REVIEW

of a dissertation for awarding the educational and scientific degree "Doctor" in the scientific specialty: "Animal Breeding, Biology and Biotechnology of Reproduction";
Field of Higher Education – 6. Agricultural Sciences and Veterinary Medicine; Professional field – 6.3. Animal Husbandry.

Author of the dissertation: Georgi Kirilov Georgiev, part-time doctoral student at the Department of Animal Sciences, Faculty of Agronomy, Agricultural University – Plovdiv.

Title of the dissertation: "Morphophysiological and Biochemical Characteristics of Fish from the Family Acipenseridae."

Reviewer: Prof. Dr. Ivaylo Nikolaev Sirakov, Trakia University, Stara Zagora; Field of Higher Education – 6. Agricultural Sciences and Veterinary Medicine, Professional field – 6.3. Animal Husbandry, Scientific specialty: "Fish Farming, Fisheries and Industrial Fishing", appointed as a member of the scientific jury by Order No. RD–16-613 / 14.05.2025 by the Rector of the Agricultural University.

1. Brief Presentation of the Candidate

The PhD candidate Georgi Kirilov Georgiev was born on October 21, 1986. He completed his secondary education with a professional qualification as a "veterinary technician" at the Vocational High School of Veterinary Medicine "I.P. Pavlov" in Stara Zagora. He continued his studies at the Agricultural University – Plovdiv, where he consecutively earned the educational degrees of "Bachelor" and "Master." Later, he enrolled in a doctoral program at the Department of Animal Sciences, Faculty of Agronomy, Agricultural University – Plovdiv, in the scientific specialty "Animal Breeding, Biology and Biotechnology of Reproduction," within professional field 6.3. "Animal Husbandry."

His professional career includes over a decade of experience in the practical management of aquafarms. Since 2021, he has held responsible managerial positions in enterprises specializing in the production of trout, carp, and sturgeon.

He has an excellent command of English and possesses strong computer skills, including proficiency in specialized aquaculture management software (Aqua Tracker, Aquanetix). He is the author of business projects and has experience in consulting farms and preparing economic analyses in the agricultural sector.

2. Relevance of the Topic

Against the backdrop of global food insecurity and increasing pressure on natural aquatic ecosystems, aquaculture is increasingly emerging as a strategic priority in global food production. The depletion of wild fish stocks – a consequence of climate change, anthropogenic pressure, and unsustainable fishing – significantly limits the ability to meet the growing demand for high-quality animal-based foods. Over the past three decades alone, global fish consumption has increased by more than 120%, and in 2022 the world population reached 8 billion – trends that require sustainable and highly productive production solutions.

Of particular concern is the status of sturgeon populations (family *Acipenseridae*), which are among the most endangered species worldwide. There is a direct link between their high market value (especially due to their valuable caviar and high-quality meat) and their dramatic decline in the wild. The causes are multifaceted – habitat degradation, the massive construction of hydroelectric facilities that interrupt migratory routes, as well as poaching and uncontrolled fishing. In response, the EU, including Bulgaria, has introduced a complete ban on the fishing of sturgeon species from natural water bodies.

In this context, sturgeon farming – the intensive cultivation of sturgeon species – is becoming not only an alternative to wild capture, but also a key tool for preserving biodiversity and meeting market demand. The sector is experiencing rapid global growth, and in Bulgaria several specialized production facilities have already been established. Nevertheless, the scientific foundation on this topic remains scarce, especially with regard to studies conducted under real industrial conditions such as the super-intensive cage systems built in warm-water reservoirs like the "Kardzhali" dam.

This dissertation fits precisely into this critical scientific and production niche, offering a comprehensive assessment of the productivity and qualitative characteristics of three key genotypes: Russian sturgeon (*A. gueldenstaedtii*), Siberian sturgeon (*A. baerii*), and their hybrid. By examining morphometric, slaughter, and biochemical indicators in fish of different live weights, cultivated in a super-intensive environment, the dissertation directly addresses the need for a scientific basis for improving technologies and optimizing production in sturgeon aquaculture.

The relevance of the topic is further underscored by the need for objective data on the biological value of the meat, its protein profile, and the influence of live weight on production yield – all critical factors in aquaculture decision-making. Additionally, hybridization between economically valuable species such as *A. baerii* and *A. gueldenstaedtii* offers opportunities for combining desirable economic

traits, yet scientific information on the productivity of such hybrids under real production conditions is still limited.

Therefore, the present study is not only timely but also necessary from both a scientific and applied perspective, with potential contributions to the sustainable development of sturgeon farming in Bulgaria and the wider region.

3. Aim, Objectives, Hypotheses, and Research Methods

The aim of the dissertation is to investigate the morphophysiological and biochemical characteristics of fish from the family *Acipenseridae* – Siberian sturgeon (*Acipenser baerii*), Russian sturgeon (*Acipenser gueldenstaedtii*), and their hybrid (F1 *A. baerii* × *A. gueldenstaedtii*), with varying live weights, cultivated under industrial cage farming conditions.

To achieve this aim, the following objectives and sub-objectives were pursued:

1. Morphophysiological analysis of Siberian sturgeon with different live weights:
    - 1.1. Determination of plastic (phenotypic) traits;
    - 1.2. Calculation of morphometric and morphophysiological indices;
    - 1.3. Determination of slaughter characteristics.
2. Meat analysis of Siberian sturgeon with different live weights:
    - 2.1. Determination of chemical composition and energy value;
    - 2.2. Analysis of amino acid profile;
    - 2.3. Investigation of protein composition.
3. Morphophysiological analysis of Russian sturgeon with different live weights:
    - 3.1. Plastic traits;
    - 3.2. Morphometric and morphophysiological indices;
    - 3.3. Slaughter characteristics.
4. Meat analysis of Russian sturgeon:
    - 4.1. Chemical composition and caloric value;
    - 4.2. Amino acid profile;
    - 4.3. Protein profile.
5. Morphophysiological analysis of the hybrid (*A. baerii* × *A. gueldenstaedtii*):
    - 5.1. Plastic traits;
    - 5.2. Morphometric and morphophysiological indices;
    - 5.3. Slaughter characteristics.
6. Meat analysis of the hybrid:

- 6.1. Chemical composition and energy value;
- 6.2. Amino acid profile;
- 6.3. Protein profile.

7. Comparative analysis of morphophysiological indicators between Siberian sturgeon, Russian sturgeon, and their hybrid at different live weights.
8. Comparative analysis of the protein profile of the meat of the three studied forms with different body weights.

The working hypotheses have been well-founded and provide a reliable basis for achieving the set aim and fulfilling the specific objectives. The study applied modern and scientifically validated methodologies, fully aligned with the thematic focus and complexity of the problem. This is a clear indicator of the PhD candidate's excellent theoretical preparation and practical competence.

4. Visualization and Presentation of the Results

The dissertation addresses a current issue in aquaculture by examining the morphophysiological and biochemical characteristics of three economically significant forms from the family *Acipenseridae* – Siberian sturgeon (*Acipenser baerii*), Russian sturgeon (*Acipenser gueldenstaedtii*), and their hybrid (F1 *A. baerii* × *A. gueldenstaedtii*), cultivated in a cage farm at different live weights.

The dissertation comprises 191 pages and includes 38 tables and 43 figures that visualize the main results and facilitate the understanding of the analysis. The scientific credibility of the study is supported by an extensive bibliography of 277 sources, including 77 in Cyrillic and 200 in Latin script, reflecting a broad familiarity with both national and international literature.

The topic is in full alignment with contemporary priorities in aquaculture, particularly the need for sustainable production of foods rich in essential fatty and amino acids, under the constraints of limited natural resources and the global fishing limit already being reached. The study's focus – sturgeon species and their hybrid – is of high economic value due to their quality caviar and nutritionally valuable meat.

The formulated scientific thesis is substantiated through an in-depth literature review, demonstrating the doctoral candidate's strong academic foundation and awareness. Both classical and contemporary authors are cited, highlighting the author's scientific maturity and ability to synthesize and apply a wide range of knowledge.

The main research tasks are logically linked to the stated aim and encompass morphometric and slaughter traits, as well as analyses of the chemical composition, amino acid, and protein profiles of fish across various weight categories. The tasks are distributed across clearly structured research blocks, allowing for consistent and comprehensive execution of the study.

Modern analytical methods and laboratory equipment appropriate to the nature of the tasks were employed. The applied variation-statistical analysis enables an objective interpretation of the data and the identification of significant correlations, which have direct applications in modern sturgeon farming practices.

The dissertation fully meets the requirements of the Agricultural University – Plovdiv, including all mandatory components of a scientific work of this kind. The comprehensive approach of the study, combining morphophysiological, biochemical, and technological aspects, represents a significant contribution to the scientific and applied knowledge base in the field of sturgeon aquaculture.

5. Discussion of Results and Literature Used

It was established that the body dimensions (length, height, thickness, girth) of fish from all genotypes increased with higher live weights, with the differences in Russian sturgeon and the hybrid being statistically significant. For Russian sturgeon, the lower weight group showed better slaughter performance – with a carcass yield of 90.4% and edible yield of 87.2%, both higher compared to larger fish ($p<0.01$ and $p<0.05$). A similar trend was observed in the hybrid, where lighter individuals also demonstrated better slaughter and edible yields, although the statistical significance was less pronounced.

The chemical composition analysis revealed that protein content in the dry matter was highest in the lower weight groups – 84.5% in the hybrid, 78.5% in Russian sturgeon, and 75.0% in Siberian sturgeon. Conversely, fat content increased with body size – reaching 28.3% in Siberian, 25.4% in Russian, and 20.6% in the hybrid. This led to higher overall energy value but lower protein-based energy density in heavier fish.

Regarding the amino acid profile, it was found that proteins were biologically most complete in the meat of Russian sturgeon and the hybrid from the lower weight group, where the proportion of essential amino acids reached 67.2% and 55.5%, respectively. The differences compared to other groups (ranging from 31.2% to 47.9%) were primarily due to higher contents of lysine, isoleucine, and phenylalanine—key indicators in assessing the nutritional value of fish meat.

The protein profile, examined using SDS-PAGE, showed distinct differences between the individual genotypes and weight groups.

In summary, the results demonstrate that body weight has a complex effect on the morphophysiological and biochemical parameters, with effects clearly dependent on genotype. The data are valuable both for scientific understanding in the field of comparative sturgeon physiology and for the optimization of production technologies in aquaculture practice.

6. Contributions of the Dissertation

The contributions of any scientific work reflect its importance both in theoretical and in practical-applied contexts. In this regard, Georgi Georgiev's dissertation represents an in-depth and comprehensive study, within which ten key contributions have been formulated. These can be summarized and systematized as follows, according to their scientific and scientific-applied value:

Scientific Contributions

1. It was established that under the studied conditions, weight group has a significant influence on morphological characteristics, slaughter parameters, as well as on the chemical and amino acid composition of the meat. These effects vary across genotypes, revealing specific dependencies. **– Original scientific contribution**
2. The analysis of amino acid composition showed that the proteins in the meat of Russian sturgeon and the hybrid from the lower weight group have the highest biological value, with essential amino acids comprising 67.2% and 55.5% of the total, respectively. These are followed by the heavier Russian sturgeon individuals (47.9%), while the remaining groups ranged between 31.2% and 36.2%. The differences are mainly due to higher levels of lysine, isoleucine, and phenylalanine in the lower-weight Russian sturgeon and lysine in the hybrid of the same weight class. **– Original scientific contribution**
3. It was confirmed that the electrophoretic profiles of protein fractions can be used as a reliable marker for distinguishing between different sturgeon species, with potential application in genetic and breeding research. **– Confirmatory scientific contribution**

Scientific-Applied Contributions

1. It was established that Siberian sturgeon, Russian sturgeon, and their hybrid, cultivated in a super-intensive industrial cage system, exhibit good

slaughter characteristics and meat with desirable consumer qualities.
– Confirmatory scientific-applied contribution

2. A detailed study was conducted on the slaughter productivity, chemical and amino acid composition, and protein profile of the meat of the three genotypes with different live weights, raised in a cage farm located in the "Kardzhali" reservoir.
– Original for Bulgaria scientific-applied contribution
3. It was found that in Russian sturgeon, fish with lower live weight demonstrate better technological performance – a carcass yield of 90.4% versus 86.7% in heavier fish, an edible yield of 87.2% versus 84.3%, and a higher relative fillet proportion – 49.9% of the whole fish and 77.8% of the carcass.
– Confirmatory scientific-applied contribution
4. It was determined that in the hybrid, the lower weight group had a higher carcass yield (89.5% vs. 86.5%, $p<0.05$) and edible yield (86.6% vs. 83.8%, $p<0.05$). Larger individuals, however, showed higher fillet yields and better processing suitability for the canning industry.
– Confirmatory scientific-applied contribution
5. In Siberian sturgeon, the differences between weight groups were less pronounced. Slightly higher values for carcass yield (86.9% vs. 86.4%) and edible yield (84.2% vs. 83.5%) were recorded in heavier fish. Only the difference in fillet yield from the carcass was statistically significant – 82.5% vs. 78.4% ($p<0.001$).
– Confirmatory scientific-applied contribution
6. A comparison between the three genotypes showed that the lower-weight Russian sturgeon group outperformed the others in all yield parameters and relative fillet proportions. Siberian sturgeon showed the best fillet values among heavier fish, while the hybrid occupied an intermediate position, sometimes slightly outperforming the parent species.
– Original for Bulgaria scientific-applied contribution
7. It was found that the meat of fish from the lower weight group had the highest protein content in dry matter – 84.5% in the hybrid, 78.5% in Russian sturgeon, and 75.0% in Siberian sturgeon. In heavier fish, protein content decreased to 73.5%, 64.0%, and 64.1% respectively. Fat content increased with weight – from 12.5% to 20.6% in the hybrid, 15.7% to 25.4% in Russian, and 17.4% to 28.3% in Siberian sturgeon. The meat of all genotypes was classified as medium-fat.
– Original scientific-applied contribution

7. Critical Remarks and Recommendations

The dissertation has a distinctly applied focus, which reinforces its value and scientific merit. A particularly positive aspect is the effective integration of knowledge from various related disciplines. I would like to offer the following recommendation to the PhD candidate:

In future research related to the dissertation topic, it would be advisable to identify the most economically efficient live weight for slaughter in Siberian sturgeon, Russian sturgeon, and their hybrid. This analysis should consider both the maximum carcass yield and the optimal biochemical composition of the meat. Such an evaluation would enable more precise planning of the production cycle and contribute to increased profitability in intensive sturgeon aquaculture.

To the doctoral candidate, I would also like to pose the following questions:

1. How was the sample size determined (n=5 per weight group)?
2. Could some of the differences in yield among the studied genotypes be due to skeletal structure differences rather than solely to soft tissue variation?

The abovementioned recommendation and questions in no way diminish the quality and significance of the submitted dissertation, which fully complies with the requirements of the **Bulgarian Law on the Development of Academic Staff (ZRASRB)**.

8. Published Articles and Citations

In connection with the dissertation, PhD candidate Georgi Georgiev has published a total of four scientific articles directly related to the research topic. Three of these are published in the *Bulgarian Journal of Agricultural Science*—a well-established, peer-reviewed journal indexed in globally recognized scientific databases. The fourth article appears in *Agricultural Sciences*, which is also indexed in international scientific information systems and holds appropriate academic recognition.

In one of these publications, Georgi Georgiev is listed as the first (lead) author, and in the remaining three—he holds second and third author positions. This is a strong indication of his active involvement and genuine contribution to the development and presentation of the research findings. Such authorship positioning demonstrates the candidate's engagement in all stages of the scientific process—from experimentation to result interpretation.

The doctoral candidate's research activity has earned a total of 43.5 points under the current national evaluation system (exceeding the minimum requirement of 30 points), thus significantly surpassing the formal criteria for obtaining the educational and scientific degree "Doctor."

The submitted abstract concisely yet clearly reflects the structure, content, key ideas, and findings of the dissertation, providing an accurate impression of its scientific value and contribution.

Conclusion

The critical questions and recommendations do not in any way undermine the significance or quality of the submitted dissertation, which fully adheres to the requirements of the **Law on the Development of Academic Staff in the Republic of Bulgaria (ZRASRB)**. The thematic focus and the selection of the biological model are well chosen and scientifically substantiated. The experimental phase was executed with a high degree of precision and professional competency. The data was generated and processed using modern techniques and advanced equipment.

The discussion is relevant, well-reasoned, and comparable to current scientific achievements in the fields of aquaculture and fisheries. The conclusions, scientific contributions, and practical implications are of particular importance for the fish farming sector.

The PhD candidate demonstrates not only in-depth theoretical knowledge but also a strong capacity for analytical thinking and result interpretation. In this context, the doctoral training of Georgi Georgiev can be regarded as highly successful, with the materials presented for evaluation exceeding the minimum national requirements.

I give a high evaluation of the dissertation, the accompanying abstract, and the related scientific publications, and I wholeheartedly recommend to the esteemed members of the Scientific Committee that they vote in favor of awarding the educational and scientific degree "Doctor" to **Georgi Kirilov Georgiev** in the scientific field *"Breeding of Farm Animals, Biology and Reproductive Biotechnology"*, professional field 6.3 *"Animal Husbandry."*

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