

## STATEMENT

By Prof. Dora Zlatareva, MD, PhD  
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External member of the Scientific Jury,  
appointed according to Order No. ПД-09-37/27.07.2023 of the Director of IEMPAM-BAS  
for evaluation of a thesis for the award „Doctor of Science“

Scientific Area 4. Natural Sciences, Mathematics and Informatics;  
Professional Field 4.3. Biological Sciences;  
Specialty „Anthropology“ (01.06.01)

Author: Assoc. Prof. Silviya Yanakieva Nikolova, PhD, IEMPAM-BAS

Title: „Biomedical aspects of cranial sutures: microstructure, physiological closure, metopism“

### 1. General presentation of the procedure and the dissertant

The presented by Assoc. Prof. Sylvia Nikolova set of materials on electronic media is in compliance with the Law of Development of Academic Staff in the Republic of Bulgaria, the Regulations for its implementation and the requirements under the Regulations for the conditions and procedure for obtaining the degree of "Doctor of Science" of IEMPAM-BAS and includes the necessary documents.

The dissertation is written on 251 pages and is illustrated with 71 figures and 28 tables. 378 literature sources are cited. The scientific metrics exceed the requirements of the Law and the Regulations for the Opening of the Procedure for the Defence of a Dissertation for the Scientific Degree "Doctor of Science".

Assoc. Prof. Sylvia Nikolova has submitted 32 publications in refereed journals, most of them with IF.



### **Biographical data and career development**

Assoc. Prof. Sylvia Yanakieva Nikolova, PhD was born on 14.3.1982. Since 2003 she is a Bachelor of Biology and Chemistry at Sofia University "St. Kliment Ohridski". She is a Ph.D. student in Biology and Chemistry at Sofia University St. Kliment Ohridski. In 2005 she graduated with a master's degree in General Anthropology, majoring in Biology, Sofia University "St. Kliment Ohridski". She received her PhD in Anthropology at the Institute of Experimental Morphology and Anthropology with Museum, BAS in 2011.

She started her academic career in 2009 as a biologist at the Institute of Experimental Morphology and Anthropology with Museum, BAS. Since May 2011 she has been Assistant Professor, July 2012-January 2023 – Assist. Professor, and since February 2023 - Associate Professor at the same Institute. The dissertant is fluent in English and has excellent computer skills, including reconstruction and measurement of 3D models from computed tomographic images. Member of the European Anthropological Association, Bulgarian Anatomical Society, Member of the Federative International Programme for Anatomical Terminology (FIPAT), Working Group: Anthropology (TAnthr)

She actively participates in national and international courses, congresses and conferences presenting the results of her research. Evidence of the publication and scientific activity of Assoc. Prof. Nikolova's research and publication achievements are the awards she has received in 2016, 2021 and for the period 2019-2021. The dissertant is a referee in a number of international refereed journals with impact factor. She is the leader of three research projects and a member of three other projects.

The h-index in Scopus is 7.

### **2. Relevance of the topic**

Assoc. Prof. Sylvia Nikolova focuses her scientific research on the microstructure, reorganization and physiological closure of the cranial sutures regarding the age of the individual. The relevance of the topic is related to the need to establish the basic mechanisms in the formation, functioning and closure of the sutures of the cranial vault that lead to the normal morphogenesis of the skull. Craniosynostosis is detected in infancy and very often is a subject of surgical treatment, which explains the multitude of research in this field. In contrast, the delayed closure, and in particular metopism, has been studied in a limited number of scientific studies.



There are many questions related to the altered morphology of the skull and the frontal sinus, the anatomical variations and pathological conditions in persistent metopic suture. The author aims to enrich the knowledge of the peculiarities in cranial morphology in metopism. The application of modern multidisciplinary approaches in comparative morphological studies contributes to the significance and relevance of the thesis.

### **3. Knowledge of the problem**

The literature review demonstrates the author's excellent knowledge of the subject matter along with the ability to critically analyse the still unresolved and emerging issues in this area. An extensive bibliography compiled from contemporary literature sources is presented. Assoc. Prof. Nikolova is informed about the problem in detail, both at the conceptual and theoretical level, but she also pays attention to the practical and clinical aspects.

### **4. Methods**

The applied research methodology includes state-of-the-art morphometric analyses - digital morphometry performed entirely in the virtual space. The generation of 2D and 3D images of the examined skulls is performed by digitizing the examined material using digital radiography, volumetric 3D imaging and laser scanning. This allows achieving the set goal and obtaining an adequate answer to the objectives considered in the thesis. The statistical methods are modern and adequately selected. Geometric morphometrics as well as artificial intelligence, machine learning and data mining approaches are used for data processing and analysis.

### **5. Characteristics and evaluation of the thesis and contributions**

The paper is written in 251 pages and illustrated with 71 figures and 28 tables. The bibliography comprises 378 references. The thesis is structured in the following sections: Introduction, Literature review, Aim and Objectives, Material and Methods, Results and Discussion, Summary, Conclusions, Bibliography. The technical layout of the thesis conforms to



the requirements. The bibliography is up-to-date and comprehensive, covering contemporary sources.

As a result of the review, a clear **aim** is logically derived: to study the microstructure and physiological closure of the cranial sutures and to evaluate the peculiarities in cranial morphology in metopism. The formulated 6 **objectives** are consistent with the aim and scientifically justified. They have been performed in stages during the study.

The study proposed for review is based on a rich research material, from the osteological collection of the IEMPAM-BAS (medieval male and female cranial series and single findings) and material from the Ossuary at the National Museum of Military History, Sofia.

The results of the study are presented in 6 sections: 1. Suture microarchitecture; 2. Physiological suture closure and individual's age; 3. Cranial suture closure in metopism; 4. Cranial suture configuration in metopism; 5. Metopism and pneumatization of the frontal sinus; 6. Metopism, anatomical variations and pathological conditions. Assoc. Prof. Nikolova logically presents the results in detailed tables and illustrates the distribution by groups according to different criteria. The data are compared with the known literature.

The author has formed 6 conclusions regarding reorganization of the microarchitecture in sagittal suture closure, Correlation between physiological sagittal suture closure and individual's age, Sagittal suture closure in metopic crania, Delayed sagittal suture closure, Specific modifications in cranial morphology, Reduced frontal sinus pneumatization, Supernumerary bones in the cranial vault in metopi crania. The conclusions are based on the literature review, analysis of own results and discussion. They are accurately formulated and reflect the objectives and results obtained.

The contributions described faithfully represent the qualities of the dissertation. The scientific and applied contributions are 7: Protocols for generation of 3 images of dry crania by laser scanning and micro-computed tomography at optimal parameters have been elaborated; An innovative method has been developed and a protocol has been validated for scanning objects larger than the detector of the  $\mu$ CT system (Nikon XT H 225); A virtual collection of high-resolution 3D images of metopic and control crania has been created; artificial intelligence approaches have been applied to morphometric data and models for individual's age-at-death



prediction have been created. The original fundamental contributions are 6: The typical structure of open cranial sutures has been established, weak correlations between suture closure and age have been demonstrated, and accompanying metopic changes in cranial bones have been identified. It is hypothesized that metopism-specific features may be considered as a disturbance in the intramembranous ossification.

**I fully accept the Assoc. Prof. Nikolova's contributions.**

#### **6. Assessment of publications and personal contribution of the PhD student**

The author has submitted a total of 32 publications related to this procedure, which have been published in refereed journals, most of them with Impact Factor. They have been cited more than 100 times. The majority of the citations are in scientific journals, refereed and indexed in world-renowned databases of scientific information, which is an indication of the international recognition of the author's scientific achievements.

The text of the dissertation, the abstract and the presented publications show the personal involvement of the candidate.

#### **7. Author abstract**

The abstract reflects the essence of the dissertation and fully meets the requirements. It is presented in 59 pages and consists of parts that present the structure and content, main results and contributions of the dissertation.

**I have no critical comments or recommendations for the research and materials presented.**

### **CONCLUSION**

The work under review *contains applied and original theoretical results, which represent an original contribution to the science* and a theoretical summary of a significant problem. The thesis and the publications related to it **meet the requirements** of the Law for Development of



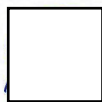
Academic Staff in the Republic of Bulgaria, the Regulations for the Implementation of the law and the Regulations for the Conditions and Procedure for the Acquisition of the Scientific Degree "Doctor of Sciences" of IEMPAM-BAS.

The thesis shows that Assoc. Prof. Sylvia Yanakieva Nikolova, Ph.D. possesses in-depth theoretical knowledge and professional skills in the scientific specialty, demonstrating the qualities and skills to independently conduct scientific research and to lead a research team.

In view of the foregoing, I confidently give my **positive evaluation** of the research presented in the above-reviewed thesis, abstract, results and contributions, and **propose to the Honorable Scientific Jury to award the degree 'Doctor of Science'** in the Scientific Area 4. Natural Sciences, Mathematics and Informatics; Professional field 4.3. Biological sciences; Scientific speciality 'Anthropology' (01.06.01) to Assoc. Prof. Sylvia Yanakieva Nikolova, PhD.

11.10.2023 г.

Sofia



Prof. Doza Zlatareva, MD, PhD