Protected polymorphism of phosphoglucomutase in the Pompeii worm and its variant adaptability is only governed by two QE linked mutations

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The Pompeii worm lives on the walls of hydrothermal-vent chimneys along the East Pacific Rise (EPR). This habitat is highly fluctuating over space with temperature decreasing over the lifespan of the vent edifices. Previous genetic studies on allozymes of the phosphoglucomutase suggested that balancing selection acts on the frequencies of isoforms 90 and 100 due to the thermal variations at small spatial scales. Both protein stability and thermal optimum of enzyme activity were clearly different between isoforms. Allozymes also displayed a clinal distribution from North to South with an abrupt replacement of isoform 100 by isoform 78 (The equatorial break). In the present study, alleles encoding these isoforms were completely sequenced (4188 bp gene subdivided in 11 exons encoding a protein of 562 aa) from northern and southern individuals. The distribution of highly divergent alleles without recombination on both sides of the EPR are likely the result of balancing selection combined with spatial isolation. Only two non-synonymous mutations (EQ) located in the exon 3 explain the polymorphism of charge of the protein. Directional mutagenesis allowed us to mutate allele 100 into the two other alleles and to overexpress them in order to explore the additive effect of the two mutations over the biochemical properties of the enzyme in the face of temperature. Results are coherent with those obtained on native proteins and showed the direct effect of mutations on the protein thermostability.