

Reaction of inducible *hsp70* form on different environmental conditions in *Ommatogammarus flavus*

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ABSTRACT. The aim of the research was to estimate heat shock protein expression under the change in ambient temperature and hydrostatic pressure in Baikal deep-water amphipods *Ommatogammarus flavus*. The expression of the constitutive *hsp70* transcript did not change in response to the influence of both environmental factors. The inducible *hsp70* form did not differ after the change in hydrostatic pressure in amphipods captured from the depth of 50 and 750 m. High expression of inducible *hsp70* transcript was shown during gradual increase in ambient temperature when it reached 22°C. The detected increase in *hsp70* expression is associated with the cells reaction to protein damage at the high temperature. Thus, the studied *hsp70* inducible form is involved in the adaptation to change in ambient temperature in *O. flavus* despite the fact that this species inhabits the deep-water zone with stable temperature conditions. It is necessary to analyze other isoforms of *hsp* in the further studies to find those that participate in the adaptation to high hydrostatic pressure.

Keywords: Baikal, amphipods, adaptations, heat shock proteins, hydrostatic pressure, temperature

Only in Lake Baikal, there is a freshwater fauna of amphipods that inhabit the deep-water zone. Among Baikal deep-water amphipods, the eurybathic species *Ommatogammarus flavus* is of great interest. This species inhabits a narrow range of temperatures ($4 \pm 0.5^\circ\text{C}$) but a wide range of hydrostatic pressures (1.3-130 atm) (Bazikalova, 1945; Kozhova and Izmet'eva, 1998). Brown and Thanje (2014) report that adaptations to temperature and high hydrostatic pressure are interconnected. Several isoforms of heat shock proteins, which are known to protect the cells from the damage caused by different types of stressors, may be involved in the adaptation to high hydrostatic pressure (Ritchie et al., 2018). The purpose of the study was to assess the expression of heat shock protein transcripts (*hsp70*) under the change of ambient temperature and hydrostatic pressure in Baikal deep water amphipods *O. flavus*.

The amphipods were collected at Lake Baikal (Bolshie Koty bay) from the depths of 50, 100 and 750 m. Animals from the depths of 50 and 750 m were fixed in liquid nitrogen right after sampling. The amphipods from 100 m depth were acclimated in the laboratory conditions during 7 days at 4°C. After that, the acclimated animals were exposed to the gradual increase (1°C per hour) of the ambient temperature from 4°C (control group) to 22°C and fixed in liquid

nitrogen. The expression of constitutive and inducible forms of *hsp70* genes was determined with quantitative reverse transcription polymerase chain reaction. Two pairs of primers (Protopopova et al., 2014; Drozdova et al., 2019) were used for these genes. *Gpdh* was used as a reference gene for the calculation of ΔC_t .

It was shown that the expression of both constitutive and inducible *hsp70* was at the low level and did not differ in the individuals of *O. flavus* captured from the depths of 50 and 750 m (Fig.). The level of expression in constitutive *hsp70* was 6-fold higher in the amphipods from 50 m and 9-fold higher in the individuals from 750 m then in inducible form. The expression of the studied *hsp70* isoforms was at the low level in the control group of the amphipods (after 7 days of laboratory acclimation). In this group, the expression of constitutive *hsp70* was up to 40-fold higher in comparison to the inducible transcript. Inducible *hsp70* expression enhanced during experimental exposition under gradual increase of temperature. In this case, the expression increased 124-fold in comparison to the control value when the temperature reached 22°C. At this temperature, the level of expression was 3 times lower in constitutive *hsp70* then in inducible.

The fact that the expression of constitutive and inducible *hsp70* did not differ in *O. flavus* from different depths indicates that the studied HSP70 proteins are

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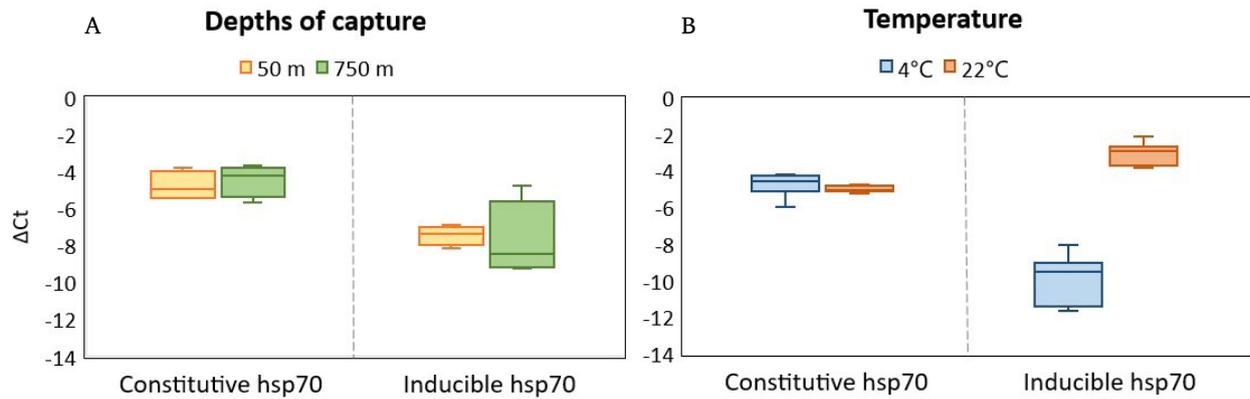


Fig. Reaction of constitutive and inducible *hsp70* on the change of hydrostatic pressure (A, n = 4) and temperature (B, n = 8).

probably not involved in the adaptation to change of hydrostatic pressure. The detected elevation of inducible *hsp70* expression during the increase of the ambient temperature in studied species is connected with the reaction of cells to the proteins damage.

In spite of our knowledge that *O. flavus* mostly inhabits the deep-water zone in the conditions of stable low temperature, the expression of *hsp70* in this species increases in the response of increase of temperature. Thus, increase of *hsp70* expression, conservative mechanism of heat shock response common for the majority of the species, participates in the adaptation of *O. flavus* to change of temperature. Further investigations should be focused on the search of heat shock protein isoforms that protect the proteins from changes in hydrostatic pressure.

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