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**Physiology**

# TENSION CHANGES IN BODY OF BREAM *ABRAMIS BRAMA* (L.) IN HOMOGENOUS ELECTRIC FIELD IN RELATION TO FLOW DIRECTION OF DIRECT CURRENT AND TO TOTAL LENGTH OF FISH

# ZMIANY NAPIĘCIA SYLWETKI LESZCZA *ABRAMIS BRAMA* (L.) W ZALEŻNOŚCI OD KIERUNKU PRZEPŁYWU PRĄDU STAŁEGO ORAZ DŁUGOŚCI CAŁKOWITEJ (L.t.) W JEDNORODNYM POLU ELEKTRYCZNYM

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Body tension of bream *Abramis brama* (L.) in homogenous electric field of DC current in relation to direction of current flow and to fish length had been investigated under aquarium conditions.
It ascertained that, treshold tension values in body depend on initial position of fish in relation to force lines of electric field and an increase of value in body tension under particular reactions is proportional to length of fish.

An electrification of fishing gear applied to increase the effects of catching is closely related to protection problems of non-caught ichthyofauna present in electric field.

A determination of electric field treshold parameters which cause the particular reactions and the investigations of physical and biological factors which influence the change of such values, may contribute towards rational exploitation of fish resources.

Next to the properties of electric field, specific conductivity of water, fish species and its physiological conditions, the length of fish is one of the factors which influence the degree of fish reactions to activity of electric field.

An extent of tension in body is related to length of fish. Initially adapted was such opinion that for the defined species the tension of body is of constant value (Mc Millan, 1928), and this was formulated as, "law of constancy in tension of body" (Holzer, 1932). Further investigations (Bary, 1956; Nusenbaum, Faleeva, 1961; Szatybełko, 1967; Sentiakov, 1964) proved that, the biological and physical factors influence the value of body tension. It had been noted during these in-

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vestigations that, in relation to increase of fish length is increasing the value of body tension in degree of particular reactions, to activity of electric current.

Tension of body (Gestaltspannung) is defined by value of tension existing between equipotential lines which run through the beginning and the end of fish body and at which respective reaction takes place. Obtained results are valid under such condition only when the axis of fish body is covering with force line direction of electric field at the moment when current is switched on (C h m i e l e w s k i, 1967).

In homogenous field, the value of body tension is obtained from the result of current field intensity and length of fish, viz.:

$$U_r = K \cdot L_r$$

where: $U_r$ - tension of body (V)

$K$ - intensity of current field ($\frac{V}{cm}$)

$L_r$ - total length of fish (L.t.) (cm).

Existing investigations on changes of body tension which had been performed to increase the output of fishing, are still very incoherent owing to wide variety of species and environment. This calls for further parallel investigations of physical and biological factors which influence the changes occuring in fish organism within the field of electric current.

Present investigations were aimed to determine the relationship existing between body tension of bream, its total length (L.t.) and direction of current flow in homogenous DC electric field under defined aquarium conditions. The characteristics of such parameters for particular species and environment permit to study the changes which occur in fish organism, under particular grades of reactions, to activity of electric current.

The investigations had been carried-out during March, on 76 breams Abramis brama (L.) of both sexes (without feeding), originated from Płoń Lake, under aquarium conditions in supply system water of temperature 9 ± 1°C and of specific conductivity 286 μS $cm^{-1}$. Total length (L.t.) of investigated fish oscillated between 18 and 45 cm. The aquarium was out of glass in steel framing of dimensions 430x150x130 cm filled in with water upto height of 1 m. The electrodes (100x80 cm) were made out of galvanized steel sheet and suspended on insulators at apposite sides of aquarium. Applied the smooth rectified current with apparatus presented on fig. 1.

The investigations were proceeded by control measurements for homogeneity of electric field, according to method given in work of S z a t y b e ł k o (1968), which shown the presence of non-linear zones in vicinity of electrodes and aquarium bottom. The space of homogenous field of dimensions 320x150x70 cm was partitioned with plastic net within aquarium at 55 cm from electrodes and 30 cm from bottom of aquarium.

In first serie of tests, were determined the treshold values for body tension of first reaction at ascending current (fish heading towards cathode) and at descending current (fish heading towards anode). In second serie of tests determined, at descending current, the treshold values for body tension of first reaction, anodotaxis, electroanesthesia and stupor stages.

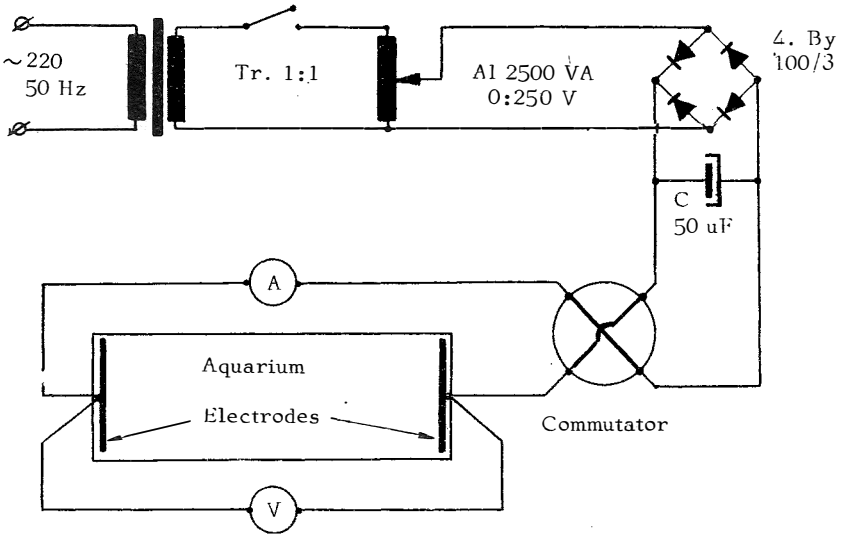


Fig.1. Diagram of apparatus for tests of fish reactions in homogenous electric field of smooth rectified current

According to S c h e m i n s k y (1936), for treshold of first reaction was assumed minimum intensity of electric field at which occured the fish trembled. The treshold of anodotaxis was determined by intensity of electric field at which the fish moved continously towards anode and reversed towards anode, when direction of current flow was changed. For electroanesthesia treshold, defined the tension of electric field at which the fish became unbalanced, was lying aside without any reactions to mechanical stimulis, but at change of current direction flow, was immediately reversing to head towards anode. Tension of electric field at which the fish was in convulsive condition and did not react to change of current direction flow, was defined as treshold for stupor stage.

The investigations to determine the treshold values for body tension under particular reactions, had been carried out seperately with each fish. Average time of current activity for defined reactions amounted to about 5 secundes.

Determined value of tension in homogenous electric field within seperated space (which caused particular reactions) and total length of fish (L.t.) formed the basis for calculations made according to formula given above.

## RESULTS AND DISCUSSION

Treshold values of body tension at first reaction, for the examined fishes in relation to their behaviour towards the electrodes, are presented in Table 1. Appearance of first reaction was dependend on direction of current flow. For three examined fish groups, the first reaction is occuring at lower values of body tension under ascending current then under descending cur-

rent. The increase of value in body tension is also dependend on total length of fish (Fig. 2).

Table 1

Value of body tension ($U_r = K \cdot L_r$) of first reaction related to fish behaviour towards electrodes

| Length of fish (L.t.) | Number of fish (n) | Ascending current + - | | Descending current + - | |
|---|---|---|---|---|---|
| | | $\bar{x}$ | from-to | $\bar{x}$ | from-to |
| 30.0-35.9 | 6 | 0.75 | 0.69-0.79 | 1.01 | 0.93-1.11 |
| 36.0-40.9 | 9 | 0.82 | 0.76-0.95 | 1.12 | 1.03-1.24 |
| 41.0-45.9 | 6 | 1.09 | 0.71-0.97 | 1.29 | 0.95-1.46 |

Tension changes of body, in relation to length of fish examined at descending current (Tab. 2), are showing successive increase in tension under particular stages of reaction **proportionally to length of fish.**

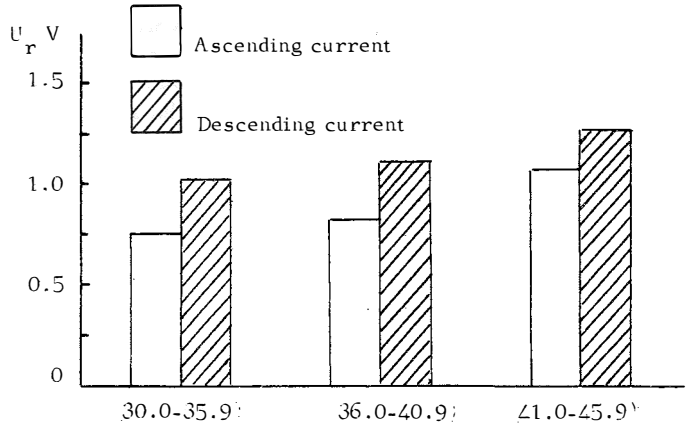


Fig. 2. $U_r$ values of first reaction related to fish behaviour towards electrodes

Highest values and differences in subsequent length-groups are appearing at stage of electroanesthesis and stupor. Lowest increase and differences in values of body tension were observed under first reaction (Fig. 3).

Smaller specimen were showing higher fragility to current; this is seen from smaller increasing parameters of electric field which cause subsequent stages of reaction.

The differences in body tension ascertained for first reaction at ascending and descending current, and for anodotaxis, electroanesthesis and stupor

Table 2

Changes of tension values in body ($U_r = K \cdot L_r$) of particular reaction stages in relation to length of fish

| Length of fish (L.t.) | Number of fish (n) | First reaction $U_r$ (V) | | Anodotaxis $U_r$ (V) | | Electroanesthesis $U_r$ (V) | | | Stupor $U_r$ (V) |
|---|---|---|---|---|---|---|---|---|---|
| | | $\bar{x}$ | from-to | $\bar{x}$ | from-to | $\bar{x}$ | from-to | $\bar{x}$ | from-to |
| 18.0-24.9 | 13 | 0.74 | 0.71-0.79 | 1.54 | 1.33-1.68 | 2.17 | 1.65-2.39 | 2.87 | 2.50-3.00 |
| 25.0-31.9 | 8 | 0.95 | 0.93-0.99 | 1.63 | 1.54-1.73 | 2.67 | 2.33-3.08 | 3.84 | 3.56-4.14 |
| 32.0-38.9 | 29 | 1.09 | 1.00-1.20 | 1.96 | 1.71-2.20 | 3.09 | 3.00-3.19 | 4.56 | 3.90-4.92 |
| 39.0-45.9 | 26 | 1.18 | 1.09-1.26 | 2.26 | 2.10-2.45 | 3.16 | 3.10-3.48 | 4.85 | 4.62-5.04 |

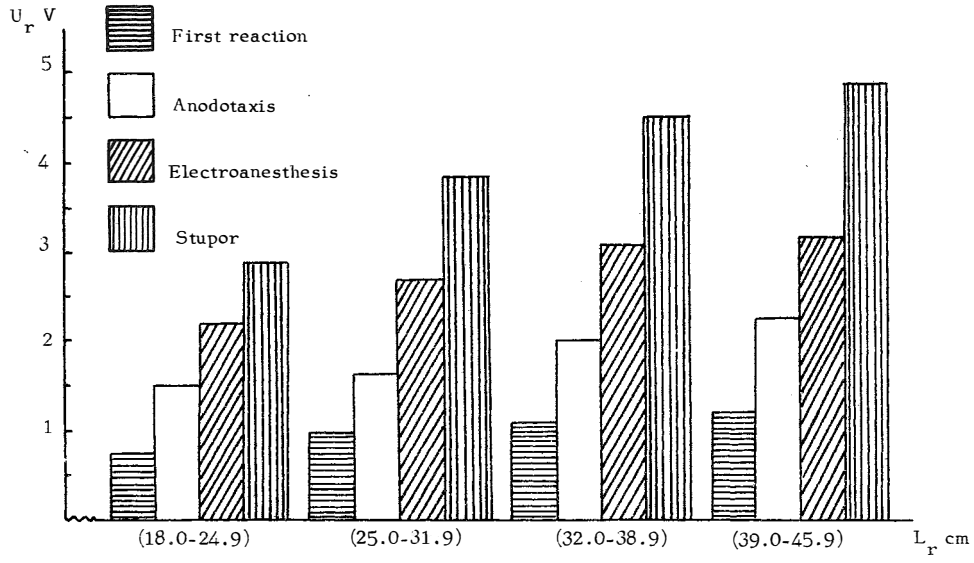


Fig.3. $U_r$ values of particular stages of reactions related to length of fish

of bream at descending current only, support the results obtained on other species of fish (Blasius, Schweizer, 1893; Daniulite, Malukina, 1967; Szatybełko, 1971). It is apparent thus, that not only the nature of reaction, but also the parameters of electric field required to cause the reaction, are strictly related to direction of current flow.

Basing on observations of Halsband (1965), a fish may be considered as electrolytic conductor of small dimensions. For such electrolytic conductor of small dimensions, voltage drops at anode and cathode have deciding influence on resistance. An influence of electrodes spacing for total resistance is negligeable. Tension changes in body under influence of temperature, described by Sentiakov (1964) are covering with behaviour of electrolytic conductor. The compliance of phenomenons cited above, relating to tension of fish body and to resistance of electrolytic conductor, support the hypothesis that a fish is an object of electrolytic conductivity and thus, the definition of body tension may be substituted by definition of voltage drop in fish resistance.

The presented investigations may permit to determine the changes appearing in fish organism during particular reactions at nominated parameters of electric field, under aquarium conditions.

## CONCLUSIONS

1. Changes of values in tension of bream body are dependend on direction of current flow and on length of fish.

2. Treshold values of tension in body are lower at ascending current in relation to values obtained at descending current.

3. The increase in values of body tension of particular reactions is proportional to length of fish.

## REFERENCES


Bary B.Mc., 1956: The Effect of Electric Fields on Marine Fishes - Marine Research. 8: 1-32.

Blasius E., Schweizer F., 1893: Electropismus and verwandte Erscheinungen. - Pflüg. Arch. f.d. ges. Physiol. 53: 493-545.

Chmielewski A., 1967: Study of Reactions and Behaviour of Fish in a Heteregeneous Field with Single and Multiphase Current. - Fish. Electricity, London. Fish. News (Books): 202-221.

Daniulite G., Malukina G., 1967: Issledovanije fizjologicheskogo mechanizma deistvia pola postojannogo elektriceskogo toka na ryb. - Provedenija i Recepcji Ryb. Moskva: 56-62.

Halsband E., 1965: Eine elektrische Messmethode zur Bestimmung des Körperwiderstandes von Fischen. - Elektromedizin. 10,3: 126-129.

Holzer W., 1932: Über eine absolute Reizspannung bei Fischen. - Pflüg. Arch. f.d. ges. Physiol. 229: 153-172.

Mc Millan F.O., 1928: Electric Fish Screen. - Bull. of U.S. Bureau of Fisheries, 44: 97-128.

Nusenbaum L.M., Faleeva T.I., 1961: Isledovanije povedenija ryb v elektriceskom pole. - Izv. GOSNIORCH. Leningrad 52, 1: 1-95.

Scheminsky F., 1936: Zur Physiologie der Galwanonarkoze bei Wassertieren. - Pflüg. Arch. f.d. ges. Physiol., 237, 3: 273-283.

Szatybełko M., 1967: Sprawozdanie z badań reakcji ryb w polu elektrycznym. [Report on investigations of fish reactions in electric field] (in typewriting) . - MIR. Gdynia (maszynopis).

Szatybełko M., 1968: Sprawozdanie z badań reakcji ryb w polu elektrycznym. [Report on investigations of fish reactions in electric field]. (in typewriting) . MIR. Gdynia (maszynopis).

Szatybełko M., 1971: Metoda badań ruchowej reakcji ryb na pole elektryczne. [Investigation method of motional reaction of fish on electric field. - Scientific Conference of Team of Technics in Fishery] . - Konferencja Naukowa Zakładu Techniki Rybackiej. Gdynia: 143-151.

Sentiakov V.A., 1964: Presnovodnyj elektrotralovnym low ryby s primenenen peremennego toka. - Moskva. Piscevaja Promysl. 8: 1-80.

## ZMIANY NAPIĘCIA SYLWETKI LESZCZA ABRAMIS BRAMA (L.) W ZALEŻNOSCI OD KIERUNKU PRZEPŁYWU PRĄDU STAŁEGO ORAZ DŁUGOSCI CAŁKOWITEJ (L.t.) W JEDNORODNYM POLU ELEKTRYCZNYM


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

Badano u leszczy zależność napięcia sylwetki (Gestaltspannung) od kierunku przepływu prądu i długości całkowitej w jednorodnym polu elektrycznym pulsującego prądu stałego (Smooth Rectified Current).

Stwierdzono, że wartości napięcia sylwetki reakcji pierwszej zależne są od orientacji ryb względem elektrod i są mniejsze przy prądzie zstępującym.

Wzrost wartości napięcia sylwetki poszczególnych reakcji proporcjonalny jest do długości ryb.


## ИЗМЕНЕНИЯ НАПРЯЖЕНИЯ НА ТЕЛЕ ЛЕЩА Abramis brama (L.) В ЗАВИСИМОСТИ ОТ НАПРЯВЛЕНИЯ ТЕЧЕНИЯ ПОСТОЯННОГО ТОКА, А ТАКЖЕ ОТ ОБЩЕЙ ДЛИНЫ В ОДНОРОДНОМ ЭЛЕКТРИЧЕСКОМ ПОЛЕ


### Р е з ю м е

Исследована у леща зависимость напряжения на теле (Gestaltspannug) от направления течения тока в однородном электрическом поле пульсирующего постоянного тока (Smath Rectified Current).

Установлено, что величины напряжения на теле первой реакции зависят от ориентировки рыб по отношению к электродам и являются меньшими при входящем токе по сравнению с величинами, полученными при выходящем токе.

Увеличение величины напряжения на теле отдельных реакций является пропорциональным по отношению к длине рыбы.



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