

How changes in meristem patterning drive evolutionary innovations: insights from syncephalia in the sunflower family (Asteraceae)

The sunflower family (Asteraceae), with over 32,000 species, is one of the largest and most diverse families of flowering plants. A key factor behind their evolutionary success is the capitulum—a complex, flower-like inflorescence seen in popular ornamentals like gerberas and marigolds. Some members of this family take complexity even further by forming compound heads, known as syncephalia, where multiple capitula are united into a single capitulum-like structure.

All plant organs, such as leaves and flowers, originate from meristems—small clusters of actively dividing cells located at the growing tips of shoots. Changes in meristem patterning underpin the formation of syncephalia, yet the mechanisms driving this process remain poorly understood. The two primary hypotheses suggest either the condensation of a capitulescence (an inflorescence of capitula) or the looping of an individual capitulum's developmental program. Testing these hypotheses is the central goal of this project.

This study focuses on two ornamental species: globe thistle (*Echinops ritro*) and billy buttons (*Pycnosorus globosus*). By combining morphology with state-of-the-art molecular and bioinformatic techniques, we aim to identify the genes and regulatory networks involved in syncephalia development. These findings will be compared with data from closely related species with simple heads, such as common burdock (*Arctium lappa*) and dwarf everlast (*Helichrysum arenarium*), to determine whether the independent evolution of syncephalia across Asteraceae follows similar genetic mechanisms.

This project will provide valuable insights into how meristem activity drives the emergence of novel plant structures like syncephalia, shedding light on the evolutionary pathways that lead to increased complexity in plant architecture. The understanding of structural variation in reproductive shoots has significant economic implications, as these traits are primary drivers of ornamental appeal and crucial determinants of yield in many crop species.