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Wild bees as pollinators of four *Gentiana* species on Mount Vitoša (Bulgaria)

Abstract

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Bumble-bees (*Bombus* species) are the most effective and thus the main pollinators of *Gentiana lutea, G. punctata* and *G. asclepiadea. Gentiana cruciata* is pollinated by bumble-bees and *Halictus* bees. The flower constancy of the pollinators is high.

Introduction

The flowers of *Gentiana lutea* L. are not adapted to any particular pollinator, while those of *G. punctata* L., *G. asclepiadea* L., *G. cruciata* L. and some others are bombophilous (Müller 1881: 329-349). The bumble-bees are the main pollinators of some *Gentiana* species, whereas the role of solitary bees is more or less ancillary (Parrish & Bazzaz 1979, Spira & Pollak 1986, Costello 1988, Petanidou & Nijs 1991, Kožuharova & al. 1994). The resource choice of the bees and their flower constancy (which is generally high) depends on the bee species and many other factors (Brian 1957, Free 1970, Heinrich 1979, Teräs 1985).

The aim of this paper is to investigate the role of wild bees in the pollination of some *Gentiana* species that are morphologically adapted to them.

Material and methods

The pollination ecology of natural populations of *Gentiana lutea* subsp. *symphyandra* (Murb.) Hayek, *G. punctata, G. asclepiadea,* and *G. cruciata* has been studied in plots of 1000-2000 m^2 on Mt Vitoša (S.W. Bulgaria), between 1000 and 1950 m a.s.l., during the summer seasons of three consecutive years (1990-1992). The behaviour of the insects visiting the flowers was observed. Some were collected for identification and analysis of their pollen loads. The pollen types were identified by comparison with reference slides of pollen collected from flowers in the same area.

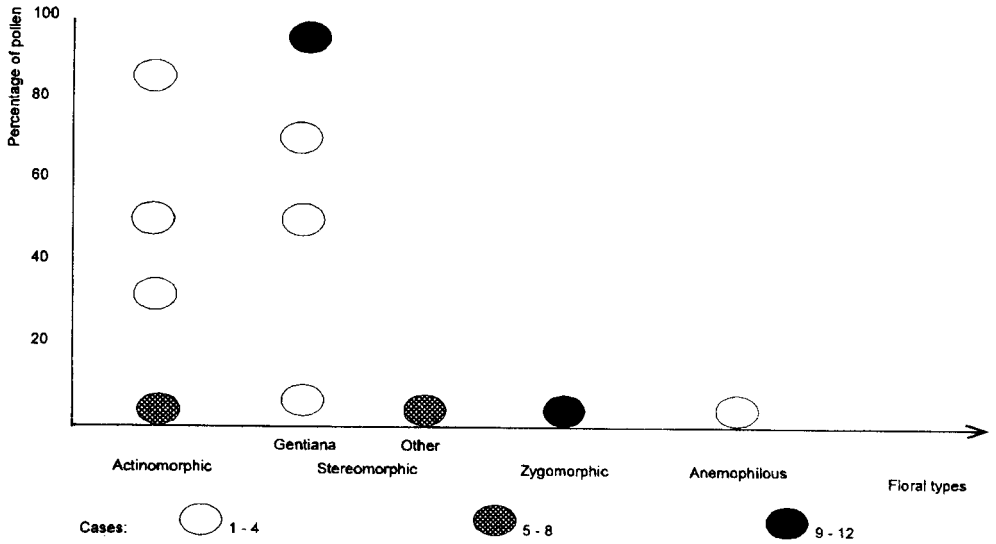

Fig. 1. Percent composition of the pollen loads of *Gentiana lutea* pollinators, by different flower types and by frequency classes of individuals: *Bombus pratorum* (10 workers), *B. pyrenaeus* (2 workers), *B. lapidarius* (1 worker) and *Halictus* species (1 female).

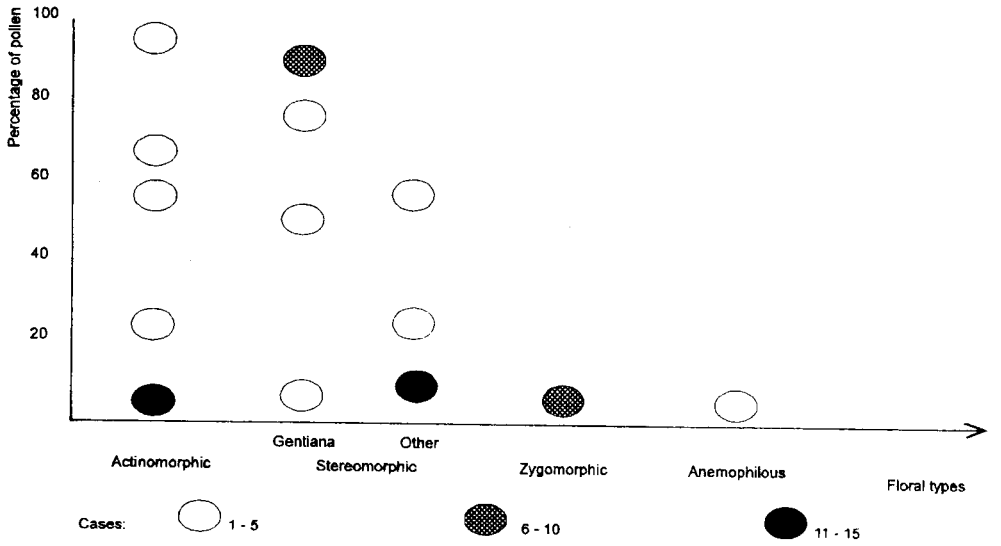

Fig. 2. Percent composition of the pollen loads of *Gentiana punctata* pollinators, by different flower types and by frequency classes of individuals: *Bombus pratorum* (9 workers), *B. hortorum* (2 workers), *B. pyrenaeus* (1 worker), *B. terrestris* (1 worker) and *Halictus* species (4 females).

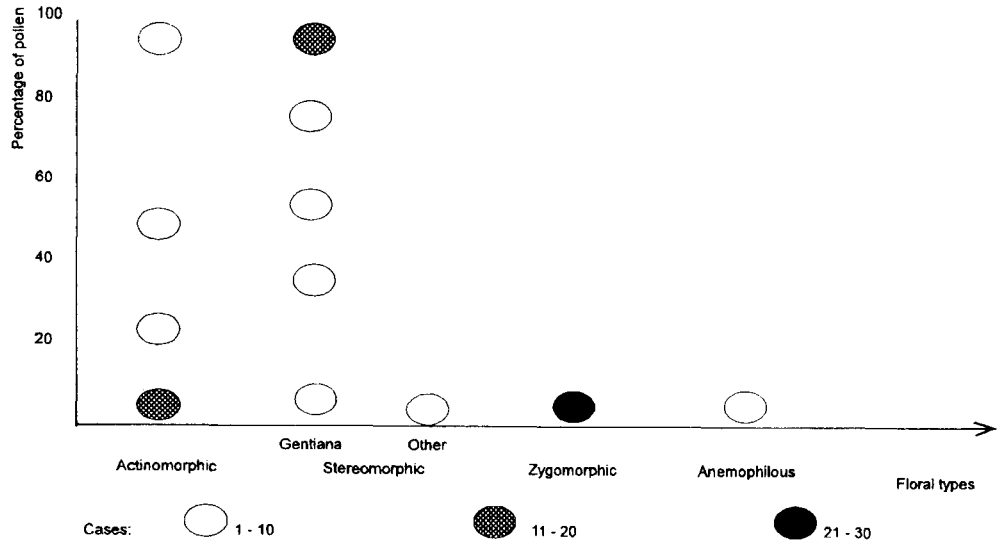

Fig. 3. Percent composition of the pollen loads of *Gentiana asclepiadea* pollinators, by different flower types and by frequency classes of individuals: *Bombus terrestris* (5 workers), *B. pratorum* (4 workers and 4 queens), *B. agrorum* (5 workers), *B. lapidarius* (2 workers), *B. hortorum* (3 workers) and *Halictus* species (1 female).

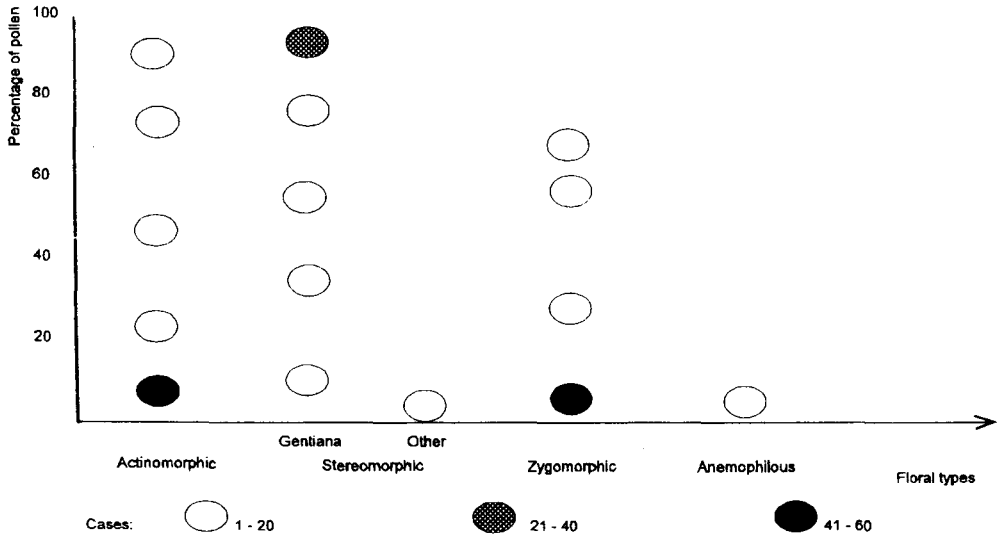

Fig. 4. Percent composition of pollen loads of *Gentiana cruciata* pollinators, by different flower types and by frequency classes of individuals: *Halictus* species (42 females), *Bombus pratorum* (1 worker) and *B. hortorum* (1 worker).

Results and discussion

Bumble-bees (*Bombus* species) are the main pollinators of *Gentiana lutea, G. punctata, G. asclepiadea,* and *G. cruciata* because they are more effective than any other visitors. They were not however the most frequent visitors, since they accounted only for 25.9 % of all insect visits in *G. lutea,* 12.3 % in *G. punctata,* 10.7 % in *G. asclepiadea,* and 12.4 % in *G. cruciata.*

Bombus pratorum was most frequently seen at the flowers of *Gentiana lutea* and *G. punctata, B. hortorum* at those of *G. cruciata* and *G. asclepiadea,* and *B. agrorum* was only found visiting *G. asclepiadea* flowers. *B. terrestris* paid rare visits to *G. punctata* and *G. asclepiadea. B. lapidarius* preferred other plant species.

The diversity of bumble-bees pollinating these *Gentiana* species is considered to be a consequence of the pollinators' varying feeding preferences, colonial habits, and morphology.

Pollen-collecting species were effective pollinators of *Gentiana lutea,* but most of the bumble-bees visited its flowers in quest of nectar. *G. lutea* flowers have five nectar pockets situated between the stamen filaments at their attachment point to the shallow corolla tube. Those nectar collectors which probed the five nectar "pockets" in succession were effective pollinators, climbing over the filaments around the style and touching the stigma. Others, which fed only on a single nectar "pocket", did not touch the stigma (Kožuharova & al. 1994). In the flowers of the other three *Gentiana* species bumble-bees usually preferred nectar, always touching the generative organs when feeding.

The analysis of the corbicular pollen loads confirmed the report of Macior (1974) that bumble-bees are generally polylectic. Pure pollen loads were exceptions. Bumble-bees foraging on *Gentiana lutea* flowers had 76 % *Gentiana* pollen in their pollen load on average, those visiting *G. punctata,* 73 %, the *G. asclepiadea* visitors, 66 % (Fig. 1-3). The percentage of *Gentiana* pollen varies widely among individuals as well as species of bumble-bees (Fig. 1-3). Besides the gentians, bumble-bees preferred yellow actinomorphic flowers (*Hypericum, Potentilla,* etc.), other stereomorphic flowers (*Campanula, Vaccinium,* etc.), and zygomorphic ones (*Asteraceae, Lamiaceae, Fabaceae,* etc.), in the sense of Leppik (1957) (Fig. 1-3). The presence of *Aconitum* pollen in the pollen loads of *G. asclepiadea* pollinators is indicative of the bumble-bees' large foraging areas, since no *Aconitum* grows in the neighbourhoods of the gentian plot.

Bee species of the genus *Halictus* collect mainly pollen, but they visited gentian flowers both in their male and female functional states. They were frequently found at the flowers of *G. cruciata* (43.2 % of all visitors) but not of the other gentians. There is a clear spatial segregation between the *G. cruciata* plants pollinated by *Bombus* species and those visited by *Halictus* species. Judging from seed set, both pollinators are about equally effective. The pollen of *Gentiana* accounted for 66 % of the pollen loads of *Halictus* bees on average (Fig. 4) but this proportion varied widely among individuals. Besides gentians, *Halictus* bees preferred yellow and white actinomorphic flowers *(Potentilla, Hypericum, Galium, Apiaceae)* and zygomorphic flowers *(Lamiaceae, Asteraceae, Fabaceae).*

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