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Nectar robbing in bellflower (*Sesamum radiatum*) benefited pollinators but unaffected maternal function of plant reproduction

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Nectar robbing – foraging nectar illegitimately – has negative, neutral, or positive effects on maternal function of plant reproduction and/or on pollinators. It has been suggested that nectar robbing has a non-negative effect on maternal function of plant reproduction in autogamous and mixed breeding plants; however this hypothesis requires deeper understanding with more studies. We investigated the impact of natural nectar robbing on maternal function of plant reproduction and visitation characteristics of pollinators in *Sesamum radiatum*, an autogamous plant. Pollinators were observed on unrobbed open flowers and robbed open flowers. In robbed flowers, pollinators' visit type and foraging time were examined. The seed sets of these flower types were examined. *Xylocopa latipes* was both a primary robber and a legitimate pollinator, *X. bryorum* was an exclusive primary robber, and *Megachile disjuncta* was a cosmopolitan pollinator. In robbed flowers, most of the pollinators foraged mostly as secondary nectar robbers. The foraging time shortened considerably when pollinators robbed nectar – a positive effect on pollinators' foraging efficiency. Robbing did not negatively affect seed set – a neutral effect on the plant's reproduction. Our study agrees that nectar robbing might have a non-negative effect on reproduction in autogamous and mixed breeding plants.

Plant-pollinator interaction is an example of mutualism. In this interaction, both the plant and the pollinator are benefited from the visits of pollinators on the flowers[1]. However, many plant-pollinator mutualisms are disrupted by cheaters[2] – visitors that exploit but leave the flowers unrewarded. Nectar robbers are often costly and ubiquitous disruptor of plant-pollinator mutualisms[3,4]. Nectar-robbing is an adaptive trait evolved in some pollinators, which increases their foraging efficiency over legitimate pollinators[4–8]. It has been predicted that facultative exploiters, such as floral nectar foragers, might exploit rather than collaborate with the robbed flowers in order to improve their foraging efficiency[5–7].

In plant-pollinator-robber interactions, although robbers are always benefited[2], plants and pollinators may be affected positively or negatively; or remain unaffected[3,8–12]. Like any other species interactions[13], the net effect of nectar robbing on each partner species and on the plant-pollinator mutualism depends on the context[4]. The breeding mechanism of plants might predict the net effect of nectar robbing on plants' maternal function of plant reproduction[12,14].

Nectar robbing in plants can affect male or female reproductive functions[4]. Nectar robbing has a negative effect on female reproductive function in both self-compatible and self-incompatible species which have not developed autogamy as a reproductive strategy[12,14]. Nectar robbing in plants that set seeds through selfing may have a positive or neutral effect on the maternal function of the plant reproduction[8]. Zhang *et al.*[14] studied the effect of nectar robbing in three sympatric plant species having three different mating strategies (selfing, facultative outcrossing, and obligate outcrossing) and found that the female reproductive function of selfing species was not affected, the facultative outcrossing species was benefited, and the obligate outcrossing species was negatively affected. Similarly, Burkle *et al.*[12] suggested that nectar robbing has negative effect on female reproductive function of pollen-limited self-incompatible plants. However, testing this hypothesis requires deeper understanding with more case studies.

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