoeadales* by *Papaverales* s.l. with four suborders; *Papaverinae, Capparinae, Tovarianae* and *Moringanae*. The family was closely related to the *Brassicaceae*, *Capparidaceae*, *Resedaceae*, *Tovariaceae* and *Moringaceae*[6-9]. The position of these families in the same order is due to flower characters, such as regular and hypogenous flowers, anther arranged in many whorls and the carpels are syncarpous from two to many with parietal ovules.

Family *Papaveraceae* Adans. Nom.cons. s.l. which is a north temperate, mostly herbaceous family consisting of 23 genera and about 250 species[10], newly recorded species raises the number of genera to 35 as Royal Botanical Gardens in Kew list [2006]. The family has three synonyms; *Chelidoniaceae* Martinov., *Echscholziaceae* Ser. and *Platystemonaceae* (Rchb.ex Spatch) Lilja. According to Cronquist System[11], family *Papaveraceae* s.l. is under Subclass *Magnoliidae* together with the *Magnoliaceae*, *Nymphaeaceae* and *Ranunculaceae*. This subclass is characterized by well developed flowers with separated perianth or Calyx and Corolla, the stamens are numerous and gynoecium is apocarpous, in Papaveraceae gynoecium is paracarpous. According to South West Virginia flora, the *Magnoliideae* comprises nine families; *Magnoliaceae*, *Annonaceae, Lauraceae, Ranunculaceae*, *Papaveraceae, Fumariaceae, Berberidaceae, Menispermaceae*, and *Aristolochiaceae*.

The family is closely related to the *Fumariaceae* which often included within it[9, 12-16]. Meanwhile, the family has close affinity to members of *Ranunculales* with the only differences are a paracarpous gynoecium and the presence of secretory idioblasts or laticifers in the *Papaveraceae* s.l., and both families are considered as primitive families.

Parker[17] separates the *Papaveraceae* in order *Papaverales* and the *Ranunculaceae* in order *Ranunculales* and both orders under subclass *Magnoliidae* class *Magnoliopsida*. This class refers to small group containing *Papaveraceae, Ranunculaceae* and *Berberidaceae* as sisters to Monocots. Recent work on molecular analysis, done by Hoot *et al.*[18], the *Papaveraceae* s.l. has been considered as one of the families belonging to order *Ranunculales* and they up graded the order *Ranunculales* from *Magnoliidae* to the base of the Eudicots, which is in close association with the Monocots. He gathered the three families; *Ranunculaceae, Berberidaceae* and *Papaveraceae* s.l. in the order *Ranunculales,* while the *Nelumbonaceae, Platanaceae* and *Proteaceae* in the order *Proteales* (Fig. 1). According to their work, they considered the *Papaveraceae* s.l., *Fumariaceae* and *Euptelea* are among the earliest branching group, at the base of the eudicots, according to atpB, rbcL and 18S nuclear ribosomal sequences, while they considered the *Ranunculaceae* within the eudicots, as well, but is more advanced than them (Fig. 2 & 3).

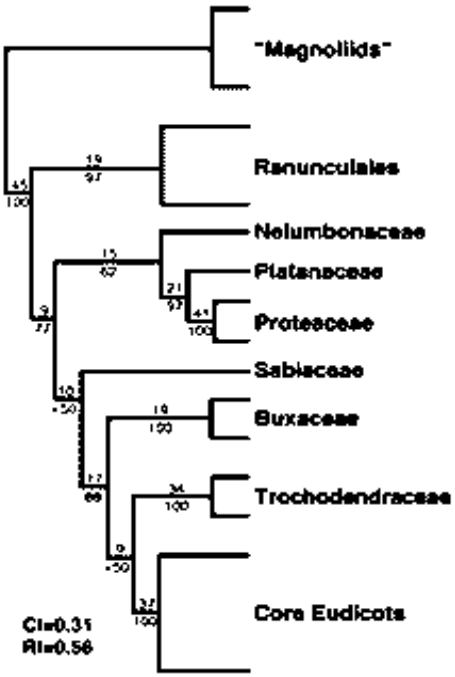

Fig. 1. Position of *Ranunculales* within the "Lower" Eudicots based on atpB, rbcL and 18S sequence data (Tree adapted from Hoot *et al.,* 1999).

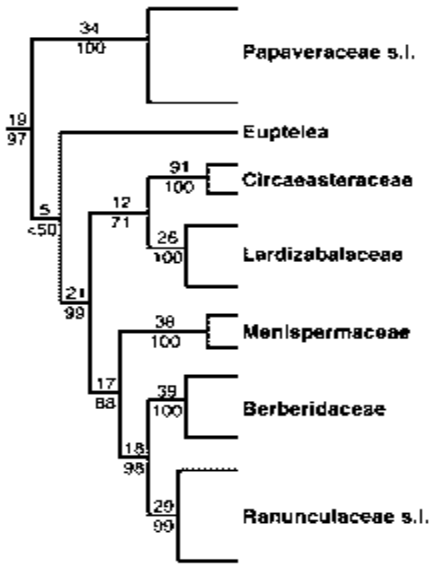

Fig. 2. Phylogeny of the *Ranumculales*, showing relative positions of the major families within this order (Tree adapted from Hoot *et al.*, 1999).

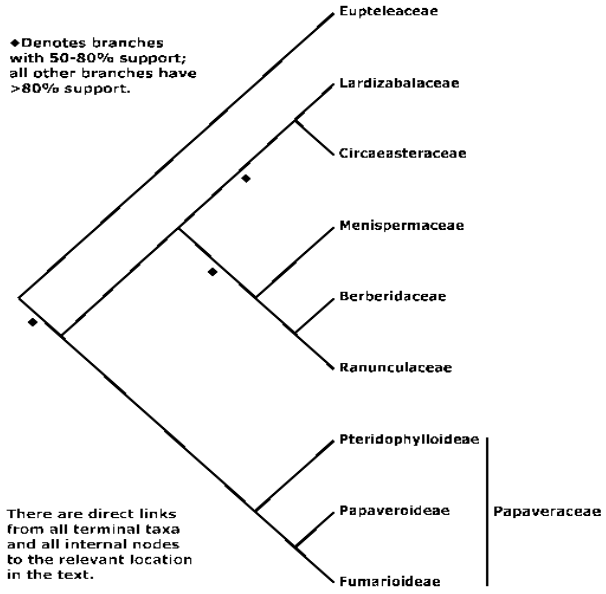

Fig. 3. Position of Papaveraceae, with its three subfamilies, within the Ranunculales (Tree adapted from Lecointre *et al.*,1993).

General Features of the Family

The family has plants in different varieties of life forms and morphological characters. They are herbs or sub-shrubs, shrubs, or even small trees (*Dendromegon rigida*). Annuals, biennials, or perennials having taproots or rhizomes with leafy or naked erect or spreading stems. Leaves basal and/or cauline, alternate to opposite or whorled, simple ex-stipulate petiolate or sessile with entire blade or lobed in pinnate, subpalmate , or palmate orders of lobes. In *Argemone* the leaves are dissected with spiny margins. The leaves mostly glabrous, except few species covered with ramified or glandular hairs with smooth walls. Stomata are either diacytic or anomocytic with isodiametric or elongated epidermal cells.

The family has variety of flower arrangements, forms and colors, but all are bracteate, radially symmetric, pedicellate or sessile, receptacle sometimes expanded and forming cup or ring beneath calyx (in *Eschscholzia, Meconella* and *Platystemon*). The flowers are either solitary or arranged in groups which are either terminal or axillary. The inflorescences are either cymose or racemose, umbelliform or corymbiform. Perianth and androecium sometimes perigenous; sepals two or three, ob-ovate, distinct or connate always caduceus. Petals distinct, colored and ob-ovate, usually four or more, sometimes absent. Stamens numerous in many whorls, sometimes 4-15 in *Meconella* and *Canbya*, with bi-locular anthers[19]. Pollen grains spheroidal or sub prolate, medium sized, usually with tricolpate apertures. In some species (*Papaver argemone, Argemone mexicana, and Roemeria hybrida*) pollen grains are polyporate[16]. Pistil 1, 2 to many (22) united carpels with one or two locules, sometimes multilocular by placental intrusion, placenta two or more in parietal position. Style usually one or absent with sessile stigmas. Stigma lobes are 2 to many in circular disc or radiating ones. Fruits are capsules dehiscent by pores, valves or dissociating and breaking transversely into one seeded segments (only in *Platystemon*). Seeds always many, small, sometimes arillate or carunculate with different colors from the white to the black or different shades of brown.

Classification of the Family

The *Papaveraceae* s.l. is subdivided into three subfamilies by Hoot *et al.*[20], *Pteridophylloideae, Papaveroideae* and *Fumarioideae*. Ernst[21],

Layka[22], Heslop-Harison and Shivana[23], Mabry[24], Kaderreit[25], Kaderreit *et al.*[26] and Bruckner[27] have divided the family into four subfamilies; *Chelidonoideae*, *Eschscholzioideae*, *Papaveroideae* and *Platystemonoideae*; while the *Fumaroideae* and *Pteridophylloideae* have been separated in new families, *Fumariaceae*, and *Pteridophyllaceae*, and the four tribes under subfamily *Papaveroideae* have been graded up to the rank of subfamilies (Fig. 5). This division is based mainly on gynoecium morphology and indumentum's characters but the evolutionary relationships within the subfamilies remain ambiguous as well as relations between the genera (Fig. 4). Hoot *et al.*[18] on the basis of *trn*K, *atp*B and *rbc*L sequences found that the genera *Corydalis* and *Hypecoum* from the *Fumarioidae* are closely related and support their separation in new family *Fumariaceae*. The same to the genus *Pteridophyllum*, to be put in a separate family *Pteridophyllaceae*, while the rest of the genera to be subdivided into three subfamilies (Fig. 4).

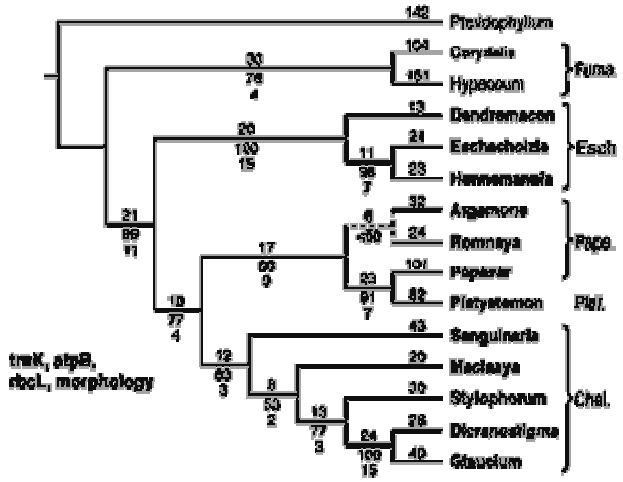

Fig. 4. Phylogenetic analysis of *Papaveraceae* based on *trn*K, *atp*B, *rbc*L molecular data and morphology. *Pteridophyllum* was designated as the outgroup (Tree adapted from Hoot *et al.*, 1999).

There are 35 recorded genera within the family as listed by Royal Botanic Gardens in Kew (2006), they are *Adlumia* Raf ex DC., *Arctomecon* Torr. & Frem. *Argemone* L., *Bocconia* L., *Canbya* Parry ex A. Gray, *Capnoides* Mill., *Ceratocapnos* Durieu, *Chelidonium* L., *Cryptocapno*s Rech. F., *Cysticapnos* Mill., *Dactylicapnos* Wall.,

Dendromecon Benth., *Dicentra* Borkh. Ex Bemh., *Dicranostigma* Hook.f. & Thomson, *Discocapnos* Cham. & Schltdl., *Eomecon* Hance, *Eschscholzia* Cham., *Glaucium* Mill., *Hesperomecon* Greene, *Hunnemannia* Sweet, *Hylomecon* Maxim., *Hypecoum* L., *Macleaya* R.Br., *Meconella* Nutt., *Meconopsis* R. Vig., *Papave*r L., *Platycapnos* (DC.) Bernh., *Platystemon* Benth., *Pteridophyllum* Siebold & Zucc., *Roemeria* Medik., *Romneya* Harv., *Rupicapnos* Pomel, *Sanguinaria* L., *Stylomecon* G.Taylor, *Stylophorum* Nutt. And *Trigonocapnos* Schltr. Some of these genera contains one species only and endemic to certain localities, while others like *Papaver, Argemone, Glaucium, Meconella, Meconopsis, Eschscholzia, Dendromegon, Chelidonium* and *Roemeria* are more abundant and well known.

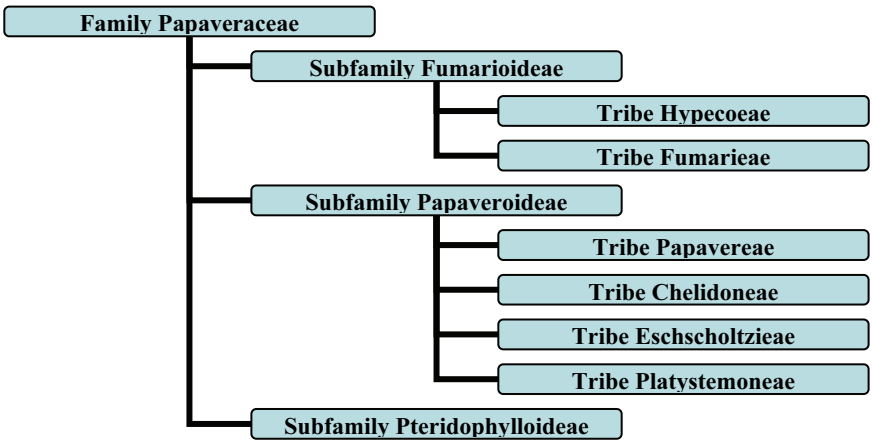

Fig. 5. Family *Papaveraceae* classification according to Hoot *et al.* (1997).

In Fig. 1&2, numbers above lines indicate the number of nucleotide changes supporting each branch. Number below the branches is the percentage of times that the branch was recovered in 1000 bootstrap replications.

In Fig. 4, numbers above lines indicate the number of nucleotide changes supporting each branch. Number below the branches is the percentage of times that the branch was recovered in 1000 bootstrap replications. Dotted lines indicate branches that collapse in the strict consensus trees derived from multiple shortest trees.

Egyptian and Saudi Genera and Species

In both Egypt and Saudi Arabia the *Papavercaceae* s.s. comprises four genera; *Papaver, Argemone, Roemeria and Glaucium*. They are narrowly distributed, in Egypt they are mainly Mediterranean annual species and in Saudi Arabia they are located mainly in the eastern and southern regions and sometimes in Najd plateau. Genus *Papaver* comprise three species only in Saudi Arabia; *P. rhoeas* L., *P.polytrichum* Boiss and *P. somniferum* L.;[28] and increased by three species in Egypt; *P. hybridum* L., *P argemone and P. mexicana.*while the other three genera are represented by one species in each. While family *Fumariacea* has one genus; *Fumaria* with two species only in Saudi Arabia; *F. parviflora* Lam and *F.judaica* Boiss. and increased by four species in Egypt; *F. bracteosa*, *F. densiflora*, *F. microstachys* and *F. officinalis* [29] . The genera are easily recognized by both capsule and leaf characters beside pollen and stigmatic surfaces[16]. Genus *Hypecoum* L. is separated in a separate family *Hypecoaceae* with close relation to *Fumariaceae*.

Taxonomic Position of the Egyptian and Saudi Genera

Family : *Papaveraceae* s.l.

Subfamily: *Papaveroideae*
Tribe: *Papaverereae*
Genera: *Papaver , Argemone , Roemaria*
Tribe: *Cheliodonea*
Genus: *Glaucum*
Subfamily: *Fumarioideae*
Tribe: *Fumarieae*
Genus: *Fumaria*
Tribe: *Hypecoeae*
Genus: *Hypecoum*

General Distribution of the Family

Genera of the *Papaveraceae* s.l. are very widely distributed, especially in the coldest parts of the world. They are largely distributed in North Temperate regions, also in South Africa, scattered in South America. Genera of the family prefer cool regions, for that they are

widely distributed in North America, Canada, Mediterranean regions, and Europe. There are some species, especially those belonging to *Papaver,* introduced and cultivated in India, China and many other Arab countries for their uses and chemical compositions. Some genera such as *Meconopsis* grown in high altitudes and for that it can be found in the Himalayan range and in the mountains of western China and native to these Asian regions.

Phylogenetic Relationships within the Family

Systematic is a historical discipline which with phylogeny we can begin to understand diversification and regularities in pattern of evolution. From the tree of life obtained from the green plants BAC Library Project, we can find the *Ranunculales*, including the *Papaveraceae* s.l., in the basal Angiosperms (Fig. 6). Recently, Takhtajan[30] has postulated new systematic of the *Angiospermae* has been done in which it contains three subphyla; the Paleoangiosperms with one order *Nymphaeales*, the *Monocotyledoneae* with three classes the *Liliidae*, the *Commelinidae* and the *Magnolopsida* (with three orders, *Magnoliales*, *Laurales* and *Pipirales*) and the *Dicotylidoneae* s.s. containing the Eudicots (Tricolpate) with two orders the *Ranunculales* (*Berberidaceae*, *Ranunculaceae* and *Papaveraceae*) and *Proteales* then the core eudicots with the rest of orders and families.

Accordingly, a large number of species previously considered "dicots" do constitute a well supported clade and renamed the tricolpate[31] or eudicots[32]. From Judd and Olmstead[33] the tricolpate clade is characterized by pollen grains with three apertures, cyclic flowers and the presence of different outer and inner perianth members, slender staminal filaments bearing well differentiated anthers and S-type plastids in their sieve elements. These morphological characters were supported to be monophyletic group by numerous molecular analysis such as Soltis *et al.*[34], Hoot *et al.*[18], Savolainen *et al.*[35], Zanis *et al.*[36] and Kim *et al.*[37].

Family *Papaveraceae* s.l. with *Fumariaceae* considered as sister to the remaining families of the *Ranunculales* (Fig. 1;[18]) and considered from the basal tricolpates (eudicots). Cronquist[11] considered the *Ranunculales* as one of the woody magnoliids because their flowers have free parts that are sometimes spirally arranged. Cronquist[11] suggested

that the connection to the woody magnoliids was via *Illiciaceae* (ANITA grade;[38]) due to the presence of triaperturate pollen in both groups. Spichiger and Savolainen[39] pointed to the similarities between the *Ranunculales* and *Papaverales* with the monocots as they share many features such as imperfect vessels; inaperturate or uniaperturate pollen (or derived types). Recent works based on molecular analysis considered the *Ranunculales* as a monophyletic group[15, 18, 34, 40-42]. Hilu *et al.*[43] , Kim *et al.*[37] and Worberg *et al.*[44] support the close relation between the *Eupteleaceae* and the rest of the *Ranunculales* families, with *Papaveraceae* s.l. the next family to diverge (Fig. 7).

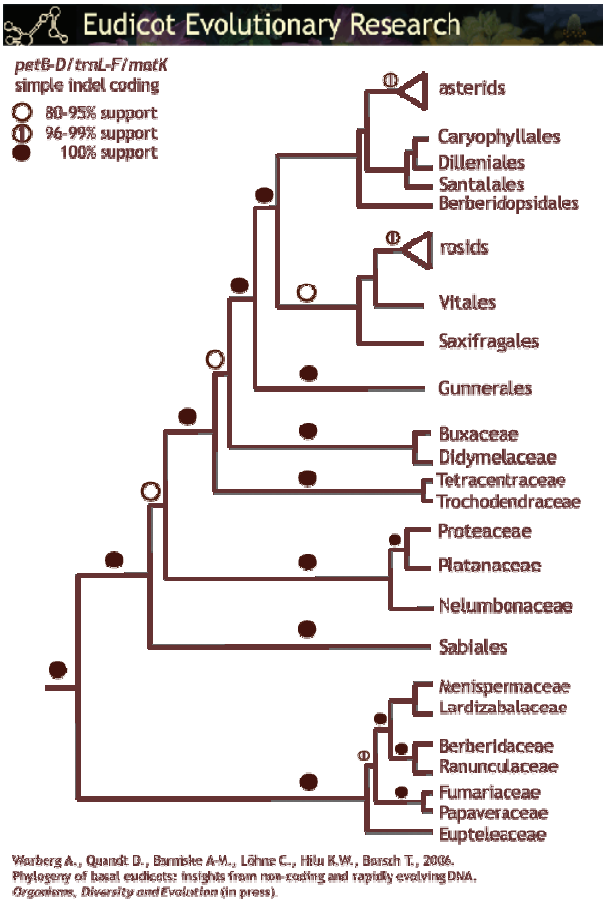

Fig. 6. Phylogenetic relations of the *Papaveraceae* on the basis of non-coding and rapidly evolved DNA data (tree adopted from Worberg *et al.*, 2006).

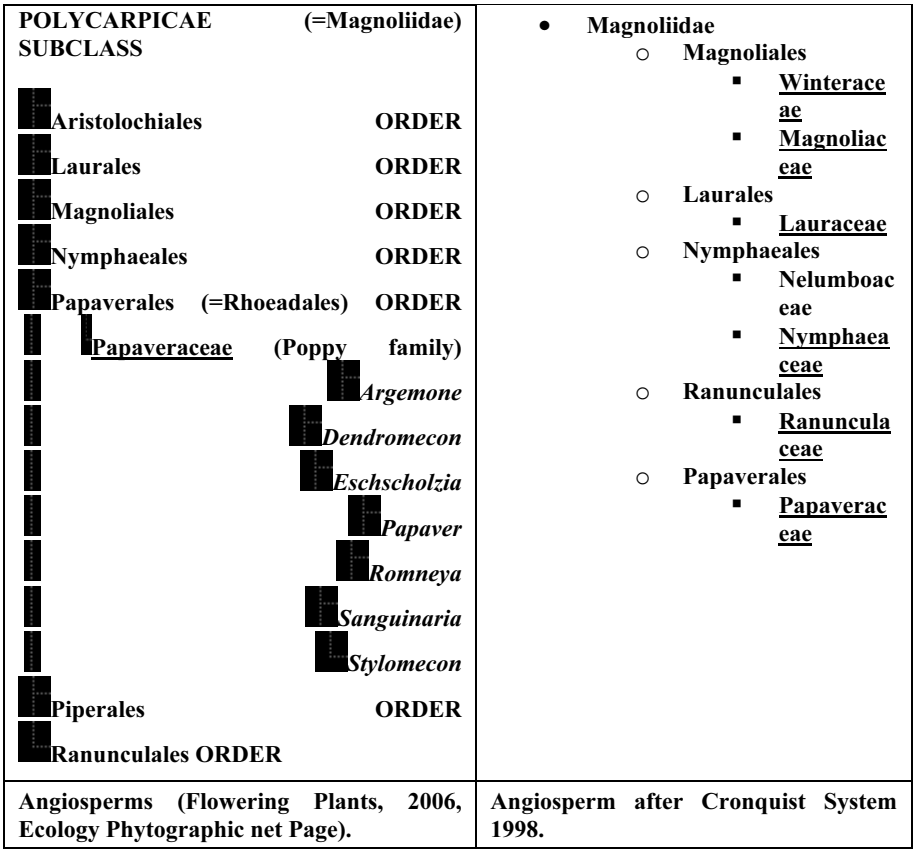

Fig. 7. Systematic position of *Papaveraceae* in the new systems of classifications.

Conclusion

This position of the *Papaveraceae* s.l. in close association with the *Fumariaceae* then the *Eupteleaceae* and the three are in close relation with the rest of the *Ranunculales* families and this is the most recent and acceptable position of the family on the basis of molecular analyses.

In spite of these relations between the genera under the *Papaveraceae* s.l. are still obscure, especially of the lack of fossils for that group and their geographical distribution. Kadereit *et al.*[26] found that the genera *Papaver* L., *Meconopsis* Vig., *Stylomecon* G.Taylor and *Roemeria* Medik. Within *Papaveraceae* s.str. subfamily *Papaveroideae* morphologically similar, in the mean time Schwarzbach & Kadereit[45] found that these

genera form a monophyletic clade on the basis of molecular analysis. These genera have several wide disjunctions in their geographical distribution, these disjunctions imply that far reaching extinction must have played a major role in the phylogeny of the group. Lecointre *et al.*[46] Kadereit *et al.*[47] and Soltis and Soltis[48] on the basis of molecular data concluded that, 1- Asian *Meconopsis* is not a monophyletic group, but paraphyletic in relation to *Papaver* s.l. including *M.cambrica*, *Stylomecon* and *Roemeria*. 2- Both *Roemeria* and *Stylomecon* are nested with *Papaver* s.l., *Roemeria* is sister group to *Papaver* sect. *Argemonidium* and *Stylomecon* to *papaver californicum*. 3- The position of *M.cambrica* within *papaver* s.l. (including *Stylomeco*n and *Roemeria*) allows the arise of it from within *Papaver* s.l. in parallel to Asian *Meconopsis* and in this case the genus *Papave*r will be monophyletic – or *M. cambrica* can be regarded as a genuine although disjunct *Meconopsis*, consequently the entire genus *Meconopsis* would be paraphyletic in relation to *Papaver* s.l.– or both *Meconopsis* and *Papaver* s.l. are polyphyletic.

References

[1] **Wettstein, R.,** *Handbook der systematischen Botanik*, Ed. 4. Franz Deuticke, Leipzig, Vienna (1935).

[2] **Melchior, H.A.,** *Engler's Syllabus der Pflanzenfamilien*, Ed.12 Gebruder Borntraeger, Berlin- Nikolassee (1964).

[3] **Tamura, M.,** *Phylogeny and Classification of the Angiosperms*, Sanseido, Tokyo (1974).

[4] **Benson, L.D.,** *Plant Classification,* Ed.2. D.C. Health, Lexington, Mass (1979).

[5] **Tutin, T.G., Burges, N.A., Chater, A.Q., Edmondson, J.R., Heywood, V.H., Moore, D.M., Valentine, D.H., Walter, S.M.** and **Webb, D.A.** (eds.), *Flora Europaea*, Ed.**2** vol.1, Lycopodiaceae to Platanaceae, Cambridge University Press, Cambridge, England (1993).

[6] **Lagowestschenski, A.W.,** *Die biochemischen Grundlagen des Evolutionsprozesses der Pflanzen*, Akademie-Verlag, Berlin (1955).

[7] **Hegnauer, R.,** Die Gliederung der Rhoeadales sensu Westtstein in Lichte der Inhaltsstoffe, *Plant Medic. (Stuttgard)*, **10**: 283-297 (1961).

[8] **Gershenzon, J.** and **Maby, T.J.,** Secondary metabolites and the higher classification of angiosperms, *Nordic Journal of Botany*, **3**: 5-34 (1983).

[9] **Norris, T.,** Torus anatomy and nectary characteristics as phylogenetic criteria in the Rhoeadales, *American Journal of Botany*, **28**: 101-113 (1941).

[10] **Heywood, V.H.,** *Flowering Plants of the World*, Andromeda Oxford Ltd. (1993).

[11] **Cronquist, A.,** *An Integrated System of Classification of Flowering Plants*, Columbia University Press, New York, New York, USA. (1981).

[12] **Fohne, D.,** Das Verhaltnin von Vergleichender Serobotanik zu Vergleichender Phytochemie, Dargestelt Anserologischen Unterschungen in Bereich der Rhoeadales, *Plant Medic*, *(Stuttgard)*, **10**: 283-297 (1962).

[13] **Kolbe, K.P.,** Serologische Beitrag zur Systematik der Capparales, *Botanical Jahrbuch Systematik*, **99**: 468-489 (1978).

[14] **Behnke, H.D.** and **Barthlott, W.,** New Evidence from the Ultrastructural and Miccromorphological Fields in Angiosperm Classification, *Nordic Journal of Botany*, **3**: 43-

66 (1983).

[15] **Chase, M.W., Soltis, D.E., Olmstead, R.G., Morgan, D., Les, D.H., Mishler, B.D., Duvall, M.R., Prince, R.A., Hills, H.G., Qui, Y.L., Krong, K.A., Rettig, J.H., Conti, E., Palmer, J.D., Manhat, J.R., Systema, K.J., Michaels, H.J., Kress, W.J., Karol, K.G., Clark, W.D., Hedren, M., Gaut, B.S., Jansen, R.K., Kim, K.J. Wimpee, C.F., Smith, J. F., Furnier, G.F., Strauss, S.H., Xiang, Q.Y., Plunkett, G.M., Soltis, P.S., Swensen, S.M., Williams, S.E., Gadek, P.A., Quinn, C.J., Eguiarte, L.E., Colenberg, E., Learn, jr, G.H., Graham, S.W., Barett, S.C.H., Dayanandan, S.** and **Albert, V.A.,** Phylogenetics of seed plants: An analysis of nucleotide sequences from the plastid gene rbcL, *Annals of the Missouri Botanical Gardens*, **80**: 528-580 (1993).

[16] **Taia, W.K.** and **Sheha, M.A.,** Systematic Study within the Papaverales (Papaveraceae and Fumariaceae), *Bulletin of Pure and Appllied Sciences,* **22B** (2): 75-93 (2003).

[17] **Parker, S.P.** (eds.), *Synopsis and Classification of Living Organisms*, Vols. 1 & 2. McGraw-Hill Book Company (1982).

[18] **Hoot, S.B., Magallon, S.** and **Crane, P.R.,** Phylogeny of basal eudicots based on three molecular data sets: *atpB, rbcL and 18S* nuclear ribosomal DNA sequences, *Annals of the Missouri Botanical Garden,* **86**: 1-32 (1999).

[19] **Kiger, R.W.,** Papaveraceae in Flora of North America Family Treatments : Magnoliidae. James L.Reveal, Lectures Notes- FNA Magnoliidae Treatment – Spring 1998 in *www.eflora.org*. (1996).

[20] **Hoot, S.B., Kadereit, J.W., Blattner, F.R., Jork, K.B., Schwarzbach, A.E.** and **Crane, P.R.,** Data congruence and phylogeny of the Papaveraceae s.l.based on four data sets: *atpB* and *rbcL* sequences, *trnK* restriction sites, and morphological characters, *Systematic Botany*, **22**: 575-590 (1997).

[21] **Ernst, W.R.,** A comparative morphology of the Papaveraceae, *Ph.D. dissertation*, Standford University (1962).

[22] **Layka, S.,** *Les methods modernes de la palynologie appliqués a l`etude des Papaverales*, Dissertation, Montpellier, C.N.R.S.A.O. 12.535 (1976).

[23] **Heslop-Harrison, Y.** and **Shivana, K.R.,** The receptive Surface of the Angiosperm Stigma, *Annals of Botany (London)*, **41**: 1233-1258 (1977).

[24] **Mabry, T.J.,** Is the order Centrospermae monophyletic? In: G. Bendz and J. Santesson (eds.), *Chemistry in Botanical Classification*, 275-285, Academic Press, New York, New York, USA. (1973).

[25] **Kadereit, J.W.,** Papaveraceae In: K. Kubitzki *et al*., ed. *The Families and Genera of Vascular Plants*, **2** vols. Berlin (1993).

[26] **Kadereit, J.W., Blattner, F.R., Jork, K.** and **Schwarzbach, A.,** Phylogenetic analysis of the Papaveraceae s.I. (including Fumariaceae, Hypecoaceae, and Pteridophyllum), *Botanische Jahrbucher fur Systematik und Pflanzengeographie*, **116**: 361-390 (1994).

[27] **Bruckner, C.,** Clarification of the carpel number in Papaverales, Capparales, and Berberidaceae, *Botanical Review*, **66** (2): 155-304 (2000).

[28] **Migahid, A.M.,** *Flora of Saudi Arabia*, University Library, King Saud University Press, Vol.**1**, 4th, Ed. pp: 38-42 (1996).

[29] **Tackholm, V.,** *Student's Flora of Egypt,* 2nd Ed., Cairo University, Cooperative Printing Company, Beirut (1974).

[30] **Takhtajan, A.L.**, *Diversity and Classification of Flowering Plants*, Columbia University Press, New York, New York, USA (1997).

[31] **Donoghue, M.J.** and **Doyle, J.A.**, Phylogenetic analysis of angiosperms and the relationships of Hamamelidae. In: P.R. Crane and S. Blackmore (ed.), *Evolution, Systematics and Fossil History of Hamamelidae*, vol. 1, Introduction and "lower" Hamamelidae. Systematics Association Special Volume 40A, 17-45, Clarendon Press, Oxford, UK (1989).

[32] **Doyle, J.A.** and **Hotton, C.L.**, Diversification of early angiosperm pollen in a cladistic context, In: S. Blackmore and S. H.Barnes (ed.), Pollen and Spores: *Pattern of Diversification*, 165-195, Clarendon Press, Oxford, UK (1991).

[33] **Judd, W.S.** and **Olmstead, R.,** A survey of tricolpate (Eudicots) phylogenetic relationships, *American Journal of Botany*, **91**: 1627-1644 (2004).

[34] **Soltis, D.E., Soltis, P.S., Nickrent, D.L., Johnson, L.A., Hahn, W.H., Hoot, S.B., Sweere, J.A., Kuzoff, R.K., Kron, A., Chase, M.W., Swensen, S.M., Zimmer, E.A., Chaw, S.M., Gillespie, L.J., Kress, W.J.** and **Sytsma, K.J.,** Angiosperm phylogeny inferred from *18Sr* DNA, *rbcL* and *atpB* sequences, *Botanical Journal of the Linnean Society*, **133**: 381-461 (1997).

[35] **Savolainen, V., Fady, M.F., Albach, D.C., Backlund, A., Vander Bank, M., Cameron, K.M., Johnson, S.A., Lledo, M.D., Pintaud, J.C., Powell, M., Sheahan, M.C., Soltis, D.E., Soltis, P.S., Weston, P., Whitten, W.M., Wurdack, K.J.** and **Chase, M.W.,** Phylogeny of the eudicots: a nearly complete familial analysis based on *rbcL* gene sequences, *Kew Bulletin*, **55**: 257-309 (2000).

[36] **Zanis, M., Soltis, P.S., Qiu, Y.L. , Zimmer, E.** and **Soltis, D.E.,** Phylogenetic analyses and perianth evolution in basal angiosperms, *Annals of the Missouri Botanical Garden*, **90**: 129-150 (2003).

[37] **Kim, S., Soltis, D.E., Soltis, P.S., Zanis, M.J.** and **Suh, Y.,** Phylogenetic relationships among early eudicots based on four genes: Were the eudicots ancestrally woody*? Molecular Phylogenetics and Evolution*, **31**(1): 16-30 (2004).

[38] **Qui, Y.L., Chase, M.W., Hoot, S.B., Conti, E., Crane, P.R., Systema, K.J.** and **Parks, C.R.,** Phylogenetics of the Hamamelidae and their allies: Parsimony analyses of nucleotide sequences of the plastid gene *rbcL*, *International Journal of Plant Science*, **159**: 891-905 (1998).

[39] **Spichiger, R.** and **Savolainen, V.,** Present state of Angiospermae phylogeny, *Candollea*, **52**: 435-455 (1997).

[40] **Drinnan, A.N., Crane, P.R.** and **Hoot, S.B.,** Patterns of floral evolution in the early diversification of non-magnoliid dicotylidns (eudicots), *Plant Systematics and Evolution (Supplement)*, **8**: 93-122, Springer wien (1994).

[41] **Hoot, S.B.** and **Crane, P.R.**, Interfamilial relationships in the Ranunculidae based on molecular systematics, *Plant Systematics and Evolution (Supplement)*, **9**: 119-131, Springer wien (1995).

[42] **Kallersjo, M., Farris, J.S., Chase, M.W., Bremer, B., Fay, M.F., Humphries, C.J., Petersen, G., Seberg, O.** and **Bremer, K.,** Simultaneous parsimony jackknife analysis of 2538 *rbcL* DNA sequences reveals support for major clades of green plants, land plants and flowering plants, *Plant Systematics and Evolution*, **213**: 259-287, Springer wien (1998).

[43] **Hilu, K.W., Borsch, T., Muller, K.,** *et al.*(16 co-authors)**,** Angiosperm phylogeny based on *matK* sequence information, *American Journal of Botany*, **90**:1758-1776 (2003).

[44] **Worbeg, A., Quandt, D., Barmiske, A.M., Hiter, K.W.** and **Borsch, T.,** Phylogeny of basal eudicots: Insights from non-coding and rapidly evolving DNA, Organisms, Diversity and Evolution (2006).

[45] **Schwarzbach, A.E.** and **Kadereitt, J.W.,** Rapid radiation of North American desert genera of the Papaveraceae: evidence from restriction site mapping of PCR-amplified chloroplast DNA fragments, In: U. Jensen & J.W. Kadereit (ed.): Systematics and Evolution of Ranunculiflorae, *Plant Systematics and Evolution. Suppl*., **9**: 159-170, Springer wien (1995).

[46] **Lecointre, G., Philippe, H., Le', H.L.V.** and **Guyader, H.,** Species sampling has a major impact on phylogenetic inference, *Molecular Phylogenetic Evolution*, **2**: 205-224 (1993).

[47] **Kadereit, J.W., Schwarzbach, A.E.** and **Jork, K.B.,** The phylogeny of Papaver s.l. (Papaveraceae): Polyphyly or monophyly? *Plant Systematics and Evolution*, **204**: 75-98. Springer wien (1997).

[48] **Soltis, P.S.** and **Soltis, D.E.,** The origin and diversification of angiosperms, *American Journal of Botany*, **91**: 1611-1626 (2004).

دراسة مرجعية في الفصيلة الخشخاشية مع الإشارة إلى الوضع التقسيمي لكل من الأجناس المصرية والسعودية تبعًا للنظم التقسيمية الحديثة

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المستخلص. هذه الدراسة شملت مسحًا كاملا للمراجع والدراسات الحديثة التي تناولت الأجناس المختلفة التابعة للفصيلة الخشخاشية في العالم . كما تناولت الآراء التصنيفية الحديثة لأوضاع الأجناس المختلفة التابعة للفصيلة الخشخاشية، والأنواع التي تم انضمامها إليها بعد الدراسات الحديثة على أساس الدلائل المتحصل عليها من تحليلات الحامض النووي والبروتينات المختلفة. ومن خلال هذه الدراسة والآراء المختلفة، تم سرد الأجناس النباتية التابعة لهذه الفصيلة والنامية بكل من مصر والمملكة العربية السعودية، مع توضيح وضعها التصنيفي تبعا للنظم التقسيمية الحديثة. كما تناولت الدراسة توضيح وضع الفصيلة الخشخاشية بالنسبة للفصائل المجاورة لها من تحاليل الأحماض النووية، والآراء حول العلاقة بينها وبين كل من الفصائل الفيومارية والهيبيكورية، والشقيقية. وأوضحت أن الفصائل الثلاثة، الخشخاشية، والفيومارية، والأيوبتلية ذات صلات وثيقة فيما بينهن، وأن لهن علاقة وثيقة برتبة الشقيقيات.