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PhD Thesis

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Abiotic determinants of the environmental succession of the Chinese sleeper *Perccottus glenii* Dybowski, 1877

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SUMMARY

Biological invasions, associated with the uncontrolled spread of plants and animals, are currently one of the most significant global environmental problems on the globe. The appearance of alien species in the area, where they did not previously occur, usually poses a threat to the native biodiversity, although the consequences from their presence are manifold. These include for example the competition for habitat, food or spawning grounds that they exhibit against indigenous taxa, the transfer of new pathogens and parasites, the potential for hybridization with autochthonous fish and finally the measurable economic losses to fish farms and angling industry. In general, these fish are perceived as a threat to the resource of native ichthyofauna and to the ecological stability of aquatic ecosystems and globally to sustainable fisheries management.

At the turn of the 20th and 21st centuries, the presence of 26 alien fish species was recorded in our open waters, of which 19 are now a permanent element of the ichthyofauna, representing for 24% of all freshwater fish species in Poland. One such taxon is the Chinese sleeper *Perccottus glenii* Dybowski 1877, the only representative of the family *Odontobutidae* whose natural range includes the Amur River basin, i.e. China, eastern Russia and Mongolia. It is officially recognized as the alien invasive species, posing a threat to the entire European Union, as it is capable of efficiently reproducing and establishing populations in newly occupied areas, and its presence negatively affects native species and disrupts the functioning of aquatic ecosystems in various ways.

The basis of the succession of all representatives of ichthyofauna defined as alien/invasive species is their relatively high genetic variability and incredible morphological and physiological plasticity. They are generally characterized by a short life cycle, rapid growth and development of juvenile stages and opportunistic foraging strategies including omnivorous feeding. Their reproductive behaviour exhibited, associated with spawning abortiveness and active care by males for eggs and hatched larvae, facilitates their colonization of new habitats while constituting an important element of differentiation from native taxa.

In the case of the Chinese sleeper, an important feature favouring its range expansion is resistance to changing environmental conditions (short-term oxygen deficits, temperature fluctuations). However, information on the influence of abiotic factors on the growth or survival of its juvenile stages is scarce. Therefore, this study attempts to assess

the influence of a few selected - key - abiotic factors with the potential to promote or negatively influence embryonic development, survival and growth of the early stages of the Chinese sleeper. In all experiments the study material consisted of embryos and/or larvae obtained as a result of semi-natural reproduction of mature spawners of Chinese sleeper collected from the Wloclawek Reservoir in accordance with the terms of Decision No. WOPN.672.3.2017.MJ.2 of the Regional Director of Environmental Protection in Olsztyn of 7th August 2017 and Decision No. DZP-WG.672.208.2022.MK of the General Director of Environmental Protection in Warsaw on 6th September 2022. The aim of the study was to determine the influence of temperature, pH and salinity of water on the course of embryogenesis and the growth, condition and survival of juvenile stages of the Chinese sleeper, as well as to determine critical values of water parameters that may facilitate or limit the spread of this representative of alien invasive ichthyofauna in Polish freshwater ecosystems.

Of the three environmental factors studied, i.e. temperature, salinity and water pH, the temperature was the most differentiating factor in the rate of embryogenesis, as well as weight and body length gains of Chinese sleeper larvae within the study groups. Incubation of eggs at 25°C resulted in twice as rapid initiation of individual stages of embryonic development, already noticeable at the time of the eyed stage, compared to eggs whose embryogenesis process took place at 15°C and lasted 10 days. It was found that a water salinity of 5‰ had a positive effect on survival of eggs during embryogenesis, preventing, among other things, the development of fungal infections by *Saprolegnia* sp. and resulted in a faster increase in body weight in larvae/fry reared in the same salinity compared to fresh water. In contrast, a water salinity of 10‰ was considered to be close to lethal, as it resulted in the death of all embryos in the first 8 days of embryogenesis. This was due to changes in the structure of the egg shells, causing developmental disorders, body deformities and, ultimately, embryo death. On the other hand, the varied pH of the water used in the experiment, ranging from 6 to 9, did not show any significant effect on the rate of embryogenesis in Chinese sleeper and the initiation of particular - key stages of this process, i.e. eyed stage, gastrulation or hatching. The 28-day experimental rearing of Chinese sleeper larvae in the water of temperatures 15, 20 and 25°C resulted in statistically significant differences between groups in body weight and length at the end of the process. Larvae from the T25 group reached an average body weight of 81.3 ± 16.3 mg, which was almost five times that of fish from the T15 group (15.6 ± 2.2 mg), which also had a higher value of cumulative mortality of 34.7%. Significantly higher body weight gains of Chinese sleeper larvae were also recorded in the group of fish reared in alkaline water (pH9 group),

compared to those kept in acidic and neutral water. The values for the body length differentiation index of Chinese sleeper larvae, body weight differentiation index, relative weight index and condition factor differed significantly between the T15 group and the T20 and T25 groups. In the experiment, where salinity was the differentiating factor between the experimental groups, such differences were recorded only for the larval body length and body weight differentiation index. In contrast, no such differences were recorded after the 28-day rearing of Chinese sleeper larvae in water with different pH. Statistically significant intergroup differences ($P<0.05$) were also recorded for condition index (K) values and relative body weight gain (SGR) only in the experiment, where the water temperature was the differentiating factor between the research groups. The highest percentage, of the order of 16% in group Z5, of abnormal Chinese sleeper larvae, associated with deformities of their lower jaw and vertebral structure, was recorded after the 28-day rearing, where salinity was the differentiating factor. The reported mortality of Chinese sleeper larvae/fry resulting from cannibalism type I and type II in the experimental rearing was marginal, oscillating between 0.5% and 6.0% in groups pH9 and Z0 respectively.

Analysis of the results of experiments in which the early life stages of Chinese sleeper (embryos and larvae) were kept under different environmental conditions, in terms of the values of selected abiotic factors (temperature, pH and salinity), showed its adaptability and high tolerance to changes in environmental parameters. Climate change, the homogenization of water parameters within freshwater bodies and irresponsible or ill-considered human actions result in a systematic increase in temperature, salinity and acidification of surface waters. This has having serious consequences for native, often stenotypic fish species, whose adaptive capacity is far less than that of taxa such as the Chinese sleeper, which are much more easily adapted to such environmental disturbances.

The results of the present study, in addition to providing valuable information on the biology of the Chinese sleeper, may also be helpful in determining the critical values of water parameters favour or limit the development of the early stages of ontogenetic development, and thus identify potential boundaries of expansion areas. In addition, in the future, they may also form the basis for work aimed at attempts to eradicate or significantly reduce the increasing abundance of the Chinese sleeper in freshwater ecosystems.

Key words: Chinese sleeper, temperature, salinity, pH, embryogenesis, larvae, alien invasive species