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Адрес: 625008, Червишевский тракт, д. 13, e-mail: vestnik.ipos@inbox.ru

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Address: Chervishevskiy trakt, 13, Tyumen, 625008, Russian Federation; mail: vestnik.ipos@inbox.ru
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Федорчук О.А. [a, b, c], Чиркова А.Х. [a, b, *], Ладынин И.А. [d], Березина Н.Я. [a]

[a] МГУ имени М.В. Ломоносова, НИИ и Музей антропологии, ул. Моховая, 11, стр. 1, Москва, 125009
[b] Центр палеоэтнологических исследований, Новая пл., 12, корп. 5, Москва, 109012
[c] МГУ имени М.В. Ломоносова, Ленинские горы, 1, стр. 12, Москва, 119234
[d] МГУ имени М.В. Ломоносова, Ломоносовский проспект, 27, корп. 4, Москва, 119192
E-mail: lela.fed@yandex.ru (Федорчук О.А.); melnichuk.alina@mail.ru (Чиркова А.Х.);
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КРАНИОЛОГИЧЕСКАЯ ХАРАКТЕРИСТИКА СРЕДНЕВЕКОВОГО НАСЕЛЕНИЯ СЕВЕРНОГО СУДАНА (НА ПРИМЕРЕ МАТЕРИАЛОВ ПАМЯТНИКА ДЕРАХЕЙБ)

История Северной Африки издревле тесно переплетена с событиями, происходящими на Евразийском континенте. Миграции и путешествия в обоих направлениях фиксируются как в письменных источниках, так и по многочисленным археологическим свидетельствам. Для лучшего понимания исторических процессов необходим комплексный подход, включающий в себя также изучение останков людей, живших на этой территории в разные эпохи. К сожалению, средневековое население этого региона очень слабо изучено и представлено в публикациях, особенно это касается метрических параметров, являющихся основными биологическими характеристиками палеопопуляции. В данной работе мы публикуем краниологическую характеристику серии Южного некрополя Дерахейб, частично заполняя пробел в данных. По историческим источникам, изучаемый памятник являлся центром золотодобычи — городом аль-Аллаки, существовавшим в IX–XV вв. и привлекавшим множество людей возможностью заработка. Кроме того, аль-Аллаки был одной из остановок на караванном пути, соединявшем верхнеегипетский город Асуан с красноморским портом Айзаб. Этот путь использовался как купцами, так и паломниками, пересекавшими Нубийскую пустыню по пути в Джидду. Материалом исследования являются 14 мужских и 9 женских черепов, измеренных по 55 линейным размерам стандартной краниометрической программы с привлечением дополнительных признаков. Статистическая обработка данных была выполнена с помощью пакетов языка R, а также программы Multican. Исследование показало неоднородность как мужской, так и женской частей серии на внутригрупповом уровне, что согласуется с результатами археологических исследований и исторических свидетельств. Однако небольшая численность серии не располагает к однозначности интерпретаций. Результаты межгруппового анализа в сравнении с экваториальными и европеоидными популяциями этого и соседнего регионов показали, что погребенные на Южном некрополе памятника Дерахейб морфологически более сходны с европеоидным населением, чем с группами из Восточной Африки.

Ключевые слова: биологическая антропология, палеоантропология, краниология, Африка, Северный Судан, средневековье.

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[*] Corresponding author.

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Fedorchuk O.A.[a, b, c], Chirkova A.Kh. [a, b, *], Ladynin I.A. [d], Berezina N.Ya. [a]
[a] Lomonosov Moscow State University, Anuchin Research Institute and Museum of Anthropology
Mokhovaya st., 11, Moscow, 125009, Russian Federation
[b] Paleoethnology Research Center, New Square, 12-5, Moscow, 109012, Russian Federation
[c] Lomonosov Moscow State University, Leninskie Gory, 1-12, Moscow, 119991, Russian Federation
[d] Lomonosov Moscow State University, Lomonosovsky Prospekt, 27, building 4, Moscow, 119192, Russian Federation
E-mail: lela.fed@yandex.ru (Fedorchuk O.A.); melnichuk.alina@mail.ru (Chirkova A.Kh.); ladynin@mail.ru (Ladynin I.A.); berezina.natalia@gmail.com (Berezina N.Ya.)

A craniometric study of the Medieval sample from Deraheib (Northern Sudan)

The history of North Africa has been always tightly connected to events occurring in Eurasia. Human migrations in both directions are well-documented in written sources and archaeological records. To gain a comprehensive understanding of historical processes, it is essential to study the remains of individuals who inhabited this region during various time periods. A lack of cranial metric data on the Medieval population of North Africa impedes thorough investigation of the population history of the region. This paper presents a craniometric study of the sample from the Southern necropolis at Deraheib. This study contributes to filling the existing void in the understanding of the Medieval population of North Africa. According to written sources, the site was a center of gold mining, known as the city of al-Allaki, dated to the 9th to 15th centuries AD. The city attracted a diverse population seeking economic opportunities. Besides this, Al-Allaki served as an important point on the caravan route which was utilized by merchants and pilgrims traversing the Nubian Desert on their way to Jeddah. The study analyzes cranial metrics of a total of 23 individuals (14 male and 9 female) skulls recovered from the southern necropolis Deraheib sample and employs 55 linear dimensions, following Martin's/Howells craniometric protocol as well as some additional measurements. Statistical analyses were performed using the R language packages and the Multican software. Our results revealed heterogeneity of the sample in male and female parts of the sample at the intragroup level: an observation aligning with existing archaeological and historical evidence. The limited size of the sample warns against any firm conclusions regarding affinities of the Deraheib population. Our intergroup comparison has shown that the cranial sample from the Southern Necropolis of the Deraheib site displays morphological features that are more similar to neighboring Caucasoid populations rather than equatorial groups from East Africa.

Key words: biological anthropology, paleoanthropology, craniology, Africa, North Sudan, Middle Ages.

Introduction

The archaeological site of Deraheib is located at the source of Wadi al-Allaki, the largest wadi in the southeastern part of the Eastern Desert of the Sudan Republic (Fig. 1). Deraheib consists of various structures, including the Northern Fortress, the Southern Fortress, the Settlement, the Southern Necropolis, and settlements associated with gold mining activities in ancient and Medieval times [Bukharin, Krol, 2020, p. 180; Krol et al., 2023, p. 267]. The site is not completely investigated currently.

According to historical information from Medieval Arab sources, the city of al-Allaki, which thrived from the 9th to the 15th centuries, was potentially located in the settlement area. It served as a hub for gold mining in the Nubian Desert, and a stop along the caravan route that connected the Upper Egyptian Aswan city with the Red Sea port of Aizab. This route was used by both merchants and pilgrims heading to Jeddah and from there to the holy cities of Islam [Bukharin, Krol, 2020, p. 180–181].

Since 2017, the archaeological site of Deraheib has been actively studied by the Nubian archaeological and anthropological missione of the Anuchin Research Institute and Museum of Anthropology, Lomonosov Moscow State University. Numerous burial sites, including 50 burials at the Southern Necropolis, have been excavated during multiple expedition seasons. Among these, 43 burials date back to the Islamic period, while the remaining seven burials represent an earlier time and deviate from Islamic burial practices, with the bodies buried in a crouched position [Krol et al., 2023, p. 272–273].

After the paleoanthropological research, the skeletal remains were reburied. The study protocol included: craniometric, osteometric, and odontological methods. Non-metric cranial traits, stress markers and pathological conditions were identified. All crania were photographed in detail for further 3D models building, photographs were also taken of the postcranial bones, focusing on injuries, pathologies, rare cranio- and osteophenetic traits, and other findings [Krol et al., 2023, p. 272–273].

Currently, there has been only a limited number of anthropological studies of skeletal collections from the medieval archaeological sites of Northeast Africa.

Previous research has primarily focused on reconstructing paleopopulations buried at the source of Wadi al-Khawad in the Kom II necropolis (works by the Italian-Russian mission [Lebedev, Reshe-

* Corresponding author.

tova, 2017]). Other paleoanthropological studies conducted by Russian researchers have analyzed skeletal remains from ancient Egyptian and other archaeological sites [Vasilyev, Borutskaya, 2020; Borutskaya, Vasilyev, 2021; Vasilyev et al., 2022].

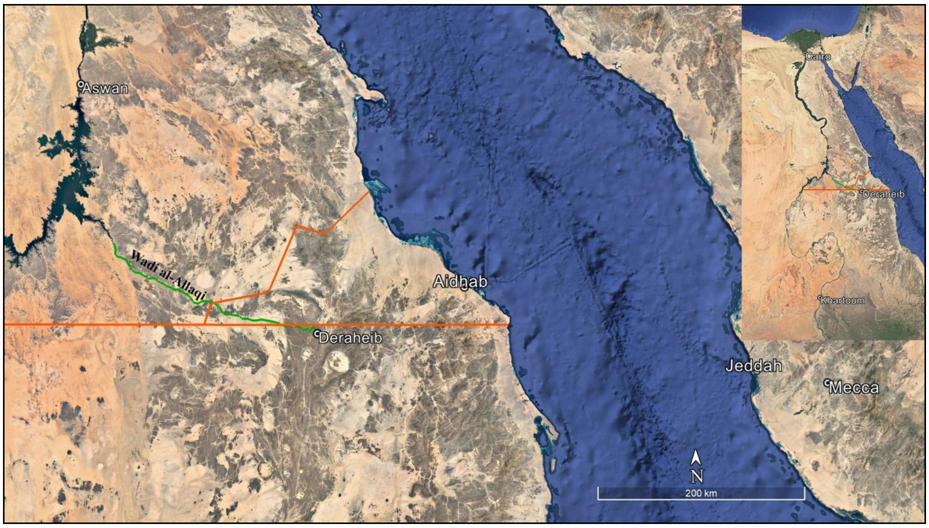

Fig. 1. Geographical features mentioned in the article (Map made on the base of the Google Earth image).
Рис. 1. Карта, сделанная на основе сервиса Google «Планета Земля»,
с указанием основных географических названий, упомянутых в статье.

Published data on skeletal biology of North African ancient populations are scarce. Data on the ancient populations of Sudan have been obtained as a result of excavations in the Kadruk necropolis (Tabo, Northern Province) [Simon, 1997]. Thorough excavations in Northern Dongola (Sudan) necropolises dated to the classical period of the Kerma culture and the Kushite period, revealed data on the southern group of the Kerma culture population [Welsby, 2001]. An analysis of the skeletal remains of Meroitic (1st–4th centuries) and post-Meroitic burials has been performed using samples from the Gabati cemetery. Measurements of the crania and postcranial skeletons were performed, but not analyzed in detail [Judd, 2012].

Medieval materials were also presented in the proceedings of the Nubian Expedition of the University of Kentucky on the island of Kulubnarti in Sudanese Nubia, where two large necropolises of the 15th–17th centuries were uncovered [Adams et al., 1999, p. 1].

Given the limited anthropological research conducted in this region, there is a clear need for more comprehensive studies.

This research focuses on the analysis of crania from Medieval burials at Deraheib, aiming at filling "blank spots" and contributing to the anthropological study of the Medieval populations of Northern Sudan and Northeast Africa.

Materials

The sample employed in this study included 14 male and 9 female crania from Islamic burials. The raw cranial measurements were used for calculating one-dimensional statistical parameters and were subsequently employed in multivariate analyses.

To analyze intragroup variability, three comparative samples were used. The first sample comes from the northern provinces of Ethiopia (Tigre) [Sergi, 1912]. The second group, from Uganda, was published by S. Górny [1957]. The third group Teita comes from Kenia [Kitson, 1931]. Additionally, sample means for various groups from Western Asia and Europe were used as reference data (Table 1). The comparative material was selected based on the relatively close geographical location, as well as the similarity of the measurement research program.

Research methods

Age and sex were estimated following standard protocols based both on cranial and postcranial features [Todd, 1920; McKern&Stewart, 1957; Pashkova, 1963; Alekseev, Debets, 1964; Ubelaker, 1989].

Craniometric program. The measurement protocol included 55 linear dimensions and 13 standard indices (Table 1) [Hrdlicka, 1920; Martin, 1928; Debets, 1935; Alekseev, Debets, 1964]. Most of the measurements followed standard Russian craniometric form [Alekseev, Debets, 1964], some were quoted from various studies [Bunak, 1960; Gokhman, 1961; Benevolenskaya, 1991; Howells, 1973]. During all field seasons at the Southern Necropolis, except the last one (winter 2022), angular measurements of the crania were not performed in the field. In the previous excavation season (2022), the angle of the nasal bones protrusion was measured (Mart. 75(1)). For the remaining skulls in the Deraheib sample, this angle was measured on the 3D models using the Amira 3D software. The reliability of these virtual measurements was tested on the skulls for which the angle was measured in the field. Differences between measurements obtained using different methods were not statistically significant. For this study, only the values of angles measured from three-dimensional images were used. The 3D models from digital photographs were obtained using Agisoft Metashape.

Table 1

List of groups for comparative analysis

Таблица 1

Список групп для сравнительного анализа

	Period	Region	Series	*n*	Source	Author of measurements
1	1th–4th centuries	Sudan	Meroitic	34	Nielsen, 1970	
2	4th–6th centuries	Sudan	X-group	42	Nielsen, 1970	
3	6th –16th centuries	Sudan	Christian	12	Nielsen, 1970	
4	4th–8th centuries	Egypt (Faiyum)	Copts	29	Borutskaya et al., 2006	Borutskaya et al., 2006
5	8th–11th centuries	Iran (ancient)	Shah Tepe	11	Table 7a [Bernhard, 1993, p. 119]	Furst, 1939
6	11th centuries.	Iran (ancient)	Turang	8	Table 7a [Bernhard, 1993, p. 119]	Field, 1939
7	9th–10th centuries	Mesopotamia	Nippur	20	Table 7a [Bernhard, 1993, p. 118]	Swindler, 1956
8	5th–10th centuries	Asia Minor	Bogazkoy	31	Table 7a [Bernhard, 1993, p. 118]	Wittewerb, 1987
9	recent	Asia Minor	Turks	7	Table 8a [Bernhard, 1993, p. 125]	Ehrich, 1940
10	recent	Asia Minor	Greeks	50	Table 8a [Bernhard, 1993, p. 125]	Weisbach, 1882
11	recent	Asia Minor	Armenians	36	Table 8a [Bernhard, 1993, p. 126]	Giuffridarug, 1908
12	recent	Asia Minor	Kurds	12	Table 8a [Bernhard, 1993, p. 126]	Chantre, 1985
13	recent	Asia Minor	Greeks	45	Table 8a [Bernhard, 1993, p. 125]	Weisbach, 1882
14	recent	Iran	Persians	7	Table 8a [Bernhard, 1993, p. 126]	Ledzelter, 1931
15	recent	West Asia	Bedouins 1	67	Table 8a [Bernhard, 1993, p. 124]	Arensburg, 1973
16	recent	West Asia	Bedouins 2	10	Table 8a [Bernhard, 1993, p. 124]	Henke, 1984
17	recent	West Asia	Bedouins 3	14	Table 8a [Bernhard, 1993, p. 124]	Summels, (s. text)
18	recent	West Asia (Uzbekistan)	Irani	19	—	measured by the author
19	recent	Europe	Italians	27	—	measured by the author
20	recent	East Africa	Tigre	69	Sergi, 1912	Sergi, 1912
21	recent	East Africa	Teita	57	Kitson, 1931	Kitson, 1931
22	recent	East Africa	Uganda	94	Górny, 1957	Górny, 1957

Statistical data processing. The statistical analyses were performed using R language packages and the Multican software [Goncharov, Goncharova, 2016]. For the multivariate analysis of intragroup variability, the principal component analysis (PCA) (“stat” package) was applied [R Core Team, 2022]. For the multivariate analysis of intergroup variability, canonical discriminant analysis based on individual data (package “candisc” [Friendly, Fox, 2021]) and canonical discriminant analysis based on mean values (Multican [Goncharov, Goncharova, 2016]) were carried out. The latter analysis applied the correlation matrix calculated for a number of African cranial samples.

Results

General cranial morphology. Male skulls are medium-long, narrow, and medium-high (based on the standards by Alekseev and Debets, 1964; Table 2), mesocranic and orthocranic. Cranial base is medium-long and narrow. The frontal bone is narrow and short. The parietal bones are medium-long. The occipital bone is narrow and medium-long. The facial skeleton is of medium height; narrow (lepten), short, with a medium protrusion, orthognathic. The face is also narrow at the upper and middle levels. The nose and orbits are medium size. Orbits are of mesoconchal shape, the nasal index is — mesorrhine. The alveolar arch is medium long, narrow, and mesuran according to the index. The palate is long, medium wide. The nasal bridge is wide and medium-high, with a medium nose protrusion.

The cranial vault of the female skulls is of medium length, narrow and medium high, mesocranic in shape, of medium height relative to the longitudinal diameter (Table 2). The cranial base is short, very narrow. The frontal bone is narrow, medium-long, and moderately curved. The parietal bones are of medium length, and the occipital bone is narrow and medium-long. The facial skeleton is of medium height, narrow (lepten), medium-long, mesognathic. At the upper level, the face is narrow, and at the middle level it is medium-wide. The orbits are narrow, medium-height, orbital index is medium. The no-se is low, narrow, mesorrhine. The alveolar arch is medium-long, narrow, and medium in shape. The palate is long, medium wide. The nasal bridge is medium-wide, high, with medium index, and moderate nasal protrusion.

Standard deviations (SD) of some traits exceed the average limits [Alekseev, Debets, 1964]: transverse diameter, parietal cord, alveolar arch dimensions, orbital width, nasal width, and simotic width. On the other hand, other dimensions display reduced values of SD, including the longitudinal diameter, minimum and maximum forehead widths, cranial base width, occipital arch and chord, zygomatic diameter, full face height, upper and middle face widths. However, the low sample size may affect these results, making it difficult to draw definitive conclusions about the increased or decreased variability of cranial size in this group.

Table 2

Mean craniometric values of male and female crania from the Derheib site

Таблица 2

Морфометрическая характеристика мужских и женских черепов из памятника Дерхейб

Measurement and indexes	men							women						
	n	*x*	*s*	med	min	max	se	*n*	*x*	*s*	med	min	max	se
Maximum cranial length (M.1)	13	178,1	5,3	178,0	169,0	188,0	1,5	9	172,2	6,7	172,0	159,0	185,0	2,2
Maximum cranial breadth (M.8)	13	135,1	5,9	135,0	127,0	147,0	1,6	8	130,0	5,2	128,5	124,0	139,0	1,8
Basion-bregma height (M.17)	13	132,5	5,1	131,0	126,0	143,0	1,4	9	129,1	1,2	129,0	128,0	131,0	0,4
Porion height (M.20)	12	112,7	4,9	111,8	104,9	122,9	1,4	9	110,6	2,2	110,6	106,3	113,1	0,7
Cranial index (M.8:1)	13	75,9	3,2	76,0	67,6	80,8	0,9	8	75,7	5,9	74,6	67,0	87,4	2,1
Altitudinal-longitudinal (M.17:1)	13	74,4	3,0	74,0	69,7	79,2	0,8	9	75,1	3,2	74,4	69,2	81,1	1,1
Basion-nasion length (M.5)	13	102,3	9,7	99,0	93,0	131,0	2,7	9	94,9	3,6	95,0	90,0	100,0	1,2
Minimum frontal breadth (M.9)	13	92,1	4,1	89,0	87,0	100,0	1,1	9	90,0	3,4	90,0	84,0	94,0	1,1
Maximum frontal breadth (M.10)	12	114,0	4,4	115,0	107,0	120,0	1,3	8	110,9	4,8	110,5	103,0	119,0	1,7
Biauricular breadth *au-au* (M.11)	13	118,4	4,2	117,0	110,0	123,0	1,2	9	110,1	3,0	111,0	106,0	115,0	1,0
Biauricular breadth (M.11b)	12	117,0	4,1	117,5	109,0	122,0	1,2	9	109,1	2,2	110,0	106,0	112,0	0,7
Biasterionic breadth (M.12)	13	106,3	4,6	106,0	101,0	113,0	1,3	9	101,2	3,4	100,0	97,0	107,0	1,1
Fronto-basilar index (M.10:11)	12	96,2	4,3	96,7	89,2	104,5	1,2	8	100,6	6,2	99,6	92,0	112,3	2,2
Fronto-malar index (M.9:43)	13	90,0	3,8	89,9	82,8	95,2	1,1	9	91,5	1,7	91,8	88,2	94,0	0,6
Basel-posterior breadth (bas-post)	12	122,3	4,6	122,0	115,0	130,0	1,3	9	114,9	4,0	115,0	110,0	124,0	1,3
Horizontal circumference (M.23)	12	503,1	16,8	504,0	470,0	539,0	4,8	9	482,2	10,2	482,0	471,0	504,0	3,4
Transverse arc (M.24)	12	305,3	15,1	305,0	283,0	332,0	4,3	8	296,1	8,0	297,0	281,0	305,0	2,8
Sagittal arc (M.25)	12	364,0	14,3	365,0	337,0	391,0	4,1	9	354,2	11,6	354,0	338,0	374,0	3,9
Sagittal frontal arc (M.26)	12	124,6	6,2	125,5	115,0	132,0	1,8	9	122,4	7,4	121,0	114,0	138,0	2,5
Sagittal parietal arc (M.27)	12	125,2	9,4	123,0	111,0	147,0	2,7	9	119,2	4,1	119,0	112,0	127,0	1,4
Sagittal occipital arc (M.28)	12	114,3	4,0	112,5	111,0	122,0	1,2	9	112,6	4,6	116,0	106,0	117,0	1,5
Frontal chord (M.29)	12	109,7	4,6	109,5	103,0	117,0	1,3	9	107,2	4,6	107,0	99,0	115,0	1,5
Bregma-lambda chord (M.30)	12	111,5	6,8	111,0	101,0	126,0	2,0	9	107,1	5,5	108,0	94,0	114,0	1,8
Occipital chord (M.31)	12	96,3	4,2	95,5	89,0	107,0	1,2	9	95,4	2,7	95,0	92,0	100,0	0,9
Frontal curvature index (M.29:26)	12	88,1	1,8	88,1	85,4	91,4	0,5	9	87,7	2,7	88,4	83,3	92,1	0,9
Bregma-lambda curvature index (M.30:27)	12	89,2	2,0	90,2	85,7	91,2	0,6	9	89,8	2,3	90,2	83,9	91,6	0,8
Occipital curvature index (M.31:28)	12	84,3	4,7	84,3	77,7	96,4	1,4	9	84,9	2,3	85,2	81,0	88,0	0,8
Occipitoparietal index (M.28:27)	12	91,7	7,2	91,0	78,9	103,5	2,1	9	94,4	3,1	94,6	90,1	98,3	1,0
Chord *n–l*	12	174,2	5,1	173,0	165,0	182,0	1,5	9	167,7	5,2	168,0	159,0	178,0	1,7
Chord *b–o*	12	145,0	5,8	144,5	136,0	155,0	1,7	9	143,0	3,3	142,0	139,0	148,0	1,1
Height on over ft-ft	12	20,0	2,1	19,5	17,4	23,0	0,6	9	18,8	2,8	19,3	14,2	22,9	0,9
Height frontal curvature (M.29b)	12	25,6	3,3	26,1	19,6	30,1	0,9	9	25,3	4,3	25,9	19,3	34,6	1,4
Height occipital curvature (M.33)	12	25,5	3,9	26,0	19,1	32,6	1,1	9	25,1	4,0	25,1	17,3	30,0	1,3
Foramen magnum length (M.7)	12	36,1	2,4	36,0	32,0	41,8	0,7	9	34,6	2,4	34,8	31,0	38,7	0,8
Foramen magnum breadth (M.16)	12	29,4	1,4	29,1	27,9	32,2	0,4	9	27,6	2,3	27,1	24,7	32,5	0,8
Bizygomatic breadth (M.45)	13	126,7	4,1	126,0	120,0	134,0	1,1	9	117,3	2,4	118,0	112,0	120,0	0,8
Facial length (M.40)	12	96,4	4,8	95,5	91,0	104,0	1,4	8	93,6	3,7	95,0	87,0	98,0	1,3
Facial length to *ss* (40ss)	12	92,8	5,3	92,5	86,0	103,0	1,5	8	88,9	4,3	89,0	81,0	95,0	1,5
Upper facial height (M.48)	11	70,3	3,9	70,0	64,0	76,0	1,2	8	68,3	2,8	68,5	63,0	72,0	1,0
Upper facial height to *pr* (48pr)	12	65,8	7,1	66,5	46,4	72,5	2,1	8	64,9	2,9	65,0	60,0	69,0	1,0
Upper facial (M.48:45)	10	55,8	3,4	55,2	51,5	60,8	1,1	8	58,3	3,0	57,6	53,4	61,6	1,0
Facial height (M.47)	11	115,1	5,3	114,0	108,0	124,0	1,6	8	109,6	5,2	109,0	101,0	116,0	1,9
Superior facial breadth (M.43)	13	102,4	3,6	101,0	99,0	111,0	1,0	9	98,4	3,1	99,0	93,0	102,0	1,0
Midfacial breadth (M.46)	13	93,1	2,8	93,0	88,0	98,0	0,8	9	90,3	4,1	92,0	81,0	94,0	1,4
Alveolar arch length (M.60)	10	53,5	3,5	53,0	49,0	60,0	1,1	8	51,1	2,0	51,0	47,0	53,0	0,7
Maxillo-alveolar breadth (M.61)	12	60,0	3,9	59,5	54,0	68,0	1,1	9	58,0	2,1	58,0	55,0	62,0	0,7
Maxillary-alveolar index (M.61:60)	10	112,5	5,6	113,7	103,5	121,6	1,8	8	113,1	6,0	113,7	105,7	123,4	2,1
Palate length (M.62)	10	47,7	2,3	47,5	44,7	51,2	0,7	7	46,9	2,7	47,4	41,3	49,1	1,0
Palate breadth (M.63)	9	40,6	2,3	41,1	36,8	44,0	0,8	7	38,1	1,2	38,4	36,7	39,5	0,5
Nasal height (M.55)	13	51,2	2,8	51,5	47,0	55,0	0,8	9	47,4	1,8	48,0	44,5	50,0	0,6
Nasal breadth (M.54)	13	25,1	2,0	24,8	21,8	28,9	0,6	9	23,3	1,5	23,8	20,9	24,9	0,5
Nasal index (M.54:55)	13	49,1	4,5	49,4	42,8	56,1	1,2	9	49,3	3,8	49,2	43,7	54,7	1,3
Orbit breadth (M.51)	13	41,2	2,1	40,7	38,7	44,4	0,6	9	39,7	1,5	39,8	37,2	41,5	0,5
Orbit breadth to *d* (M.51a)	13	38,6	2,4	38,4	33,6	41,6	0,7	9	37,2	1,4	37,9	35,2	38,9	0,5
Orbit height (M.52)	13	33,9	1,7	33,5	31,8	37,5	0,5	9	33,4	1,5	33,0	31,9	36,2	0,5
Orbit index (M.51:52)	13	82,6	6,9	82,4	73,6	96,9	1,9	9	84,1	4,0	83,5	77,6	89,4	1,3
Internal biorbital breadth (M.43(1))	13	94,9	4,2	94,0	90,4	105,0	1,2	9	90,7	3,8	91,8	83,2	94,9	1,3
low sub	13	18,9	2,1	19,0	14,3	21,6	0,6	9	16,7	1,0	16,5	15,5	19,1	0,3
Bimaxillary breadth (M.46b)	13	92,4	4,1	91,3	87,0	100,0	1,1	9	89,0	3,4	89,5	81,5	92,5	1,1
Zygomaxillary subtense (M.46c)	13	23,9	3,9	23,9	17,0	29,1	1,1	9	23,7	3,5	22,5	19,8	31,2	1,2
Simotic chord (SC)	13	9,6	2,4	9,7	5,8	13,2	0,7	9	9,4	1,8	10,0	6,7	11,7	0,6
Simotic subtense (SS)	13	4,8	0,7	4,7	3,9	6,0	0,2	9	3,7	0,8	4,0	2,2	4,8	0,3
Simotic index (SS:SC)	13	52,4	12,8	49,0	35,0	84,5	3,6	9	39,5	8,4	37,6	31,0	53,9	2,8
Anterior interorbital breadth (MC)	13	19,4	2,8	19,3	15,0	24,6	0,8	9	17,7	2,5	17,8	13,0	21,0	0,8
Nose protrusion angle (M.75(1))	12	25,6	4,4	25,6	19,8	31,6	1,3	8	26,8	7,8	26,1	12,5	39,2	2,8

The principal components analysis of the male part of the sample reveals that the individuals from burials 10, 11, and 50 have larger values for transverse neurocranial dimensions (Fig. 2). On the other hand, the crania from burials 20, 34, 41, and 25 display smaller values for these traits. Burials 7 and 5 stand out as isolated cases. The individual from burial 5 shows a slight increase in neurocranium breadth but a decrease in facial width. The individual from burial 25, in contrast, exhibits a decrease in transverse dimensions of the neurocranium, opposing individuals from burials 10 and 11. The skull from burial 25 has been previously described as displaying pronounced general facial prognathism [Krol et al., 2022, p. 111]. The individual from burial 8 exhibits an increased facial width.

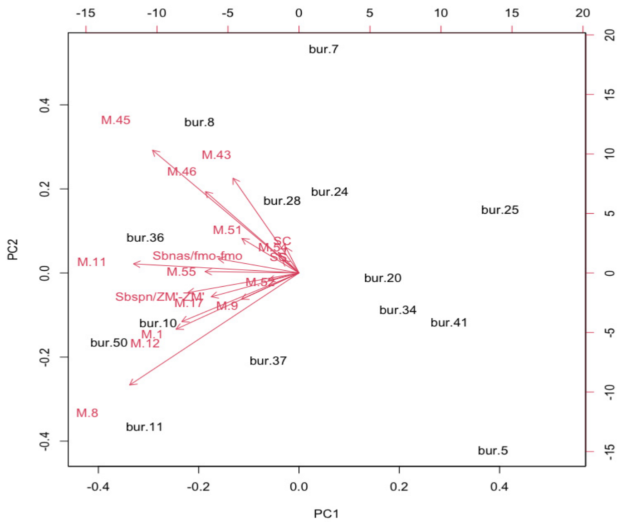

Fig. 2. Male individuals of the sample in the space of the first and second principal components.
Рис. 2. Расположение индивидов мужской части выборки в пространстве первой и второй главных компонент.

The analysis demonstrates that the transverse dimensions of the face and neurocranium display high variability in the male part of the sample, while other measurements make less contribution to the first and second principal components (Table 3).

Table 3

Loadings of the studied craniometric traits on the first and second principal components in the male part of the sample

Таблица 3

Значения нагрузок первой и второй главных компонент на исследуемые краниометрические признаки в мужской части выборки

Measurement	PC1	PC2
M.1	-0,29	-0,21
M.8	-0,42	-0,49
M.17	-0,22	-0,10
M.9	-0,14	-0,11
M.11	-0,41	0,04
M.12	-0,30	-0,24
M.45	-0,36	0,53
M.43	-0,16	0,41
M.46	-0,23	0,35
M.55	-0,23	0,01
M.54	-0,05	0,09
M.51	-0,14	0,15
M.52	-0,08	-0,03
Sbnas/fmo-fmo	-0,20	0,06
Sbspn/ZM'-ZM'	-0,28	-0,09
SC	-0,03	0,11
SS	-0,04	0,06

Substantial heterogeneity is also observed in the female part of the sample. Five individuals are located in the central part of the distribution, while four are plotted at the margins (Fig. 3). The individual from burial 21 stands out in the area of large values of the second principal component (PC), exhibiting large transverse dimensions (Fig. 3; Table 4). Conversely, the individual from burial 33 is found in the opposite area, with small transverse cranial dimensions. Individuals from burials 35 and 38 are also found at the opposite sides of the first principal component (Fig. 3). Therefore, the individual from burial 35 has a relatively short and wide cranial vault, whereas the individual from burial 38 has the opposite characteristics.

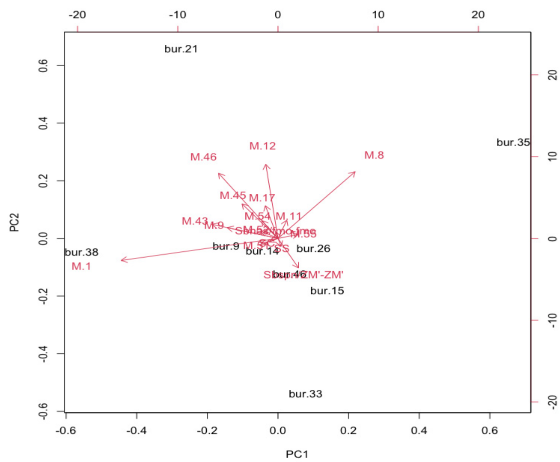

Fig. 3. Female individuals of the sample in the space of the first and second principal components.
Рис. 3. Расположение индивидов женской части выборки в пространстве первой и второй главных компонент.

Table 4

Loadings of the studied craniometric traits on the first and second principal components in the female part of the sample

Таблица 4

Значения нагрузок первой и второй главных компонент на исследуемые краниометрические признаки в женской части выборки

Measurement	PC1	PC2
M.1	-0,74	-0,16
M.8	0,37	0,48
M.17	-0,06	0,24
M.9	-0,24	0,08
M.11	0,04	0,13
M.12	-0,06	0,54
M.45	-0,17	0,25
M.43	-0,31	0,10
M.46	-0,28	0,47
M.55	0,10	0,03
M.54	-0,08	0,13
M.51	-0,08	-0,04
M.52	-0,08	0,05
Sbnas/fmo-fmo	-0,01	0,05
Sbspn/ZM'-ZM'	0,10	-0,21
SC	-0,04	-0,03
SS	0,01	-0,06

Intergroup comparison

The intergroup comparison was conducted using canonical discriminant analysis with three additional samples from Africa: from Uganda, the northern provinces of Ethiopia (Tigre), and from Kenya (Teita). It is assumed that Teita and Uganda sample include crania that represent equatorial morphological complex, while the Tigre sample displays traits associated with Caucasoid ancestry.

The first vector (PC) is associated with the zygomatic width (M.45) and orbital width (M.52), while the second PC is negatively associated with the bimaxillary breadth (M.46) and nasal breadth (M.54) (Table 5). The crania from Deraheib predominantly fell within the distribution area of the Ethiopian sample which displays Caucasoid morphological features (Fig. 4). Some individuals were found to overlap with the distribution area of the Ugandan crania. Notably, the individual from burial 8 is plotted between the distribution areas of Teita and Uganda samples thus exhibiting Equatorial features.

For a broader intergroup analysis, sample means for groups of different periods from Africa and the Middle East were used (Fig. 4). The first vector (PC) displayed maximum loadings for the cranial length (negative association) and cranial breadth (positive association) (Table 6). The second vector (PC) exhibited a strong correlation with orbit width. The Deraheib sample turns out to be most similar to the Bedouin samples from Jordan, as well as to the sample of Italians. In other words, Deraheib displayed affinities to the samples of European ancestry from the Mediterranean area. Similarly, samples with equatorial features (Teita, Uganda) were clustered on one pole of the distribution, while those from the Middle East were located on the other pole. The studied sample, along with the Bedouins and Italians, fell between these two groups. Other Bedouin samples, as well as the samples from North and East Africa, were located separately in the region of small values for the second vector (Fig. 5).

Table 5

Standardized coefficients of discriminant functions calculated based on cranial vault and facial dimensions

Таблица 5

Стандартизованные коэффициенты дискриминантных функций, рассчитанные на основе признаков мозгового и лицевого отделов черепа

Measurement	Can I	Can II
M.1	0,19	0,02
M.8	-0,29	0,28
M.17	-0,31	-0,31
M.9	0,40	-0,00
M.10	-0,04	0,07
M.12	0,32	0,27
M.26	-0,24	-0,23
M.27	-0,25	-0,26
M.28	0,08	0,24
M.29	-0,22	-0,15
M.30	-0,16	-0,28
M.31	-0,19	0,17
M.45	0,56	-0,10
M.46	0,15	-0,57
M.55	-0,16	-0,04
M.54	0,40	-0,38
M.51	0,75	-0,04
M.52	0,31	-0,12

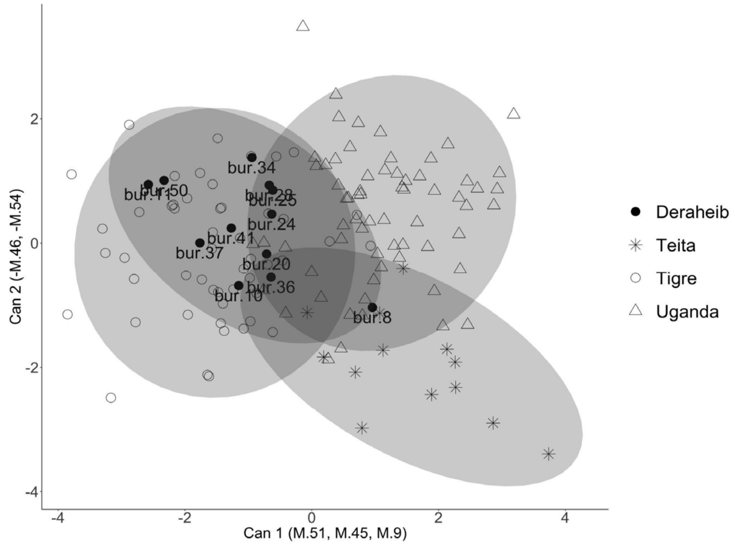

Fig. 4. Individuals of four cranial samples in the space of the first and second canonical vectors obtained as a result of canonical discriminant analysis based on cranial vault and facial dimensions
Рис. 4. Распределение индивидов четырех краниологических серий в пространстве первого и второго канонических векторов, полученных в результате канонического дискриминантного анализа, проведенного по признакам мозгового и лицевого отделов черепа.

Discussion

The territory of Northern Sudan has experienced complex ethnic processes since ancient times, as confirmed by modern linguistic data [Dyakonov, 1988, p. 23–24]. Egyptian colonization of Northern Sudan in the II millennium BC did not significantly contribute to the ethnic composition of the region, in contrast to the influence of the speakers of the Nilo-Saharan languages, including Meroi [Rilly, de Voogt, 2012, p. 174–175]. The infiltration of the Arab population at the end of the I millennium AD had the most significant impact on the population of Northern Sudan. However, many aspects of the population dynamics in this region throughout its history remain unclear, thus requiring a comprehensive analysis of all available data, including cranial samples.

Previous studies of Northeast African skeletal remains dated to the ancient to Medieval times, including those from Northern Sudan, have clearly shown the heterogeneity of the population of the region [Lebedev, Reshetova, 2017, p. 176].

Table 6

Standardized coefficients of discriminant functions calculated on based on average values of cranial vault and facial dimensions

Таблица 6

Стандартизованные коэффициенты дискриминантных функций, рассчитанные на основе средних значений признаков мозгового и лицевого отделов черепа

	Can I	Can II
Proportion	51,7	26,3
M.1	-0,69	-0,53
M.8	0,56	-0,03
M.9	0,00	0,00
M.17	0,41	0,00
M.45	0,03	-0,02
M.51	-0,10	0,98
M.52	-0,02	0,14
M.54	-0,28	0,12
M.55	0,52	-0,25

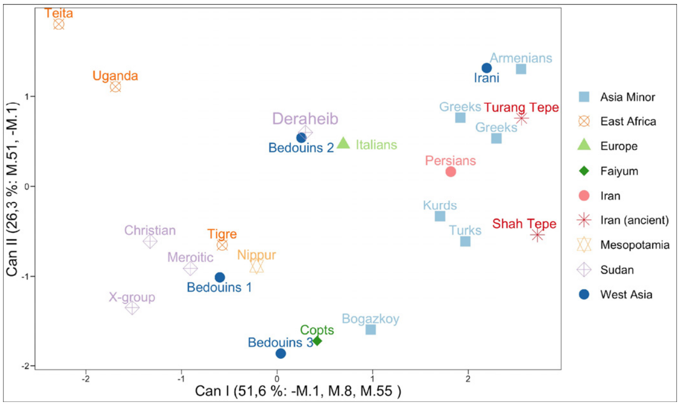

Fig. 5. Distribution of groups in the space of the first and second canonical vectors, calculated from the average values.

Рис. 5. Распределение групп в пространстве первого и второго канонического векторов, рассчитанные по средним значениям.

The scarcity of skeletal samples dated to the Medieval period in the studied region makes the results of this research unique.

Intragroup analysis of the Deraheib sample reveals that it is not morphologically homogeneous. This result is in accordance with that of the analysis of various types of burial rites found at the site, and with the information from Medieval written sources that mention the heterogeneity of the population of this territory [Krol, Tolmacheva, 2023, in press].

Most of the crania are similar to modern southern Caucasoids from Ethiopia. According to the mean cranial measurements, the Deraheib sample is close to the Bedouins from Jordan, characterized by a medium length and a small width of the skull [Bernhard, 1993, p. 121]. However, this result must be taken cautiously, since Bedouin groups are uniform in terms of lifestyle but not biological characteristics. The Deraheib sample is not similar to other Bedouin groups, which is not surprising considering that “Bedouins” is an umbrella name for various populations.

The Deraheib sample exhibits no similarity to other samples from Sudan of different periods. This observation emphasizes the discontinuity between the Nubian Christian population of the VI–XVI centuries and the Muslim population. On the other hand, samples Meroitic, X-group and Christians from Sudan are close to each other. This may imply continuity of the population during earlier times in this territory, a finding also observed in other samples.

The sample from Deraheib does not exhibit similarity to the East African equatorials as well; this is yet another argument in support of the prevalence of the South Caucasoid component. Finally, the morphological similarity of the studied sample to modern Italians is also worth noting.

In terms of intergroup analysis, the Deraheib sample occupies an isolated position compared to almost all reference groups. Thus, while the Deraheib population primarily displays features associated with Caucasoid morphological complex, it also exhibits unique traits that separate it both from Caucasoids and Equatorials. These findings are evident in the results of both intragroup and intergroup analyses.

Conclusion

Our study of the cranial sample from the Southern necropolis of Deraheib supports both the historical evidence and previous archaeological research, indicating heterogeneity of the population of the site. However, due to the limited sample size, the exact level of morphological variation of the population cannot be definitively determined. Nevertheless, the morphological specific of some individuals from Deraheib, both at the intragroup level and against a background of various reference samples, is clearly observed.

Through a comparative intergroup analysis employing numerous Equatorial and Caucasoid samples from this and neighboring regions, it can be inferred that the population buried in the Southern necropolis of the Deraheib shares more morphological similarities with the groups of European ancestry rather than with the populations of East Africa.

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Fedorchuk O.A., https://orcid.org/0000-0002-9645-2014
Chirkova A.Kh., https://orcid.org/0000-0002-4332-0747
Ladynin I.A., https://orcid.org/0000-0002-8779-993X
Berezina N.Ya., https://orcid.org/0000-0001-5704-9153

Сведения об авторах:

Федорчук Ольга Алексеевна, кандидат биологических наук, научный сотрудник, Московский государственный университет имени М.В. Ломоносова, биологический факультет, Москва.

Чиркова Алина Харисовна, кандидат исторических наук; научный сотрудник, Научно-исследовательский институт и Музей антропологии им. Д.Н. Анучина, Московский государственный университет, Москва.

Ладынин Иван Андреевич, доктор исторических наук, доцент, исторический факультет, Московский государственный университет имени М.В. Ломоносова, Москва.

Березина Наталия Яковлевна, кандидат биологических наук, старший научный сотрудник, Московский государственный университет имени М.В. Ломоносова, Научно-исследовательский институт и Музей антропологии им. Д.Н. Анучина, Москва.

About the authors:

Fedorchuk Olga A., PhD, Researcher, Lomonosov Moscow State University, Faculty of biology, Department of anthropology, Moscow.

Chirkova Alina Kh., PhD, Researcher, Lomonosov Moscow State University, Anuchin Research Institute and Museum of Anthropology, Laboratory of Studies about races, Moscow.

Ladynin Ivan A., PhD, Lomonosov Moscow State University, Faculty of History, Moscow.

Berezina Natalia Yakovlevna, PhD, Senior Researcher Lomonosov Moscow State University, Anuchin Research Institute and Museum of Anthropology, Laboratory of Studies about races, Moscow.

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