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FLORAL REWARD IN RANUNCULACEAE SPECIES

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Floral reward is important in ecological and evolutionary perspectives and essential in pollination biology. For example, floral traits, nectar and pollen features are essential for understanding the functional ecology, the dynamics of pollen transport, competition for pollinator services, and patterns of specialization and generalization in plant–pollinator interactions. We believe to present a synthetic description in the field of floral reward in Ranunculaceae family important in pollination biology and indicating connections between ecological and evolutionary approaches. The links between insect visitors' behaviour and floral reward type and characteristics exist.

Ranunculaceae is a family of aboot 1700 species (aboot 60 genera), distributed worldwide, however the most abundant representatives are in temperate and cool regions of the northern and southern hemispheres. The flowers are usually radially symmetric (zygomorphic) and bisexual, but in *Aconitum, Aquilegia* are bilaterally symmetric (zygomorphic). Most Ranunculaceae flowers offer no nectar, only pollen (e.g., *Ranunculus, Adonis vernalis, Thalictrum*), but numerous species create trophic niches for different wild pollinators (e.g. *Osmia, Megachile, Bombus, Andrena*) (Denisow *et al.* 2008).

Pollen is a source of protein, vitamins, mineral salts, organic acids and hormones, but the nutritional value varies greatly between different plant species. The pollen production can differ significantly between Ranunculacea species. The mass of pollen produced in anthers differ due to variations in the number of developed anthers. For example, inter-species differences are considerable, 49 anthers are noted in *Aquilegia vulgaris*, 70 anthers in *Ranunculus lanuginosus*, 120 in *Adonis vernalis*. A significant intra-species differences' in the number of anthers are also noted (e.g. 41 to 61 in *Aquilegia vulgaris*, 23-45 in *Ranunculus cassubicus*. Pollen production can be up to 62 kg per ha for *Ranunculus acer* on meadows.

Nectaries are secretory structures that synthesize and release nectar, a multi-component carbohydrate-rich aqueous solution. The relative location of nectaries within a flower is under pressure to maximize relations with pollinators, and hence to ensure the deposition of pollen on the stigma by pollinators. Nectaries are common in Ranunculaceae. Location, morphology and structure of the floral nectaries differ among Ranunculaceae representatives. Nectaries are tubular in *Helleborus* spp. or situated in nectary spurs (*Aconitum, Aquilegia*). Nectaries consist of an external epidermis, a photosynthesizing parenchyma, large branches of vascular tissue, a nectar-producing parenchyma, and an internal epidermis (Vesprini *et al.* 2008).

Nectar production is generally associated with mutualistic relations with animals that rely on sugar secretions in their nutrition. Inter-species differences in the amount of nectar produced and nectar chemistry are noted among Ranunculaceae species. Significant variations in nectar carbohydrate composition between male and female sexual phases occur both in the protandrous and protogynous flowers. In *Aconitum carmichaelii*, male-phase flowers produced 2.4-fold more nectar than female-phase flowers. Nectar sugar composition can differ between species within genera. The nectar

can be sucrose-dominant, e.g. in *Aconitum carmichaelii* or sucrose-rich and lacking glucose in *A. lycoctonum* (Antoń & Denisow 2014). Variability in nectar production and/or carbohydrate composition in an individual plant may be considered to be evolutionarily significant. It can modify insect movements between flowers and plants, impact on visitation rates, reduce geitonogamy and thus increase plant fitness by cross-pollination. The floral morphology and the type of the floral attractant in *Anemone sylvestris* is an example of the in-between form from entomophily to anemophily (lack of nectar, papillous stigma, dense hairs situated between single carpels, small pollen grains – 10-25 μm, lack of balsam on the exine surface, starch accumulation in pollen).

In conclusion, the flower morphology and type of floral reward in Ranunculaceae species indicate the patterns for generalized insect visitors/pollinators (Apoidea bees, Coleoptera, Diptera) in actinomorphic species, for specialization towards bumblebees or show in-between form from entomophily to anemophily.

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