Inside JEB is a twice monthly feature, which highlights the key developments in the *Journal of Experimental Biology*. Written by science journalists, the short reports give the inside view of the science in JEB.

Inside JEB

FRUIT FLIES STICK OUT TONGUE TO BREATHE

Small insects like fruit flies don't bother with ventilation mechanisms to breathe, they simply rely on diffusion to supply their tissues with oxygen – at least, that's what many researchers thought. Now, a study by Fritz Lehmann and Nicole Heymann suggests that this conclusion was a bit premature. Studying CO_2 release in flying fruit flies, the pair discovered that these tiny insects do indeed ventilate, but in a rather unconventional way: they use their "tongue" as a pump (p. 3645)!

It all started when Lehmann and Heymann used a new gas analyser to study gas exchange in flying fruit flies. The new tool was sensitive enough to detect minute respiratory changes in a tethered insect flying in a virtual-reality flight arena. The first time they tried it, they stumbled across something completely unexpected: huge cyclic fluctuations in a fly's CO_2 release, despite the fact that the flying insect's metabolic rate was constant. This was surprising, because a small insect's CO_2 release rate is thought to match the animal's metabolic needs, so at a constant metabolic rate we would expect constant CO_2 release.

Figuring that people had wrongly assumed that tiny insects don't need to ventilate while flying, Lehmann and Heymann decided to test whether abdominal pumping, a common ventilation mechanism in insects, could explain the mysterious CO_2 fluctuations. Insects have flexible air sacs located in various spots in their body, which they compress by pumping their abdomen. To measure abdominal pumping during flight, the pair painted fluorescent dots on the flies and tracked the dots' movements on video as the insects flew. But they found no correlation between abdomen movements and CO_2 release patterns; it seems fruit flies don't use conventional ventilation mechanisms to power their cyclic breathing pattern.

The pair had to explore other explanations for the flies' unusual breathing. 'We had noticed that fruit flies stick out their proboscis while flying, but we had no idea what it meant', Lehmann says. Considering that the large air sacs in a fruit fly's head could be compressed by the fly's large proboscis, he wondered if flies use their proboscis as a pump. Sure enough, when the pair bathed a flying insect in infrared light and tracked changes in light intensity as the fly stuck out its proboscis, they found a strong correlation between the fly's CO_2 release pattern and its proboscis movements. Fruit flies don't just use their proboscis to eat; they also use it to breathe while flying.

'This was nice, but we suspected that it wasn't the whole story', Lehmann says. He explains that insects mainly regulate their gas exchange using four large spiracles (openings) on their thorax. He constructed an analytical model to test whether cyclic CO_2 patterns can result when these spiracles act independently of one another. The model revealed periods when the spiracles were opening in phase with one another, followed by periods when spiracle opening patterns were not synchronised. Astonishingly, the model's CO_2 release pattern was indistinguishable from that of a real fly! While the model suggests that a fruit fly's spiracles may control cyclic CO_2 release patterns during flight, Lehmann is not sure how the fly benefits from these cyclic patterns. But he can see why a fruit fly uses its "tongue" to ventilate its head: to ensure that metabolically greedy organs, like the eyes and brain, always get enough oxygen.

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Lehmann, F.-O. and Heymann, N. (2005). Unconventional mechanisms control cyclic respiratory gas release in flying *Drosophila*. *J. Exp. Biol.* **208**, 3645-3654.

TROUT BLOOD CELLS CHURN OUT NITRIC OXIDE

Our red blood cells dutifully transport oxygen to our tissues – but could they play a more sophisticated role than we suspect? Rather than indiscriminately supplying oxygen, red blood cells may sense when our tissues need an oxygen boost and release substances to relax local blood vessels and increase blood flow to an oxygen-deprived area. We now know that, in our red blood cells at least, deoxygenated haemoglobin converts nitrite into nitric oxide. When nitric oxide escapes from the red blood cell, it diffuses into and relaxes the muscles around blood vessels, increasing local blood flow. If we can do this, perhaps fish can too, Frank Jensen and Claudio Agnisola reasoned (p. 3665).