Tyrosine metabolism and parthenogenetic development in a symbiotic insect, the pea aphid: the central function of phenylalanine hydroxylase

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Tyrosine metabolism and parthenogenetic development in a symbiotic insect, the pea aphid: the central function of phenylalanine hydroxylase

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Abstract:

Nutritional symbioses are widespread associations among insects, contributing to the evolutionary adaptation and the invasive power of this class of animals. The endosymbiosis between the pea aphid, *Acyrthosiphon pisum*, and the bacterium, *Buchnera aphidicola,* is an interesting model of symbiotic partner's integrated metabolism, particularly for the production of amino acids lacking in the aphid's diet. An important supply of these nutrients has to be provided especially for the phenomenal aphid growing rate observed during parthenogenetic viviparous reproduction.

A recent transcriptomic analysis, performed in our laboratory, allowed us to identify a key metabolic pathway regulated in the pea aphid parthenogenetic development: the tyrosine pathway. This biosynthetic pathway is shared by the two symbiotic partners, all the precursors being produced by *B. aphidicola.* To determine the involvement of this pathway in aphid development, we silenced by RNAi approach the unique gene in the pea aphid genome that encodes for phenylalanine hydroxylase (*ACYPI007803*, EC 1.14.16.1), the specific enzyme of tyrosine biosynthesis catalyzing the conversion of Phe to Tyr.

ACYPI007803 knockdown by microinjection of dsRNA yielded several defective phenotypes, specifically targeting the two symbiotic compartments: the bacteriocytes and the embryo chains. The *ACYPI007803* gene expression inhibition, confirmed by qRT-PCR, considerably affected aphid fecundity by diminishing the number of nymphs produced. Furthermore, the RNAi-mediated treatment resulted in a significant impairment of embryo development, with the production of non-viable and deformed neonatal nymphs. To attest of the tyrosine biosynthesis disruption following *ACYPI007803* knockdown, single embryo HPLC analyses were performed and demonstrated a significant reduction of tyrosine amount as well as a coherent increase of phenylalanine, the upstream amino acid precursor.

Altogether, our findings shed new light on the importance of the tyrosine pathway in the embryonic development of parthenogenetic pea aphids and establish the phenylalanine hydroxylase contribution to this process, notably by regulating the tyrosine biosynthesis.