EUROPEAN EXPERTISE IN RESEARCH ON THERMAL ADAPTATION

RESPIRATION AS A MEASURE OF THERMAL ADAPTATION OF ORGANISMS

Anton Brancelj & Tatjana SIMČIČ
National institute of biology
Večna pot 111
1000 Ljubljana
SLOVENIA

THEORETICAL BACKGROUND:

Organisms respond to stressful environmental factors appearing in natural ecosystems by using adaptations that help them evade, tolerate and recover from stress. Potential and acute negative effects of stressors can be measured by using different bioassays. It is shown that oxygen consumption is useful indicator of organism's fitness or stress, caused by exposure to stressful factors. Measurements of oxygen consumption in neutral environment give us information about "normal" oxygen consumption. In general, exposure to factors that have negative effects on organism causes an increase of oxygen consumption because of stress. The reason for increased respiration at the beginning of the exposure to stressors is intensive movement of organism that is trying to "escape" from unfavourable effects. Organisms also tend to respond to stress by inducing defence and repair processes, resulting in increased maintenance costs. An increased respiration at the start is usually followed by its decreasing. Measurements of oxygen consumption can provide information about the current intensity of metabolism under particular conditions, but the question remains as to what the measured energy demands, relative to the whole respiratory capacity. For this reason, respiratory electron transport system (ETS) activity – the value of oxygen consumption that would occur if all enzymes functioned maximally – has to be determined to estimate potential metabolic activity.

The ratio between ETS activity and respiration (ETS/R ratio) is an important index of the organisms' metabolism and its fitness to particular environemnt. It is a measure of the exploitation of the metabolic potential. Ratio differs between related species having different ecological requrements and tolerances. High ETS/R ratios are characteristic of animals with wide ecological tolerances, as they can cope with variable or changed environmental conditions.

BRIEF DESCRIPTION OF METHODS:

Oxygen consumption

Oxygen consumption is measured using a twin-flow microrespirometer (CYCLOBIOS, Innsbruck). A single animal is placed in a small chamber with aerated water which allows animal to move only minimally. The concentration of oxygen is measured before and after the chamber, using polarographic oxygen sensors. Oxygen consumption is calculated from the reduction in oxygen concentration and the flow rate of the water, using the computer program. The method can be used for aquatic organisms only.

Electron transport system (ETS) activity

ETS activity is measured using the method proposed by Packard (1971) and improved by G.-Tóth (1999). The main reaction is the reduction of the tetrazolium chloride (INT) instead of

the reduction of the natural electron acceptor, O_2. The product of the reaction is red coloured formazan, production rate of which is easily determinable with a spectrophotometer at wavelength of 490 nm. It is a destructive method where organism must be victimize.

REFERENCES:

G.-Tóth L. (1999) Aktivität des Elektronentransportsystems. In: Biologische Gewässeruntersuchung Methoden der Biologischen Wasseruntersuchung 2 (Eds W. von Tümpling & G. Friedrich), pp. 465-473. Gustav Fischer Verl., Jena, Stuttgart, Lübeck, Ulm.

Packard T.T. (1971) The measurement of respiratory electron- transport activity in marine phytoplankton. Journal of Marine Research, 29, 235-244.

Applications by authors:

• Simčič, T. & A. Brancelj, 2004. Respiratory electron transport system (ETS) activity as an estimator of the thermal tolerance of two *Daphnia* hybrids. Journal of Plankton Research 26(5):525-534

• Simčič, T. 2005. The role of plankton, zoobenthos, and sediment in organic matter degradationin oligotrophic and eutropic mountain lakes. Hydrobiologia 532: 69-79.

• Simčič, T., S. Lukančič & A. Brancelj, 2005. Comparative study of electron transport system activity and oxygen consumptionof amphipods from caves and surface habitats. Freshwater Biology 50: 494-501.

• Simčič, T. 2005. Respiratory electron transport system (ETS) activity and respiration rate in cold-stenothermal and eurythermal chironomid larvae from high-mountain lakes. Archiv fuer Hydrobiolgie 162 (3): 399-415.

• Simčič, T. & A. Brancelj, 2006. Effects of pH on electron transport system (ETS) activity and oxygen consumption in *Gammarus fossarum, Asellus aquaticus* and *Niphargus sphagnicolus*. Freshwater Biology 51: 686-694.