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Physiology

DAILY CHANGES OF THE HEART AND RESPIRATORY
RATES OF THE BULLTROUT (*SALMO TRUTTA TRUTTA* L.)
DOBOWE ZMIANY RYTMU SERCOWEGO I ODDECHOWEGO
U TROCI WSTĘPUJĄCEJ (*SALMO TRUTTA TRUTTA* L.)

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The frequency of the heart stimulations and respirations of the bulltrout (*Salmo trutta trutta* L.) was examined from the point of view of the daily rate in the aquarium conditions.

INTRODUCTION

The daily changes of the biological processes activity are the sign of the adaptation ability for the varying biotic and abiotic factors of the habitat.

The findings of numerous authors concerning the water animals (Jones, 1955; Kasimov, 1961; Kleerkoper et al., 1961; Spencer, 1939 and others) unanimously state that, the abiotic factors of the habitat (light, temperature, tides, etc), had been decisive in creating the daily rhythms (especially the rhythm of the movement activity and of the nourishing) – making the external mechanisms develop (mainly the hormonal ones), which direct the various symptoms of the vital activity.

The vital activity of the fish that use the sense of sight in the procurement of food depends on the daily changes of the light intensity (Mantejfel et al., 1965; Nomura et al., 1968).

The salmonidae fish due to the alternating habitats constitute a particularly interesting subject for the research of the biological rhythms. The present work defines the daily changes of the heart rate and the respiratory rate of *Salmo trutta trutta* L. – the bulltrout.

MATERIALS AND METHODS

The investigations were carried out in autumn (the sunrise at about 5 a.m., the sunset at about 6 p.m.) on 12 specimen of the bulltrout (5 males and 7 females with the weight of 1.5–4.0 kg) directly after the fish having been caught by the trap method downstream the Rega river.

The experiments were made in one hundred litre aquaria containing the oxygenated and exchanged a few times daily river water (temp. 14–15°C, oxygen content 8.3–8.9 mg/l, free CO₂ content 13.4–15.2 mg/l pH 7.8–8.5).

The frequency of the respiratory rate of the bulltrout was measured with the stop watch, the frequency of the heart rate was marked by a single-channel electrocardiograph of Simplicard-2 type utilising the needle electrodes placed in the vicinity of the heart, according to Labat's method (1966), the water pH was measured by means of a LBS 61 pH-meter, the amount of the free CO₂ was measured by titration of a water sample with 0.1 n Na₂CO₃ solution for phenophthalein, the oxygen content was marked by Winkler's method.

All the above mentioned measurements and markings were taken repeatedly every three hours for the period of 24 hours.

The obtained results were described statistically, calculating the arithmetic average and the average deviation of the arithmetic average (standard error).

DISCUSSION

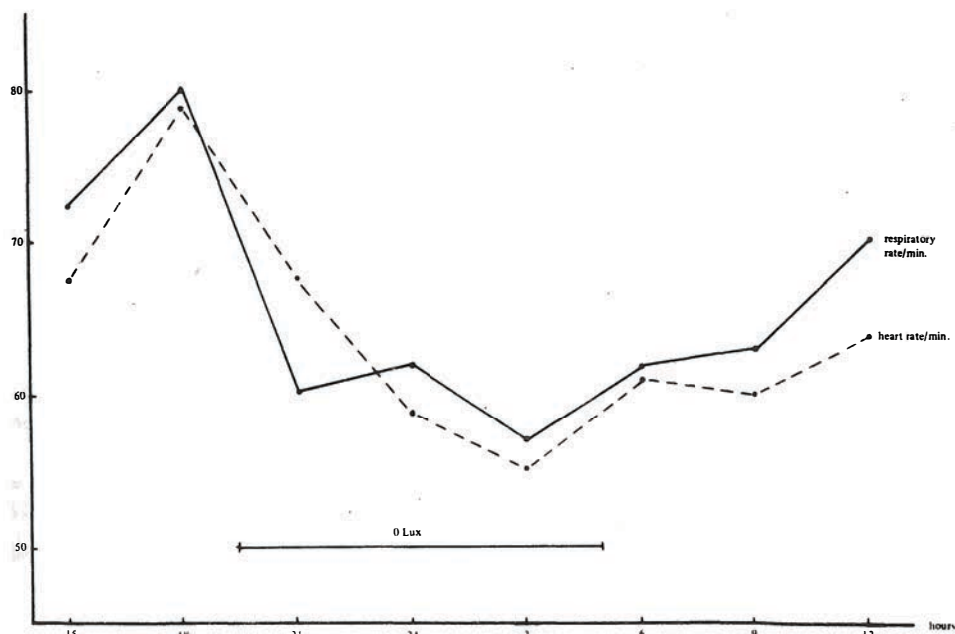
The obtained results (Fig. 1) showed that in the aquarium conditions similar to the conditions of the habitat of the bulltrout, there exists (regardless of the sex and weight) the clear correlation between the frequency of the heart rate and the respiratory rate.

Considering the course of the daily changes, the highest values for both parameters were noted at 6 o'clock p.m., during the sunset (respiratory rate $80 \pm 4.7/1$ min., heart rate $78 \pm 3.1/1$ min.).

After the sunset, with the darkness growing, the respiratory rate and the heart rate decreased, reaching the minimal values at 3 o'clock a.m. (respectively $57 \pm 7.3/1$ min.) and then gradually increased in proportion to the growth of the natural light in the water.

The obtained results confirmed the investigations of Nomura et al. (1968) on the rainbow trout, that the vital activity of the salmonidae fish (whose indication among others is the frequency of the respiratory and heart rates) is clearly connected with the daily changes of the sun light intensity penetrating into the water habitat.

The highest daily values of the respiratory and the heart rate were noted at 6 p.m., the time of the day, when the sun light intensity was lower than in the day, when the sun light intensity was lower than in the afternoon hours, thus, this seems to be connected with the empirically known fact (proved in research of other species of fish) Mantefjel et al. (1965) of the intensified movement activity and the intensification of feeding of "daytime food procuring" fish at the time of the day, before the sunset, after which the procurement of food by these species becomes practically impossible.



Daily changes of heart and respiratory rhythm of ascending *Salmo trutta trutta* L.

CONCLUSIONS

1. The correlation of the frequency of the respiratory and the heart rate of the bulltrout was ascertained.
2. In the course of the daily changes, the respiratory rate and the heart rate of the bulltrout achieve the highest values at 6 o'clock p.m. (during the sunset) and the lowest ones at 3 o'clock a.m. (about 2 hours before the sunrise) during the autumn season.
3. No statistically significant differences connected with the sex or weight regarding the frequency and the course of the daily changes of the respiratory rate and the heart rate of the bulltrout were discovered.

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DOBOWE ZMIANY RYTMU SERCOWEGO I ODDECHOWEGO U TROCI WSTĘPUJĄCEJ (*SALMO TRUTTA TRUTTA L.*)

Streszczenie

Przeprowadzone badania dobowych zmian rytmu oddechowego i rytmu sercowego *Salmo trutta L.* – troci wstępującej w sezonie jesiennym do rzeki Regi wykazały, że niezależnie od płci i ciężaru ryb, istnieje korelacja częstości rytmu oddechowego i rytmu sercowego.

W przebiegu zmian dobowych stwierdzono, że najwyższe wartości osiąga rytm oddechowy i rytm sercowy troci o godz. 18⁰⁰ (odpowiednio $80 \pm 4,7$ i $78 \pm 31/1$ min.) w czasie zachodu słońca, wartości najniższe obu rytmów zanotowano o godz. 3⁰⁰ nad ranem (odpowiednio $57 \pm 6,8$ i $55 \pm 7,3/1$ min.) ok. 2 godz. przed wschodem słońca.

СУТОЧНЫЕ ИЗМЕНЕНИЯ СЕРДЕЧНОГО И ДЫХАТЕЛЬНОГО РИТМА У ВХОДЯЩЕЙ КУМЖИ (*Salmo trutta trutta L.*)

Резюме

Проведенные исследования суточных изменений дыхательного и сердечного ритма кумжи – *Salmo trutta L.* – входящей в осеннем сезоне в реку Регу, показали, что, независимо от пола и веса рыб, существует корреляция частоты дыхательного и сердечного ритма.

При исследовании протекания суточных изменений установлено, что самых высоких показателей достигает дыхательный и сердечный ритм кумжи в 18 часов (соответственно $80 \pm 4,7$ и $78 \pm 31/мин.$), во время захода солнца; самые низкие показатели обоих ритмов отмечены в 3 часа утра (соответственно $57 \pm 6,8$ и $55 \pm 7,3/мин.$), приблизительно за 2 часа до восхода солнца.

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