

INTERDISCIPLINARY RESEARCH OF GLAGOLITIC MANUSCRIPTS – NEW APPROACHES TO CULTURAL HERITAGE STUDIES PROJECT КП-06-H60-09/2021: “INTERDISCIPLINARY METHODS AND TOOLS FOR RESEARCH OF MANUSCRIPT HERITAGE”

Inna Dimitrova

University of Library Studies and Information Technology (BULGARIA)

Abstract

In recent years, there has been a clear disparity between the emergence of new research on the Glagolitic alphabet and the publication interest in the subject. The lack of new scientific development on the cultural history of the earliest glagolism is a topic, which unless adequately adapted to the requirements of modern digital research and training, will create future obstacles for the training of new scientists. Now not only the number of young scientists is very limited, but also their preparation for theoretical and practical work on the above issues. This includes the interest in the publication of new monuments, the study of palaeography, graphematics and codicology of old monuments, the creation of new theories dealing with certain aspects that could not be explored without solid scientific training.

Current methods of research and analysis of the Glagolitic heritage can also be criticized. In many respects, the desire to create something new in modern Glagolitic studies is greatly constrained by the lack of appropriate aids in line with current trends in the study of manuscripts and, therefore, the results of the aspirations of these authors are not up to date at all. Research on the early state of the Glagolitic alphabet is extremely closely connected with the study of sources. Without mastering an adequate scientific methodology, the results will be deprived of the opportunity to upgrade the existing database. Therefore, special attention should be paid to new technical capabilities available today, like multispectral digitization and computer image processing; hyperspectral and spectroscopic analysis (XRF, FTIR, Raman, UV-vis) of the constituent material of the manuscripts (parchment, inks, pigments, dyes, etc.) and - in special cases - microbiological analyses (DNA, metagenome) of parchment and the microbiota (such as viruses and bacteria), which allow a large amount of new information to be obtained and studied with precision otherwise impossible to achieve.

This framework gives a new perspective for the philological study of a number of Glagolitic monuments - mostly damaged or poorly preserved parchment codices, palimpsests containing two or more manuscript layers, as well as those with multiple images. The study of the material from which a manuscript monument is made - the composition of the ink, pigments, binder, chemical and multispectral analysis is increasingly used to confirm its historical and textual authenticity. Based on all these data, the objective study of a number of textual and documentary sources enters a new phase and is widely used by historians and philologists. The analysis of the material from which the studied monument is made also contributes to its more accurate dating, as well as to the creation of a more precise classification. The ultimate goal of this new type of teamwork is to compare the totality of all interdisciplinary research, outlining the relationship of data from different models of analysis and thus reaching new knowledge about already known or newly studied objects.

Keywords: interdisciplinary, Glagolitic, manuscripts, material analysis, multispectral images, palimpsest.

1 INTRODUCTION

This paper focuses on the methodology for interdisciplinary research of the early Glagolitic heritage, developed by the *Centre of Image and Material Analysis in Cultural Heritage (CIMA)* [1] - an interuniversity research institution which was established in 2014 in the framework of a project financed by the Austrian Ministry of Science and Research for the investigation of Slavonic manuscripts (mainly Glagolitic) in the library of St. Catherine monastery in Mount Sinai. The experience of the laboratory is viewed as a framework for the creation of interdisciplinary methodological model for future training of specialists from different spheres of knowledge to work with Glagolitic sources and gain expertise in solving non-standard technical issues related to research of written cultural heritage.

1.1 Overview of The Issues Concerning the Early Glagolitic Written Monuments

In recent years, there has been a clear disparity between the emergence of new research on the Glagolitic alphabet and the publication interest into the subject. The lack of new scientific development on the cultural history of earliest glagolitism is a topic, which unless adequately adapted to the requirements of modern digital research and training, will create obstacles for the future training of new scientists. Now, not only the number of young scholars is very limited, but also their preparation for theoretical and practical work on the above issues. This includes the interest in the publication of new monuments, the study of codicology, paleography, and graphemics of old monuments, the creation of new theories dealing with certain aspects that cannot not be explored without solid scientific training.

Despite the considerable scientific production of the previous generation of Glagolitic researchers in Bulgaria, Austria, Czech Republic, America, Croatia [2] and some other counties, the number of young scholars interested in the subject in the recent years is diminishing. This tendency refers not only to the paleographic, linguistic and codicological research of existing Glagolitic monuments, but also to issues concerning the writing system itself - its construction principles, alphabet genesis, typological and individual letter characteristics and motivation. One reason for the limited interest in the early Glagolitic studies is the lack of appropriate university courses (in the above countries), capable of accommodating the subject to the requirements of the newly developed spheres of knowledge, mainly related to the field of Information Technology. The second reason for the limited interest in the early Glagolitic Studies concerns the unattractiveness of the subject as an opportunity for the young scientists' future development. Both reasons contribute to the overall criticism of the educational sources on the subject, which, apart from being outdated, offer not enough knowledge to the interested scholar, and fail to generate theoretical background for new developments.[3] The need to establish new guidelines for the overall theoretical development of the discipline is crucial and it refers not only to issuing new textbooks and teaching aids, which correspond to the newest developments of research methodology, but also to the creation of scientific database of all early Glagolitic monuments – a task, which requires considerable interdisciplinary cooperation of scientists in the fields of humanities, IT, and material science (chemistry and biology). Digitalization makes available the investigation of cultural monuments from the earliest eras, but this is not always enough to carry out their complete scientific study. Often the apt digital copy of a monument is not sufficient for its proper analysis and positioning as part of the cultural history of a region and period. Equally important is the material analysis of the monument and the data obtained from the so called “technical stage” of the study, which will designate features other than those of its linguistic and paleographic observation.

In the recent years the multidisciplinary approach to the early Glagolitic manuscript heritage, has achieved remarkable results. Here we refer mainly to the account of the above mentioned *Centre of Image and Material Analysis in Cultural Heritage (CIMA)*, which represents a unique facility with an interdisciplinary approach to the investigation of cultural heritage. The Centre brings together the expertise of the following disciplines from four universities and the Austrian Academy of Sciences: Philology (presently 5 institutes of the University of Vienna and the Medieval Centre of the Austrian Academy of Sciences), Computer Sciences (Computer Vision Lab, Vienna University of Technology), Chemistry and Microbiology (Institute of Natural Sciences and Technology in the Arts, Vienna Academy of Fine Arts) as well as Restoration-Conservation (University of Continuing Education, Krems). The laboratory's unique experience is of utmost importance for the study of early Glagolitic codices (written mainly on parchment), and for some of the monuments the methodology developed for their material investigation by the CIMA researchers, proved to be the only source confirming their provenance. For example, a 2017 study of the Glagolitic *Missale Sinaiticum* [4] demonstrated microbiologically the presence of a rare virus that infected a plant called Tarot grown in Egypt, from which the blue pigment (respectively the blue ink) is derived. This finding confirmed the hypothesis that the manuscript originated from Sinai. Another example of CIMA good practices is the two-volume edition of the Glagolitic Psalterium Demetrii Sinaistici [5], where special consideration is given to the interdisciplinary approach. The different chapters include, among others, a detailed graphemic description of all used scripts and identified scribal hands (Glagolitic and Cyrillic) in the form of tables with enhanced photographic images, as well as a detailed account of parchment and ink spectrographic measurements and multispectral images of some of the palimpsest pages. This comprehensive approach leads the way to a new stage of medieval manuscript investigation and, specifically, the Glagolitic manuscript tradition, because it allows for the creation of huge digital databases (of various parameters), where research on a specific item, or issue can be carried out with a higher degree of precision. Building such databases require not only availability of the research data in the first hand, but also the collective efforts of experts and students (undergraduate, master's and doctoral) from several fields of knowledge to obtain, collect, classify, document and digitize all available information for a given monument before loading it on a digital platform.

2 METHODOLOGY

2.1 Comprehensive Model for Interdisciplinary Research of Medieval Codices

Considering the best interdisciplinary research practices in the sphere of the early Glagolitic Studies and in order to perform the activities according to our project КП-06-H60-9/2021: “Interdisciplinary methods and tools for research of manuscript heritage” [6] we assume that we need to build a comprehensive model for interdisciplinary research of medieval codices, which will allow us to achieve better results. Our team of experts was configured in a similar way as that of CIMA’s and we are working in collaboration regarding methodology. Our comprehensive model comprises of two initial stages and several successive. The first stage, which is called “descriptive” is focused on the linguistic and codicological description of the researched objects. It has various aspects, outlined below, and the objective of this stage is to map out the main focal points to be studied or discussed in the research. The second stage – the so called “technical stage” involves different measurements of the manuscript parchment body (material analysis) regarding the origin and chemical composition of the parchment, the inks, the binding, the covers etc., as well as multispectral capturing of its barely visible and palimpsest pages (if any). Each of these stages has its own methodology and criteria of evaluation and analysis, and has to be researched separately before the final quantitative and qualitative analysis. The following scheme outlines the main sub-divisions of the comprehensive model and the order of the successive stages.

- 1 Descriptive stage - philological and codicological features - linguistic (graphemic, palaeographic, orthographic, textological) and codicological (physical description – parchment, binding, layout, history of the codex, provenance (origin), etc.).
- 2 Material analysis of the body - Data obtained from the “technical stage” of the study:
 - Spectroscopic analysis (XRF, FTIR, Raman, UV-vis) of the composite material of the manuscripts (parchment, inks, pigments, dyes, etc.) with specialized equipment, which performs non-contact and non-invasive capturing of data, completely protecting the studied manuscript from damage;
 - Multispectral Imaging – image capturing of barely visible manuscript layers; can be useful to study rewritten manuscripts (palimpsests), as well as poorly preserved texts, whose investigation by conventional means is not possible.
- 3 Computer analysis and visualization of images - a modern technique for digital visualization and data processing, which uses software such as Computer Vision , OCR or other - to track graphic and font features, image and element selection and text reading, etc ..
- 4 Documenting - preparing data description of researched objects – characteristic features and components; establishment of systems and procedures for the use and storage of data in digital, analog or another format.
- 5 Classification - building a database of categories defined according to selected criteria and their systematic arrangement.
- 6 Quantitative and qualitative analysis – establishing interpretative models and principles.

The model provides a comprehensive approach for the study of medieval codices based on objective criteria and capable of establishing multi-aspect database which can be subjected to quantitative and qualitative analysis and thus secure objective criteria for future research. It can serve as a prospective basis for other projects, or training modules.

2.2 Research of the material body employs the following methodology and instruments

Hyperspectral imaging (HSI): is used to obtain the spectrum for each pixel in the image of a scene, with the purpose of finding objects, identifying materials, or detecting processes. While MSI uses only a modest number of about 11 different narrow bands, HSI divides the spectrum into many more, continuous spectral bands. Its applications reach from astronomy, agriculture, molecular biology, biomedical imaging, geosciences, etc. up to cultural objects, which leave unique 'fingerprints' in the electromagnetic spectrum. Known as spectral signatures, they are used for identification of the materials that make up a scanned object. Thus it is a new and complementary means to spectroscopy that also can serve to obtain information about tiny relics of inks in a palimpsest.

X-ray fluorescence analysis (XRF): is usually the first step of the examination of manuscript-material since it does not involve taking original sample material or inducing any material alterations. XRF performed in air produces qualitative and semi-quantitative results of the elements present in the analysed area and enables to gain information about the class of pigments and inks applied.

Fourier transform infrared analysis in the reflection mode (rFTIR): is also a non-invasive analytical method, for which no sampling is required. In rFTIR spectroscopy, the incident radiation (Mid Infrared, 4000-400 cm^{-1}) at the sample surface causes characteristic molecular vibrations specific for each chemical compound. This technique enables us to detect precisely functional groups in molecules for both organic and inorganic materials.

Raman: is a technique used to receive a structural fingerprint by which molecules can be identified. It relies upon inelastic scattering of photons, known as Raman scattering. A laser light interacts with molecular vibrations, photons or other excitations in the system, resulting in the energy of the laser photons being shifted up or down. The shift in energy gives information about the vibrational modes in the system and typically yields similar yet complementary information, thus acting – in addition to rFTIR – as a complementary method to XRF.

Multispectral Imaging (MSI): measures light in an appropriate number of narrow bands of the electromagnetic spectrum suitable for a given purpose, in our case the restoration of degraded text in a medieval parchment manuscript. The human eye is sensitive only to the wavelength range from approximately 400 (blue) to 700 nm (red). Depending on the writing material, the lower (UV) and higher range (IR), but also the combination of images taken in these ranges, can be useful to make poorly preserved texts visible. rewritten manuscripts (palimpsests), the study of which by conventional means is not possible due to poor preservation and barely noticeable traces of previous layers. They are few in number and usually scattered among many libraries and museums, but especially valuable because they often contain texts that are no longer preserved in "normal" manuscripts.

3 RESULTS

The cooperation between the experts in humanities and natural and computer scientists during the first stage of project KΠ-06-H60-9/2021: "Interdisciplinary methods and tools for research of manuscript heritage" proved that: 1) the implementation of study resources and tools developed in the fields of IT technologies and material analysis, offers an opportunity for the humanities to bring new life into scientific fields that have long been captured at the standstill of classical methodology; 2) with the help of these non-invasive interdisciplinary tools and resources, many difficult-to-research aspects of the early Glagolitic (i.e. monument dating, region of origin and codex history, damaged text or poor image reading and restoration, digitalization of palimpsest layers, building a database based on quantitative and qualitative criteria etc.), are researched with greater precision and receive better interpretation.

4 CONCLUSIONS

In conclusion, the implementation of interdisciplinary approach to medieval manuscript heritage, and in particular, the Glagolitic studies, will bring about new perspectives for the development of some currently unattractive spheres of manuscript research and will provide for their better positioning among the priority specializations of young scholars in IT, material sciences and humanities. For this reason it is essential to 1) educate and train the university staff to work with the state-of-art equipment for recording, photo-processing and chemical analysis of manuscripts; 2) use the existing digital data from recorded Glagolitic codices and palimpsests (including data from CIMA) to carry out research work and build a structurally organized digital database, capable of being quantitatively analyzed; 3) establish a teaching module "Interdisciplinary methods and tools for research and preservation of written cultural heritage (manuscripts)" for university students of different majors (including IT, Humanities, Library Studies, etc.); 4) systematic digitalization and research of Glagolitic manuscripts and expanding knowledge acquisition of Glagolitic culture and heritage through the above mentioned methods and full-fledged research and specialization. This will bring new horizons for the future development of medieval manuscript studies and early Glagolitic cultural background research in conformity with the advances of the new Information age and the demands of the technological society.

REFERENCES

- [1] Fruehmann, B.; Cappa, F.; Vetter, W.; Schreiner, M.; Miklas, H.; Rapp, C.; Sablatnig, R.: Research and Investigation of Cultural Heritage within the Interdisciplinary CIMA Project. In: *Global Journal of Archaeology and Anthropology* 3 (2018) 3, 1-3 (555614). DOI: 10.19080/GJAA.2018.03.555614).
- [2] Dimitrova, I.; Miklas, H. "Glagolicheskite izsledvanija – savremenno sastojanie i perspektivi". In: *Sedmi mezhdunaroden kolokvium po starobalgarskita, Sofia, 26-28.08.2019*. Univ.izd., pp.230-238, 2020.
- [3] Dimitrova, I. *Glagolicata v savremennite izsledvanija*. Sofia, Za bukvite, pp.38-44, 2021.
- [4] Piñar, G.; Tafer, H.; Schreiner, M.; Miklas, H.; Sterflinger, K.. *Decoding the biological information contained in two ancient Slavonic parchment codices: an added historical value*. // *Environmental Microbiology*. DOI: 10.1111/1462-2920. 15064, 2020.
- [5] Miklas, H. et al. *Psalterium Demetrii Sinaitici monasterii sanctae Catharinae codex slav. 3/N adiectis foliis medicinalibus*. Vienna: Holzhausen Verlag, Vol. 1 (2012); (editio critica) Vol 2 (2021).
- [6] (project information)
https://www.fni.bg/sites/default/files/competition/Rezultati2021/Info_HumanitarniNauki/Фундаментални%20изследвания/КП-06-Н60-9/Forma_new_BG-2.pdf (accessed 12.05.2022)