

Molecular characterization of $\Delta 9$ desaturases from the Sharpshooters, *Homalodisca coagulata* and *Oncometopia nigricans* (Hemiptera: Cicadellidae)

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Introduction



Glassy-winged sharpshooter (GWSS) (*Homalodisca coagulata*) and the Leafhopper, *Oncometopia nigricans* (ON) are important agricultural pest that transmits Pierce's disease of grapes. Pierce's disease is caused by the bacterium, *Xylella fastidiosa*. The bacterium blocks the xylem, the water- and nutrient-conducting vessels of plants. *Xylella fastidiosa* also causes almond leaf scorch, phony peach disease, alfalfa dwarf, oleander leaf scorch, and citrus variegated chlorosis.

What are Fatty Acid Desaturases?

Fatty acid desaturases are enzymes that catalyze the insertion of a double bond at the $\Delta 9$ position of fatty acids. A full length cDNA was cloned from the GWSS and the protein characterized *in silico*.

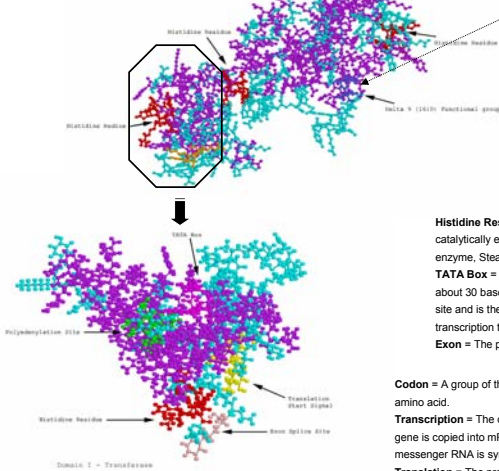
Unsaturated fatty acids are important constituents of all cell membranes and are required for normal insect growth and pheromone synthesis. Both sequence and structural analyses indicate that the $\Delta 9$ desaturases from the GWSS and ON share both sequence, structural, and functional homology



The GWSS is the primary vector of the bacterial pathogen of grapes known as Pierce's disease of grapes.

	FA desaturase	Family: 2	Motif 6	Functional Motif 6
<i>H. coagulata</i>	YS-NGETWTKNMFVALIRVYVTFLLNVTWLNLSAALHNGG-RFVYDKI			YKPSRSLVAVDAL
<i>O. nigricans</i>	HS-WDETWTKNMFVALIRVYVTFLLNVTWLNLSAALHNGG-RFVYDKI			YKPSRSLVAVDAL
<i>A. domesticus</i>	--NNETWNSAMFVALIRVYVTFLLNVTWLNLSAALHNGG-RFVYDKI			YKPSRSLVAVDAL
<i>A. domesticus</i>	--NNETWNSAMFVALIRVYVTFLLNVTWLNLSAALHNGG-RFVYDKI			YKPSRSLVAVDAL
<i>H. assulita</i>	TKGNDENPWTNVTALIRVYVTFLLNVTWLNLSAALHNGG-RFVYDKI			YKPSRSLVAVDAL
<i>C. parvialata</i>	--NNETWNSAMFVALIRVYVTFLLNVTWLNLSAALHNGG-RFVYDKI			YKPSRSLVAVDAL
<i>A. velutina</i>	--NNETWNSAMFVALIRVYVTFLLNVTWLNLSAALHNGG-RFVYDKI			YKPSRSLVAVDAL
<i>E. borealis</i>	--NNETWNSAMFVALIRVYVTFLLNVTWLNLSAALHNGG-RFVYDKI			YKPSRSLVAVDAL
<i>P. octo</i>	--NNETWNSAMFVALIRVYVTFLLNVTWLNLSAALHNGG-RFVYDKI			YKPSRSLVAVDAL
<i>D. melanogaster</i>	--NGETWNSAMFVALIRVYVTFLLNVTWLNLSAALHNGG-RFVYDKI			YKPSRSLVAVDAL
<i>M. domestica</i>	--NGETWNSAMFVALIRVYVTFLLNVTWLNLSAALHNGG-RFVYDKI			YKPSRSLVAVDAL
<i>H. zea</i>	--NGETWNSAMFVALIRVYVTFLLNVTWLNLSAALHNGG-RFVYDKI			YKPSRSLVAVDAL
<i>T. ni</i>	--NGETWNSAMFVALIRVYVTFLLNVTWLNLSAALHNGG-RFVYDKI			YKPSRSLVAVDAL
<i>B. mori</i>	--NGETWNSAMFVALIRVYVTFLLNVTWLNLSAALHNGG-RFVYDKI			YKPSRSLVAVDAL
<i>O. sublaevis</i>	--NGETWNSAMFVALIRVYVTFLLNVTWLNLSAALHNGG-RFVYDKI			YKPSRSLVAVDAL
<i>E. postsvirata</i> A11	--NGETWNSAMFVALIRVYVTFLLNVTWLNLSAALHNGG-RFVYDKI			YKPSRSLVAVDAL
<i>A. velutina</i> A11	--NGETWNSAMFVALIRVYVTFLLNVTWLNLSAALHNGG-RFVYDKI			YKPSRSLVAVDAL
<i>H. zea</i> A11	--NGETWNSAMFVALIRVYVTFLLNVTWLNLSAALHNGG-RFVYDKI			YKPSRSLVAVDAL

His148 residue = red
His47 = green
His148 = orange
His148 = functional group = blue



Glossary of Terminology

Translation start signal = A codon that directs initiation of protein translation by stimulating the binding of initiator transfer RNA. In prokaryotes, the codons AUG or GUG can act as initiators while in eukaryotes, AUG is the only initiator codon.

Exon Splice Site = Nucleotide sequences located at the ends of coding regions and recognized in pre-messenger RNA by the spliceosome. These sites are joined during the RNA splicing reaction, forming junctions between the coding regions.

Histidine Residue = Amino Acid residue that is catalytically essential in the membrane-associated iron enzyme, Stearoyl-CoA desaturase (syn: $\Delta 9$ desaturase).

TATA Box = A nucleic acid sequence usually located about 30 bases upstream (-30) from the transcription start site and is the one sequence required for any significant transcription to occur.

Exon = The protein-coding DNA sequence of a gene.

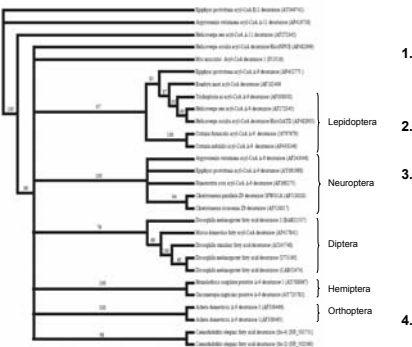
Codon = A group of three adjacent nucleotides that code for a single amino acid.

Transcription = The organic process whereby the DNA sequence in a gene is copied into mRNA; the process whereby a base sequence of messenger RNA is synthesized on a template of complementary DNA.

Translation = The process whereby genetic information coded in messenger RNA directs the formation of a specific protein at a ribosome in the cytoplasm.

How can we utilize this gene and information associated with it?

- 1. Evolutionary analyses:** Fatty acid 9-desaturases have been found in a variety of organisms. The cloning and characterization of different fatty acid $\Delta 9$ desaturase genes will assist in determining evolutionary divergence from one another.
- 2. Disruption of Insect Biology:** Aim is to disrupt insect feeding as well as reproduction through disruption of pheromone production.
- 3. Pharmaceutical:** By affecting intramembrane transport membrane permeability $\Delta 9$ desaturases play a role in the efficacy of a variety of pharmaceuticals, including cancer chemotherapeutic agents. Insulin can influence intramembrane transport and subsequent absorption of chemotherapeutic agents by activating $\Delta 9$ desaturase enzymes, resulting in increases in membrane fluidity and thus drug absorption at physiologic temperatures.
- 4. Food:** Another area of application is the alteration of plant lipid biosynthesis for food and industrial uses. In plants, the first step in C-18 fatty acid desaturation is catalyzed by $\Delta 9$ desaturase. Cotton has been altered with the $\Delta 9$ -desaturase gene for use in the food industry to increase the percentage of monounsaturated fatty acids to polyunsaturated Fatty Acids.



The known $\Delta 9$ desaturases from the Hemiptera, such as the GWSS, form a clade separate from other insect families.