Вестник Московского университета. Серия XXIII. Антропология. 2025. № 4. С. 134–148
Lomonosov Journal of Anthropology. 2025. No 4, pp. 134–148

ИСТОРИЧЕСКАЯ АНТРОПОЛОГИЯ / ANTHROPOLOGY
Научная статья / Research Article
https://doi.org/10.55959/MSU2074-8132-25-4-11
УДК/UDC 572.5; 03.61.21

Complex Research of Ancient Egyptian 'Mummy of the Priest' from the Collection of the Lomonosov Moscow State University Research Institute and Museum of Anthropology

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ABSTRACT

Introduction. The article is dedicated to a comprehensive study of a male mummy from the Egyptological collection of the Research Institute and Museum of Anthropology of the Lomonosov Moscow State University.

Materials and methods. The mummy of a male stripped of its funerary bandages and shrouds, was donated by Professor A.I. Babukhin in 1876 to D.N. Anuchin, the museum's founder. Since 2016, the mummy has been the object of detailed studies conducted by the Research Institute and Museum of Anthropology of the Lomonosov MSU. The study employed the methodologies of diverse scientific disciplines: anthropological study based on computer tomography data, textile analysis, radiocarbon dating, gas chromatography and mass-spectrometry studies, archeopalynological investigation etc.

Results and discussion. A facial reconstruction and a craniological and osteological description of the mummy were produced using computed tomography (CT) data. The interdisciplinary studies have revealed the specific features of the mummification method, which was characteristic of the Late New Kingdom and the Third Intermediate Period, but also continued in later periods. The chromatographic analysis of the skin samples revealed a complex mix of embalming agents, one of which was pine resin. This is consistent with data obtained by spore-pollen analysis. The technological characteristics of the burial textiles preserved on the mummy were also studied. The age of the mummy could be determined through radiocarbon dating as 3,080 ± 35 BP (2σ 1426–1259 cal BC), indicating that the individual in question lived during the Eighteenth – first half of the Nineteenth Dynasty of the New Kingdom.

Keywords: mummy; New Kingdom; tomography; GC-MS; embalming agents; textile studies

Funding. his article was written with the support of the Lomonosov MSU Program of Development. Project No 23 Sch 02-22 "Hystory, anthropology and ethnology of the North-Eastern Africa in context of Ecological Changes during last 13 millenia. Interdisciplinary Research" Archeopalynological investigations were carried out within the framework of the issue Scientific Research Work of the Institute of Archaeology RAS "Interdisciplinary Approaches to Studying the Formation and Development of Ancient and Medieval Anthropogenic Ecosystems" (No. of R&D 122011200264-9). The textile studies were carried out within the framework of RSF grant 'A comprehensive study of archaeological textile and pottery using natural science techniques, based on the findings of the Nubian expedition conducted by Moscow State University' (№ 25-28-01025)

Acknowledgements. Research was carried out under partial support of MSU Shared Research Equipment Center "Technologies for obtaining new nanostructured materials and their complex study", National Project "Science" and MSU Program of Development.

For citation: Krol A.A., Babenko A.N., Tolmacheva E.G., Bashilov A.A., Rasskasova A.V., Kitova A.O., Perevozchikova A.A., Lazarev M.N. Complex Research of Ancient Egyptian 'Mummy of the Priest' from the Collection of the Lomonosov Moscow State University Research Institute and Museum of Anthropology. *Lomonosov Journal of Anthropology*. 2025 (4), pp. 134-148. https://doi.org/10.55959/MSU2074-8132-25-4-11

Вестник Московского университета. Серия XXIII. Антропология. 2025. № 4. С. 134–148
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Комплексное исследование древнеегипетской «мумии жреца» из собрания НИИ и Музея антропологии МГУ имени М.В.Ломоносова

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РЕЗЮМЕ

Введение. Работа посвящена комплексному исследованию памятника из египтологической коллекции НИИ и Музея антропологии МГУ – мумии мужчины, лишенной погребальных бинтов и пелен, подаренной профессором Московского университета А.И. Бабухиным основателю музея Д.Н. Анучину в 1876 г.

Материалы и методы. С 2016 г. мумия является объектом комплексных исследований, которые проводятся в НИИ и Музее антропологии МГУ. В ходе изучения были задействованы методики различных дисциплин. Были осуществлены антропологическое исследование на основании данных компьютерной томографии, радиоуглеродное датирование, газовая хроматография и масс-спектрометрия, исследование текстиля, спорово-пыльцевой анализ.

Результаты и обсуждение. На основании данных компьютерной томографии выполнена реконструкция лица по черепу и составлено краниологическое и остеологическое описание мумии. В ходе дальнейших исследований были выявлены особенности техники мумификации, характерные для конца Нового царства и III Переходного периода, но существовавшие и в более позднее время. Хроматографический анализ образцов кожи отражает сложный состав бальзамирующих веществ, одним из компонентов которых являлась смола сосны, что не противоречит данным спорово-пыльцевого анализа. Были также определены технологические характеристики сохранившихся на мумии погребальных тканей, позволившие отнести их к числу стандартных пелен и бинтов, среднего качества. Методом радиоуглеродного датирование был установлен возраст мумии 3080 ± 35 л. н., что означает, что исследуемый индивид жил в эпоху правления XVIII – первой половины XIX династии Нового царства.

Ключевые слова. древнеегипетские мумии; Новое царство; компьютерная томография; газовая хроматография и масс-спектрометрия; бальзамические смолы; исследование текстиля

Финансирование. Работа выполнена при поддержке Программы развития МГУ, проект № 23-Ш02-22 (номер договора 004179) НОШ МГУ Сохранение мирового культурно-исторического наследия «История, антропология и этнология Северо-Восточной Африки в контексте экологических изменений за последние 13 тыс. лет (опыт междисциплинарных исследований)». Археопалинологические исследования выполнены в рамках темы НИР ИА РАН «Междисциплинарный подход в изучении становления и развития древних и средневековых антропогенных экосистем» (№ НИОКТР 122011200264-9). Разделы, касающиеся исследования текстиля, выполнены по гранту РНФ «Комплексное изучение археологического текстиля и керамики с использованием естественно-научных методов: по материалам Нубийской экспедиции МГУ» (№ 25-28-01025).

Благодарности. Исследование проводилось при поддержке ЦКП МГУ «Технологии получения новых наноструктурированных материалов и их комплексное исследование», национального проекта «Наука» и Программы развития МГУ.

Для цитирования: *Крол А.А., Бабенко А.Н., Толмачева Е.Г., Башилов А.А., Рассказова А.В., Китова А.О., Перевозчикова А.А., Лазарев М.Н.* Комплексное исследование древнеегипетской «мумии жреца» из собрания НИИ и Музея антропологии МГУ имени М.В.Ломоносова // Вестник Московского университета. Серия XXIII. Антропология. 2025. № 4. С. 134-148. https://doi.org/10.55959/MSU2074-8132-25-4-11

Introduction

The first mention of the mummy, with an inventory number of KP 5 No. 3484, KO No. 368, is found in a description of the exhibition at the Museum of Anthropology of Moscow State University, which was likely composed by the museum's founder, D.N. Anuchin: "…on the table under a glass dome lies the Egyptian mummy of a priest of the god Amun, dating back to approximately 900 years before Christ, unwrapped and remarkably well-preserved; it was found in one of the tombs of ancient Thebes and brought to Russia in 1876 by the late Professor A.I. Babukhin" (Krol, 2019).

Professor A.I. Babukhin (1827–1891) was dispatched by Moscow State University to Luxor in 1877 to conduct scientific observations and experiments (Babukhin, 1877, p. 250–274). Upon his return to Russia, he brought back not only the aforementioned mummy, but also two skulls, which he gifted together with the mummy to D.N. Anuchin. Babukhin's collection also included four mummified heads, which are currently kept in the Anatomical Museum of Sechenov University, and a further mummified head is now stored in the Museum of the History of Medicine at Sechenov University. From 1883 to 1907, the mummy was exhibited at the State Historical Museum alongside other items from the collections of the Museum of Anthropology. Since 1907, it has been on display in the Moscow State University building on Mokhovaya Street (Krol, 2019, pp. 755–756).

The mummy was unwrapped, and only fragments of the burial bandages were preserved on its back (Fig. 1). This not only renders it impossible to conduct a comprehensive analysis based on art historical standards, but it also complicates the dating of the mummy. On the other hand, it does facilitate a more detailed investigation of the actual mummification process.

The significance of preserving the body can be traced in funerary rites throughout ancient Egyptian history. The arid climate facilitated the preservation of bodies buries in the sand, and embalming techniques were continually improved (Ikram, Dodson, 1998, p. 35). Mummification is believed to have reached its peak during the New Kingdom, and the mummies of royals and high-ranking nobles from the subsequent Third Intermediate Period are characterized by the excellent preservation and elaboration of details. The later democratization of mummification practices led to a variety of new techniques and their widespread adoption across all social strata (Aufderheide, 2003, p. 45). Traditionally, the mummification process included a number of stages, such as removing the internal organs, cleaning the body, and drying, embalming, and wrapping the body in bandages and shrouds.

Materials and methods

The object of study is a mummified human body.

The body is extended in a supine position (Fig. 1), with the arms slightly bent at the elbows and pressed against the torso. The palms touch the outer surface of the thighs, and the fingers are extended. The head is tilted slightly forward, with the chin bent toward the chest. The entire posterior is flattened and aligned with the surface on which it lay during mummification. The skin is well-preserved, with no areas of skeletal exposure. From the back, the skin is gathered in large folds, indicating lifetime obesity. The eyelids and nostrils retain their original shape. The anterior abdominal wall maintains its form, although there is no filler in the abdominal cavity. The head is set with short, reddish hair. The nose is slightly flattened, and the nostrils, while retaining their shape, are asymmetrical – with the left nostril somewhat larger than the right.

The textiles of the first layer of wrappings, fixed crosswise with narrow bandages, are preserved on the back.

Anthropological Study based on Computer Tomography Data

The sex of the mummy was determined by primary sexual characteristics, while the age was estimated through standard methodology (Alekseev, Debetz, 1964), based on dental wear and the degree of fusion of skull sutures observed in three-dimensional tomographic reconstructions. Additionally, the morpho-functional state of the skeleton was assessed for age-related changes in joint surfaces (Ubelaker, 1978).

The craniological and osteological study followed a standard protocol (Alekseev, Debetz, 1964; Alekseev, 1966). Facial reconstruction was performed using standard techniques based on the method of M.M. Gerasimov (Gerasimov, 1955) with additions and modifications by other scholars (Lebedinskaya, 1998; Veselovskaya, Balueva, 2012; Veselovskaya, 2018; Rasskazova et al. 2020). The

Figure 1. Ancient Egyptian 'Mummy of the Priest' from the Collection of the Lomonosov Moscow State University Research Institute and Museum of Anthropology

Рисунок 1. «Мумия жреца» из собрания НИИ и Музея антропологии МГУ имени М.В.Ломоносова

body length was estimated using the Pearson and Lee (Pearson, Lee, 1899), and Trotter and Gleser (Trotter, Gleser, 1958) formulas.

Textile Analysis

The technological characteristics of the mummy's burial fabrics were studied using standardised methods developed for the analysis of Egyptian archaeological textiles (Orfinskaya, Tolmacheva, 2016; 2019). Visual examination and high-resolution videomicroscopy (Hirox RH-2000) were employed to determine the yarns' diameter and twist direction, the weave type, warp and weft count, angle of spin, and other parameters. The fibre types were identified through using microscopic analysis using a halogen-illuminated Olympus BX51 microscope.

Radiocarbon Dating

Radiochemical analyses were performed at the CCU 'Geoecology' of The Herzen State Pedagogical University of Russia using a low background liquid scintillation counter Quantulus 1220 (Wallac). The activity of the radioactive carbon isotope was determined in a sample of linen fabric taken from the mummy's back. The age was calculated in accordance with standard protocols (Kulkova, 2011), and the obtained data calibrated using the OxCal 4.4.4 software, IntCal20.

Gas Chromatography and Mass-Spectrometry

The samples for GC analysis were prepared according to the protocol of Abdel-Maksoud et al., with minor modification (Abdel-Maksoud et al., 2021, p. 1–10). Skin and linen samples were collected from the external surface of the mummy in the area of the frontal bone of the skull, the sternum, abdominal cavity, femur, and talus bone.

The analysis was performed using an Agilent 6850 gas chromatograph equipped with an HP-5ms column (30 m, 0.25 μm, 0.25 mm) with carrier gas flow rate of 0.9 mL/min in the constant flow mode. The injector temperature was set to 250°C in splitless mode. The temperature gradient was applied as follows: an initial hold at 60 °C for up to 2 minutes, followed by gradual raise in temperature of 10 °C/ min up to 290 °C, and a subsequent hold for 20 minutes. The mass-spectrometer

(Agilent 5973N) detected ions in the range of 50-550 Da, with a solvent delay of 6 min.

The data was processed with MSDIAL software.

Spore-pollen Analysis

The contents of the lower rectum and pelvic region of the mummy were examined. The respective sample weights were only 2.7 g and 2.6 g. For this reason, the chemical treatment of the samples was not carried out using standard spore-pollen analysis protocols, but instead with the Callen and Cameron method (Callen, Cameron, 1960), using a 0.5 % sodium orthophosphate solution ($Na_3PO_4 \cdot 12H_2O$), since archaeoparasitological studies of the same samples are also planned. The prepared samples were examined under 400-fold magnification using an ADF U300 microscope.

Results

Visual Examination and Tomographic Analysis

The soft tissues of the nasal septum are preserved in the nasal cavity, as are the structures of the nasal passages. The perpendicular plate of the ethmoid bone is intact, but slightly shifted to the right. The horizontal plate of the ethmoid bone is almost completely destroyed, with more pronounced damage on the left side. The ethmoidal foramen is pear-shaped, and measures 26×20 mm. Remnants of the brain are visible on the internal surface of the occipital bone. There are no resins, textile, or other fillers in the cranial cavity.

A vertical incision can be observed on the anterior abdominal wall along the midclavicular line. It extends from the hypochondrium to the upper edge of the iliac spine. The incision edges are not together. The complete diaphragm and lungs had been removed from the body cavities, as was a part of the mediastinal organs, the remnants of which are displaced to the right. The abdominal cavity had also been emptied. A heterogeneous mass is visible on the posterior wall of the thoracic and abdominal cavities, as well as in pelvic cavity. Colon and rectum remnants can be traced in the lesser pelvis.

Four visceral bundles (three cylindrical, one rounded) consisting of the extracted internal organs can be observed inside the body cavities to the right of the vertebral column.

Results of the Anthropological Analysis. Facial Reconstruction based on CT Scans

The mummy could be identified as a male of 40–60 years age. The sex and age of the mummy were determined based on morphological features and CT data. The lifetime body length was reconstructed based on the maximum length of the femur length, measured by the tomograph. Several formulas were used to reconstruct the body length: Pearson and Lee formula (1899) ($L = 81.306 + 1.880 \times F1$), according to which the body length measured 165 cm, and the Trotter and Gleser formula (1958) ($L = 65.53 + 2.32 \times F1$), according to which the body length measured 169 cm.

CT visualizations of the mummy's internal system revealed osteophytes – i.e. bone proliferations or soft tissue ossifications – on the epiphyses of the distal femurs, suggesting age-related tissue changes. Antemortem destruction of bone tissue was observed on articular surfaces of the proximal tibial epiphysis, suggesting osteoarthritis, but due to the quality of the tomogram, it was difficult to determine the exact origin of the defect. Intervertebral disc thinning can also be observed in the thoracic spine.

The results of the craniometric analysis are presented in Table 1. The skull is mesocranic with a large braincase. The longitudinal and transverse diameters, the frontal chord, the width of the occiput and the base of the skull fall into the large size category. The face is of medium width, the bi-orbital diameter small, and the nose wide and medium-high. The height and width of the orbit fall into the small size category, and the orbital index is low. Significant horizontal profiling can be observed in the area of the naso-malar angle.

An anthropological description of the face was prepared based on facial features reconstructed from the skull. The cephalic index is mesocephalic (79.7). The shape of the head is rounded. The face is oval-shaped and relatively narrow. The forehead is wide, rounded in profile, and its slope is vertical. The brow ridges are weak. The palpebral fissures are horizontal. The upper eyelid is slightly drooping. The cheekbones are moderately prominent. The nose is wide, of medium height.

Table 1. The cranial metric traits of the mummy
Таблица 1. Основные краниологические размеры мумии

№ (R.Martin)	Metric traits / Измерительные признаки	mm
1	Maximum cranial length (g – op)	189
8	Maximum cranial breadth (eu – eu)	149
8/1	Cranial index	78,8
17	Maximum cranial height (ba – b)	136
11	Cranial base breadth (ba – n)	129,5
9	Minimum frontal breadth (ft – ft)	91,7
10	Maximum frontal breadth	120
12	Occipital breadth (ast – ast)	112
40	Basion–prosthion length (ba – pr)	100
45	Bizygomatic diameter (zy – zy)	132,5
48	Upper facial height (pr – n)	69
29	Frontal chord (n – b)	116
30	Parietal chord (b – l)	110
43	Upper facial breadth (fmt – fmt)	104,5
46	Medium facial breadth (zm – zm)	91,5
55	Nasal height (ns – n)	52
54	Nasal breadth (al – al)	28,9
54/55	Nasal aperture index	55,6
52	Orbital height (greatest, perpendicular to breadth)	32
51	Biorbital breadth (from mf)	40,9
52/51	Orbital index	78,2
43[1]	Biorbital breadth (ec – ec)	96,2
77	Naso-malar angle	136,7
<Zm’	Zygomaxillar angle	132,6
75[1]	Rhinion – nasion – prostion angle	25,2

Notes. Craniometric landmarks (White et al, 2012, p. 55–59): al – alare; ast – asterion; b – bregma; ba – basion; ec – ectoconchion; eu – euryon; fmt – frontomalare temporale; ft – frontotemporale; g – glabella; l – lambda; mf – maxillofrontale; n – nasion; ns – nasospinale; op – opisthocranion; pr – prosthion; zm – zygomaxillare; zy – zygion.
Примечания. Краниометрические точки (White et al, 2012: p. 55–59): al – alare; ast – asterion; b – bregma; ba – basion; ec – ectoconchion; eu – euryon; fmt – frontomalare temporale; ft – frontotemporale; g – glabella; l – lambda; mf – maxillofrontale; n – nasion; ns – nasospinale; op – opisthocranion; pr – prosthion; zm – zygomaxillare; zy – zygion.

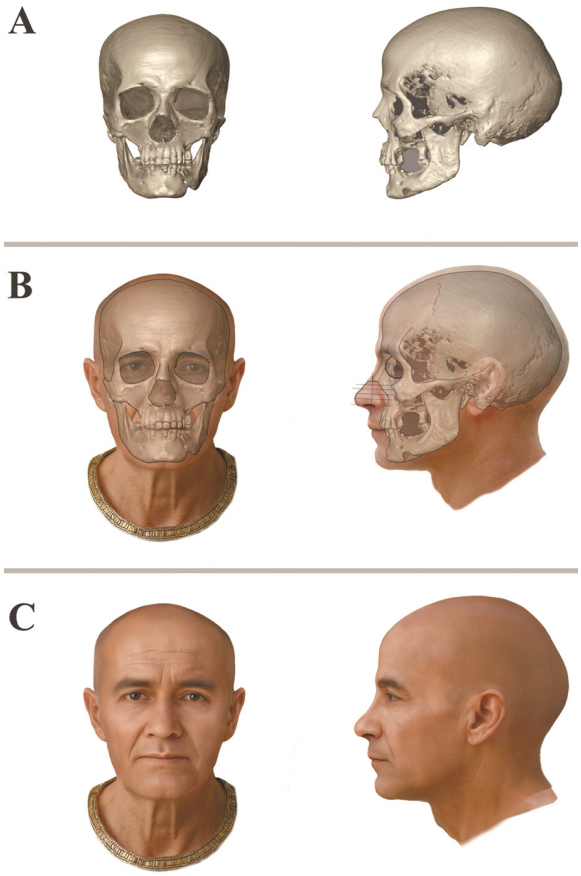

Figure 2. Stages of facial reconstruction based on the mummy's skull by A.V. Rasskasova

Notes. A – Skull in frontal and profile projection; B – Superposition of the skull image on the face in frontal and profile projection; C – Graphic reconstruction of the face based on the skull

Рисунок 2. Этапы реконструкции лица по черепу. Автор реконструкции А.В. Рассказова

Примечания. А – Череп в проекции фас и профиль; В – Наложение изображения черепа на лицо в проекции фас и профиль; С – Графическая реконструкция лица по черепу

The bridge of the nose is slightly concave. Nasal projection is moderate. The upper lip protrudes over the lower lip. The chin is rounded and of medium size. A facial reconstruction is presented in fig. 2, 3.

Osteological measurements indicate that all longitudinal dimensions of the long bones of the individual fall within the medium range. The humeral robusticity index is average, and the humeral diaphyseal cross-sectional index is medium. The radiohumeral (brachial) index is medium. Femoral robusticity is also average. The pilastric index (femoral shaft shape) is stenomeric (narrow). The tibia is robust. The intermembral index also falls within the medium range. The radiohumeral (brachial) index is classified as medium. The humerofemoral index is average. The radiotibial (brachio-crural) index falls within the large category. Muscle markings on the long bones are moderately developed.

Figure 3. Facial Reconstruction of the "priest" by A.V. Rasskazova

Рисунок 3. Реконструкция внешнего облика «жреца». Автор реконструкции А.В. Рассказова

Textile Analysis

Only a limited number of fabric samples could be taken from the mummy analysis, as its funerary bandages and shrouds were removed before it entered the museum collection. Several textile samples of varying fabric type were taken (Fig. 4. 4; 4. 5). Microscopic analysis confirmed the material to be flax (Fig. 4. 6).

Sample 1. Two fragments of plain weave fabric, balanced tabby weave (Fig. 4. 2); S-twist (Fig. 4. 1); warp and weft count of 12 yarns per cm, distance between the yarns of 0.2-0.3 mm, angle of spin medium and loose, thickness of warp and weft yarns of 0.3–0.4 mm.

Sample 2. Two fragments of basket weave (2/2) (Fig. 4. 3; Fig. 4. 7), extended tabby weave, with yarns used in parallel pairs rather than individually; S-twist; warp count of 8 yarns per cm, weft count of 12 yarns per cm (yarns are paired), medium angle of spin, warp and weft yarn thickness of 0.4–0.5 mm.

Gas Chromatography and Mass-Spectrometry Analysis

Over 200 compounds of various classes were identified. Among the objects analysed, four clusters could be identified (using K-means clustering, following PCA decomposition) with differing chemical compositions. Cluster I included a fragment of a funerary shroud and a ‘negative control’. No embalming substances of plant- or animal-extraction could be detected here.

Cluster II and Cluster III were characterized by the presence of phenolic compounds of plant origin, as well as resin acids (diterpenes) and their oxidation products. The primary distinction between these clusters is the different ratio of fatty acids and phenolic compounds, resin acids. The samples in Cluster III may have contained plant oils among the embalming components (indicated by the presence of long-chain fatty acids), or, alternately, been treated with a less concentrated embalming compound containing resin acids, plant-derived extracts.

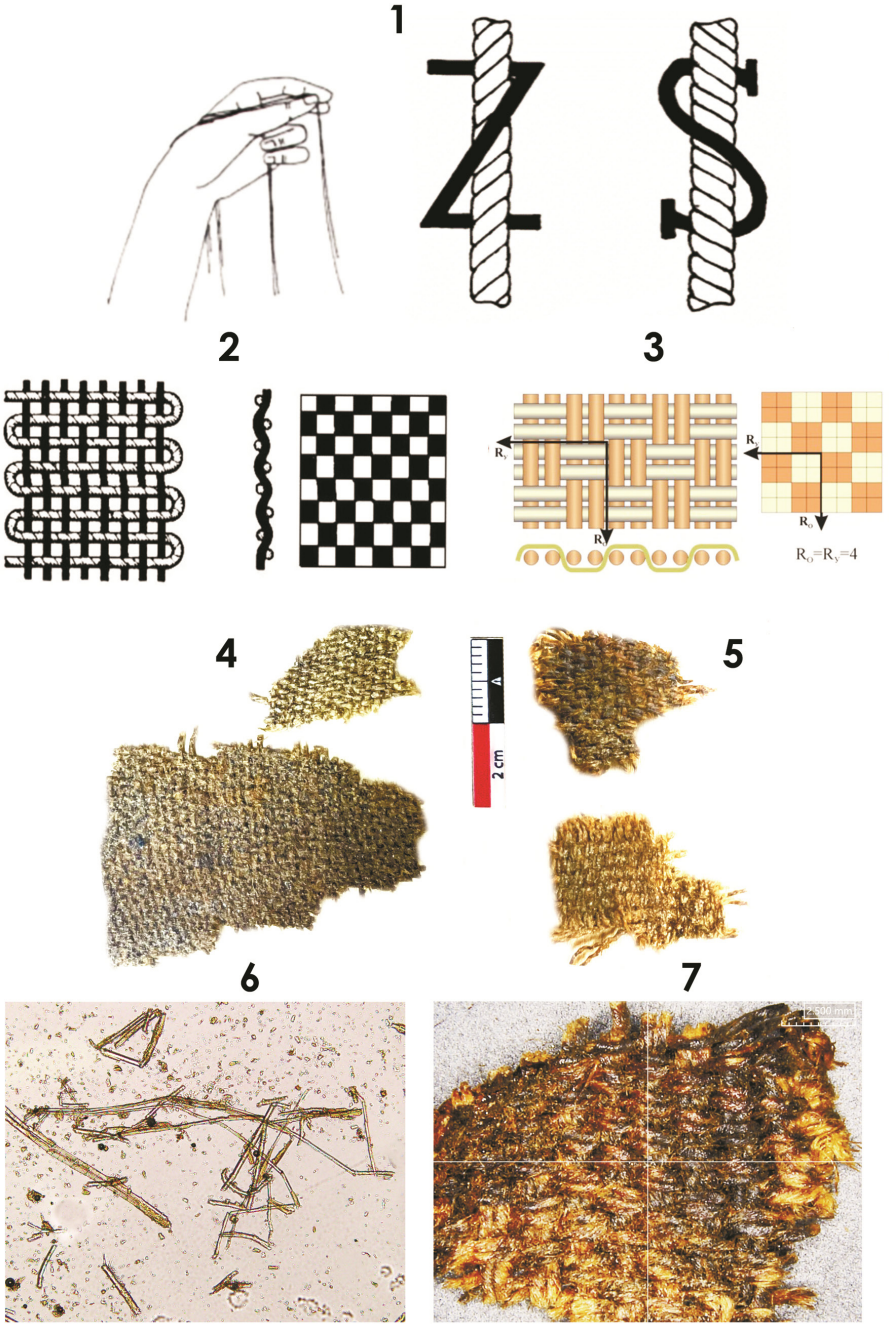

Figure 4. Textiles of the 'Mummy of the Priest' from the Collection of the Lomonosov Moscow State University Research Institute and Museum of Anthropology

Notes. 1 – Type of twist; 2 – Tabby weave; 3 – Basket weave; 4 – Sample 1; 5 – Sample 2; 6 – Flax fibers; 7 – Basket weave.

Рисунок 4. Текстиль «Мумии жреца» из собрания НИИ и Музея антропологии МГУ имени М.В.Ломоносова

Примечания. 1– схема направления крутки; 2 – полотняное переплетение; 3 – рогожка; 4 – образец 1; 5 – образец 2; 6 – льняные волокна под микроскопом; 7 – рогожка.

Cluster IV, represented by a sample from the mummy's back, is characterized by a reduced content of oxidized resin acids, together with a high concentration of relatively volatile sesquiterpene turmerone. Increased levels of turmerone were also detected in a sample taken from the peritoneum. This may be due to the fact that the embalming mixture was better preserved by the supine position of the mummy (less evaporation of volatile components and less contact with oxygen).

Taphonomic changes resulted in the severe degradation of the samples (some of the analytes evaporated, other oxidized), complicating the identification of the specific types of plant materials used in the embalming mixtures. Based on a number of markers, however, we can assume that the embalming agents included resins/ resin extracts of family *Pinaceae* (Buckley et al., 2004; Łucejko et al., 2017; Sarret et al., 2017; Huber et al., 2022).

Ricinoleic acid, specific to the common castor oil plant (Van de Loo et al., 1993), was also identified, suggesting the use of castor oil or extracts from the castor oil plant in the embalming agents (Regert et al., 1998; Yatsishina et al., 2020).

C16-C20 fatty acids were the most intense of the fatty acids detected. While these are characteristic for humans, scholars sometimes interpret them as indicators of plant oils (Łucejko et al., 2017). We do not agree with this interpretation, since the samples for this study were prepared using a hydrolysis procedure, which destroys the membrane lipids of cells while releasing a wide range of fatty acids.

The samples studied revealed a wide array of phenolic compounds, suggesting the use of either aqueous/hydroalcoholic plant extracts (Alara et al., 2021) or wood distillation products (Łucejko et al., 2017).

Archeopalynological Investigation

This study focuses on data that supplement information about the mummification techniques and composition of the embalming agents. A full spore-pollen analysis will be published separately. Within the framework of the present study, it should be pointed out that pine pollen (*Pinus*) dominates the spore-pollen spectra of the samples investigated. Microscopic cysts of the *Pseudoshizaea* algae and testate amoeba shells (*Arcella* spp.) are intermittent in the non-pollen palynomorphs.

Radiocarbon Dating

The mummy was dated to 3080±35 BP (2σ 1426-1259 calBC) using radiocarbon dating.

Discussion

The anatomical integrity of the body and the absence of visible skin damage associated with putrefactive changes suggest that mummification was initiated soon after death. Natron (a mixture of sodium salts: carbonate, bicarbonate, chloride, and sulphate) was used to dry the body, ensuring high osmotic pressure and rapid moisture removal, and helping halt autolysis and putrefaction while preserving the histological structures of the soft tissues. The anterior abdominal wall could retain its shape if the body was filled with something during dehydration – likely natron bags. Their use in removing moisture from body cavities, together with immersion of the body in dry natron, has been described frequently in the relevant literature (Leblanc, 1989, p. 117; Ikram, Dodson, 1998, p. 112). The experimental mummification studies of B. Brier and R. Wade have demonstrated natron's efficiency in preserving soft tissues and their plasticity. Other materials, such as sawdust or straw mixed with sodium, could also have been used to temporary fill the body cavities during the period of dehydration (Iskander, Shaheen, 1964, p. 131).

E. Arsenault suggests a possible correlation between hair preservation or shaving of the heads and social status of the deceased (Arsenault, 2021, p. 142). He notes, in particular, that most of the royal mummies of the New Kingdom retained their hair (Arsenault, 2021, p. 118).

The idea that the arm positions served as both a social marker and a chronological indicator has been put forward repeatedly (Elias et al., 2014; Arsenault, 2021). Of particular interest are the multiple variations of crossed arms across the chest – a symbol of royal power for the mummies of the Eighteenth – Twentieth Dynasties, and later a widespread and actively used archaism in the funeral rites of the Ptolemaic Period. In New Kingdom burials, the pose with extended arms often involved placing the palms in either the suprapubic region or along the front thighs (Elias et al., 2014). Arms extended along the body with palms pressed against the outer thighs are found in mummies of the Twentieth – Twenty-first Dynasties (Elias et al., 2014), but are most characteristic of mummification during the Roman Period (Leblanc, 1989, p. 98–99, 433).

The most important stage of mummification – crucial to halting the decomposition of the body – involved the removal of the internal organs and dehydration of the tissues.

The brain of the mummy under study was removed through an opening in the ethmoid bone. One of the objectives of this investigation was to analyse the penetration axis of the tool used by the embalmers during the excerebration. The absence of significant damage to the internal nasal structures indicates that, the amplitude of the tool's motion at the nasal entrance during the transnasal craniotomy was minimal, and limited by the left nostril. The amplitude of motion at the level of the ethmoid bone was dictated by the shape and dimensions of the opening, and is therefore also small. Its largest axis is diagonal, running from right-front to left-rear. Despite the small size of the openings and amplitude of tool motion, the brain had been mostly removed.

Numerous types of metallic hooks used for excerebration – bronze rods, 4-8 mm in diameter, 27-34 cm length – are known, mainly from museum collections, but also from a few finds in the embalmers' caches of the Late Period (Bietak, Reiser-Haslauer, 1982, p. 191). Herodotus describes a method of removing the brain with such tool, one that has been confirmed repeatedly through experimental studies (Sudhoff, 1911; Leek 1969; Brier, Wade, 2001). The most successful examples of such experiments involved disrupting the integrity of the brain tissues and meninges using a tool inserted through an opening in the ethmoid or sphenoid bone into the cranial cavity. In other experiments, the cranial cavity was washed through the nose with the body lying face down – a process during which some of the softened brain tissue would be released by gravity, while the rest was washed out (Brier, Wade, 2001).

The practice of removing internal organs through an incision in the anterior abdominal wall dates back to the Early Dynastic Period (Ikram, Dodson, 1998; Wade, Nelson, 2013). Throughout the history of transabdominal evisceration, the incision placement has varied exclusively within the area of the left abdomen. The lowest oblique incisions are found mainly in burials of the Eighteenth – Twentieth Dynasties. Their low placement provided access primarily to the abdominal cavity and small pelvis, enabling the removal of organs of the gastrointestinal tract, the main source of putrefactive microflora. Lateral vertical incisions, on the other hand, provided access to the diaphragm, allowing manipulation of the entire thoracoabdominal region. Such incisions were used more frequently both before New Kingdom and after, and all the way up to Roman times (Wade, Nelson, 2013). In the present case, the shape and placement of the incision belong to this latter, more common incision type.

As previously noted, the mummy contained bundles with viscera, which had been removed from the body during mummification, embalmed and reinserted into the body. Since ancient times, internal organs were removed either completely or partially, dried, and placed in special vessels – canopic jars. Modern data has shown that the placement of visceral bundles in the thoracic and abdominal cavities was first practiced in the royal burials of the Twenties Dynasty, and grew more widespread during the Twenty-first Dynasty. The cylindrical and flattened visceral bundles placed in the body cavities find analogies in the graves of the Theban Necropolis throughout various periods (Raven, Taconis, 2005). Thus, in the Late Period, visceral bundles were placed on or between the legs, or on the stomach of the mummy. However, the placing of bundles on top of the mummy's body was limited to the Late Period (Ikram, Dodson, 1998). Later on, the embalmed organs would again be placed in the chest and abdominal cavities of the body (Raven, Taconis, 2005; Elias et al., 2014). Findings of a recent study of tomograms of dated mummies suggest that dense cylindrical visceral bundles appeared relatively late, but bundles similar to those found in the mummies of Moscow State University are typical mainly for the 10^{th} – 7^{th} centuries BC. Notably, scholars generally consider the use of the chest for visceral bundles a chronological marker of Ptolemaic Period (Elias et al., 2014, p. 57).

The next important stage of mummification was dehydration using natron. After dehydration, the body was rehydrated with river water (Rosso, 2014). *Pseudoshizaea* cysts and remains of *Arcella* testate amoebae living in freshwater biotopes could have entered the mummy during the rehydration processes before and/ or after dehydration (Beyens, Meisterfeld, 2002; Chen et al., 2013).

Chemical Composition of Embalming Mixtures

The more expensive the embalming, the more complex the mixtures could be used. The fun-

damental importance of coniferous resins in these compounds was established in the early stages of their study (Lucas, 1945). Subsequent scholars have noted the heterogeneity and compositional complexity of these mixtures. Four primary components can typically be identified (coniferous resin, fat, bitumen, and beeswax), but the mixtures are also heterogeneous in their combination.

Contemporary studies have noted the presence of coniferous resin, evidenced by diterpenoids, in mummies samples of various periods, from the New Kingdom to the Greco-Roman Period (Tchapla et al., 2004; Brettell et al., 2017; Łucejko et al., 2017). Some scholars proposed the use of mixtures of various resins, as well as resins in combination with products of dry distillation of wood (Rageot et al., 2023). It is difficult to identify the specific plant materials in embalming compounds, but our data confirm the use resins or resin extracts of the *Pinaceae* family in the embalming agents of the mummy presented here (Łucejko et al., 2017; Sarret et al., 2017; Huber et al., 2022).

The resin was applied not only directly to the skin, but sometimes also poured through the nasal cavity into the skull, or applied as a resin-impregnated linen cloth (Saleem, Hawass, 2013). Additionally, embalmers could use tampons in the nasal and auditory apertures, as well as in the rectum (Pommerening, 2010). The predominance of pine pollen in the spore-pollen spectra, coupled with abundant microscopic fragments of linen fibres in the sample taken in the lower part of the rectum, suggests the presence of a tampon in the rectum. Contamination with modern pollen during storage of the mummy, despite the absence of bandages, is unlikely, since samples were taken from otherwise inaccessible areas. This is also supported by the size of pine pollen grains, which corresponds with those of Mediterranean pines (*P. halepensis*, *P. pinea*, and *P. pinaster*) and is smaller than that of the *Pinus sylvestris*, which is widespread in the central part of the European part of Russia (Desprat et al., 2015). Thus, we can conclude that pine resin was used for embalming, which is consistent with the results of chromatographic analysis.

The presence of ricinoleic acid indicates castor oil or the use of herbal extracts of *Ricinus communis* (Regert et al., 1998; Yatsishina et al., 2020). Beyond household use, castor oil was also used in various kinds of ointments and cleansers.

The presence of long-chain fatty acids (>C22) and alcohols also indicate the use of various plant oils and waxes (Regert et al., 1998; Buckley et al., 2004).

Textile Analysis

The wrapping of the body in linen bandages and shrouds constituted a crucial practical and ritual aspect of mummification. While the techniques of wrapping of the mummified body with textiles evolved continuously throughout Egyptian history, the general model of bandaging remained constant. The body was wrapped successively in layers of broad bandages, followed by layers of shrouds, which were secured with narrow bindings. This was followed, in most cases, by a layer of ‘padding’ using textiles of standard and lower quality, often recycled, such as fragments of clothing, interior and household textiles (basket-weave textiles) (Orfinskaya, Tolmacheva, 2018, p. 224). The mummy’s bandaging was finished with layers of facial swaddling. Most often, textiles were brought to funeral workshops from other households (Johnstone, 2002, p. 603). Fabrics of varying quality were used to swaddle the mummies. Researchers have observed that high-quality fabrics were placed closer to the body, or used for the frontmost layers of swaddling, while coarse fabrics used in the middle layers to create volume (Orfinskaya, Tolmacheva, 2018, p. 228, 231).

Two types of textiles exhibiting standard characteristics of ancient Egyptian textiles were chosen for this study – textiles with a linen warp-faced or balanced tabby weave, and textiles with a basket-weave (2:2) with an S-twist (fig. 4) (Orfinskaya, Tolmacheva, 2016, p. 78). The yarn thickness and twist are not beyond average. The use of basket-weave textiles in the wrapping layers closer to the body deserves attention. This household cloth, simple and cheap in its production, was used during mummification for the *middle* wrapping layers, as a rule (Orfinskaya, Tolmacheva, 2018, p. 228, 231), and not closer to the body. This rule was not followed in the case of the mummy presented here. In general, all textile samples are of standard or average weaving quality.

Conclusion

Our examination of the mummy revealed it to belong to a male individual aged 40–60 years. A facial reconstruction and a craniological and osteo-

logical description of the mummy were produced using computed tomography (CT) data. The skull is mesocranic with a large braincase. The face is of medium width, with a small interorbital distance and a wide, moderately high nose. The height and width of the orbits fall into the small-size category. Significant horizontal profiling can be observed in the region of the naso-malar angle. All other metric traits are classified as small. All long-bone lengths and indices are medium; exceptions are a stenomeric (narrow) pilastric index, a robust tibia, and a large radiotibial (brachio-crural) index; muscle markings are moderate.

The embalming preparation involved a transnasal craniotomy combined with evisceration – the removal of internal contents of body cavities through a left lateral vertical incision in the anterior abdominal wall, followed by the replacement of the dried organs. During natron dehydration, the abdominal cavity appears to have been filled with natron-bags and other fillers to prevent deformation of the abdominal wall. The presence of non-pollen palynomorphs indicates the use of river water for washing the body cavities. Chemical analysis identified over 200 compounds, demonstrating the multicomponent composition of the embalming mixture. The use of pine resin has been confirmed by spore-pollen analysis.

The transnasal craniotomy combined with evisceration, the placement of internal organs inside the body in the form of visceral bundles, positioning of the body, together with the lack of a resin filling for the body with resin combined with a good quality of skin preparation, allows us to date the mummy to a chronological period which is later than that indicated by radiocarbon dating.

The complex composition and probable use of different mixtures for various areas of the body and mummification stages indicate a high-cost procedure, implying the elevated social status of the individual whose mummy is kept at the Research Institute and Museum of Anthropology at Moscow State University. This interpretation contradicts – to some extent – the data obtained from the analysis of textile fragments taken from the lower layer of swaddling. The standard quality of the fabrics and the use of household textiles (burlap) in bandaging layers close to the body suggests the mummified person to have had an average income. Further study of the material may help clarify the answer to this and other questions.

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Поступила в редакцию 03.08.2025.
Получена после доработки 26.09.2025.
Принята к публикации 26.09.2025.

Received 03.08.2025.
Revised 26.09.2025.
Accepted 26.09.2025.