*Supplementary Material*

**Comparative Case Study of Evolutionary Insights and Floral Complexity in Key Early-Diverging Eudicot Ranunculales Models**

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**Table 1**. Comparative morphological traits among Ranunculales species. Symbols: \* tepals, - no data available, † fused, ‡location data obtained from [*Plants of the World Online | Kew Science*](https://powo.science.kew.org/). Abbreviations: Act: Actinomorphic, Zyg: Zygomorphic, P: Perennial, A: Annual, B: Bees, BB: Bumblebees, H: Hummingbird, HM: Hawkmoth, F: Flies, W: Wasps.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Family*** |  | **Morphology** | | | | | | | | | | | | | |
|  | Sepal | Sp. Sepal | Petals | Sp. Petal/s | R. Petal | L. Petal | Staminodia | Nectary | No. Stamens | Carpel | Symmetry | Life Cycle | Pollinators | Native Range | Reference |
| ***Aquilegia*** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ***coerulea*** | P |  | P | P |  |  | P | P | 40-130 | 4-10 | Act | P | B, BB, HM | N. America | 4, 8, 33, 40, 47, 48 |
| ***ecalcarata*** | P |  | P |  |  |  | P |  | 10, 40-60 | 5 | Act | P | F | China | 3, 4, 19, 25, 30, 48, 49 |
| ***formosa*** | P |  | P | P |  |  | P | P | 40-70 | 5 | Act | P | H | N. America | 3, 14, 21, 49 |
| ***jonesii*** | P |  | P | P |  |  |  | P | 40-70 | 4-6 | Act | P | BB | N. America | 21, 23, 30, 33, 48 |
| ***pubescens*** | P |  | P | P |  |  | P | P | 40-70 | 4-6 | Act | P | HM | N. America | 22, 49 |
| ***Delphinium*** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ***ajacis*** | P | P | P | P | P |  |  | P | 13-17 | 1 | Zyg | A | BB, F | Eurasia‡ | 27, 58 |
| ***anthriscifolium*** | P | P | P | P | P | P |  | P | 12-22 | 3 | Zyg | A | BB | China | 6, 26, 52, 56, 57 |
| ***ecalcaratum*** | P |  | P |  | - | - |  | - | 5 | 3 | Act | - | - | China | 15 |
| ***grandiflorum*** | P | P | P | P | P | P |  | P | - | 3-5 | Zyg | P | BB | Eurasia‡ | 15, 28 |
| ***turcicum*** | \* |  | \* |  | P |  |  |  | 12-18 | 3 | Act | A | - | C. Turkey | 10, 16, 50 |
| ***Consolida*** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ***regalis*** | P | P | P | P | P |  |  | P | 13-20 | 1 | Zyg | A | B, BB | Medit. | 7, 9, 15 |
| ***Aconitum*** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ***lycoctonum*** | P | P | P | P |  |  |  | P | 17-35 | 3 | Zyg | P | BB | Europe | 1, 2, 24, 27, 32 |
| ***Gymnaconitum*** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ***gymnandrum*** | P |  | P | P | P |  |  | P | 30-90 | 6-14 | Zyg | A | BB | Qinghai-Tibetan Plateau | 38, 56, 58 |
| ***Staphisagria*** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ***macrosperma*** | P | P | P | P | P | P |  | P | ~40 | 3 | Zyg | A | BB, HM, F | Medit.‡ | 27, 55, 58 |
| ***picta*** | P | P | P | P | P | P |  | P | ~40 | 3 | Zyg | A | BB, HM, F | Medit.‡ | 27, 55, 58 |
| ***Thalictrum*** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ***dioicum*** | P |  |  |  |  |  |  |  | 20-42 | 5-17 | Act | P | Wind | N. America | 12, 36 |
| ***thalictroides*** | P |  |  |  |  |  |  |  | 45-76 | 3-11 | Act | P | B, BB, F | N. America | 18, 31, 39, 42 |
| ***Nigella*** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ***damascena*** | P |  | P |  |  |  |  | P | 30-45 | 3-5† | Act | A | B, BB, W | Medit. | 28, 29, 37, 59 |
| ***Papaver*** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ***Eschscholzia californica*** | P |  | P |  |  |  |  |  | 16-39 | 2† | Act | A | B, BB, Wind | N. America | 5, 11, 20 |
| ***somniferum*** | P |  | P |  |  |  |  |  | (25)60-223 | 8-12† | Act | A | B, F | Medit. | 13, 20, 41, 43 |

**Table 2**. Expression of floral organ identity (MADS box) genes in five genera (2.1-2.5) within the Ranunculales order. Plus and minus signs correspond to the presence and absence of expression, respectively. The slash is used to indicate observed expression change as the flower transitions from early to late developmental stage. S, strong expression; w, weak expression; ND, no data available.

**2.1** *Aquilegia coerulea*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Aquilegia coerulea* | | | | | | |
| Gene | Sepal | Petal | Stamen | Staminodium | Carpel | References |
| *AqvAP3-1* | + (w) | + (w) | + (w) | + (s) | + (w) | 34 |
| *AqvAP3-2* | + (w) | + | + (s) | + (w) | + (w) | 34 |
| *AqvAP3-3* | - | + (s) | + (w) | - | - | 34 |
| *AqvPI* | + (w) | + | + | + (w) | + (w) | 34 |
| *AqcFL1\** | + (w) | + | + | + | + | 45 |
| *AqcAG1* | ND | ND | + | ND | + | 34, 46 |
| *AqcAG2* | ND | ND | ND | ND | + | 34, 46 |

**\****AqcFL1A* and *AqcFL1B*

**2.2** *Thalictrum thalictroides* and *Thalictrum dioicum*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Thalictrum thalictroides* and *Thalictrum dioicum* | | | | | |
| Gene | Sepal | Stamen | Carpel | Ovule | Reference |
| *ThtAP3-1* | +(s) | + | - | ND | 12, 39 |
| *ThtAP3-2a* | +(w) | + | - | ND | 12, 39 |
| *ThtAP3-2b* | +(s) | + | - | ND | 12, 39 |
| *ThtPI* | +(s) | + | - | ND | 12, 39 |
| *ThtAG1* | - | + | +(w) | +(s) | 17, 39 |
| *ThtAG2* | - | - | +(w) | + | 17, 39 |
| *ThtSEP1* | + | +(w) | - | ND | 39 |
| *ThtSEP2* | + | + | + | ND | 39 |
| *ThtSEP3* | + | + | + | ND | 39 |
| *ThdPI-1* | + | + (Staminate) | - | - | 12 |
| *ThdPI-2* | + | + (Staminate) | - | - | 12 |

**2.3** *Nigella damascena* (Reference:51)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Nigella damascena* | | | | |
| Gene | Sepal | Petal | Stamen | Carpel |
| *NdAP3-1* | - | + | + (s) | +/- |
| *NdAP3-2* | -/+ | +/- | -/+ | +/- |
| *NdAP3-3* | - | + (s) | +/- | - |
| *NdPI1* | + | + (s) | + (s) | +/- |
| *NdPI2* | + (s) | + (s) | + (s) | +/- |
| *NdFL1* | + | +/- | +/- | + |
| *NdAG1* | - | - | -/+ | + |
| *NdAG2* | - | - | - | + |
| *NdSEP1* | +/- | +/- | +/- | +/- |
| *NdSEP3* | + | + | + | + |
| *NdAGL6* | + (s) | + (s) | + | + |

**2.4** *Delphinium ajacis* (Reference:58)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *Delphinium ajacis* | | | | | | | |
| Gene | Sepal | Spurred Sepal | Petal | Spurred Petal | Reduced Petal | Stamen | Carpel |
| *DeajAP3-1* | - | - | + | - | + | + (s) | +/- |
| *DeajAP3-2* | -/+ | -/+ | -/+ | + | -/+ | + (s) | + |
| *DeajAP3-3* | - | - | + (s) | +(s) | - | +/- | +/- |
| *DeajPI1* | + (s) | + (s) | + (s) | + (s) | + (s) | + (s) | +/- |
| *DeajPI2* | +/- | - | +/- | - | +/- | + | +/- |
| *DeajAGL6-1a* | + (s) | + (s) | + (s) | + (s) | + (s) | +/- | + |
| *DeajAGL6-1b* | + | + | + | + (s) | + | + | +/-/+ |
| *DeajAGL6-2* | + | + | + | + | + | +/- | +/- |

**2.5** *Papaver somniferum* and *Eschscholzia californica*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Papaver somniferum* and *Eschscholzia californica* | | | | | |
| Gene | Sepal | Petal | Stamen | Carpel | Reference |
| *PapsAP3-1* | +(w) | + | + | +(w) | 13 |
| *PapsAP3-2* | +(w) | + | + | +(w) | 13 |
| *PapsPI-1* | - | + | + | - | 13 |
| *PapsPI-2* | + | + | + (w) | +(w) | 13 |
| *PapsFL-1* | + | + | + | + | 44 |
| *PapsFL-2* | + | + | + | + | 44 |
| *EScaFL1* | + | +(w) | + | +(s) | 44 |
| *EScaFL2* | +(s) | +(s) | +(s) | +(s) | 44 |
| *EScaAG1* | - | - | +(s) | +(s) | 35, 53 |
| *EScaAG2* | - | - | + | +(w) | 35, 53 |
| *DEF1* | - | +(w) | +(w) | - | 35 |
| *DEF2* | - | +(s) | + | - | 35 |
| *DEF3* | - | +(s) | + | - | 35 |
| *SEI* | - | +(s) | + | - | 35 |
| *EScaAGL9* | +(w) | + (s) | + (s) | + | 53 |

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