

## A BIOMETRIC ANALYSIS AND FISHERMEN'S PERCEPTION ON *Pseudorasbora parva* (Temminck & Schlegel, 1846): A CASE STUDY FROM ROMANIA

Mala-Maria STAVRESCU-BEDIVAN<sup>1</sup>, Gabriel-Cătălin GÎLEA<sup>1</sup>,  
Cristina Florentina ALISTAR<sup>2,3</sup>, Sabin-Adrian ȘTEFAN<sup>1</sup>, Ionuț Cosmin SFETCU<sup>1</sup>

<sup>1</sup>University of Agronomic Sciences and Veterinary Medicine of Bucharest,  
Faculty of Agriculture, 59 Mărăști Blvd., District 1, 011464, Bucharest, Romania

<sup>2</sup>University of Bucharest, Faculty of Biology, 91-95 Splaiul Independenței,  
050095, Bucharest, Romania

<sup>3</sup>Perfect Care Manufacturing, 82 Complexului Street, Mihăilești, Giurgiu, 085200, Romania

Corresponding author email: mala\_stavrescu@yahoo.com

### Abstract

A population of teleost fish stone moroko (*Pseudorasbora parva*) belonging to a Romanian freshwater pond located in Gorj County was analysed in order to reveal the length-weight relationship and condition factor, during two sampling seasons: October 2023 and February 2024. Positive allometric growth was estimated for 418 *P. parva* collected in 2023 ( $TW = 0.0065 \times TL^{3.305}$ ;  $TW = 0.003 \times SL^{3.3946}$ ), while a negative allometric growth pattern was established for 764 *P. parva* collected in 2024 ( $TW = 0.0122 \times TL^{2.7309}$ ;  $TW = 0.0252 \times SL^{2.5731}$ ). The values for condition factor *K* ranged between 0.47 and 0.74 (2023) and 0.31 and 1.47 (2024). For all individuals included in this study, the values for slope *b* were within the expected range of 2.5-3.5. In 2023, with *b* greater than 3, the growth type was estimated as positive allometric, while in 2024, the *b* lower than 3 indicated a hypoallometric growth type.

On the other hand, in April 2024, a questionnaire was created in order to investigate the human knowledge about the traits of stone moroko in Romania. The surveyed fishermen appreciated both the initiative to address the impact of this invasive fish species and the integration of educational information in the questionnaire. Analysing the received answers, it was confirmed that people are aware about the necessary to apply methods in order to limit the reproduction of the stone moroko in Romania.

**Key words:** biometry, condition factor, length-weight relationship, questionnaire, stone moroko.

### INTRODUCTION

*Pseudorasbora parva* (Temminck & Schlegel, 1846) is an alien species from Europe, which in recent decades has invaded large areas of the entire continent (Curtean-Bănăduc & Bănăduc, 2008; Gavriiloaie et al., 2008).

*P. parva* is considered one of the major invasive species worldwide, therefore it is included in the "List of invasive alien species of interest to the Union" by Regulation (EU) No 1143/2014 on the prevention and management of the introduction and spread of invasive alien species.

Originally from East Asia, stone moroko is a small-sized fish that was accidentally introduced into the hydrographic network of Romania in 1960-1962, together with other cyprinid species of economic value (Iacob & Petrescu-Mag, 2008). Currently, it successfully

populates natural water bodies, having one of the highest spread rates in the regional fish fauna (Curtean-Bănăduc & Bănăduc, 2008).

After its first report in the fishing resort of Nucet-Dâmbovița (Romania), where it was introduced for reproduction, the species gradually spread in several areas of the country, and numerous studies were carried out in this direction (Bănărescu, 1964; Oțel, 2007; Gavriiloaie et al., 2008; Telcean et al., 2015).

Regarding habitat preferences in Romania, *P. parva* demonstrates a high plasticity in habitat use, as it inhabits a wide variety of lentic and lotic ecosystem types (lakes, ponds, rivers, ditches, canals, reservoirs, etc.), most often those with silty substrate from plain and hill areas (Bănărescu, 1964; Oțel, 2007; Bănăduc et al., 2013). However, stone moroko was also found in the hydrographic basins with rocky substrate, in the south of the Făgăraș

Mountains (Gozlan et al., 2010; Telcean et al., 2015). Its affinity for ecosystems with dense submerged vegetation is well documented, but there are exceptions (Gozlan et al., 2010).

*P. parva* is an opportunistic bentophag species, which adapts its feeding habits according to its life stage (limited to body size), but also according to the ecosystem in which it is found. The diet of fish is mainly represented by relatively small foods (zooplankton, phytoplankton, detritus, crustaceans, rotifers and other benthic macroinvertebrates) (Gavriloaie et al., 2003; Iacob & Petrescu-Mag, 2008; Gozlan et al., 2010; Rolla et al., 2020).

It has been reported that the feed may also consist of eggs and larvae of native fish species, depending on environmental conditions and developmental stage. They also sometimes feed on integumentary mucus and certain ectoparasites of other fish species, causing them superficial lesions, thus classifying them as facultative parasites (Crăciun, 1998; Gavriloaie et al., 2008; Gozlan et al., 2010).

The ecological features of *P. parva*, such as phenotypic plasticity, growth rate and extraordinary reproductive capacity (females lay eggs even 3-4 times a year), rank it as one of the most successful aquatic invaders in Europe. It is considered a highly invasive alien species, due to the potentially negative impact on native species in invaded ecosystems, with which it competes for food resources, territory and breeding sites (Kottelat & Freyhof, 2007; Yan & Chen, 2009; Rolla et al., 2020; Kirczuk et al., 2021).

Another relevant threat is its ability to carry pathogens, such as the intracellular parasite *Sphaerothecum destruens* (Gozlan et al., 2009; Rolla et al., 2020; Gozlan & Combe, 2023). For these reasons, its spread could lead to an important loss of native ichthyofauna.

The species-specific length-weight relationship (LWR) and condition factor (K) are crucial tools in studying the biology, physiology, ecology and invasive population dynamics of *P. parva*. However, fish growth is influenced by several factors and the LWR changes accordingly (Stavrescu-Bedivan et al., 2016).

Extensive investigation of the impact of different factors on the length-weight relationship can demonstrate significant

differences in LWR between populations belonging to the same species, from different geographic regions.

The present study aimed to investigate both some biometric features of *P. parva* inhabiting a Romanian pond and the level of knowledge among fisherman concerning the potential of invasive species such as this cyprinid.

## MATERIALS AND METHODS

This survey was conducted in 2023 (October) and 2024 (February) into a private pond located in Gorj county (Spahii village, Turburea commune) (latitude N 44°40'54.624, longitude E 23°31'24.142) (Figure 1).

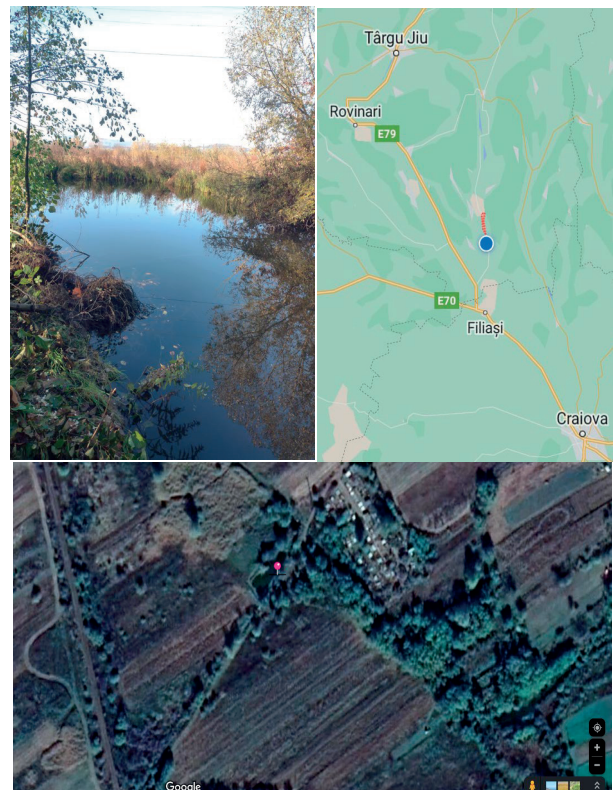


Figure 1. Study site (top left - original view of the pond, top right - GoogleMaps view, bottom - Google Earth view)

The fish samples were caught with the aid of two portable minnow mesh traps (Figure 2).

In 2023, were collected and analysed 418 (unsexed) individuals of *Pseudorasbora parva* and 764 (unsexed) in 2024, respectively.

The scientific name of stone moroko and other fish species mentioned in this report were used according to FishBase database (Kottelat & Freyhof, 2007; <https://www.fishbase.se/>).



Each fish individual was measured for total and standard length (TL, SL, in cm) and total weight (TW = total body weight, in grams) to the nearest 1.0 mm and 0.1 g, respectively (Scăețeanu et al., 2023).



Figure 2. Capturing stone moroko in Gorj county

The length-weight relationships (LWRs) for stone moroko were calculated as  $TW=aTL^b$  and  $TW=aSL^b$ , intercept  $a$  describing the rate of change of weight with length of fish, while slope  $b$  gives information about the type of growth (Froese, 2006). The coefficient of determination ( $R^2$ ) was calculated with a confidence interval (CI) of 95% for the intercept and the slope.

A positive allometric pattern of growth is registered when  $b > 3$ , while  $b < 3$  suggests a negative allometric or hypoallometric growth type (Karachle & Stergiou, 2012).

In order to assess the well-being of *P. parva* in their habitat, the Fulton's condition factor (K) was calculated as  $K = (TW/TL^3) \times 100$  (Khan et al., 2020; Stavrescu-Bedivan et al., 2023).

The online questionnaire concerning the knowledge of Romanian fishermen about *Pseudorasbora parva* was launched in April

2024, using Google Forms. The survey was addressed to respondents affiliated with some groups of Romanian fishermen on social networks.

Respondents were asked to answer the following questions about stone moroko, with the aim of testing the degree of recognition of this fish species based on the description and one photo inserted in the form:

1. Can you identify the species of fish in the picture?

2. What is the name of the species in the previous picture?

Since the purpose of the questionnaire was also an educational-interactive one, between question 2 and 3 was added the text "The species in the image presented previously is called stone moroko (*Pseudorasbora parva*). At maturity it reaches 6-8 cm in length.

3. Have you captured stone moroko from Romanian waters?

4. If you fished stone moroko, from what kind of water body did you catch it?

5. How often have you fished stone moroko?

6. Do you think that stone moroko affects the environment?

7. If you captured stone moroko and bearing in mind that it is an invasive species, did you take any measures to limit its reproduction in Romanian waters? Name the method.

This question was designed with the aim of detecting what measures (regarding limiting the negative impact on ecosystems) were taken by the fishermen who caught this species of interest.

8. What methods do you think we can use to alleviate the negative impact of stone moroko in Romania? For example, in some countries, once invasive species are captured, their release is prohibited. Name the method.

## RESULTS AND DISCUSSIONS

### Fish biometric analysis

The biometric data for *Pseudorasbora parva* collected from Gorj County in 2023 and 2024, were registered as follows:

- October 2023: SL (min. 2.3 - max. 7.1 cm, average 3.79 cm), TL (min. 3 - max. 8.6 cm, average 4.62 cm), TW (min. 0.14 - max. 4.53, average 0.64 g).

LWRs (Figure 3) were calculated as:

$TW = 0.0065SL^{3.305}$  ( $R^2 = 0.881$ , 95% CI);  $TW = 0.003TL^{3.3946}$  ( $R^2 = 0.923$ , 95% CI).

- February 2024: SL (min. 2.2- max. 7.2 cm, average 3.29 cm), TL (min. 2.8 - max. 8.3 cm, average 4.01 cm), TW (min. 0.17 - max. 5.63 g, average 0.6 g).

LWRs (Figure 4) were calculated as:

$TW = 0.0252SL^{2.573}$  ( $R^2 = 0.860$ , 95% CI);  $TW = 0.0122TL^{2.7309}$  ( $R^2 = 0.916$ , 95% CI).

For all *P. parva* analysed individuals, the values for slope *b* were within the expected range of 2.5-3.5. In 2023, with *b* values greater than 3, the growth type for stone moroko was estimated as positive allometric (fish grows faster in weight than in length), while in 2024, the  $b < 3$  indicated a hypoallometric growth type (fish increases less in weight than in length).

By analysing LWR and the factors that influence the nutritional status, growth and reproduction of the species, important information can be obtained for the sustainable management of native fish populations. The length-weight relationship can serve as an ecological indicator for assessing the impact that invasive fish species have on local species and their habitats, and the fish condition factor is useful for shedding light on the physiological state, hypertrophy and health of fish (Ragheb, 2023; Li et al., 2023).

Fish growth and change in LWR values are affected by a variety of natural factors, including geographic region, environmental factors (temperature, climate, salinity), biological factors (sex, habitat, health, diet), as well as anthropogenic factors (change, habitat fragmentation or destruction, pollution and intensive fishing or fish poaching) (Froese, 2006; Arnason et al., 2009; Stavrescu-Bedivan et al., 2016; Wang et al., 2017; Kelly et al., 2017; Hohne et al., 2020; Li et al., 2023).

Fulton's condition factor *K* for stone moroko in the analysed pond presented an average value lower than 1 in both sampling seasons (min. 0.47 - max. 0.74, average 0.54, in 2023; min. 0.31 - max. 1.47, average 0.85, in 2024).

A low value of Fulton factor may suggest poor fish body condition, slow growth, or

competition for the food resource. All of these can be related to poor living environment, lack of food or competition for food, environmental stressors or other factors that can affect the health and growth rate of the fish (Mon et al., 2020; Ragheb, 2023).

As various studies postulated (Rosli and Isa, 2012; Stavrescu-Bedivan et al., 2022), the length of the fish could be more biologically relevant than age.

According to FishBase, the common total length for *P. parva* is 8 cm (Kottelat & Freyhof, 2007). In the present study, the TL value of most stone moroko individuals measured less than 5.00 cm both in 2023 (73.92%) and 2024 (90.18%) (Figure 5), while most of fish weighted less than 1 gram (82.54% in 2023, 88.74% in 2024) (Figure 6).

In addition to stone moroko, during the study period, the following fish species were noticed in the analysed pond from Gorj county: brown bullhead *Ameiurus nebulosus* (Lesueur, 1819), Prussian carp *Carassius gibelio* (Bloch, 1782), and rudd *Scardinius erythrophthalmus* (Linnaeus, 1758).

A parasite was found, respectively the copepod *Lernaea cyprinacea* (Linnaeus, 1758), but only in two specimens of stone moroko captured in 2023.

### **Level of knowledge about stone moroko in Romania**

To the first item in the questionnaire, 66% of the respondents answered that they can identify the fish in the photo inserted in the Google Forms, 12.7% answered negatively, while 21.3% declared that they were not sure.

Regarding the name of the fish species, 52.5% correctly identified the fish in the image, 18.5% answered they were not sure, 10.9% referred to gudgeon *Gobio gobio* (Linnaeus, 1758), while smaller percentages were correlated with erroneous identifications such as schneider *Alburnoides bipunctatus* (Bloch, 1782), European bitterling *Rhodeus amarus* (Bloch, 1782) or ruffe *Gymnocephalus cernua* (Linnaeus, 1758).

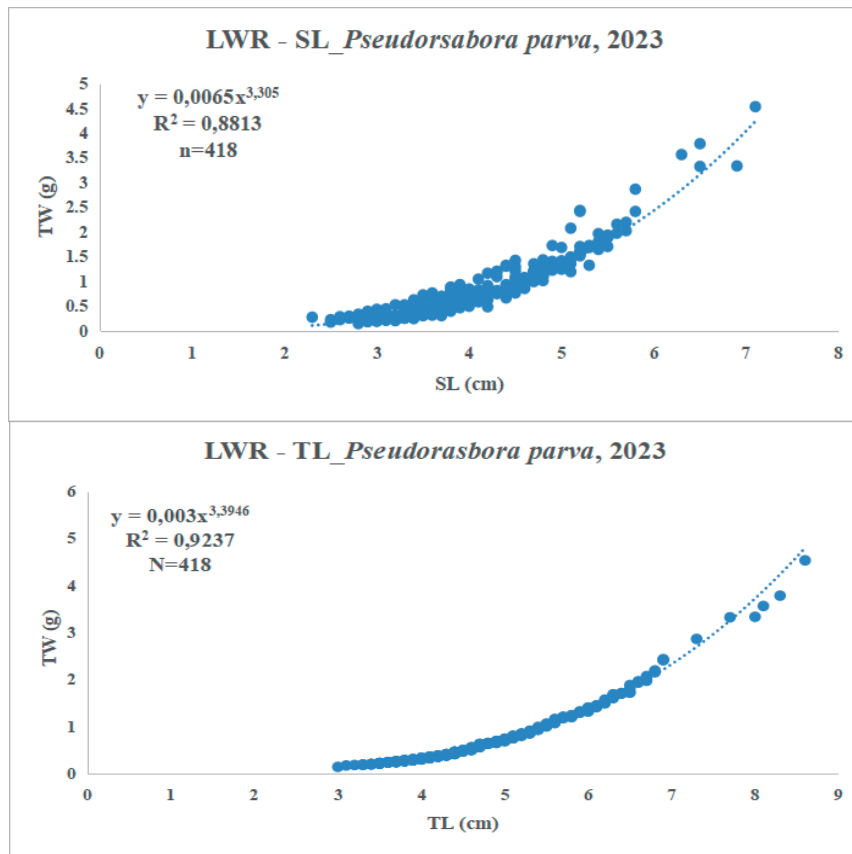


Figure 3. Length-weight relationship for stone moroko sampled in 2023

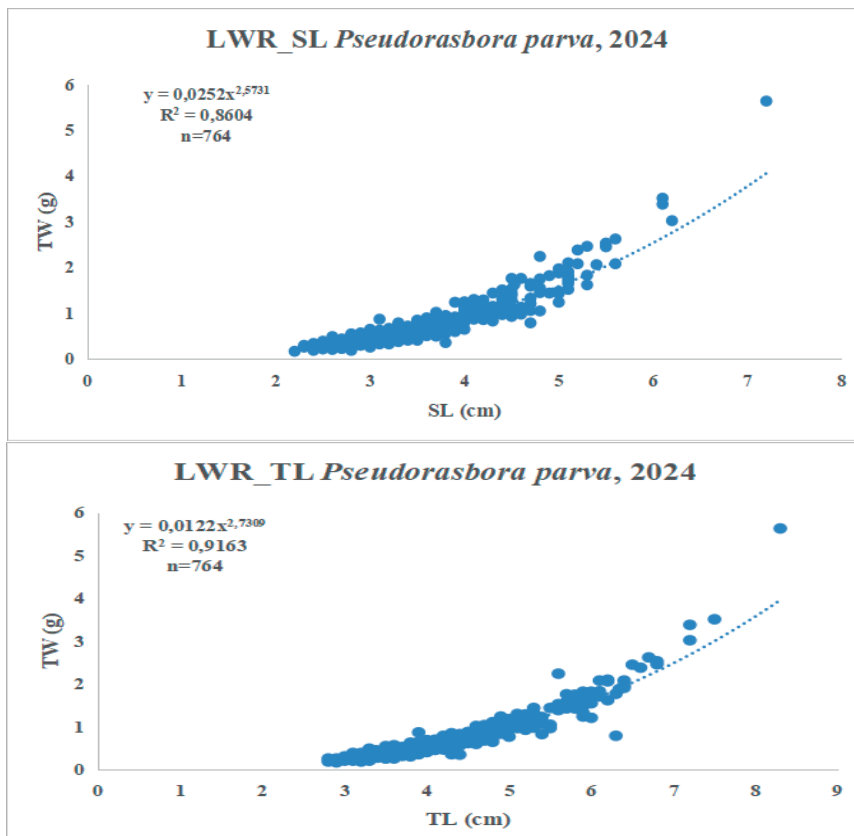


Figure 4. Length-weight relationship for stone moroko sampled in 2024

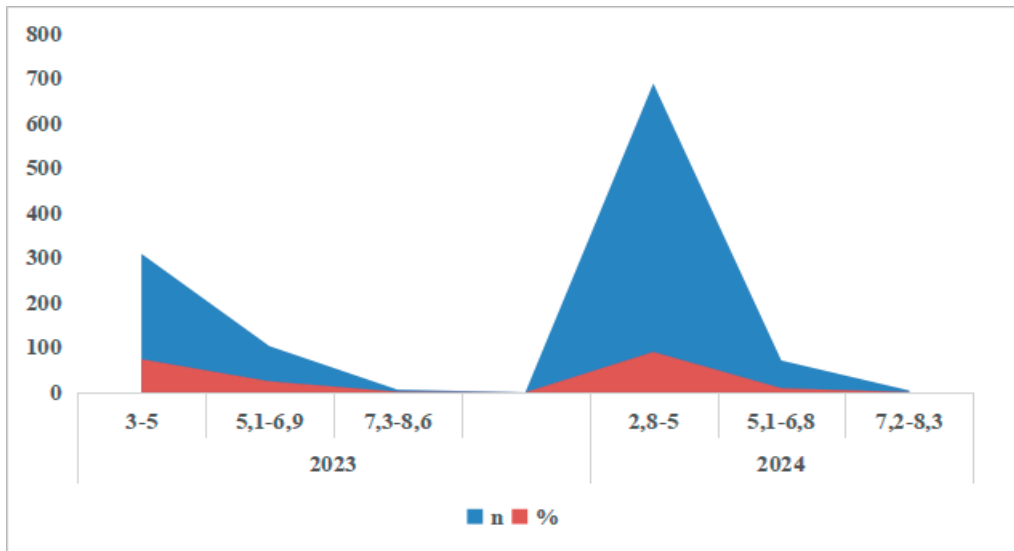


Figure 5. Total length distribution among size groups of *P. parva* in both sampling seasons

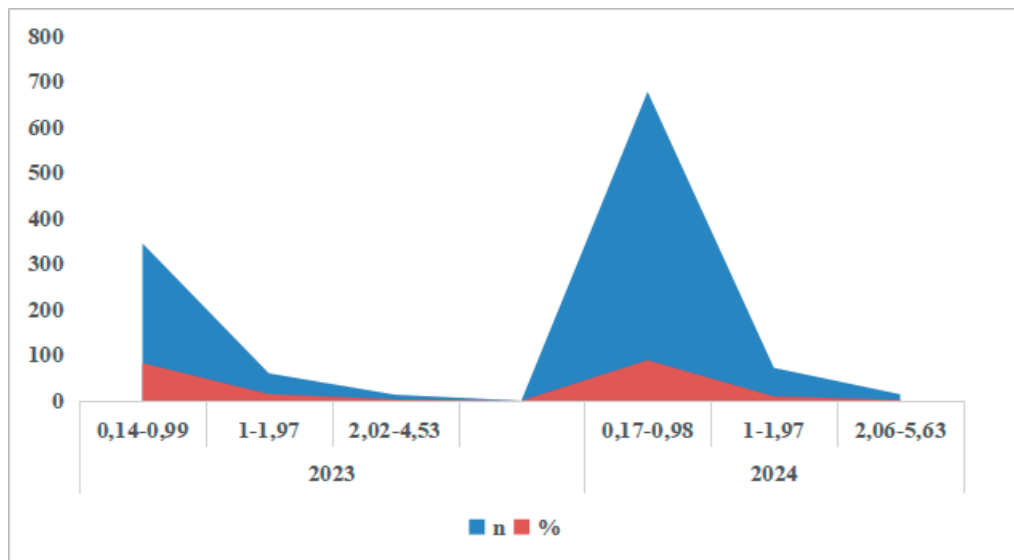


Figure 6. Total weight distribution among size groups of *P. parva* in both sampling seasons

On the third question, 62.5% of the participants stated that they captured the stone moroko, 30.3% said that they did not capture it and 7.2% said that they were not sure of the answer.

To the fourth question, 39.1% of the participants declared that they fished stone moroko in natural lakes, 28.9% of the respondents answered that they fished this species from rivers, 25.2% from private fishing ponds, while 32.8% admitted that they did not catch this fish until the time of completing the questionnaire.

Regarding the frequency of catching this fish, 22.6% of the fishermen declared that it is rare (once every few months), 15.6% very rare (once or twice a year), 16.9% answered often

(several times per month), and 8.6% stated that very often captured this fish (at almost every fishing trip).

Questioning the belief in the negative impact of the *P. parva* species on the environment, 49% of the respondents admitted that they are not sure that this is the case, 26.6% answered yes, while 24.4% answered no.

To question number seven, it was received answers such as: "I used the specimens as bait for predatory fish", "I didn't release it", "I cooked it" or "I left it on the shore". However, many participants in this survey answered that they did not take any action, which is understandable, due to lack of information.

More than 90% of the responses to the last question supported the idea of prohibiting the



release of stone moroko back into the water, once fish is captured, approximately 5% did not mention any measure and 3% did not give any answer.

## CONCLUSIONS

For stone moroko captured from an ecosystem located in Gorj county, the low values obtained after calculating the condition factor can be correlated with both the small size of the fish and the low body mass. In this study, it can suggest an intense competition for the food resource, in an environment where the population density is abundant, referring to the area of the habitat.

The feedback received from the surveyed fishermen was positive in that they appreciated the initiative to address the impact of an invasive fish species, as well as the integration of educational information in the questionnaire. Through this questionnaire it was possible to find out the level of knowledge regarding *Pseudorasbora parva*. It was confirmed that the Romanian fishermen are aware that it is necessary to apply methods to limit the reproduction of this species in all kinds of freshwater (lakes, rivers, fishing ponds).

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