Luciferase-like enzymes in non-luminescent beetles: a model of beetle protoluciferase?

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The origin of insect bioluminescence remains a mistery. In beetles, the luciferases arose from AMP/CoA-ligases, a family of enzymes which adenylate carboxylic substrates with their subsequent transfer to CoA. How AMP-ligases acquired the new bioluminescent function during the evolution is a challenge. In 1996 we first reported the occurrence of luciferase-like enzymes in the fat body of the mealworm Tenebrio molitor, a non-luminescent beetle lacking luciferin distantly related to fireflies (Viviani and Bechara, 1996). These enzymes produce a low level chemiluminescence in the presence of D-luciferin and ATP. As expected, these luciferase-like enzymes are 60 kDa proteins displaying antigenicity against firefly luciferase antibodies. Their chemiluminescence is also stimulated by CoA. These ligases adenylate luciferin, which undergoes a spontaneous oxidation producing weak chemiluminescence. Similar bioluminogenic AMP-ligases were also found in other non-luminescent larvae of closely and distantly related beetle families. These luciferase-like enzymes could be paralogous enzymes which kept resemblances with the protoluciferase from which luciferases evolved.