

Body Size Affects Nectar Uptakes Rates in Bumblebees (Hymenoptera: Apidae: *Bombus terrestris*)

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It is known that larger bumblebee foragers collect nectar at higher rates than smaller foragers (GOULSON, PEAT, STOUT ET AL 2002, INGS, SCHIKORA & CHITTKA 2005, INGS, WARD & CHITTKA 2006, SPAETHE & WEIDENMÜLLER 2002). Several mechanisms for this have been suggested (INGS et al 2005). One untested suggestion is that larger bees are able to ingest nectar more quickly and therefore have reduced handling times. To test this hypothesis the nectar uptake rates of different sized bees were measured. Individually marked bees were trained to visit a feeder (a Lego® brick), containing a known mass of artificial nectar (66.3% sugar (w/w)), located in a feeding chamber attached to a nest box by a clear plastic tube. The time individual bees took to feed from the feeder was recorded and the mass of nectar ingested was calculated by subtracting the final mass of the feeder from its mass before bees fed. For each bee, the rate of nectar uptake was measured at least 10 times and the size of bees was quantified by measuring their thorax width at a point just below the wing bases.

The uptake rates of 19 bees with thorax widths ranging from 4.0 to 5.7 mm were measured. Within this size range, nectar uptake rates were significantly positively related to body size (uptake rate = $0.247 \cdot \text{thorax width} - 0.399$; $R^2 = 0.628$, $F_{1,17} = 28.734$, $p < 0.001$), i.e. larger bees ingested nectar faster than small bees. A 25% increase in thorax width (4 to 5 mm) resulted in a 42% (0.59 to $0.84 \mu\text{l s}^{-1}$) increase in uptake rates. To put this into context, consider that a typical bumblebee forager collects about $80 \mu\text{l}$ of nectar per foraging trip. Therefore, a large bee (5 mm thorax) will require 96 seconds of ingestion time, whilst a small bee (4 mm thorax) will require 136 seconds ingestion time.

These results support the hypothesis that large bees have shorter handling times when visiting the same flowers as smaller bees. However, it is important to consider that ingestion time is only one component of overall handling time. Also handling time is only one of many facets of bumblebee foraging that influences foraging rates. Flying between patches and among flowers within a patch is a large component of bee foraging (HEINRICH 1979), and body size might also be important for flight dynamics (but see CHITTKA, INGS & RAINE 2004). Hence, it seems unlikely that any one mechanism in isolation can fully explain the greater foraging rates of large bumblebees. Therefore, future research needs to consider how the factors influenced by body size interact to make larger bees better nectar foragers.

References

- GOULSON D, PEAT J, STOUT J C, TUCKER J, DARVILL B, DERWENT L C & HUGHES W O H [2002]: Can alloethism in workers of the bumblebee, *Bombus terrestris*, be explained in terms of foraging efficiency? - *Anim Behav* **64**: 123-30; Palo Alto/USA.
- HEINRICH B [1979] Bumblebee economics. - Harvard University Press, Cambridge/USA.
- INGS T C, SCHIKORA J & CHITTKA, L [2005]: Bumblebees, humble pollinators or assiduous invaders? A population comparison of foraging performance in *Bombus terrestris*. - *Oecologia* **144**: 508-516; Berlin/Deutschland.
- INGS T C, WARD N L & CHITTKA L [2006]: Can commercially imported bumble bees out-compete their native conspecifics? *J App Ecol* **43**: 940-948; Oxford/UK.

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