Gas exchange patterns in insects: the role of the head ganglia in neural control

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The adaptive significance of discontinuous gas-exchange cycle (DGC) in insects is contentious. The recently proposed neural hypothesis suggests that DGC is a non-adaptive consequence of adaptive downregulation of brain activity at rest, reverting ventilatory control to thoracic ganglia. According to this hypothesis, I predicted a higher likelihood for DGC in the gregarious phase Desert locust (*Schistocerca gregaria*, Acrididae), characterized by a larger brain size and increased sensory sensitivity, compared to the solitarious phase. Furthermore, surgically severing neural connection between head and thoracic ganglia would increase DGC prevalence in both phases and eliminate phase-dependent variation in gas-exchange patterns. Using flow-through respirometry, I measured metabolic rates (MR) and gas exchange patterns in locusts at 30ºC. In contrast with the neural hypothesis predictions I did not find phase–dependent differences in DGC expression. Surgically severing descending regulation of thoracic ventilatory control did not increase DGC prevalence in either phase. Moreover, solitarious locusts abandoned DGC altogether. Importantly, Low MR in connective-cut solitarious locusts mean that variation in gas exchange pattern cannot be explained by changes in MR. These results are not consistent with the predictions of the neural hypothesis for the evolution of DGC in insects, and suggest neural plasticity of ventilatory control.

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