

Talk

Vein or trachea first? A comparative and genetic study to test the hypothesis of the pleural gill origin of the insect wing



Ana Alcaina (1,*), Carlos Martín (1), Isabel Almudi (1) y Fernando Casares (1,*)

(1)Centro Andaluz de Biología del Desarrollo (CABD), Ctra. de Utrera, km. 1, 41013, Sevilla

Keywords: wing tracheae; serial homologs; *Drosophila* wing, wing veins, insect evolution

ABSTRACT

Motivation: How insect wings emerged as an evolutionary novelty that permitted the extraordinary radiation and diversification among insects is a long-standing question that remains unanswered. The fossil record suggests that the first wings evolved in aquatic insects from respiratory gills, lateral movable flat pads articulated with the trunk pleural (lateral) region (1). Extant representatives of these flying insect ancestors are the Ephemeropterans, or mayflies. Still today, their aquatic nymphs bear gills along the abdominal segments. Extant wings are formed by a bilayered epithelial wing span. Rigidity is conferred by veins, epithelial thickenings that form hollow tubes that radiate along the proximodistal wing axis. Veins allow the flow of hemolymph and are traversed by trachea (respiratory tubes) and nerves (2) coming from sensory organs distributed along the wing margin or present on the veins. Therefore, the routes taken by trachea and nerves coincide with the veins. In the model organism, veins are genetically specified early, before any trachea invade the wing. Therefore, anatomical and genetic information seem to indicate that veins would be required for trachea and sensory organs to develop (i.e. veins come first). However, mayfly gills are invaded by branching trachea and have a number of sensory (and osmoregulatory) organs along the margin and on its surface, and yet they show no signs of veins. Therefore, if the gills were the ancestors of the wings, either gills from extant species lost the veins, or tracheal invasion of the wing does not depend on veins –although their precise routes might depend on where veins are.

Methods: To address this question we made comparative studies between *Cloeon* dipterum, and two dipteran species, *Drosophila melanogaster* and *Episyrphus balteatus* using immunostainings and fly genetics.

Results and Conclusions: In this work, I set to first, describe the tracheal invasion of the developing wing in *Drosophila* and two other species, another fly (*Episyrphus balteatus*) as well as in the mayfly *Cloeon* dipterum, to compare it to the development and pattern of tracheal invasion in *Cloeon*'s gills. Second, using a genetic approach, I test the mutual dependencies between trachea, veins and nerves for their establishment. If the wing originated from tracheated movable gills without vein tracks, wing trachea in *Drosophila* should be able to invade the developing wing without genetically defined veins.

REFERENCES

1. Tomoyasu, Y., Ohde, T. & Clark-Hachtel, C. What serial homologs can tell us about the origin of insect wings. *F1000Research* 6, 268 (2017).
2. Blair, S. S. & Palka, J. Axon guidance in the wing of *Drosophila*. *Trends Neurosci.* 8, 284–288 (1985).