Allometry of mitochondrial respiration in mussels

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Allometric decline of mass-specific metabolic rate with increasing body size in organisms is a long-known and well-documented phenomenon. The patterns observed at the organismal level indicate fundamental allometric changes in the rate of cellular metabolism and mitochondrial functioning; however, the mechanistic causes of these differences remain under debate. The aerobic metabolic rate is performed through the mitochondrial pathway of oxidative phosphorylation. Therefore, it is meaningful to predict that allometric pattern for mitochondrial functioning would reflect the pattern of aerobic metabolism. Surprisingly, there have been relatively few studies that have assessed the possible link between mitochondrial respiration and body size in invertebrates. We studied body size dependence of mitochondrial respiration of blue mussels *Mytilus edulis* L. Mussels were of the same age (3 years), but differed in size. In order to test functional capacities of mitochondria from mussels of different sizes respiration was determined at normal (15˚C) and elevated (27˚C) exposure temperatures. Mitochondria were isolated from hepatopancreas and respiration rate was measured using high-resolution respirometry method (by Oxygraph-2k, Oroboros Instruments). Substrates, inhibitors and uncoupling agents for oxidative phosphorylation (OXPHOS) and electron transport system (ETS) were added step-by-step in order to assess maximal respiration rates, respiratory control ratio, proton leak, activity and impact of all complexes of ETC. Temperature significantly accelerated state 3 (ADP-stimulated) mitochondrial respiration, maximal respiration with uncoupled ETS, and caused an increase of Respiratory Control Ratios. On the contrary, state 4 respiration (indicative of the proton leak) as well as respiration related to electron flux through complexes of ETC did not show an increase at stress temperature (27˚C). Body size of mussels had a strong effect on most studied parameters. ADP-stimulated respiration, electron flux through complex IV, proton leak and uncoupled respiration showed a pronounced increase with body mass of mussels with power coefficients of 1.8, 1.2, 0.2 and 0.8, respectively. The obtained results showed that larger mussels had higher OXPHOS rates than smaller ones. Since all mussels were of the same age, larger ones obviously were characterized by rapid growth. It is possible that elevated growth abilities in some specimens compared to the others result from more efficient metabolic regulation which in turn is related to higher mitochondrial capacities.

Keywords: metabolic allometry; high-resolution respirometry; mussels; mitochondrial respiration