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2 novelties

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14 Abstract

15 Of all evolutionary events that are discussed as novelties, the origin of insect wings is perhaps
16 the most frequently cited. Yet, until now, discussions have widely neglected the involvement
17 of the circulatory system despite its mandatory function in the development and maintenance
18 of the wings. Here, we outline the multiple roles of the thoracic wing circulatory organs and
19 discuss their morphological disparity in the light of evolutionary novelty. A modification of
20 parts of the dorsal vessel is the simplest type of wing circulatory organ that exists. It
21 undoubtedly represents the plesiomorphic character state from which separate and completely
22 autonomous wing-hearts evolved multiple times independently. Only these autonomous wing-
23 hearts are considered to represent morphological novelties in a strict sense. This conclusion is
24 supported by developmental studies in *Drosophila* whose wing-hearts originate from an
25 independent pericardial cell lineage and are not individualized parts of the myocardium, as
26 previously assumed. Remarkably, the regulatory gene network underlying wing-heart
27 formation is unique, in that it is mainly somatic muscle-like, but also includes genes typical
28 for cardiomyogenesis. Further, we propose that the evolution of autonomous wing-hearts was

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