# Plant thermogenesis has played key role in attracting pollinating insects for at least 200 million years, study suggests

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Thermogenesis is present in plants such as 'Macrozamia communis', which raise the temperature of their reproductive organs when in bloom to attract pollinating insects. Credit: R. Oberprieler / Yun Hsiao

Thermogenesis is a process by which organisms generate internal heat. Although it is usually associated with animals, some plants have also developed this ability. This metabolic process allows certain parts of the plant, such as flowers and inflorescences, to raise their temperature above that of the surrounding environment.

Today, these plants, which include cycads and some angiosperms (flowering plants), rely on insects for pollination. The heat they generate helps volatilize and disperse floral fragrances and other chemical compounds that attract insects such as beetles, flies, and trips to the plants. Additionally, thermogenesis stabilizes the development of reproductive organs in cold climates and facilitates the growth of pollen tubes.

## Evidence in the fossil record

Although thermogenesis cannot be directly preserved in the fossil record , scientists can infer its presence in ancient plants by studying anatomical structures similar to those of current thermogenic plants.

A new study led by the Botanical Institute of Barcelona (IBB), a joint center of the Spanish National Research Council (CSIC) and the Consorci Museu Ciències Naturals de Barcelona, in collaboration with the Complutense University of Madrid and other institutions such as the Geological and Mining Institute of Spain (IGME–CSIC), the Smithsonian Institution, the University of Barcelona, and the Royal Botanic Gardens of Sydney, has examined the characteristics of present-day thermogenic plants and compared them with fossil plant lineages.

The work appears in *Nature Plants*.

"Our findings suggest that thermogenesis in plants is an older phenomenon than previously thought," explains David Peris, a

researcher at the IBB and the lead author of the study. "Two hundred million million years ago, the diversification of flowering plants had not yet occurred. Therefore, thermogenesis could have been a crucial factor in the evolutionary success of seed plants in general, and flowering plants in particular, as well as their pollinators."

## A discovery with evolutionary implications

In thermogenic plants, female structures mature before male structures to avoid self-fertilization. This relates to the early divergence lines of angiosperms, which had floral chambers where the stamens and carpels closed independently. The presence of reproductive chambers in fossil plants that could have trapped pollinating insects also suggests that this feature existed in the past.

Large reproductive structures, such as perianths or cones, could also indicate thermogenesis, as they retain heat more effectively. This study has allowed scientists to identify which fossil plant lineages might have exhibited thermogenic activity, suggesting that thermogenesis has been present in seed plants for longer than previously thought.

The ability to generate heat may have given certain Mesozoic plants—more than 200 million years ago—a competitive advantage over non-thermogenic plants by attracting pollinating insects more efficiently, thus contributing to their reproductive success. This strategy for attracting pollinators could have preceded others, such as bright flower colors, and may have been influenced by past climatic changes. Moreover, thermogenesis is closely linked to the emission of fragrances, another crucial factor in attracting insects.

This study opens new lines for exploring how these interactions influenced the diversification of plants and their pollinators throughout evolutionary history.

"Thermogenesis in plants is not just a botanical curiosity," notes Iván Pérez-Lorenzo, a researcher at the IBB and a participant in the study. "It is an important factor that has contributed to the success of the two most diverse groups of organisms today: insects and angiosperms, and it has key implications for understanding the evolution of pollination strategies."

**More information:** The impact of thermogenesis on the origin of insect pollination, *Nature Plants* (2024). DOI: 10.1038/s41477-024-01775-z

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