

Convoluted aorta of *Apis mellifera*

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Introduction

We investigated the anatomy of the convoluted aorta in honeybee (*Apis mellifera*) by comparing worker, drone and queen castes (Fig.1). The convoluted aorta is an extension of the dorsal vessel as it passes from the coelom, through the petiole, thorax exiting behind the brain.

Sampling

Castes were sampled at different times of the year. Most of the queens examined were young virgin queens and were reared in cell raisers and finished in an incubator in the summer. Drones were also sampled in the summer. Workers were harvested in the summer and winter to compare their respective anatomy.

Fig.1



Fig. 1 Outlines highlighting the physical differences between honey bee worker (top), drone (middle) and queen (bottom), with their respective stained and dissected convoluted aorta. Stained with fuschin and fixed in Xylene

HISTOPATHOLOGY

Fig.2



Fig. 2.

Each bee was dissected with ventral access. The dorsal vessel and the convoluted aorta was identified and removed. The samples were fixed in isopropyl alcohol, standard histological embedding and staining. There is significant cellular differences between the castes and drones. Drones have large amounts of muscle around the dorsal vessel whilst the castes have less

Caste-Specific Differences in Coelom Length (Adjusted for Size)

A generalised linear model tested the effect of caste and body length on coelom length in *Apis mellifera*.

Fig3

•**Caste effect:** After controlling for body length, drones had significantly shorter coeloms (~0.75 mm less) than workers ($p = 0.037$), while queens had significantly longer coeloms (~1.85 mm more) than workers ($p < 0.000001$).

•**Body length effect:** Body length was a strong positive predictor of coelom length ($p < 0.000000001$), confirming its inclusion in the model.

•**Model fit:** The model explained ~84% of variation ($R^2 \approx 0.84$), indicating a strong relationship between caste, body size, and coelom length.

Conclusion: Coelom length differences between castes persist even after accounting for body size, suggesting biological factors beyond simple scaling.

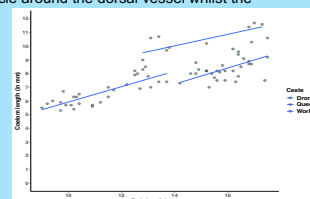


Fig.3. Significant difference between coelom length between castes, that goes beyond simply due to body length



Fig 4. CT of *Apis mellifera*

COMPUTED TOMOGRAPHY / SEGMENTATION

High-resolution CT scanning of the worker bee was undertaken to visualise the internal morphology without dissection. Fig.4 Further work is in progress to segment the dorsal vessel, including the convoluted aorta, and to compare these digital measurements with those obtained from direct dissection. This approach will allow validation of imaging techniques and provide a non-destructive method for anatomical studies.

CONCLUSION

Structural variation in workers: The abdominal convoluted aorta, when present, attaches to tergites A9–A2 before detaching via soft tissue to the crop, passing through the petiole in a bundle with the oesophagus and nerve bundle, then entering the thorax (~5 μ m wide). Not all workers had this feature, possibly due to age-related differences.

Drone morphology: Drones have a larger dorsal vessel that remains attached to the tergites, follows the A2 tergite through the petiole, and travels dorsally through flight muscles, often with a single, flatter convolution compared to workers.

Future research: Expanded seasonal and age-based sampling, improved dissection/CT techniques, and larger datasets will clarify intraspecific and caste-specific patterns.

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Comparison of the structure of the convoluted aorta in the worker, queen and drone of *Apis mellifera*; gross dissection, histology and microCT

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The convoluted aorta of *Apis mellifera* is a critical yet understudied organ, with little existing literature exploring its structure or function across castes. This study arose from the challenges encountered during a dissection class, where locating the aorta proved difficult. Using ventral-side-up dissections, the project aimed to refine dissection techniques and investigate potential structural differences in the aorta among workers, queens, and drones. A total of 30 workers, 15 drones, and 8 queens (sourced from other club members) were analysed. Distinct patterns of convolutions were observed among castes. Workers exhibited 8–10 tight convolutions adhered by connective tissue, potentially enhancing heat dissipation during sustained flight and supporting thermoregulation within the hive. Queens had 6–10 loose convolutions, reflecting their largely sedentary role with only occasional flights for mating or swarming. Drones exhibited 2–4 tight convolutions, a structure that may be linked to their larger body size and reduced capacity for heat dissipation during intense, short-duration mating flights.

Specimens were prepared by fixing in isopropyl alcohol for 24 hours, staining with fuchsin, and mounting in xylene under coverslips. While dissection and preparation presented considerable challenges in technique standardisation, the findings highlight structural adaptations of the aorta that align with the physiological demands and behaviours of each caste. Dissected aortas were sent for histology to be compared with whole body histology to give a direct comparison. This was cross referenced with micro CT carried out at Liverpool University. These histological comparisons and future morphometric analyses could further elucidate how structural features influence circulatory efficiency, thermoregulation, and overall fitness.

These preliminary observations provide a basis for future research into the functional morphology of the convoluted aorta. The study underscores the value of exploring caste-specific adaptations in social insects, offering insights into their evolution and ecology while advancing knowledge of insect circulatory systems.