Caste distinction during the development of honey bees

Honey bee female caste is considered to be an exemplar polyphenism, whereby the expression of alternate queen and worker morphs is controlled by environmental cues (Evans and Wheeler [1999](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4662310/#ece31720-bib-0014)). Unlike some other well‐studied polyphenisms that are controlled by simple abiotic factors such as temperature or photoperiod (Nijhout [2003](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4662310/#ece31720-bib-0046)), honey bee queen–worker dimorphism critically depends on social control of larval development by adult nestmates (Linksvayer et al. [2011](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4662310/#ece31720-bib-0038)). In vitro rearing studies demonstrate that in the absence of social control, queen–worker dimorphism disappears and a continuous range of phenotypes are produced (Linksvayer et al. [2011](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4662310/#ece31720-bib-0038)).

Honey bee colonies only rear new queens during specific life‐history stages, for example, in the spring when the colony is large enough to split in half, or upon the death of the current queen. Queen rearing is an emergent, colony‐level process involving the coordinated activities of hundreds or thousands of adult workers. Necessary steps include the construction of special queen cells by nurse bees (Fig. [1](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4662310/figure/ece31720-fig-0001/)), distinct provisioning behavior of nurses coupled with distinct qualitative and quantitative differences in the nutrition fed to queen‐ and worker‐destined larvae (colloquially known as “royal jelly” vs. “worker jelly”) (Haydak [1970](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4662310/#ece31720-bib-0025); Brouwers et al. [1987](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4662310/#ece31720-bib-0005)), the larval developmental response to these environmental signals, and finally, selection by nurses of a subset of larvae in queen cells to be reared to adulthood (Hatch et al. [1999](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4662310/#ece31720-bib-0024)).

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[Figure 1](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4662310/figure/ece31720-fig-0001/)

Honey bee workers rear most of their larvae in hexagonal cells (upper right) provisioned with a relatively small quantity of food so that the larvae develop into new workers. A few larvae are reared as new queens in larger queen cells (center left) that are newly constructed and provisioned with more and qualitatively different brood food.

The evolution of nonreproductive castes is a fundamental question in evolution biology. The honeybee *[Apis](https://www.sciencedirect.com/topics/neuroscience/apidae" \o "Learn more about Apidae from ScienceDirect's AI-generated Topic Pages)* mellifera L. has a reproductive division of labour: the queen is the primary egg-layer in a colony and has more than 200 ovarian filaments (ovarioles), whereas a worker normally does not reproduce and has fewer than 20 [ovarioles](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/ovarioles). The number of ovarioles influences worker [foraging behaviour](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/foraging-behavior) and the propensity to become an egg-layer in the absence of the queen, suggesting that reproductive regulatory networks evolved with foraging division of labour in honeybee workers. Cooperation between nurse bee feeding behaviour and larval developmental programming results in the differentiation of queens and workers along with variation in [ovariole](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/ovariole) number, body mass and foraging behaviour. Here, we tested how nurse bees affect ovariole number and body mass in workers, and how larvae respond to food delivery during different larval life stages. Findings demonstrate that nurses control larvae growth and ovariole number by temporally manipulating food delivery and that the response of larvae to food differs with larval life stage and genotype. Body mass of larvae was more sensitive to nutrition during the first to the fourth [instar](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/instar) (L1–L4), whereas ovariole number was more sensitive during the fifth instar (L5). It concluded that nurse feeding behaviour during L5 is critical for modulating ovariole number in workers.