CAN X-RAY MICROTOMOGRAPHY HELP US READ EVOLUTION IN BEES´ EYES?

Marie Dominique Schmidt[1], Pierre Tichit[2], Gavin Taylor[2] & Emily Baird[2]

[1]Westfälische Hochschule, Germany
[2]Lund University, Sweden

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Summary: Using X-ray micro-computed tomography (micro-CT), we reconstructed anatomical 3D models of the compound eyes from bees of different species, sizes or sex. By comparing simulations based on those models, we can quantify to which extent different bees may have a different visual experience of their world. Ultimately, we try to relate each specialisation to the visual cues available in the sensory environment bees have evolved in.

1. INTRODUCTION

Bees are present in a wide range of distinct environments, ranging from dark cluttered rainforests in the tropics to the open tundra of the arctic circle. Depending on its habitat, sex or size, each bee uses its eyes to solve a variety of visually guided tasks, such as controlling flight, landing, finding food or mates. Consequently, bees´ visual systems are constantly under selective pressures favouring forms that are adapted to gather relevant sensory information from the environment, and lead to appropriate behavioural responses.

Advanced micro computed tomography enables us to quickly construct quantitative anatomical models of the eyes of bee species, and has the enormous advantage of keeping intact the 3D position of the different eye structures relative to one another. These models allow us to understand what information bees can extract from different visual scenes, and ultimately to evaluate the adaptive value of each visual specialisation to the visual cues that are available.

2. EXPERIMENTAL METHOD

We captured and dissected several bee species at field sites in Brazil, Panama and southern Sweden. Their compound eyes were fixated, dehydrated and embedded in epoxy resin for micro-CT scanning. Imaging was performed at beamline I13-2 of Diamond Light Source, UK. We annotated the visible eye structures with AMIRA, and computed relevant visual parameters using a custom-made MATLAB script.

3. RESULTS

We reconstructed both the monocular and binocular fields of view of the bee samples. We used them as a template to map on the bees´ visual world relevant eye parameters such as contrast sensitivity (the ability to distinguish objects of different light intensities) or visual acuity (the ability to see fine details). Such maps inform us about the visual performance of bee eyes. Despite some similarities, these optical parameters differ between bees of distinct species, sizes or sex. To which extend these fine differences reflect adaptations to specific visual environments will be discussed in further detail.

References

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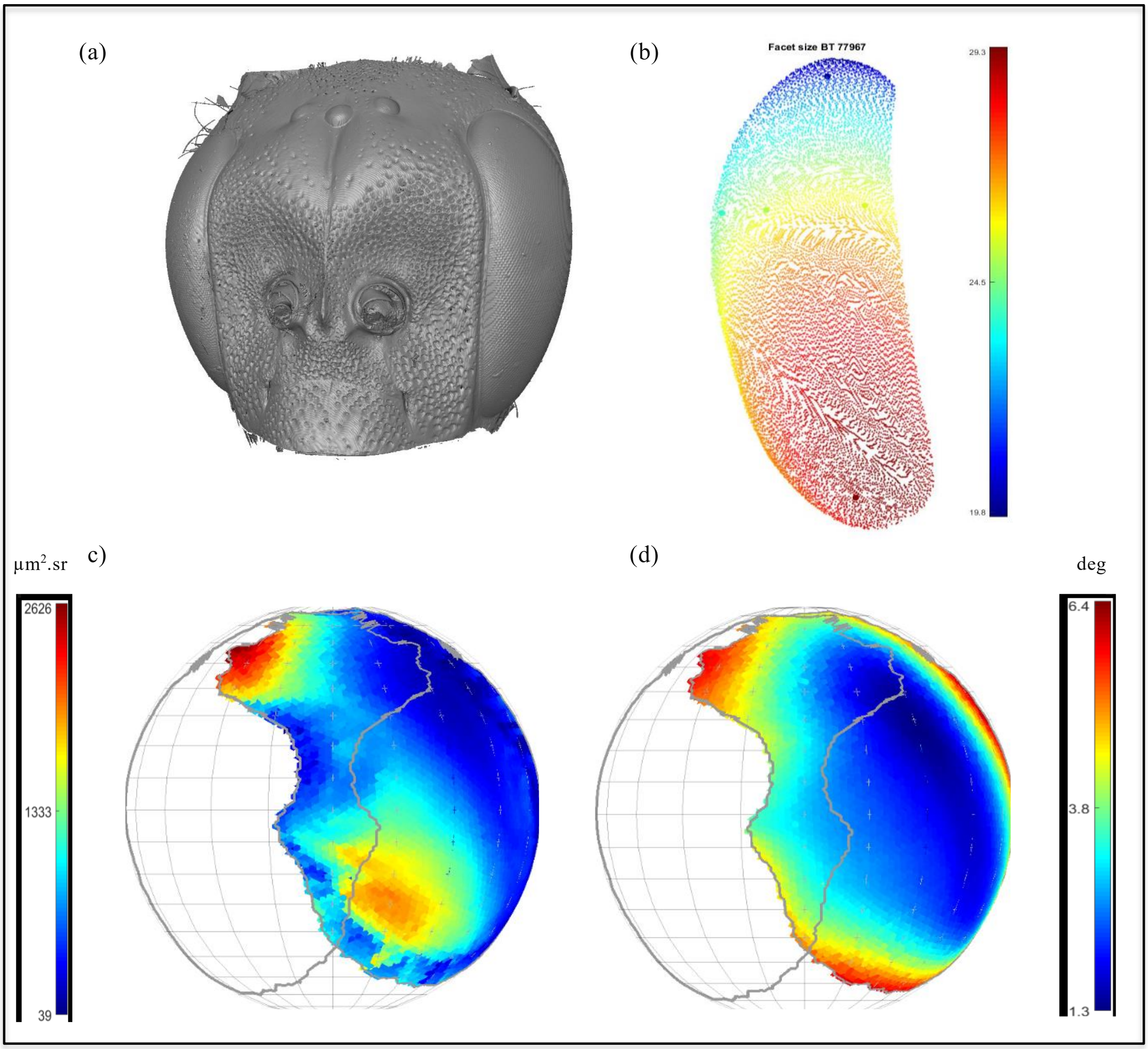

Figure 1: (a) External view of the head of a tropical bumblebee worker *Bombus morio* scanned with micro-CT. Relevant eye parameters (of a bumblebee *Bombus terrestris*) such as facet size (b) can be mapped on the left eye, or more interestingly projected, on the visual world, as sensitivity (c) and resolution (d).