Research of the effect of thermal shock on larvae of European catfish (*Silurus glanis* L.)

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Abstract

The aim of the study is to determine the effect of sudden temperature changes on the behavior and survival rate of European catfish larvae. The experiment was carried out with 100 larvae (body weight 86.17 ± 20.07 mg and length 22.67 ± 1.44 mm) in laboratory conditions and control temperature of 25 °C.

Five temperature variants were studied, with increasing and decreasing temperature at 5 °C interval. Thermal shock, expressed in change of the behavior, was observed in Variant B (final temperature of 35 °C), Variant D (final temperature of 15 °C), and in Variant E (final temperature of 10 °C).

Key words: European catfish (*Silurus glanis* L.), larvae, thermal shock

Изследване на влиянието на температурния шок върху личинки на европейски сом (*Silurus glanis* L.)

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Резюме

Целта на настоящото изследване е да се установи влиянието на резките температурни промени върху поведението и оцеляемостта на личинките на европейски сом. Проучването е извършено в лабораторни условия със 100 броя личинки (тегло 86,17 ± 20,07 mg и дължина 22,67 ± 1,44 mm) при контролна температура от 25 °C.

Експериментирани са пет температурни варианти, които се променят във възходящ и низходящ ред от контролната температура през интервал от 5 °C. Термален шок се проявява при Вариант B (финална температура 35 °C) при Вариант D (финална температура 15 °C) и при Вариант E (финална температура 10 °C).

Ключови думи: Европейски сом (*Silurus glanis* L.), личинки, температурен шок

Introduction

European catfish is one of the preferred species for culturing in fish farming. Positive characteristics, that define European catfish as valuable species, are its rapid growth rate, adaptability to changing environmental factors, high price and delicious white meat (Zaikov, 2006).

In fisheries practice, during different manipulations, the fish are often placed in conditions of sudden temperature changes. For example, when fish are transported and introduced in new habitats without equalizing the temperature of the water in the transport vessel with the temperature of the water from the place of catching or introduction. Due to temperature differences a temperature shock may occur, sometimes with lethal end.

More information is needed on the reaction of species, subject to freshwater fish farming, as they might be exposed to sudden and rapid temperature changes. Fish placed in such conditions change their behavior and show different reactions to the temperature stress. (Elliot, 1981; Hubenova and Zaikov, 2013).

Fish are poikilothermic animals and changes in the water temperature affect their metabolic processes, behavior, growth, reproduction and survival (Fry, 1971; Portner, 2001). The impact of temperature shock is species-specific and age-dependent. The same temperature has different effects on fish of the same species, in relation to the age and the stage of the individual development. With temperature increase, the temperature optimum usually becomes wider, thus its effect is the strongest in the earliest stages of the development of the organisms (Grozev et al., 1999).

Different fish species develop within certain temperature range, which determines their temperature tolerance. Temperature tolerance has been relatively well studied in different species of fish (Richardson et al., 1994; Beitinger et al., 2000; Mora and Maya, 2006; Souchon and Tissot, 2012). Previous researches often focus on the adaptive ability of fish towards slowly changing temperature conditions. (Szekeres et al., 2014) emphasize that most experiments analyze the results of a gradual change in temperature, while there is few studies of the effect as of sharp decrease or increase in the temperature of the water. The published data on temperature tolerance of European catfish show relatively wide ranges (Berg, 1964; Abdulayev et al., 1978; Hilge 1985; Schlumberger et al., 2001). Some authors have stated that the optimal temperature for its development is within the range of 12 °C–28 °C (Berg, 1964; Abdullayev et al., 1978; Hilge, 1985). According to (Schlumberger, 2001) its temperature tolerance is in a wider range – from 3 °C to 30 °C. (Mihalik, 1982) states that the lowest lethal temperature for European catfish larvae is 13 °C.

Research of the temperature tolerance of sun catfish (*Horabagrus brachysoma*) found better adaptive ability to higher temperatures and a higher critical temperature minimum value than European catfish (Dalvi et al., 2009). Same results were obtained from a study with *Pangasius pangasius* by Debnath (2006).

In contrast to temperature tolerance, the effect of thermal shock on the behavior and the survival of different fish species is poorly studied. Such scientific experiments have been done with pike (*Esox lucius*) (Hubenova et al., 2013) and sander (*Sander lucioperca*) (Kazakova et al., 2015). So far, research data on experiments with European catfish (*Silurus glanis*) have not been published.

Due to the insufficient information on the temperature shock of *S. glanis*, we conducted this study which main objective is to investigate the effect of sharp increase and decrease of temperature on the behavior of European catfish larvae.

Materials and methods

The research was conducted at the Institute of Fisheries and Aquaculture, Plovdiv. 100 larvae of European catfish, with size and weight characteristics indicated in Table 1, were used. The larvae were obtained by semi-artificial propa-

Table 1. Body weight and body length of the experimental individuals

	Body weight (BW), mg	Total body length (TL), mm
X	86.17	22.67
SD	20.07	1.44
CV, %	23.29	6.35

gation. At the beginning of the experiment, the age of the fish was 20 days. They were reared in production system, consisting of plastic tubs with continuous water flow and an average water temperature of 25 ± 1.4 °C.

All experimental variants were carried out at an initial control temperature of 25 °C. The experimental temperatures were changed in increasing and decreasing order by 5 °C from the control temperature. In order to avoid mortality and in consideration to the welfare of the animals, the experimental temperatures were change while carefully monitoring their effect on the larvae. The scheme of the different temperature variants is presented in Table 2.

During the experiment, 20 larvae were placed in tub of the corresponding temperature variant. The experimental fish were caught with minimal stress from the control tub and transferred to the test tub. The gradual changes in the water temperature are presented in Fig. 1. Throughout the study, in addition to the water temperature, the amount of dissolved oxygen was measured. The amount of dissolved oxygen in the experimental tubs does not change significantly and has value of 7.85 ± 0.92 $mg.l^{-1}$.

Changes in larval behavior and their survival were monitored for 24 hours.

Results and discussion

The results established 100% survival rate for all experimental variants. The effect of temperature shock is expressed in change in the physical activity of the larvae. The observations of the fish behavior found that at the control temperature of 25 °C, the fish have normal motor activity. After being placed in the experimental tubs with increased water temperature, they change their behavior. When the temperature was increased by 5 °C (Variant A), no changes in the behavior and the activity of the individuals were observed.

When placed in experimental variant B (final temperature of 35 °C), the catfish larvae respond with accelerated movements, which is a manifestation of temperature shock. After a period of 20 minutes, the fish restored their normal motor activity. In variant C (final temperature of 20 °C), when the control temperature is reduced by 5 °C no change in the behavior and physical activity of the larvae is observed. In variant D (final temperature of 15 °C), the temperature is decreased by 10 °C, which caused temperature shock in 20% of the fish. Iinitially, the larvae are lying still at the bottom and respond to touch. With the gradual increase of the temperature, the fish begin to regain their normal activity. All fish successfully recovered from the temperature shock after a period of eight hours.

When the catfish larvae were placed in Variant E (final temperature of 10 °C), with decrease of the control temperature by 15 °C, a temperature shock was observed, expressed in the larvae being still at the bottom for 28 minutes. After that period, the fish gradually start to move and completely regain their normal physical activity within 24 hours, with no mortality recorded.

The results of the experiment established that, temperature shock occurred in variant B (35

Table 2. Experimental variants

Variant	Water temperature, T °C		
	Control	Experimental	Temperature difference
A		30	5
B		35	10
C	25	20	5
D		15	10
E		10	15

°C), variant D (15 °C) and variant E (10 °C). The negative effect of temperature shock is reduced with time by the fact that the water temperature in the test tubs gradually decreases or increases under the influence of ambient air temperature in the laboratory. For a period of 9 hours temperature values in all experimental variants are equalized with the control. The variants with the highest and lowest values change most rapidly. The changes in the experimental variants with temperatures close to the control temperature are slower (Fig. 1).

The results obtained from the conducted research established that the larvae of European catfish (*Silurus glanis*) can adapt to sudden temperature changes, such as increase by 10 °C (Variant B) and decrease by 15 °C (Variant E).

When comparing the results with the studies with pike and sander, conducted in similar experimental settings, by Hubenova and Zaikov (2013) and Kazakova et al. (2015), it can be concluded that European catfish larvae are more adaptable to abrupt temperature changes. Lowering the temperature to 3 °C is lethal for sander, irrespective of temperature difference.

Great interest arises when comparing the effects of temperature shock in European catfish and pike due to the fact that both species tolerate shock changes in temperature. In pike, temperature shock occurs at temperature difference of 25 °C, respectively, temperature decreased from 28 °C to 3 °C, with no mortality rate. Whereas, European catfish reacts with cessation of activity and still position at the bottom of the tub at temperature difference of 15 °C, respectively, temperature decreased from 25 °C to 10 °C. Subsequent decrease in temperature most probably would cause mortality.

Conclusion

Based on the results of the conducted research it can be concluded that the larvae of European catfish showed relatively good tolerance to sudden temperature changes. Thermal shock is observed when the control temperature is increased by 10 °C (Variant B) or decreased by 10 °C (Variant D) and by 15 °C (Variant E). During the experiment the temperature shock is expressed only with change of the physical activity.

It can be recommended, when performing different manipulations with European catfish larvae in fish farming practice to avoid higher temperature amplitudes than those tested in the present study, as they might cause mortality.

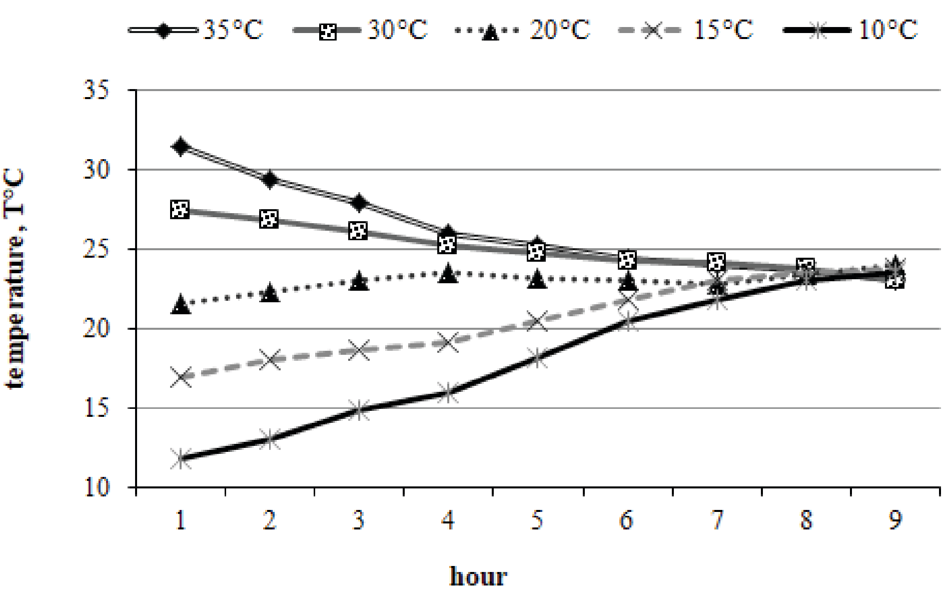

Fig. 1. Water temperature dynamics

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