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A novel indirect defence in Brassicaceae: Structure and function of extrafloral nectaries in *Brassica juncea*

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ABSTRACT

While nectaries are commonly found in flowers, some plants also form extrafloral nectaries on stems or leaves. For the first time in the family Brassicaceae, here we report extrafloral nectaries in *Brassica juncea*. The extrafloral nectar (EFN) was secreted from previously amorphic sites on stems, flowering stalks and leaf axils from the onset of flowering until silique formation. Transverse sections at the point of nectar secretion revealed a pocket-like structure whose opening was surrounded by modified stomatal guard cells. The EFN droplets were viscous and up to 50% of the total weight was sugars, 97% of which was sucrose in the five varieties of *B. juncea* examined. Threonine, glutamine, arginine and glutamate were the most abundant amino acids. EFN droplets also contained glucosinolates, mainly gluconapin and sinigrin. Nectar secretion was increased when the plants were damaged by chewing above- and belowground herbivores and sap-sucking aphids. Parasitoids of each herbivore species were tested for their preference, of which three parasitoids preferred EFN and sucrose solutions over water. Moreover, the survival and fecundity of parasitoids were positively affected by feeding on EFN. We conclude that EFN production in *B. juncea* may contribute to the indirect defence of this plant species.

INTRODUCTION

Extrafloral nectaries are nectar-secreting parts of the plant surface other than flowers. These organs are not directly involved in pollination, and can be found on virtually all aboveground plant parts (Koptur 1992; Oliveira & Pie 1998). Plants bearing extrafloral nectaries are widely distributed around the world. About 114 plant families with more than 700 genera and 4000 species of plants, including pteridophytes, gymnosperms and angiosperms, are known to possess extrafloral nectaries to date (Keeler 2008).