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Dispersed satellite DNA elements and their effect on gene expression

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Abstract:

Different from dispersed transposable elements whose role in evolution of gene regulation was investigated in diverse model organism, influence of satellites DNA on gene regulation was not investigated till now. To perform potential regulatory function, satellite DNA elements are predicted not only to be present within heterochromatin, but to be distributed in euchromatic portion of the genome, in the vicinity of genes. Within insect species *Tribolium castaneum* satellite DNAs make a substantial portion of the genome and are major constituents of pericentromeric heterochromatin. The expression of a major heterochromatic *T. castaneum* satellite DNA TCAST1 proceeds in the form of long double-strand transcripts which are rapidly processed into small interfering RNAs (siRNAs). Satellite DNA expression is strongly induced by heat shock, and increased level of satellite-derived siRNAs is accompanied by increase of repressive epigenetic modifications of histones, H3K9me2-3 at satellite DNA regions. Single repeats or short stretches of the same TCAST1 satellite DNA are also dispersed in the close vicinity of protein-coding genes within euchromatin of *T. castaneum*. To explore the potential gene-regulatory role of TCAST1 satellite elements, we examined variation of TCAST1 elements among 10 *T. castaneum* wild-type strains originating from diverse geographic locations, and followed expression of genes that either contain or have in the vicinity polymorphic TCAST1 elements. Gene expression was explored at normal as well as under heat stress conditions. Expression analysis of genes that contain polymorphic TCAST1 elements within introns indicates influence of TCAST1 elements on gene expression under heat stress conditions. The gene expression is effected by the presence of TCAST1 element as well as by the number of repeats within dispersed TCAST1 satellite element. In all cases, TCAST1 elements partially repressed activity of genes after heat shock treatment. It is proposed that TCAST1-associated siRNAs, significantly induced after heat stress, affect epigenetic state of euchromatic regions containing dispersed TCAST1 satellite elements by increasing repressive epigenetic modifications of histones. This is the first demonstration of satellite DNA involvement in the modulation of protein-gene expression and indication for the role of satellite DNA in the evolution of gene regulation.

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