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Physiology

WATER TEMPERATURE EFFECTS ON CARD IOGRAPHIC CHANGES
IN *SALMO TRUTTA* (L.)
WPŁYW TEMPERATURY WODY NA OBRAZ ZMIAN
KARDIOGRAFICZNYCH U *SALMO TRUTTA* (L.)

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Investigations upon the lability of frequency and strenght of heart systoles in *Salmo trutta* (L.) influenced by water temperature changes were carried out. There was showed the considerable lability of heart work when artificially decreasing and then increasing water temperature.

A change in water temperature causes a number of conditioned responses in fish, among others, also in their circulatory system.

So far, investigations concerning frequency of heart systoles at water temperature changes were carried out upon some species (eel, crampfish, tench). These investigations showed an increase in heart systole frequency together with an increase in the water temperature, in accordance with van Hoff's law.

Investigations upon the lability of frequency and strength of heart systoles in *Salmo trutta* (L.) at water temperature changes were based on author's method of recording heart functions (Węgrzynowicz, Zbanysek, 1969).

Recording of the mentioned changes resulting from conditioned responses of the heart was at first carried out in Summer on fishes put into the water of the temperature lower than that in which they had lived under natural conditions, and then in Autumn, in water the temperature of which was equal to that of the natural environment.

In both periods changes in the heart work were recorded at successive temperature increases.

Investigations were carried out in Summer (June, July, August) and in Autumn (October, November) on *Salmo trutta* ascending the river Rega

for spawning. Caught fishes were immediately operated (Węgrzynowicz, Zbanyszek, 1969) and that allowed to record the heart work continually. After the operation the fish were transferred to the aquarium filled with river water additionally aerated. Aquarium walls were darkened. Summer investigations included recording of heart functions in fishes placed in the water of the initial temperature 3°C which was afterwards gradually risen to 11°C (Table 1).

In Autumn water temperature was at first 7°C (natural water temperature in the river) and it was gradually risen to 11°C .

After the operation fishes were transferred to the aquarium, where at first they felt uneasy performing intensive locomotory movements but afterwards they calmed down. The cardiogram shaped typically showing arrhythmia and an increased number of systoles during faster locomotory movements.

RESULTS

There were carried out 22 investigations in Summer and 20 in Autumn. Averages of the obtained results are shown in Tables 1 and 2.

Table 1

Temperature	Number of systoles	Strength
3°C	12 - 13	7 - 8
5°C	12 - 14	7 - 8
6°C	20 - 22	5 - 11
7°C	22 - 24	5 - 6
8°C	28 - 30	10 - 11
9°C	34 - 42	9 - 11
10°C	32 - 36	11 - 12
11°C	25 - 29	4 - 9

Table 2

Temperature	Number of systoles	Strength
7°C	21 - 24	7 - 6
9°C	34 - 36	7 - 8
10°C	42 - 46	8 - 9
11°C	47 - 51	6 - 8

As shows above data, the number of heart systoles/min in fishes kept at the temperature lower than that of the natural environment, in the experiments carried out in Summer, increased with the temperature increase, amounting to maximum values (42 systoles per minute) at the temperature 9°C . At 10°C the frequency of systoles was decreasing and reached 25-29/min at the temperature 11°C .

The strength of systoles expressed in relative values (measured as the wave height in mm) shows some variations in the cardiographic picture. At 6°C there observed a great range between lower and upper limits. At 7°C the strength of systoles is clearly on the decrease. With the increase of the temperature from 8°C to 10°C there were not observed any great changes. At 11°C the decrease in the systoles strength was clearly marked.

Investigations carried out in Autumn at the initial temperature equal to that of the environment in which the fish had lived showed quite a different picture of cardiographic changes.

The number of heart systoles/min increases successively together with the increase in water temperature from 21/min at 7°C to 51/min at 11°C.

The strength of systoles undergoes insignificant fluctuations from 6 to 9 mm, not showing any considerable changes together with the increase in the number of systoles.

The above investigations illustrating variation of heart work in *Salmo trutta*, resulting from water temperature changes, indicate that a decrease in water temperature (in relation to the water temperature under natural conditions) and afterwards its increase, causes that heart conditioned responses show considerable lability both in the range of frequency and strength of heart systoles, when compared with changes of heart work in the same range of water temperatures resulting from seasonal changes.

It is characteristic that in fish for which water temperature was artificially decreased and afterwards successively increased (10°C - 11°C - Summer investigations) there was observed the decrease of heart systoles frequency and then also of systole strength, whereas the temperature increasing in the same range, but as a result of seasonal changes, causes a regular increase of systoles frequency without changes within the range of the systole strength.

REFERENCES

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WPŁYW TEMPERATURY WODY NA OBRAZ ZMIAN KARDIOGRAFICZNYCH U SALMO TRUTTA (L.)

S t r e s z c z e n i e

W oparciu o metodę własną przeprowadzono badania kardiografii u troci *Salmo trutta* (L.), przy zmianach temperatury. W wyniku badań stwierdzono znaczną labilność pracy serca u ryb umieszczonych w wodzie o temperaturze

niższej (w stosunku do temperatury wody w warunkach naturalnych), a następnie sukcesywnym podwyższaniu temperatury.

ВЛИЯНИЕ ТЕМПЕРАТУРЫ ВОДЫ НА КАРДИОГРАФИЧЕСКИЕ ИЗМЕНЕНИЯ
У SALMO TRUTTA L.

Р е з ю м е

Исходя из собственного метода были проведены испытания кардиографии у лосось-туйменей (*Salmo trutta* L.) при изменении температуры. В результате исследований установлено значительную неустойчивость в работе сердца у рыб размещенных в воде с более низкой температурой (по сравнению с температурой воды в естественных условиях), а после этого с постепенным возрастанием температуры.

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