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Fish physiology

THERMIC TOLERANCE OF *CLARIAS GARIEPINUS* (AFRICAN CATFISH) TO RAPID CHANGES IN WATER TEMPERATURE

TERMICZNA TOLERANCJA *CLARIAS GARIEPINUS* (SUM AFRYKAŃSKI) W SKOKOWYCH ZMIANACH TEMPERATURY WODY

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The aim of the work was to test the African catfish tolerance to rapid changes in temperature under aquaries conditions. Indicators of fish reaction to the temperature changes were locomotivity and respiratory symptoms, functional changes within the skin (coloration, slime excretion) responds to mechanical stimuli. A higher tolerance to rapid growth than rapid drop the water temperature was noted.

INTRODUCTION

The temperature is one of the most essential abiotic factors affecting the hydrobionts metabolism. Fish culture requires species oriented range of temperature optimum for physiological processes (so called thermopreferendum) as well as species oriented tolerance to range and rapidity of water temperature changes.

The thermopreferendum in fish is a genetically conditioned feature, which gave basis to a partition of fishes into thermo- and cold- tolerant species. Within the species thermopreferendum, there are periodical thermal optima connected with a stage of growth, spawning season, time of year, type of nutrition and so on. (Fry 1947, Crawshaw 1977, Beitinger and Fitzpatrick 1979).

Thermal tolerance in fish is also a feature conditioned genetically, connected with the acclimation temperature and anabling to judge on thermoadaptation possibilities of given species (Jobling 1981, Głębocka 1981, Węgrzynowicz et al. 1984).

A new species introduced to culture in heated up waters, in Poland is the stenothermal fish – *Clarias gariepinus* (African catfish), naturally inhabiting equatorial and south-easthern Africas area.

The thermopreferendum range of *Clarias gariepinus* is 22 to 33°C. Besides the very species has adapted to life with an oxygen deficiency (has a labyrinth- additional respiratory organ – enabling the fish to take an atmospheric oxygen) and has some positive cultural festures (taste of meat, fast increase in body weight etc.) – Richter 1976, Clay 1979, Babiker 1984, Britz and Hecht 1987, low feeding coefficient.

The industrial live-box culture (intensive feeding) of *Clarias gariepinus* in Poland was started by the Plant of Freshwater Fish Culture in Nowe Czarnowo, in cooling waters of the Dolna Odra power station. Seasonal water temperature changes in the Dolna Odra range from 6 to 14°C for winter (January, February) and from 18 to 32 in summer (June, July). Fast temperature changes (2–3°C/min) due to periodical disconnections or incorporations of the power station blocks do not exseed, within the twenty four hours scale, 3 to 4°C in winter and 7 to 8°C in the summer time (Filipiak and Trzebiatowski 1991).

The aim of this work was to test the *Clarias gariepinus* tolerance to rapid water temperature changes under aquarious conditions, as kind of a biological test usefull in selection of heated up waters environment for the *Clarias gariepinus* culture purpose.

MATERIAL AND METHODS

Surveys were conducted, on 127 individuals, with body weight 21 to 80 g, collected from the Dolna Odra culture between August and November.

Experiments were carried out in aquariums of 10 l in volume, filled up with water of pH 7.8 to 8.0.

Acclimation of fish to temperature 15, 20, 25 and 30°C lasted 12 gours. Then a rapid change in temperature took place, followed by 1 hour observations of fishes, which were transfered next to the acclimation temperature.

Each test was conducted on 6 fish individuals.

Indicators of fishes reaction to water temperature changes were:

- locomotion and respiratory sympthoms
- functional changes within the skin (tint, mucus excretion)
- reaction to mechanical stimuli.

A set of the above mentioned sympthoms, when visibly intensified was defined as thermal shock.

The Alarm Reaction Temperature was marked by the first sympthoms of excitement (The Alarm Reaction – I-st stage of physiology stress-Seyle 1956, Mazeaud et al. 1977). A sublethal temperature was estimated within the stage of a reversal shock, while the lethal one when unreversal shock stage appeared.

The water pH was determined with the type N-517 pH-meter, while behavioral sympthoms were recorded with the video camera VKR 6855/20 (Philips Co.).

RESULTS

Results of surveys of *Clarias gariepinus* tolerance to rapid water temperature changes, gained on direct observations basis and on the analysis of fish reaction registered by the video technic geathered on Fig. 1.

It was noted, that first anxiety sympthoms due to the temperature increase (spead up movements, growth in aggressivness, increase in the air intake frequency into the labyrinth organ) appeared, when temperature changed by 5 to 9°C compared to the acclimation temperature. The temperature at which the above mentioned changes occured was marked on Figures as the Alarm Reaction temperature.

Further increase of temperature within the range of thermal jump, caused increase of the anxciety sympthoms leading to the thermal shock. The shock sympthoms under high temperature were as follows: immence anxciety, efforts as to jump of an aquarium, increased excretion of mucus, disturbances in motion coordination (active swimming in up-side down position) icreasing drop in locomotion activity, loss in reaction to mechanical stimuli, brightning of body colours and death after 20 to 30 min.

With lowering down the water temperature, sympthoms of the Alarm Reaction appeared when thermal jump ranged from 2 to 6°C for fish acclimated in 15°C and 30°C, respectively (Fig. 1).

Further drop of temperature caused drop in motion activity of the fish. Within the range of low lethal temperatures, a thermal shock sympthoms appeared as – visible (after 2 to 3 min.) drop in motion activity and loss in reaction to mechanical stimuli, balance disturbances (convultions, convulsive body twists) torpor and death after 30 to 40 min.

The sympthoms of the Alarm Reaction and shock as well as with increasing and decreasing the water temperature were noted first for fish with a lowest body weight.

The results geathered on Fig. 1 indicated, that due to increase in acclimation temperature from 15 to 20, 25 and 30°C, the increase in absolute value of the Alarm Reaction temperature, sublethal and lethal temperature was noted.

The lowest tolerance to rapid drop in temperature was noted for fish acclimated in 15°C, while the lowest tolerance to rapid temperature growth was noted for fish acclimated at 30°C.

DISCUSSION

Surveys conducted proved the *Clarias gariepinus* to be the species with broad range of thermal tolerance and alike in case of other fish species (Głębocka 1978, Węgrzynowicz et al. 1984) the absolute values of lethal temperature are connected with the acclimation temperature.

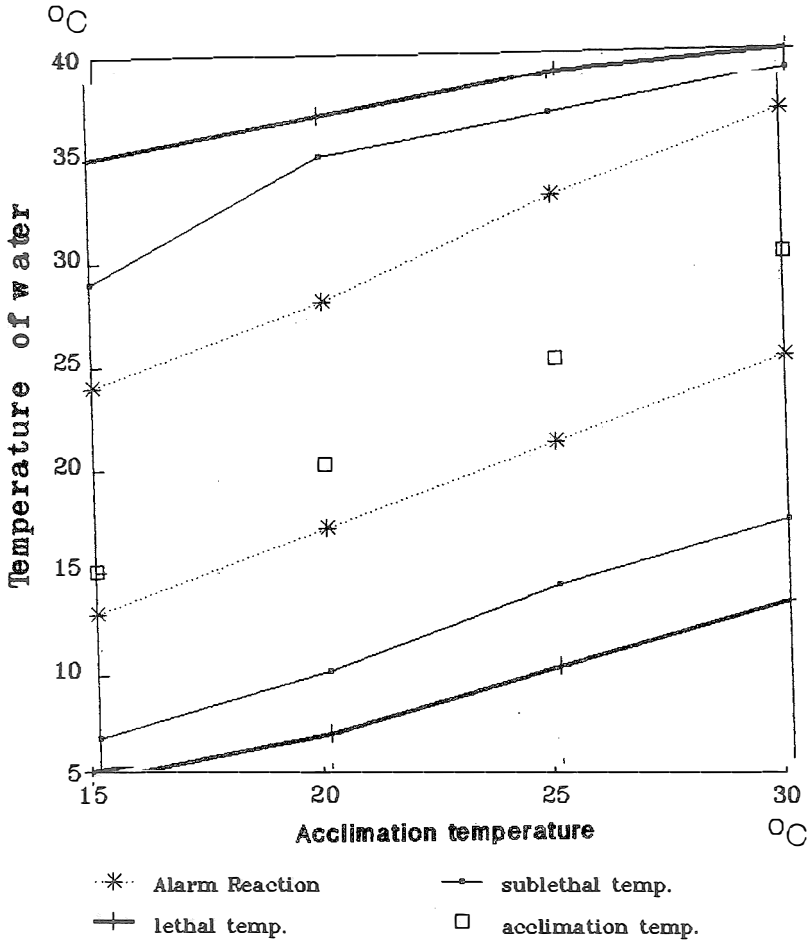

Fig. 1. Effect of rapid temperature change on Clarias gariepinus acclimated to 15, 20, 25 and 30°C

According to the stress theory, the first respond of organism to an external stimuli is a set of behavioural sympthoms called the Alarm Reaction (anxciety, increased respiration, etc.) which belong to so called first-rank sympthoms with neutral and neurohormonal background. As a result of an increased level of catecholamins and glikokorticoids the second-rank sympthoms appear, that is morphological, biochemical and functional ones (Seyle 1956, Mazeaud et al. 1977).

A higher tolerance to rapid growth than to rapid drop in water temperature (particularly clear when one looks at the temperatures causing an Alarm Reaction) noted for *Clarias gariepinus* indicate the thermoregulatory mechanisms to be more efficient within the higher temperatures range (Crawshaw 1977) and is connected with a high

(under Polish climatological conditions) thermopreferendum of this fish (Clay 1979, Britz and Hecht 1987).

A detailed analysis of the *Clarias gariepinus* reactions when under thermal shock, both within high and low temperatures range, proved succession and stress sympthoms course are simillar to previously noted ones for carp and rainbow trout (Węgrzynowicz et al. 1984).

The only difference is such that due to additional respirathory organ (the labyrinth), the rythm of *Clarias gariepinus* branchial lids is less visible, irregular and can not be used in comparative studies.

Surveys on the thermal tolerance of *Clarias gariepinus* were conducted under aquarium conditions in unpolluted water.

As to introduce the above results into practice, its verification under culture conditions for this species (cooling waters) is needed.

CONCLUSSIONS

1. Range of the *Clarias gariepinus* thermal tolerance depends on the acclimation temperature.
2. The highest thermal tolerance was noted for *Clarias gariepinus* acclimated to temperature 20 and 25°C.
3. Sublethal and lethal temperatures have higher convergence under extreme acclimation temperatures (15 and 30°C).
4. The smallest individuals show highest sensitivity to temperature changes.
5. The sympthoms of thermal shock due to high temperature are, in order of appearence: growing anxiety, increased excretion of mucus, disturbances in motion coordination, lightning of body colour, drop in locomotion activity, loss of reaction to mechanical stimuli while under low temperature: drop in motion activity connected with loss of response to mechanical stimuli, balance disturbances, convulsion, convulsive body twists, torpor leading to death.

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TERMICZNA TOLERANCJA *CLARIAS GARPIEPINUS* (SUM AFRYKAŃSKI) W SKOKOWYCH ZMIANACH TEMPERATURY WODY

STRESZCZENIE

Badania tolerancji suma afrykańskiego (*Clarias gariepinus*) na skokowe zmiany temperatury wody wykonano na 127 rybach o masie ciała 21–80 g, aklimowanych przez 12 godzin do temperatury 15, 20, 25 i 30°C. Wskaźnikiem reakcji ryb na zmianę temperatury były objawy lokomotoryczne, behawioralne, zmiany czynnościowe skóry, reakcja na bodźce mechaniczne.

Najszerszy zakres tolerancji termicznej stwierdzono u ryb aklimowanych do temperatury 20 i 25°C. Najniższą tolerancję na skokowe obniżanie temperatury wykazały ryby aklimowane w temperaturze 15°C, najniższą tolerancję na skokowy wzrost temperatury – ryby aklimowane w temperaturze 30°C.

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