wings

Flight is required for the honeybee way of life. Air travel offers a great opportunity for organisms to move quickly in the 3-dimensional space just above earth's surface. Winged flight has arisen independently on several occasions over the long, long time since life first appeared on the planet 3,800,000,000 years ago.

Of course, for most of that period, living things were very small (single-celled, microscopic). The first persistent multicellular organisms appeared about 900,000,000 years ago. Then, just 540,000,000 years ago, there was an intense diversification of life forms called the *Cambrian explosion* (see ***survivor***). Animals possessing body plans which survived set the stage for later genetic developments. **Trilobites** are one set of early arthropod well known from their fossil remnants.

Another arthropod group, **Insects**, emerged about 480,000,000 years ago. For 80,000,000 years, these animals were restricted to swimming or crawling. Then, one type of insects, the ***Pterygotes***, took to the air [*Greek **πτερόν** (***pteron***) means wing]. The popularity of flight is demonstrated by the large fraction of insects which have wings, at least for some stage of their lives.

Hymenoptera, which arose 250,000,000 years ago, have *two pairs of membranous wings, with hindwings hooking to the forewings* for functional stability. **Honeybees** belong to this ancient lineage.

(*** Figures 2, 3, 4, and 8 below are from *The Journal of Experimental Biology* 2015*:*
The function of resilin in honeybee wings - Yun Ma, Jian Guo Ning, Hui Lan Ren*, Peng Fei Zhang, and Hong Yan Zhao – see **here** ***):

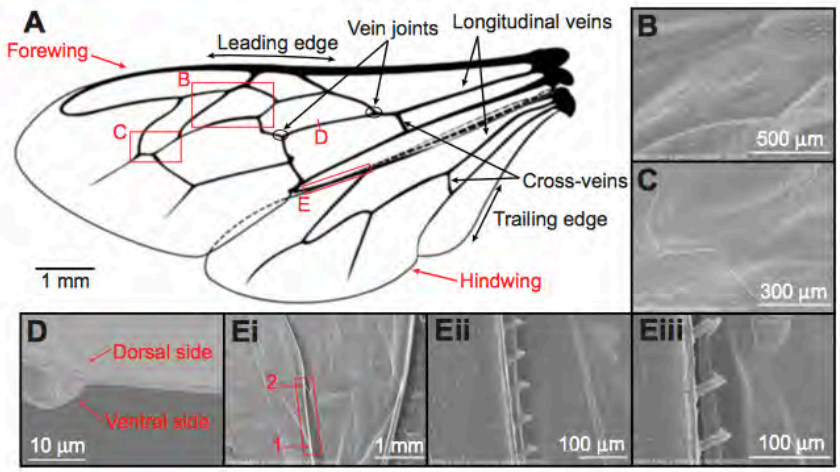

Fig. 2. Wing morphology of a worker honeybee (dorsal side). (A) A pair of coupled wings. Dashed lines illustrate the parts of the hindwing beneath the forewing. Areas labeled B–E refer to the four specific positions on the coupled wings and relate to the panels below. (B) Scanning electron microscopy (SEM) image of details of the dorsal surface at position B of the forewing. (C) SEM image of details of the ventral surface at position C of the forewing. (D) SEM image of the cross-section of a vein at position D of the forewing. (Ei–iii) SEM images of the hook structure (HS) at position E under different magnifications (ventral side). 1, vein joint on the costa; 2, end of the costa.

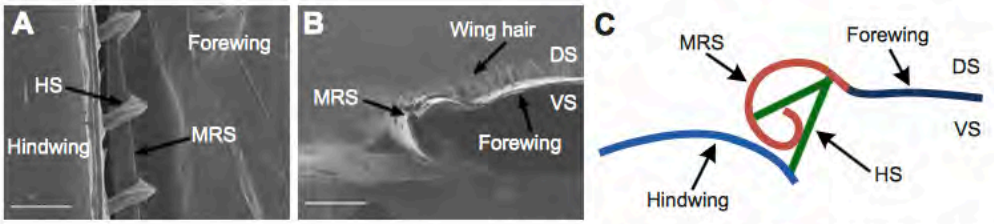

Fig. 3. SEM images and illustration of the linking structure. (A) SEM image of the HS of the hindwing. Wings are shown from the ventral side. Scale bar represents 50 µm. (B) SEM image of a cross-section of the membrane-rolling structure (MRS) of the forewing. Scale bar represents 50 µm. DS, dorsal side; VS, ventral side. (C) Schematic diagram of the cross-section of the HS and MRS connected together, which we call the linking structure (LS). The red and green lines represent the MRS and HS, respectively. The red with the dark blue line represents the forewing. The light blue with the green line represents the hindwing.

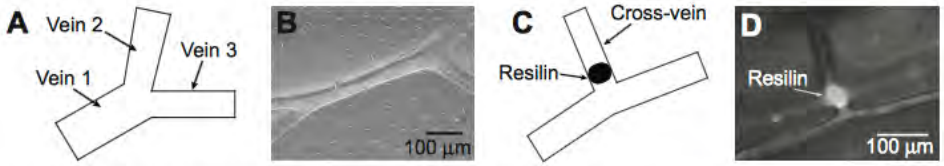

Fig. 4. Scheme and micrograph of two main types of vein joints of the honeybee wing. (A) Scheme of the immobile vein joint. (B) SEM image of the immobile joint without the imbued resilin patch. (C) Scheme of the mobile joint. (D) Fluorescence microscopy (FM) image of the mobile joint with the imbued resilin patch.

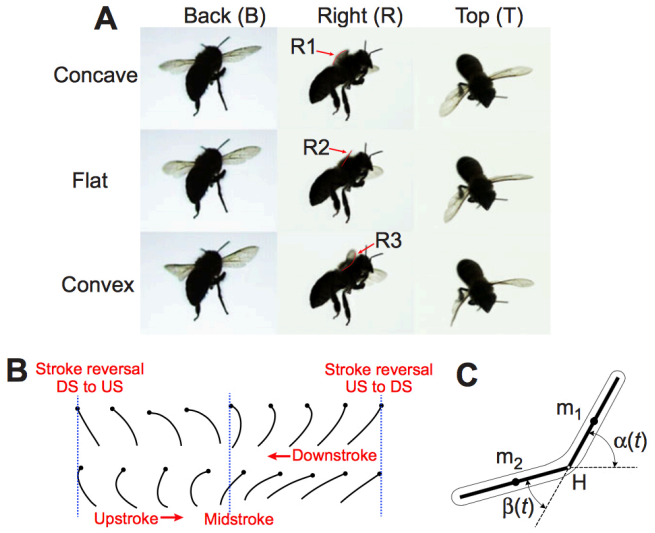

Fig. 8. Deformation of the coupled-wing profile. (A) Transition from a concave to a convex camber profile during supination. The images were recorded by three high-speed cameras. Camera shutter time was 50 µs and frames were recorded

Looking closely at the wings of the honeybee reveals much of
how they do what they must do when they take to the skies.

... for more, see: **imagessays.com -> *wings*** .