# Study shows how one insect got its wings

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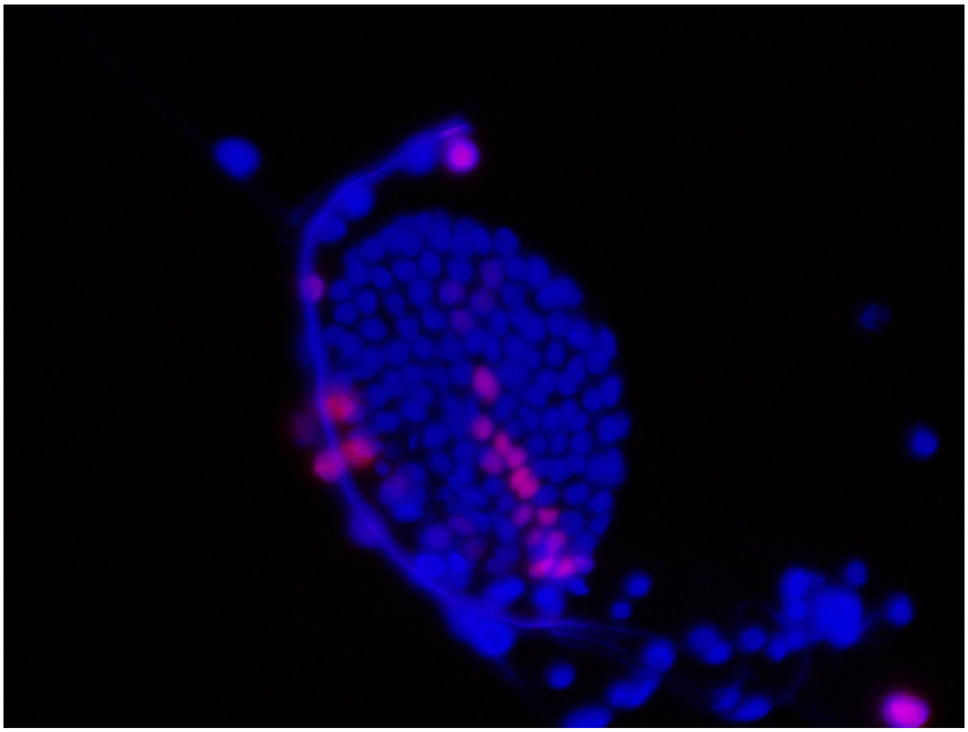

The red stripe of vn in the sac of blue cells is the first sign of a cascade of events that will produce a fly wing.

(Phys.org) —Scientists have delved deeper into the evolutionary history of the fruit fly than ever before to reveal the genetic activity that led to the development of wings – a key to the insect's ability to survive.

The wings themselves are common research models for this and other species' appendages. But until now, scientists did not know how the fruit fly, *Drosophila melanogaster*, first sprouted tiny buds that became flat wings.

A cluster of only 20 or so cells present in the fruit fly's first day of larval life was analyzed to connect a gene known to be active in the embryo and the gene that triggers the growth of wings.

Researchers determined that the known embryonic gene, called Dpp, sends the first signal to launch the activation of a gene called vn. That signal alone is dramatic, because it crosses cell layers.

The activation of vn lasts just long enough to turn on a target gene that combines with more signals to activate genes responsible for cell growth and completion of wing development.

"Our work shows how when you add a gene into the equation, you get a wing. The clue is that one growth factor, Dpp, turns on another growth factor, vn, but just for a short period of time. You absolutely need a pulse of this activity to turn on yet another gene cascade that gives you a wing, but if vn is active for too long, a wing wouldn't form," said Amanda Simcox, professor of molecular genetics at The Ohio State University and lead author of the study.

"We learned all this from investigating 20 tiny cells. The events could be responsible for this big event in evolutionary history, when the insect got its wing. With the wing, if its environment turned bad, the insect could fly off, giving it an advantage."

Within about five days, those 20 cells give rise to a 50,000-cell fully developed wing.

Simcox and colleagues aren't yet certain that Dpp's activation of vn explains how all insects got their wings because of differences in the ways these invertebrates develop.

The research is published this week in the online early edition of *Proceedings of the National Academy of Sciences*.

Simcox began the analysis on a fruit fly larva that had recently hatched from the egg. She identified a tiny sac of cells representing where a future wing would be that was attached to the body cavity through tubing that runs the length of the larval body. Simcox dissected those sacs away from the body to study them specifically.

By staining the cell sacs with substances that light up target genes, the researchers then made images of the sequence of genetic events they observed. It all started with Dpp, part of a family of genes known as bone morphogenetic protein genes that are well understood in developmental biology.

The analysis showed that Dpp sent its signal from one cell layer to the other across the gap in the middle of the sac to activate the vn gene. The mechanism allowing the genes to talk to each other across that gap remains a mystery, Simcox noted.

"But it's the only explanation because if we took away the function of Dpp, vn doesn't get turned on," she said.

Dpp's activation of vn is the critical step in turning on its target, the Egfr signaling pathway, which sets off a series of gene activations that drive wing development – specifically, activating genes called ap and iro-C. But vn also has the ability to regulate itself through a feedback loop so it stays on for longer in some cells where it is also needed for making the body of the fly at the location of the wing's attachment.

In addition to imaging the genes' activity, the researchers zoomed in on the gene structure to identify the binding sites that enabled the gene signaling to occur. When they mutated the binding sites, the signals were disabled.

"We had genetic evidence linking the events, tracing it back earlier than anyone had ever seen, and we showed directly through analysis of the binding sites that if they were mutated this expression went away," Simcox said. "We have good lines of evidence that there really is a connection."

From here, she and colleagues plan to investigate how other insects develop their wings.

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