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Monitoring of the red king crab *(Paralithodes camtschaticus)* **physiological state** **in artificial conditions**

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Transportation, keeping and marketing alive crab

- Live crabs is quality and increasingly demanded raw material.
- Product available all the year round.
- Efficiency of the sector increased because of smaller expenses for processing and higher cost of the live product.



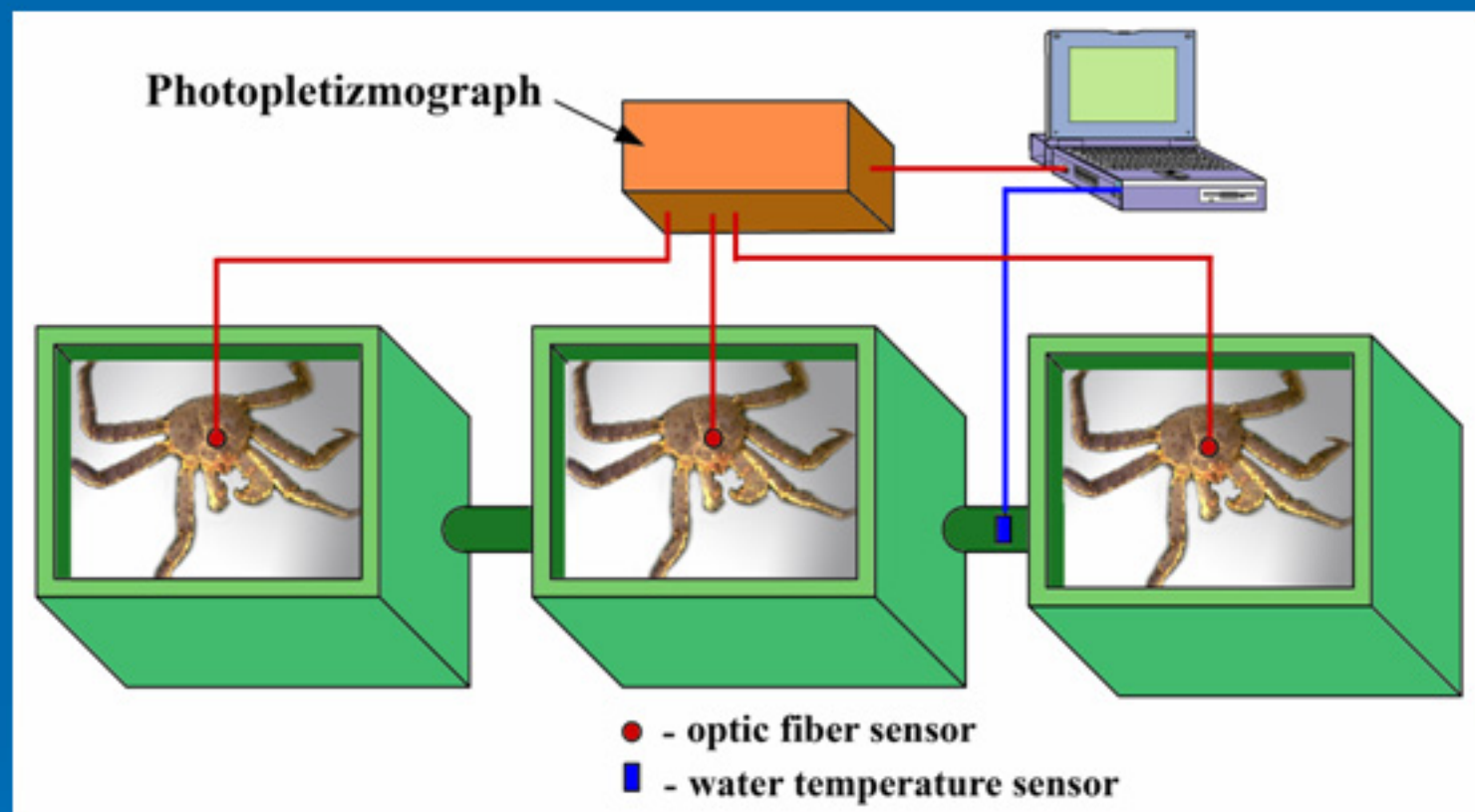
Transportation and keeping of the red king crab are made jointly by VNIRO experts and La Mare, Ltd., and Vodny Mir, Ltd., Moscow.

Object and tasks

The purpose of the research was to analyze the physiological characteristics of the cardiovascular system of the red king crab in order to determine its adaptive properties and abilities, and to monitor its reaction on different stress actions in the cultivation process.

- Examine the possibility of application the Laser photoplethysmographer method and method of variation cardiointervalography for red king crab;
- Evaluate the average value of Heart Rate Frequency (HRF) and Stress-index (SI) for red king crab, which are in congruence with status of adaptative norm, while keeping under artificial conditions;
- Identify the best conditions of keeping and transportation of red king crab.

Diagram of the experiment



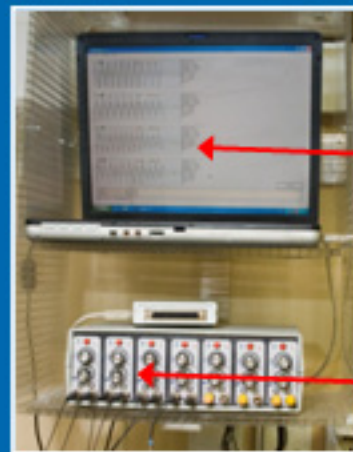
The experiments were conducted in isothermal tanks with non-transparent cover (to reduce external stress effects) of 200 and 500 liters in the artificial seawater with a temperature of 5 to 8 °C and salinity - 32 ‰.

Method of the non-invasive fixation of the sensor



To register heart activity a miniature plastic «saddle» was glued on the crab carapace in the area of heart projection, in which it was inserted a fiber-optic sensor. Fiber has consistently joined the laser photoplethysmograph, with which the signal via analog-to-digital converter enters a computer and processed with special software.

An experimental installation for recording of red king crab heart rate in aquarium room of the laboratory of crustacean reproduction (VNIRO, Moscow)



Computer

Photoplethysmograph

Tanks with crabs

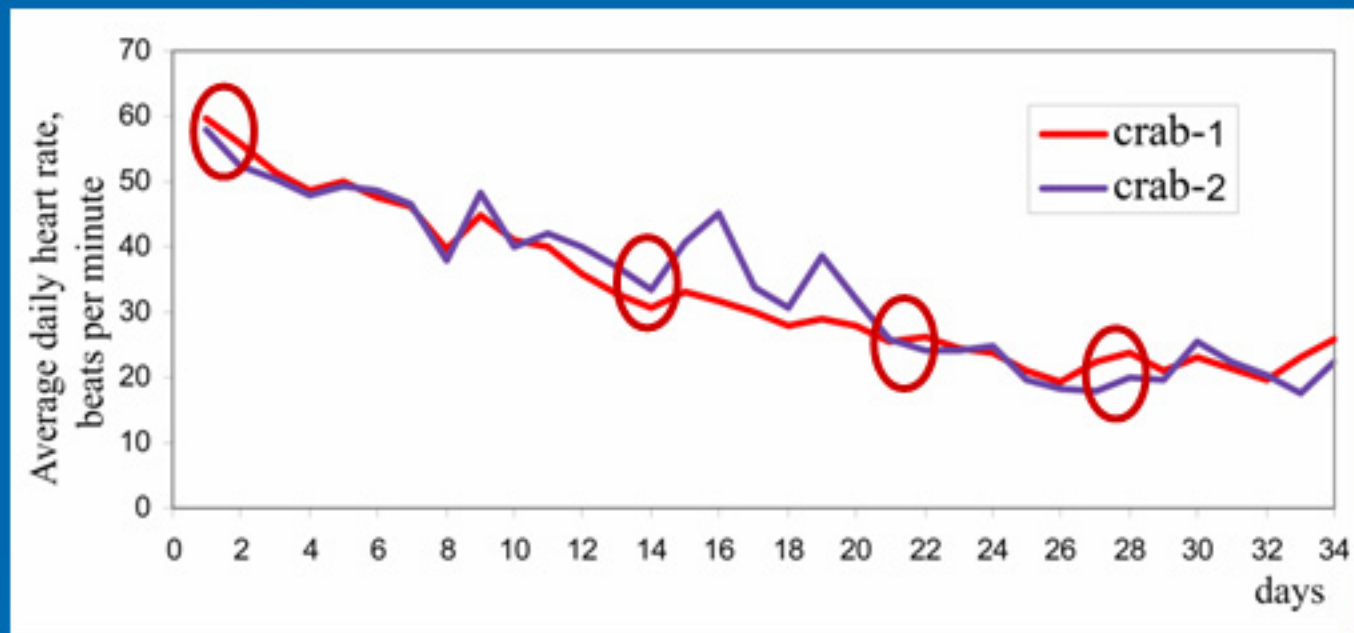
Optical fibers



Continuous recording of HRF and stress-index was carried out *in vivo* before, during and after feeding, «handling», transportation and mechanical effect.

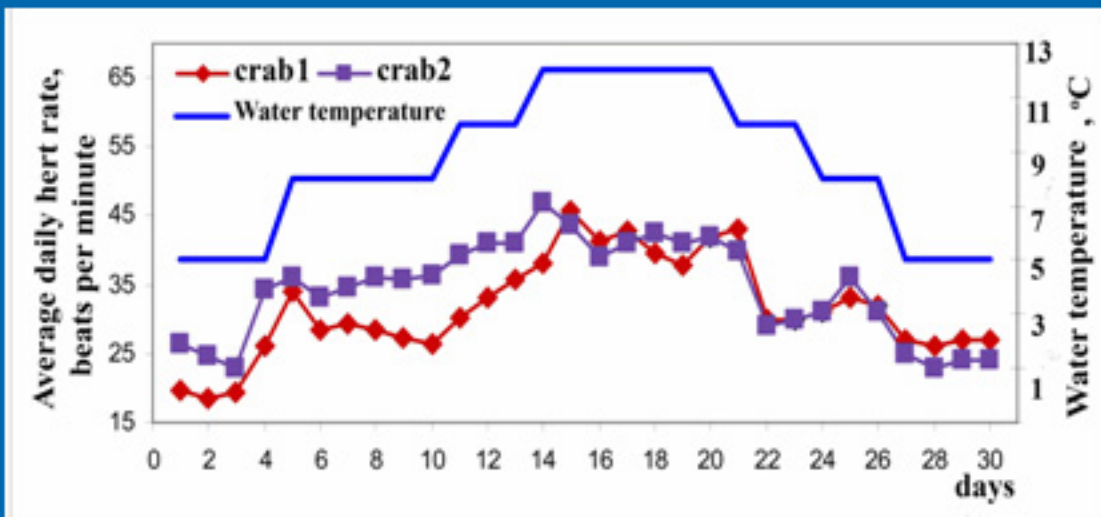
Results

Heart rate frequency dynamics (HRF) of red king crab in the process of adaptation after transportation without water from the Barentz Sea (12 hours)



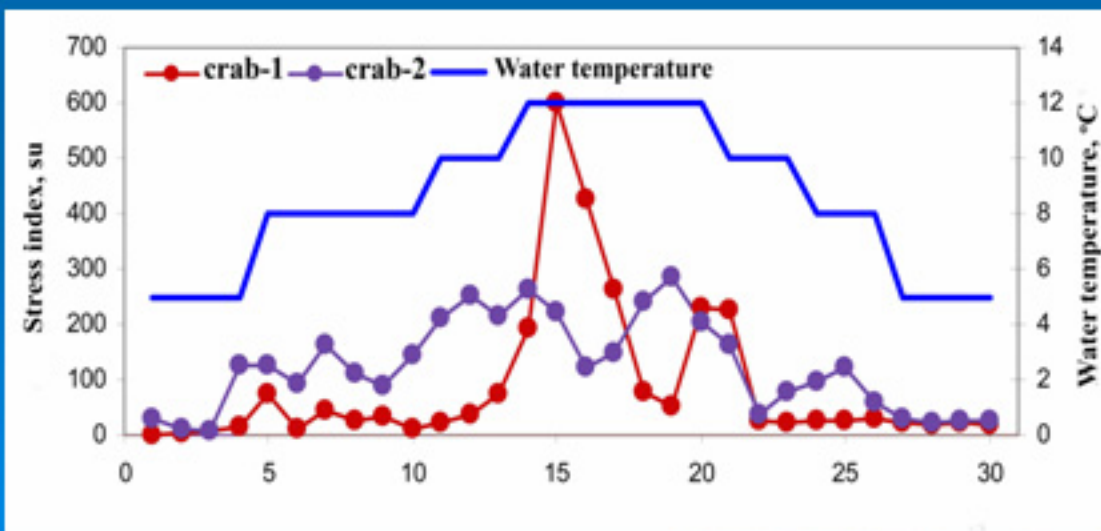
- HRF - 50-60 heartbeats/min the first days after transportation
- HRF - 30-35 heartbeats/min within two weeks
- HRF - 20-25 heartbeats/min the third week after transportation
- HRF - 18-25 heartbeats/min since the fourth week

Dependence of the red king crab HRF on water temperature



- 5 °C HRF - 18-20 and 23-25 heartbeats/ min;
- 8 °C HRF - 34-36 heartbeats/ min (both crabs);
- 12 °C HRF - 45 heartbeats/ min (both crabs)

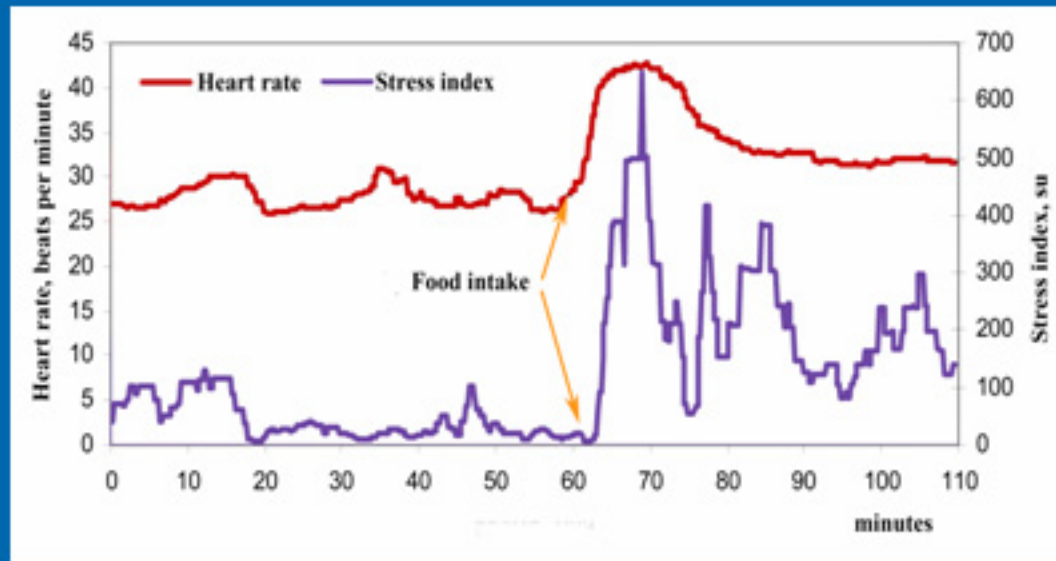
Dependence of the red king crab stress-index on water temperature



- 5 °C SI - ≤ 30 units;
- 8 °C SI - 100 units;
- 12°C SI - up to 200-300 (1) and 600 (2) units.

Decreasing of water temperature to 5 °C led to the reduction of HRF and SI to the prior level

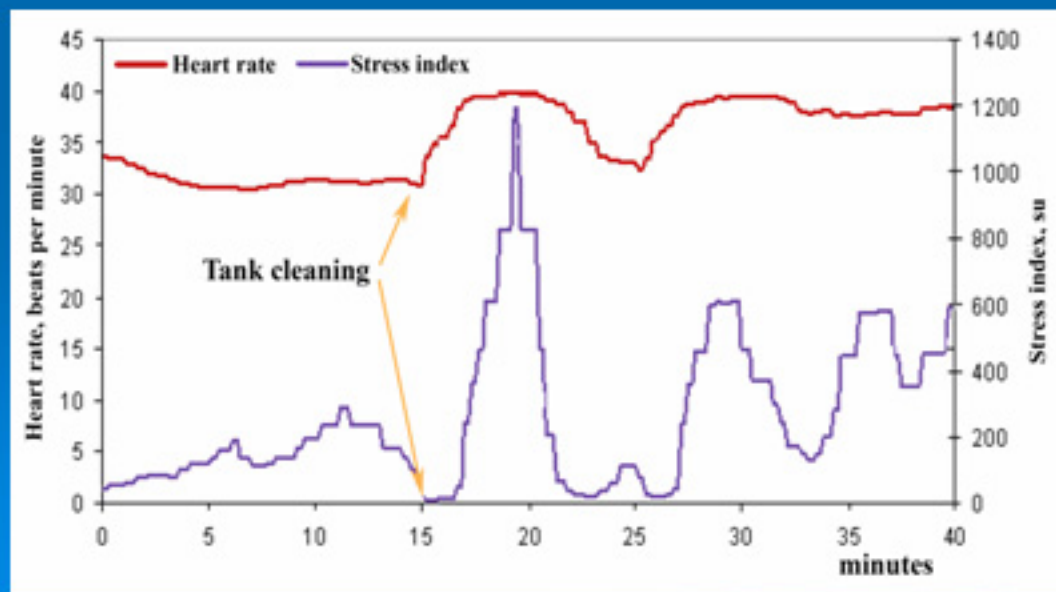
Changing in the crab HRF and SI under external influence in the process of cultivation in artificial conditions



HRF and SI dynamics of red king crab in the feeding process

- HRF – up to 40 heartbeats/ min;
- SI - from 10 to 650 units;

The rates remained increased for an hour after feeding.



Mechanical effect (cleaning of the tank)

- HRF- from 30 to 40 heartbeats/ min
- SI - from 0-200 to 1200 units

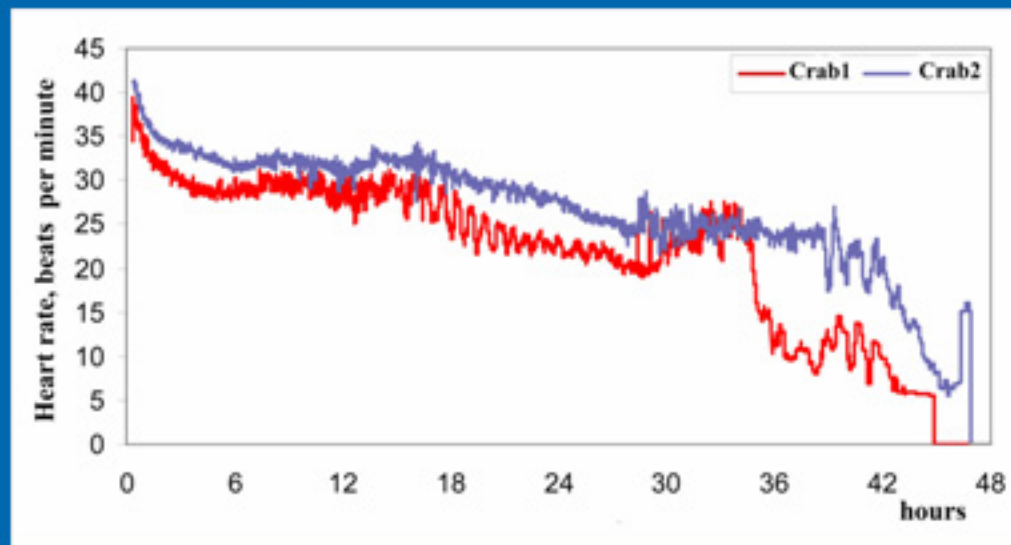
After the end of the effect, HRF and SI remained at a high level.

*A long simulating transportation
without water (48 h)*



HRF and SI of the red king crab during long simulating transportation without water (48 h)

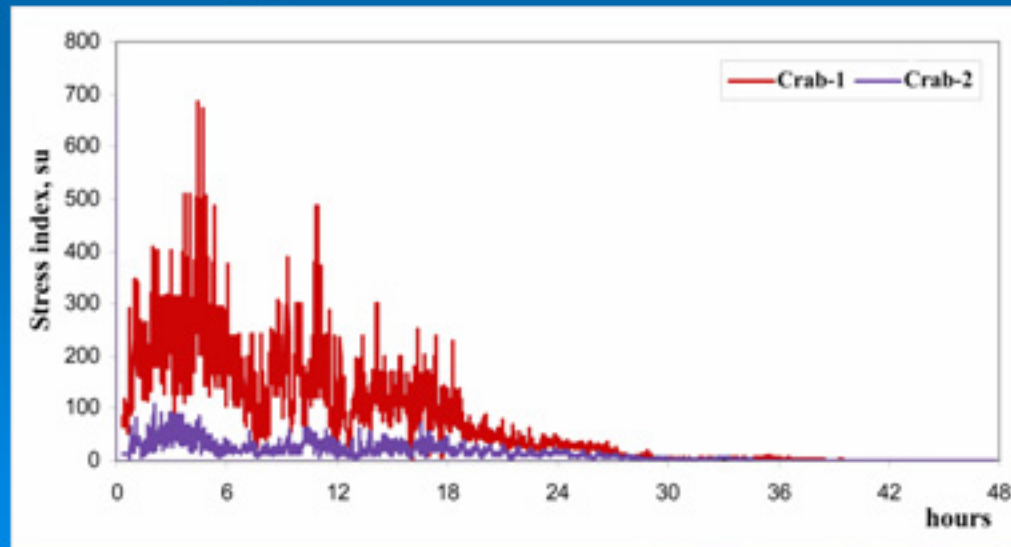
HRF



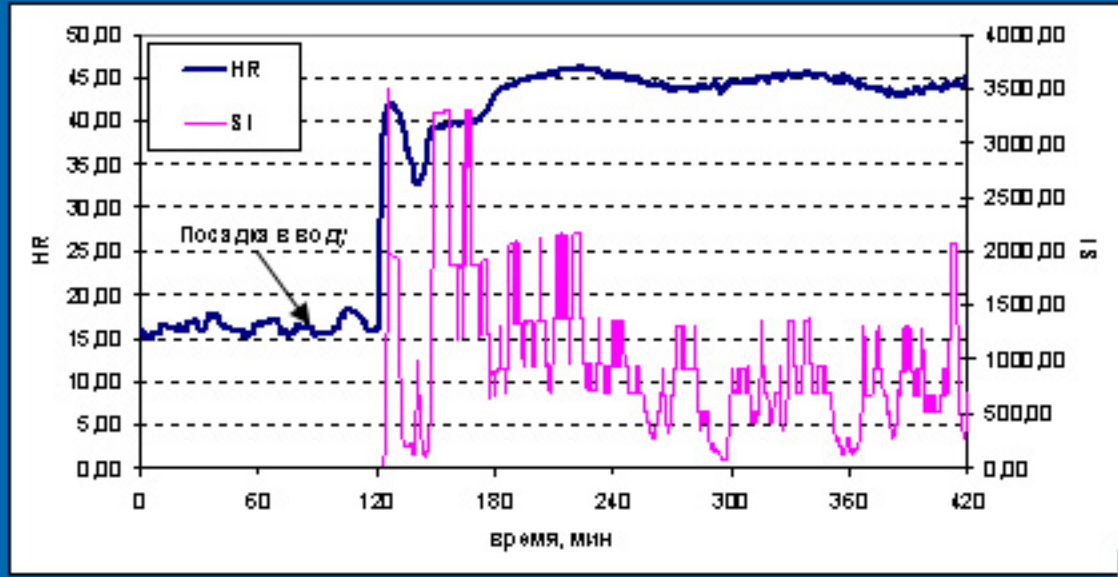
before transportation

- HRF – 27 - 30 heartbeats/min;
- SI – from 10 to 600 units;
- *In the end of transportation*
- HRF – 17 heartbeats/min;
- SI – 1 units

SI



HRF and SI of the red king crab 120 min after placement from the transportation boxes in the water

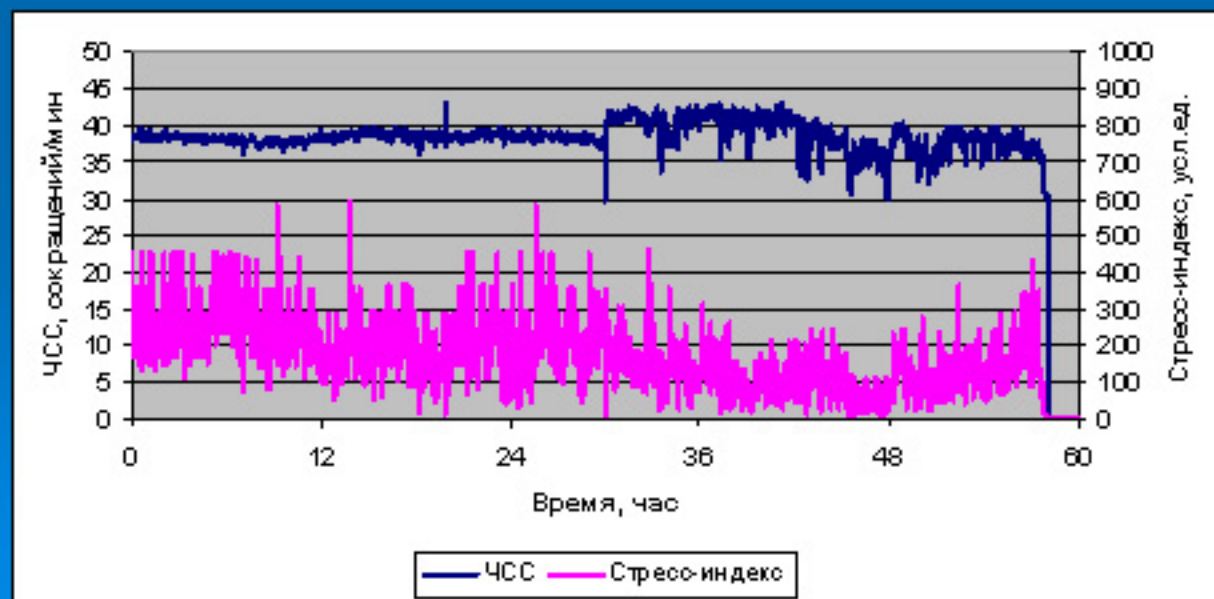


HRF - 40 heartbeats/min;
SI - up to 3500 units





*HRF and SI of the red king
in the molting process*



HRF - 38-42
heartbeats/min;
SI - 100-400 units

Heart rate frequency and stress-index value in red king crab during experiments (VNIRO)

Action	HRF, heartbeats/min	Stress-index, standard units
<i>Adaptation after transportation</i>		
first week	50-60	
second week	30-35	
third week	18-25	
fourth week	18-25	
<i>Measurement of the temperature</i>		
5°C	18-25	≤ 30
8°C	34-36	50-220
12°C	35-45	150-600
<i>Cleaning of the tank</i>	40	to 1200
<i>Feeding</i>	40	to 650
<i>Transportation 48 h</i>		
Before transportation	27-30	10-600
In the end of transportation	17	1
120 minutes after placement in the water	40-45	up to 3500

Conclusions

- Laser photoplethysmographer method and method of variation cardiointervalography adapted for invertebrates was successfully examined on the red king crab. In particular, the heart rate frequency and the stress-index were analyzed. Non-invasiveness of the method, allows carrying out long continuous monitoring of changes in physiological state of red king crab in real time without the traumatizing and stress in the cultivation process.
- The method can be used for non-invasive monitoring of red king crab physiological state, improving transportation technology, keeping and reproduction in artificial conditions.
- Registered significant changes of crab physiological state in response to stress exposure should be considered when optimizing its biotechnology cultivation and development of a strategy of red king crab conservation and restoration of natural resources by mariculture techniques.
- Our investigation exploring the fundamental principals of heart rhythmic regularities of crustaceans, depending on the conditions of habitat and, possibly, on the taxonomic status.

Thank you for your attention!

