Orchid adding bird perch for crossing ensures reproduction

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Sheaths surrounding the basal axis (perch) of C. rigida inflorescences attract and

position sunbirds for cross-pollination to ensure reproductive success. A. Inflorescence with the sheathed bird perch (arrow). B. A bird (male) on a perch bends down to probe flowers. C. Pollinaria (arrow) attached to different spots on the bird beak are cross-transferred to flowers with equivalent distances to perch. D. Fruit set from cross-pollination. E. A wasp and F. a honeybee visit flowers in the same manner, both causing infertile self-pollination. Credit: Zhong-Jian Liu and Laiqiang Huang et al.

Chinese researchers have solved the mystery of the function of sheaths in flowering orchids. In a paper published in *PLOS ONE*, the team led by Zhong-Jian Liu at the Orchid Conservation & Research Center of Shenzhen and Laiqiang Huang at Tsinghua University found the perch to be essential to orchid reproduction.

In many orchids such as Coelogyne rigida, the basal axis of the pendulous, multi-flowered inflorescence is covered by multiple coriaceous sheaths (bracts) forming a clavate cylindrical handle whose function has long been a puzzle and remained mysterious until today. Researchers have discovered that the sheaths-wrapped handle serves as the specialized perch (landing platform) to attract, secure and position foraging sunbird, Aethopyga gouldiae, for orderly collection and dispersal of pollinaria, attached to different spots of its beak, resulting in efficient cross-pollination and fruiting. The perch-enabled cross-pollination by sunbirds accounts for essentially all the seed production of this orchid, which was largely abolished by sheaths removal (perch damage) that reduced the visitations by sunbirds markedly both in frequency and duration, revealing an essential role of the perch in assuring the species' reproductive success by crossing.

Intriguingly, C. rigida, while self-incompatible, has a bi-modal pollination system. It is also self-pollinated by insects, honeybee and wasp, that use the floral lip common in orchids as visiting plate, leading

to infertile self-pollination which decreases (wastes) pollinaria and ovules otherwise available for fruitful cross-pollination, incurring high mating cost (gamete discounting). However, the insect-mediated fruitless self-pollination is offset by the efficient cross-pollination by sunbird.

This represents a new and striking mode of structural adaptation that promotes cross-pollination in angiosperms. By merely adding a perch to the basal axis of inflorescence without altering the multiple flowers on it, C. rigida gains not only reproductive assurance but also mating and fertility advantages and genetic variability from crossing. It is likely that in C. rigida, self-incompatibility has evolved to avoid inbreeding depression by rendering insect self-pollination infertile, but it can't prevent self-pollination that still leads to gamete discounting at a high cost to mating, nor directly promote crossing which becomes essential for sexual reproduction; which, in turn, necessitates and selects for the evolution of an outbreeding mechanism – the perch-enabled bird cross-pollination to assure reproductive success with multiple advantages. The findings may have broad implications for many other plant species with inflorescences and sheaths.

More information: Zhong-Jian, L. and Huang, L et al., Adding perches for cross-pollination ensures the reproduction of a self-incompatible orchid. *PLOS ONE.* 8(1): e53695. doi:10.1371/journal.pone.0053695

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