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HAPLOGROUP ANALYSIS FOR A MEDIEVAL RUSSIAN BURIAL OF 16TH–17TH CENTURES IN RADONEZH (MOSCOW AREA)

INTRODUCTION AND HISTORICAL CONTEXT

The main aim of the research was to make a haplogroup testing for a Russian medieval burial and to look at its possible analogs in other medieval DNA samples. For the test object two skulls excavated in 1989 from the Radonezh cemetery dating back to the 16th–17th centuries were chosen. The first reason for that choice was a serious significance of the region in late medieval Russian history and the second reason was the good quality of preservation of the skulls. The excavations were made by the Sergiev Posad (former Zagorsk) State History and Art Museum-Preserve expedition, and the leader of the excavations was Dr. V. I. Vishnevsky.

Radonezh was a Russian medieval town near the Sergiev Posad. To the end of XVIII century Radonezh became a small village but before it was the center of the parish of the same name. It is situated about 55 km north-east from Moscow. The first settlement of Radonezh was founded in the 11th century, probably by Novgorod Sloven of Krivichi settlers near the preceding Finno-Ugric villages.

The settlement of the entire Radonezh region followed the river Vorya, flowing into the Klyazma river. In the first millennium AD, there was a typical fortified settlement of the Finno-Ugric population in the middle course of the Vorya. At the end of 11th–12th centuries, a group of the villages of Slavic Krivichi was located there, and they are known in archeological literature due to well-preserved monuments of kurgan (mound) burials in the middle Vorya. Settlements with the name Radonezh existed in the past in the Smolensk area, at the head of the Oka river (at the junction of the modern Kursk and Orel regions) and in the middle reaches of the Kirzhach river (Vladimir region).

Most early settlements in the Moscow area, analogs of early Radonezh, ceased to exist during the Mongol invasion in the mid-13th century and were not renewed afterwards¹.

¹ *Chernov S. Z.* Historical landscape of ancient Radonezh. Genetics and Semantics // Monuments of Culture. New Discoveries. Writing. Art. Archeology. M., 1989 (URL: <http://www.rusarch.ru/chernov4.htm> (last visited — 21.12.2018)).

The area of Radonezh, lying to the north, was not devastated in 1238–1240. According to archaeological data, its second birth due to population inflow began in the second half of the 13th century and the first half of the 14th century. The custom of piling burial mounds was abandoned, but the ware style, similar to that found in mounds, and traditions dating back to the pre-Mongol period, were preserved. The name of the city is presumed to be also associated with Old Russian time, as the name «Radoneg» has a Slavonic origin, but other versions exist. Radonezh then became part of the Rostov-Suzdal and Moscow principdoms. The famous Trinity Monastery of the Russian Orthodox Church began in the vicinities of Radonezh.

The name of this territory is widely known thanks to Sergius of Radonezh, who spent part of his youth here and founded the Trinity Monastery. The first mention of «Radonezh Spring» can be found in the Life of Sergius of Radonezh, where in the 1330s families of Rostov boyars were resettled, including the parents of Bartholomew (the first name of Sergius). In documents, Radonezh is first mentioned in the testament of prince Ivan Kalita, as a village among possessions inherited by his wife Ulyana and children. In the 1370s, Prince Vladimir of Serpukhov, cousin of Grand Duke Dmitry Donskoy, the hero of the Battle of Kulikovo, became the ruler of Radonezh. At the turn of the 14th–15th centuries, Radonezh was first mentioned as a small town; under Vladimir Andreevich there might have been construction of a small earthen fortress. In 1410, Radonezh belonged to the son of the Serpukhov prince, Andrey, and until 1426 it was the capital of a small principality.

In 1422, during the reign of Prince Andrey Vladimirovich, the relics of St. Sergius were uncovered. Soon the white-stone Trinity Cathedral was built inside the Trinity Sergius Monastery, with the prince's participation. This is evidence of Radonezh's close connection with the monastery of St. Sergius. In 1425–1426, all the sons of Vladimir Andreevich died from the cold weather, and Radonezh became an ordinary town of the Serpukhov principdom; after the massacre of its owner, Prince Vladimir Yaroslavich, the grandson of Vladimir Andreevich, the town became part of the possessions of Grand Duke Basil II the Dark. At the end of the 15th century the town of Radonezh, was joined with the lands of the Moscow principality and became the center of the same-named uyezd (parish) and then volost (district).

At the beginning of the 16th century, Ivan III formed the Radonezh district. From the 14th century, trade tax and customs duties were collected, and in the 16th century a coach station was arranged, where up to 40 coachmen lived.

E. G. Ershova (Botanical Garden of Moscow State University) touched on interesting aspects of the early history of Radonezh. She tried to evoke the landscape of these places in the era of St. Sergius of Radonezh with the help of palynology data (the science of flower pollen). Vegetation typical for the southern taiga — fir, oak, aspen, and linden — prevailed in the Torgosha and the Pazha interfluvium, where the Trinity Monastery emerged at the initial stage. In the 14th century there was a significant drop in temperature, which led to rapid change in the composition of the forests. In addition, mass land clearance for plowing began during this period and reached its maximum in the 15th–16th centuries.

During the 15th–16th centuries, someone owned all land of the district, which was once free. In the middle of the 16th century, about 45 % of land was in the possession of the Trinity Sergius Monastery; about 38 % belonged to lay people; about 5 % belonged to several Moscow and Moscow-area monasteries; about 1% belonged to the royal household; and about 1 % was listed as possessions of the town.

During the Time of Troubles, Radonezh was devastated and then reborn as the village of Gorodok (Town), part of the Morozovskaya volost of the Dmitrovsky district. During the Troubles, at the beginning of the 17th century, Radonezh was completely ruined and its lands passed into the possession of the Trinity Sergius Monastery.

In November 1616, czar Mikhail Fedorovich Romanov ordered «To give Radonezh to the monastery of Holy Life-giving Trinity, the patrimony of Holy Father Sergius», never resurrecting the town of Radonezh and the twelve wastelands that were previously attributed to the coach staging post. In December of the same year, monastery authorities appealed to the czar, asking him to give them a tower from state possession in the neighboring village of Vozdvizhenskoe, because «they had nothing to build a church from and to set out a monastery court (representation house) with». A large unheated tower was converted into a tent church, dedicated to the feast of the Transfiguration of Christ (celebrated on 6/19 August). In the attached monastery canteen there were chapels of «the royal saint Michael Malein and Sergius of Radonezh».

In the spring of 1617, Polish prince Vladislav began his march on Moscow to claim the throne, at the invitation first of Tushino and then of Moscow boyars in 1610. After the unsuccessful Moscow attack on the night of October 1, 1618, the prince moved along the Pereslavl road inland. Perhaps he intended to capture the Trinity Sergius Monastery and, based on this success, to obtain money from the Sejm to continue the war. By this time, the monastery had its own archers and gunners, so Vladislav, having understood the situation and remembering the results of his previous siege, decided not to tempt fate further. He moved further along the road to the village of Rogachevo and began negotiations. They passed the village of Deulino, where the Monastery's authorities sent «with the ambassadors of the town of Radonezh, the priest Simeon with the honest life-giving cross, gold and beads, decorated with precious stones... and with a decorated analogion and with a silver dish». On December 1, the text of the treaty was finally adopted. By chance, the Radonezh priest became a participant of the truce that put an end to the Time of Troubles. As peace was restored, the Monastery's authorities quickly populated the new patrimony by granting privileges and issuing loans to peasants who agreed to move to Radonezh. By the middle of the 1620s, ten land peasants' and thirteen landless peasants' households were registered in the village of Radonezh, as well as the monastery's household, populated by «monks for the supervision of monastic plowing» and an ox farm. The households of a priest, a sacristan, and four beggars' reclusions were located in the churchyard. A bell-tower was added to the Transfiguration Church. The inactive church of St. Athanasius and Cyril of Alexandria was also preserved. The territory of the churchyard, which was not occupied by the cemetery, was rented to local peasants who used it as a farm field.

The complex of archaeological monuments of Radonezh consists of a fortified settlement (remains of the fortress of the 14th century), the village (remains of the settlement of the 14th–18th centuries), and burial ground (the cemetery of the 16th–17th centuries at the church of Athanasius and Cyril of Alexandria). In the 19th century, the village district included the village of Glebovo, the village of Antipino, Koros'kovo, Novosyolki, Repikhovo, and Ryazantsy. In 1832 it was inhabited by 750 people; the population was 809 in 1927 and now only 253. In 1989, the village regained its ancient name.

DESCRIPTION OF THE BURIAL AND PROBLEM STATEMENT

At the medieval layers of the Radonezh burial ground, excavations in 1988–1990 uncovered 38 burials, as well as remnants of 107 destroyed burials (according to the number of skulls). Fragments of white stone tombstones from the graves date back to the first half and middle of the 16th century. In burial 13, in the right hand of a skeleton, a silver coin from 1560–1584 was found.

«Burial #1 (КВ-А-Б/1-2). No traces of a pit. The burial is filled by light-brown soil with ceramic fragments. It is oriented to the South-West by the head, azimuth 245 degrees. The depth is 0.9 from the surface. The bones are of medium safety, the skeleton lies on the right side. The knees lie 20 cm from each other. The feet and shins were destroyed by later burials. The hands are folded together. The orbits are oriented towards the South-West. The skeleton is attributed to a man of the age about 25 years. In the nose bridge and in the crown area there are small oval holes of around 1 cm diameter. An iron knife was found near the hips, a bronze cross with the Calvary depiction was found below the right shoulder. The cross was dated by M. V. Sedova by 16th–17th centuries. During the excavating, just below the burial, another burial was found (burial #13)»².

Burial #1 is an exception in the position of the backbone and the placement of arms. It can be explained either by a casually neglected coffin, in the event that the funeral took place in an extreme situation. The deceased died a violent death as just above the bridge of the nose, bullet holes were found towards the top. Probably, the haste of the funeral is explained by the presence of artefacts with the deceased: a cross on the chest and a knife in a leather sheath on the belt (while all the burials, except for two, are non-inventory). The small depth of the grave is explained by the fact that the gravediggers at the hood came across the skeleton of an earlier burial, and rather than pull it out, they put the deceased on top. Burial #1 was taken out by a monolith and brought to the museum, and while dismantling it directly under burial skeleton 1, one earlier skull (skull #2) was found.

According to the dating,

«The estimated time of the Radonezh burial functioning can be estimated at around a century. The later burial #1, which overlays burial #13 (dated by coinage at 1560–1584) can be dated to the early part of the 17th century. In 1617 the nearby Church of Athanasius the Great was mentioned in the landmark book as empty, so the cemetery was abandoned. The Athanasius the Great cemetery operated from the beginning of the 16th century to the beginning of 17th century»³. The artefacts of the burial are presented by Picture 1.

² *Vishnevsky V. I.* The Report about the Excavations of the expedition of Zagorsk State History and Art Museum-Preserve in the Zagorsk district in 1989 // The Archive of the Archaeology Institute of the Russian Academy of Sciences. P-1. No. 1396; partly outlined in: *Mustafin Kh. Kh., Alborova I. E., Vishnevsky V. I., Semenov A. S.* The first results of Y-DNA haplogroup testing for a medieval Russian burial of the 16–17 centuries in Radonezh (Moscow area) // *Rusin*. 2017. №1 (47). C. 108.

³ *Vishnevsky V. I.* Old Radonezh (according to the archaeological excavations of 1980-ies), in *Sergiev Posad State History and Art Museum-Preserve. Reports, 1995*. Pp. 12–30 (URL: <http://museum-sp.ru/specialists/editions/nauchnye-izdaniya/sergievo-posadskiy-muzey-zapovednik-soobshcheniya-1995/> (last visited — 12.12.2018)); partly outlined in: *Mustafin Kh. Kh., Alborova I. E., Vishnevsky V. I., Semenov A. S.* The first results of Y-DNA haplogroup testing for a medieval Russian burial of the 16–17 centuries in Radonezh (Moscow area) // *Rusin*. 2017. №1 (47). P. 108.

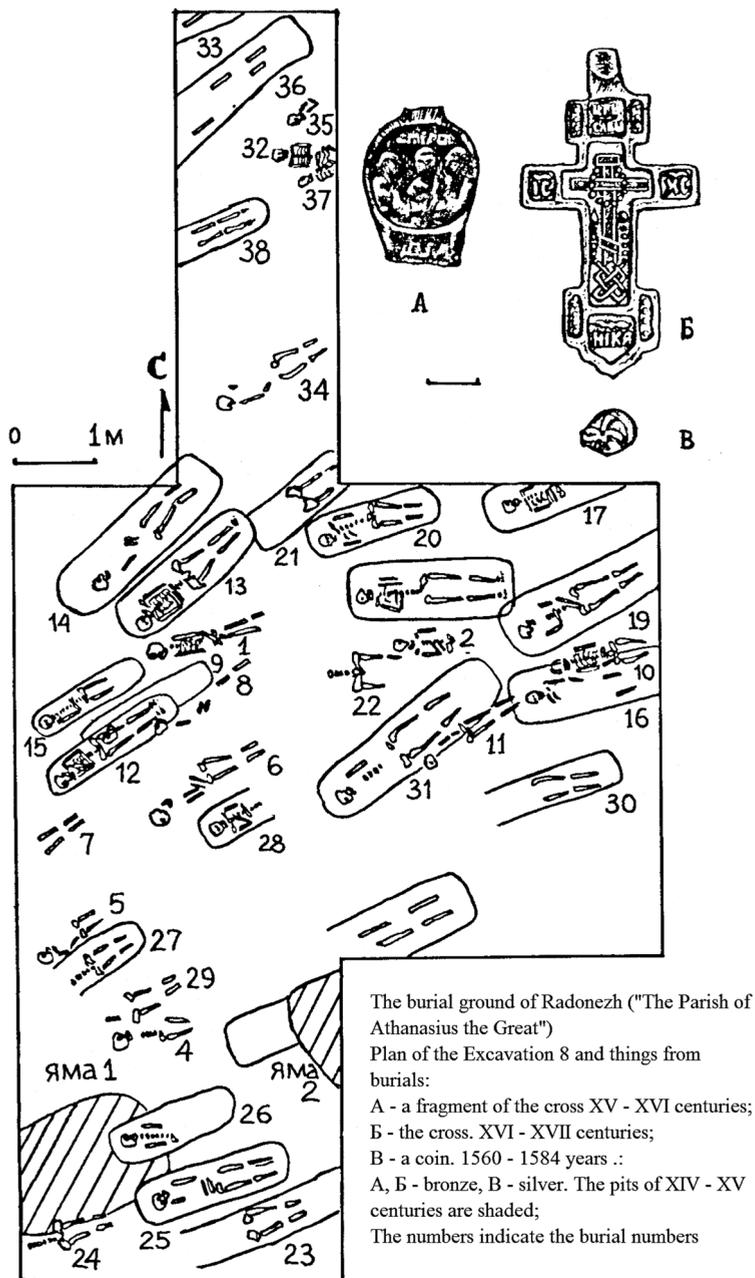


Fig. 1. The burial ground of Radonezh (The Parish of Athanasius the Great).
 Plan of the Excavation № 8 and burials.

(Vishnevsky V. I. Old Radonezh (according to the archaeological excavations of 1980-ies), in Sergiev Posad State History and Art Museum-Preserve. Reports, 1995. Pp. 12-30 (URL: <http://museum-sp.ru/specialists/editions/nauchnye-izdaniya/sergievo-posadskiy-muzej-zapovednik-soobshcheniya-1995/> (last visited — 12.12.2018)))

The skulls taken for research were kept in the laboratory of the archaeological section of the Sergiev Posad State History and Art Museum-Preserve, where they were studied and described. The aim of the research was to study these burials by the Y-DNA and mtDNA haplogroup testing and to put the results in the context of other medieval DNA from Slavic and other geographically near areas.

RESEARCH AND METHODS

These skulls were transferred in 2016 to the Laboratory of Historical Genetics, Radiocarbon Analysis, and Applied Physics of the Moscow Institute of Physics and Technology. DNA from teeth was extracted and the sequencing procedure was performed. A genetic test was done in the Laboratory of Historical Genetics, Radiocarbon Analysis, and Applied Physics of the Moscow Institute of Physics and Technology.

DNA analysis was carried out in a module, consisting of four glove boxes. To avoid contamination, each box was strictly separated from others and from the environment, and atmosphere air was replaced by inert gas of high purity. DNA from the teeth was extracted by means of commercial kit PrepFiler BTA Forensic DNA, used in criminal and forensic medicine for extracting degraded DNA from complicated objects. Obtained DNA was analyzed by means of the standard molecular genetic techniques, including real-time PCR on AB7500 equipment. Measurement of the concentration of the isolated DNA was carried out on a Qubitv2 fluorimeter on HighSensitivity chemistry. The concentration of isolated DNA was 0.3 ng in μl . The fragment analysis was carried out on the same AB 3500xl analyzer (but not in the sequencing mode, but in the fragment analysis mode). STRs were scanned at loci, the commercial Yfiler™ Plus kit (TermoFisher) was used with 27 STR markers.

Analysis of mitochondrial DNA was carried out using a set of reagents for molecular genetic identification of the individual MitoPlex MINI1 (Gordiz LLC). This reagent kit includes 4 primer pairs for enrichment of short sequences of the HVI control region (16009-16392) of human mitochondrial DNA. HVI target fragments (16009-16392) of mitochondrial DNA were enriched using real-time PCR on an AB7500 instrument. Subsequent analysis of the HVI sequences (16009-16392) was performed using Sanger sequencing with automated AB 3500xl capillary electrophoresis systems. Analysis of capillary sequencing data was carried out using Sequencing Analysis (AB) and MitoPlex (Gordiz LLC) tools.

To perform the genotyping process, the partially automated process was developed. a. The main part is a specially designed glovebox⁴ module that maintains high purity nitrogen, allowing DNA extraction in ultraclean conditions.

Below we outline the resulting process. The work contained the following stages:

- preparing equipment and tools;
- cleaning the sample from contamination;
- grinding the sample into a powdery state;

⁴ Matsvay A. D., Alborova I. E., Pimkina E. V., Markelov M. L., Khafizov K., Mustafin Kh. Kh. Experimental approaches for ancient DNA extraction and sample preparation for next generation sequencing in ultra-clean conditions, in *Conservation Genetics Resources*. 2018. Pp 1–9. (URL: <https://doi.org/10.1007/s12686-018-1016-1> (last visited — 21.12.2018)).

- extracting DNA from a ground sample;
- measuring concentration of DNA;
- carrying out PCR and capillary electrophoresis of PCR products to determine the STR loci of the Y chromosome (27 STR loci).

The Y-DNA analysis showed the R1a-M458 Y-DNA haplogroup, typical for the Slavic and other Central European populations. The result can be grouped with other still scarce Slavic Y-DNA medieval data and with one result from Central Europe (Table 1).

During the research the following haplotype was detected (table 2). According to predictor: <http://www.nevgen.org/#>, the subclade can be identified as M458-L1029 with 97 % probability.

Table 1.

Known Y-DNA haplogroups from different Old Slavic burials and a burial from Medieval Netherlandes⁵

Site	Y-DNA haplogroup	Source
Devichi Gory , Pskov district, (8 th –10 th centuries)	N-M46 (former N1c)	(<i>Chekunova et al.</i> , 2014)
Usedom , Eastern Germany (13 th century)	R1a-M458, E1b-M215	(<i>Freder</i> , 2010)
Izvoz , St. Petersburg area (11 th –16 th century)	R1b-M343	(<i>Chekunov</i> , 2016)
Vladimir (1100–1220)	I2a-M26	(<i>Sikora</i> , 2017)
Oldenzaal , Netherlandes (15 th century, sample V1278)	R1a-M458	(<i>Reusink</i> , 2014)
Radonezh , beginning of 17 th century	R1a-M458	<i>This work</i>

Table 2.

Y-chromosome haplotype of male Radonezh Burial #1

	HG	389I	389II	390	456	19	385	385-2	458	438	448
Burial #1	R1a-M458	13	29	22	17	14	11	14	16	11	20

Continuation of table 2:

	GATA_H4	392	393	439	635	447	576	449	627	481	F387S1a	F387S1b	460
Burial #1	10	11	13	10	23	23	16	32	22	25	32	37	11

⁵ Partly outlined in: *Mustafin Kh. Kh., Alborova I. E., Vishnevsky V. I., Semenov A. S.* The first results of Y-DNA haplogroup testing for a medieval Russian burial of the 16–17 centuries in Radonezh (Moscow area) // *Rusin*. 2017. №1 (47). P. 109.

DISCUSSION

According to www.gentis.ru, R1a-M458 is considered to be a subclade inherent to Slavic and Baltic people, with maximal density in Poland, Lithuania, Czech Republic, Slovakia, Ukraine, and North-Western Russia. Haplogroup R1a-M458 is found mainly in Central and Eastern Europe. The main area is limited to Poland, the Czech Republic, and Slovakia. In central and southern Poland, the frequency of haplogroup reaches its maximum, about 40 %, while in the north, east, and south-west the range is from 15 to 23 %. In the Czech Republic it is 25 %, and 18–25 % in Slovakia. Subclade M458 is present more to the East as well. In the eastern part of Europe, the frequency of M458 is still high, for example, in Ukraine and Belarus from 7 % to 22 % in the eastern part of Ukraine and Western Russia. Maximum frequencies in Russia are recorded in the Orel region (14 %), and in the Pskov, Belgorod and Kostroma regions (uniformly up to 12 %). Further to the east, in the Tatar populations, the measure is approximately 4–5 %. In the west of Poland and in Germany, the R1a-M458 frequency drops slightly to 10 %. In the Balkans it is also present: 9 % in Croatia, 8 % in Bosnia, 5 % in Albania, 5 % in Romania, 4 % in Greece, 4 % in Macedonia, 3 % in Serbia, and 2 % in Slovenia. In Scandinavia, the frequency of haplogroups is greatly reduced to 2 % in Swedes, although in Denmark it is about 4 %.

The mitochondrial results are presented in table 3.

Table 3.

**Known Y-DNA haplogroups from the population
of the Western side of Slavic area and from the Northern Europe**

Burials	HVR1 mutations	Source
Radonezh, burial #1 (male)	16354T (H2a1)	<i>This work</i>
Cedynia, 900–1400, Poland	16354T (reported as H)	<i>(Juras, 2012)</i>
Nordland Norway burials, 750–1100	16354T (H2a1)	<i>(Krzewiska, 2015)</i>
Radonezh, burial #13 (female)	16126C, 16163G, 16223T (H or JT)	<i>This work</i>

The extended analysis of the male skull revealed the H2a1 mitochondrial haplogroup (16354T is defining). The female skull revealed the H or JT mitochondrial haplogroup (the mutation 16126C is defining for JT, although it can occur in H variants, for example H14b1). Not all defining mutations were read due to destruction made by acidic soil, so extended research was carried out.

Haplogroup H is the most common mitochondrial haplogroup in Europe, as it includes more than half of the modern female population of North-West Europe. This haplogroup is also common in North Africa and the Middle East. The frequency of the spread of this haplogroup in Europe decreases towards the southeast, accounting for only 20 % in the Middle East and the Caucasus, and less than 10 % in the Persian Gulf, North India, and Central Asia.

The subclade H2 is inherent to Northern and Eastern Europe. JT are also common to the western part of Eurasia, and moving eastward the concentration of J and T falls drastically.

The research revealed that the medieval Russian people from Radonezh represent the typical Northern and Eastern European population subclades. Mitochondrial haplogroup H2a1 has its representatives in Medieval Baltic Region. The identical motives were detected in Polish Cedynia burial (900–1400) and Early Medieval Norway Nordland burials (750–1100). The different H and JT subclades could be found in medieval DNA's throughout all Europe from England to Russia (for example Ozero Beloe⁶, less than 500 km from Radonezh).

Regarding the only Y-DNA from medieval Russian burial from the Moscow area, it is too early to make definitive conclusions about the whole population of the region in XVII century. However, the presence of the R1a-M458 in the Northern Russian area not only supports the view of R1a Y-haplogroup presence for all medieval Russian lands, regardless of principality borders; but also hints that certain genetic unity with the Central Europe regions could exist (as the most serious concentrations of R1a-M458 are noticed in the western part of the Slavic area). The western migration is well-discussed in literature⁷. In particular, it is suggested that some of Novgorod Slovens and Krivichi components might have connections in the western part of Slavonic area.

Concerning Radonezh, we have two scenarios: either the buried man was a descendant of Slavic settlers of Russian times, or he was a descendant of pre-state settlers, such as Finno-Ugrians or Balts. The high level of Y-DNA N-M46 (former N1c) in Finno-Ugric and Baltic populations, and old N-M46 in pre-Rus burial (Devichi Gory, Pskov area), provide an initial hint that the buried man can descend from the second wave of settlers, most likely Slavic of Russian times. The main version is that his ancestors could be connected with the Baltic coast. The town of Radonezh is regarded by many historians as the early offspring of Novgorod Slovens (and Pskov Krivichi). In the same time, Novgorod itself could be populated partially by Baltic Slavs, being the part of Rurik's Rus. The Rostov area, to which Radonezh belongs, was also the part of Rurik's state, so a genetic continuity with Baltic settlements and Pskov-Novgorod is probable. Two medieval R1a-M458 from Usedom (12th–14th centuries, German-Polish border) and from Radonezh (17th century, Russia) support this view. Female H2a1, having counterparts in Norway and Poland, also fits this view. A complete understanding of genetic picture of Russian plain populating process requires more research projects.

We conclude that the experiment was proper and a positive result was obtained. Nevertheless, we see that even in improved conditions, the capacity of the system falls drastically, so for the needs of solving analytic tasks for acidic Russian soil, the system and process should be further improved. In conclusion, the experiment showed that the method developed at the Moscow Institute of Physics and Technology works for degraded samples and can be a good base for future development. The technology of the glovebox and new technological processes proved to be a good solution for research involving old, degraded DNA.

⁶ Kulikov E. E. Molecular Genetic Characteristics of Medieval Populations of the Russian North // Russian Journal of Genetics. 2004. Vol. 40. P. 1–9.

⁷ Молчанова А. А. Балтийские славяне и Северо-Западная Русь в раннем средневековье. М., 2008.

Информация о статье

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Заголовок: Haplogroup analysis for a Medieval Russian burial of 16th–17th centuries in Radonezh (Moscow Area) [Анализ гаплогрупп для средневекового русского захоронения XVI–XVII веков в Радонеже (Московская область)]

Резюме: В данной работе авторы сообщают о генетическом исследовании, задачей которого явилось определение гаплогрупп из двух средневековых русских захоронений на месте древнего города Радонеж около г. Сергиев Посад Московской области (археологический памятник «Радонеж», приход Афанасия Великого, раскопки Археологической экспедиции Сергиево-Посадского музея-заповедника (ранее, Загорская археологическая экспедиция, ЗАРЭ, под руководством д.э.н. В.И. Вишневого). Период времени — XVI–XVII вв., период Русского Царства и последующее Смутное время. Результатами являются выявленный субклад Y-гаплогруппы R1a-M458, типичный для Центральной и Восточной Европы, и митохондриальные гаплогруппы H2a1 и H или JT (типичные для Северной и Восточной Европы). Это позволяет сделать предположение о том, что население западнославянских регионов могло иметь определенную генетическую близость к средневековому населению Подмосковья. Возможный континуум мог включать в себя Балтийский регион (ранее был опубликован один славянский R1a-M458 от Узедома) или Дунайско-Карпатский регион (регион самого раннего славянского присутствия согласно русским летописям и присутствия Y-гаплогруппы R1a еще в эпоху Бронзы). Митохондриальная ДНК также показывает восточно-европейские или балтийские связи. Полученный результат в целом говорит о связи носителей изученных ДНК с северо- и средневропейским населением. Для процесса генотипирования был разработан уникальный процесс основанный на модуле перчаточных боксов, который поддерживает азот высокой чистоты, что позволяет извлекать ДНК в ультрочищенных условиях.

Ключевые слова: биоинформатика, идентичность, средневековая идентичность, генофонд, популяционная генетика, палео-ДНК, SNP и STR маркеры Y-хромосомы, mt-ДНК, гаплогруппы, секвенирование

Литература, использованная в статье:

Chekunova, Elena Mikhaylovna; Yartseva, Natalya Valentinovna; Chekunov, Mikhail Konstantinovich; Mazurkevich, Andrei Nikolaevich. The First Results of the Genotyping of the Aborigines and Human Bone Remains of the Archeological Memorials of the Upper Podvin'e. Archeology of the Lake Settlements of IV–II Thousands BC: The chronology of cultures and natural environment and climatic rhythms // Proceedings of the International Conference, devoted to the 50th year of research of the Pile Settlements on the North-West of Russia. St. Petersburg State Hermitage, 2014. P. 287–294.

Freder, Janine. Die mittelalterlichen Skelette von Usedom: Dissertation Free. Berlin: University of Berlin, 2010. 206 p.

Juras, Anna. Ethnogenesis of the Slavs in the light of ancient DNA analyses: Thesis. Poznan: Adam Mickiewicz University, 2012. (URL: <https://repozytorium.amu.edu.pl/jspui/handle/10593/2702> (last visited: 09.06.2018)).

Krzewiska, Maja et al. Mitochondrial DNA variation in the Viking Age population of Norway // Philosophical Transactions of the Royal Society B: Biology. 2015. 370 p.

Kulikov, Evgeniy Evgenyevich. Molecular Genetic Characteristics of Medieval Populations of the Russian North // Russian Journal of Genetics. 2004. Vol. 40. P. 1–9.

Matsvay, Alina Dmitrievna; Alborova, Irina Eduardovna; Pimkina, Ekaterina Vladimirovna.; Markelov, Michael Leonidovich, Khafizov, Kamil; Mustafin, Kharis Kharrasovich. Experimental approaches for ancient DNA extraction and sample preparation for next generation sequencing in ultra-clean conditions // Conserva-

tion Genetics Resources. 2018. P. 1–9. (URL: <https://doi.org/10.1007/s12686-018-1016-1> (last visited — 21.12.2018)).

Mustafin, Kharis Kharrasovich; Alborova, Irina Eduardovna; Vishnevsky, Vladimir Igorevich; Semenov, Alexander Sergeevich. The first results of Y-DNA haplogroup testing for a medieval Russian burial of the 16–17 centuries in Radonezh (Moscow area) // *Rusin.* 2017. № 1 (47). P. 106–110.

Reusink, Paul. Determination of biological relationships within the medieval and post-medieval cemetery of the St. Plechelmus church in Oldenzaal using ancient DNA: Master thesis Human Osteology and Funerary Archaeology at the Faculty of Archaeology, Leiden University. Leiden, 2014 (URL: <https://openaccess.leidenuniv.nl/bitstream/handle/1887/28495/Binder1.pdf?sequence=1> (last visited — 21.12.2018)).

Sikora, Martin et al. Ancient genomes show social and reproductive behavior of early Upper Paleolithic foragers // *Science.* 2017. Vol. 5. P. 1–15.

Вишнеvesкий, Владимир Игоревич. Древний Радонеж (по материалам археологических раскопок 1980-х годов) // *Сергиево-Посадский музей-заповедник. Сообщения* 1995. М., 1995. С. 12–30.

Вишнеvesкий, Владимир Игоревич. Отчет о раскопках экспедиции Загорского музея-заповедника в Загорском районе в 1989 году // *Архив Института археологии Российской Академии наук.* P-1. № 1396.

Молчанова, А. А. Балтийские славяне и Северо-Западная Русь в раннем средневековье. М., 2008.

Чекунов, Михаил Константинович. Гаплогруппа R1b в бассейне реки Луга по результатам ДНК-типирования костных останков плохой сохранности у деревни Извоз // *Конференция «Ломоносов 2016».* Москва: MAX Press, 2016. С. 1–2 (URL: https://lomonosov-msu.ru/archive/Lomonosov_2016/data/8419/uid17076_report.pdf (last visited — 21.12.2018)).

Чернов, Сергей Заремович. Исторический ландшафт древнего Радонежа. Происхождение и семантика // *Памятники культуры. Новые открытия. Письменность. Искусство. Археология.* М., 1989. (URL: <http://www.rusarch.ru/chernov4.htm> (last visited — 21.12.2018)).

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Title: Haplogroup Analysis for a Medieval Russian Burial of 16th–17th Centures in Radonezh (Moscow Area)

Summary: In this work, the authors report results of complete research of haplogroup testing for two medieval Russian burials from the Radonezh area near Serguiev Posad, Moscow region (Old Radonezh settlement, the Parish of Athanasius The Great). The excavations were made by the Sergiev Posad (former Zagorsk) State History and Art Museum-Preserve expedition, headed by Dr. V. I. Vishnevsky. The time period is the 16th–17th centuries, the periods of Russian Czardom and the consequent Time of Troubles. The results are typically Central and Eastern European Slavic R1a-M458 Y-haplogroup subclade and H2a1 and H or JT mitochondrial haplogroups (typical for the Northern and Eastern Europe). This suggests the preliminary assumption, that if the populations of western Slavic regions can have a genetic affinity to the medieval population of the Moscow area. The area of continuity could include the Baltic area (one Slavic R1a-M458 from Usedom was published) or the Danube-Carpathian region (the region of earliest Slavic presence according to Russian chronicles and Bronze Age R1a presence). Mitochondrial DNA also show the Central European or Baltic affinities. The whole result show the relation of the buried people to Northern and Central European populations. To perform the genotyping process, the partially automated process was developed and the system was assembled as a unique complex containing the glove box that maintains high purity nitrogen, allowing DNA extraction in ultraclean conditions

Keywords: gene pool, population genetics, paleo-DNA, contamination, SNP and STR markers of Y-chromosome, mt-DNA, haplogroups, sequencing, identity, medieval genome

References:

- Chernov, Sergey Zaremovich. Historical landscape of ancient Radonezh. Genetics and Semantics, in *Monuments of Culture. New Discoveries. Writing. Art. Archeology*. Moscow: Federal State Unitary Enterprise "Academic Scientific Publishing, Production and Printing and Book Distribution Center "Science", 1989. Pp. 413–438 (URL: <http://www.rusarch.ru/chernov4.htm> (last visited — 21.12.2018)).
- Chekunov, Mikhail Konstantinovich. Gaplogruppa R1b v bassejne reki Luga po rezul'tatam DNK-tipirovaniya kostnyh ostankov plohoj sohrannosti u derevni Izvoz [Haplogroup R1b in the Luga basin by the results of DNA-typing of bone remains of poor preservation near the village of Izvoz], in *Conference «Lomonosov 2016»*. St. Petersburg, Russia. Moscow: MAX Press, 2016. Pp.1–2 (URL: https://lomonosov-msu.ru/archive/Lomonosov_2016/data/8419/uid17076_report.pdf (last visited — 21.12.2018)). (in Russian).
- Chekunova, Elena Mikhaylovna; Yartseva, Natalya Valentinovna; Chekunov, Mikhail Konstantinovich; Mazurkevich, Andrei Nikolaevich *The First Results of the Genotyping of the Aborigines and Human Bone Remains of the Archeological Memorials of the Upper Podvin'e. Archeology of the Lake Settlements of IV–II Thousands BC: The chronology of cultures and natural environment and climatic rhythms. Proceedings of the International Conference, devoted to the 50th year of research of the Pile Settlements on the North-West of Russia*. St. Petersburg State Hermitage, 2014. Pp. 287–294.
- Freder, Janine. *Die mittelalterlichen Skelette von Usedom [The medieval skeletons of Usedom]*. Dissertation Free. Berlin: University of Berlin, 2010 (in German). 206 p.
- Juras, Anna. *Ethnogenesis of the Slavs in the light of ancient DNA analyses*. Thesis. 2012. Adam Mickiewicz University in Poznan. (URL: <https://repozytorium.amu.edu.pl/jspui/handle/10593/2702> (last visited — 09.06.2018)).
- Krzewska, Maja et al. Mitochondrial DNA variation in the Viking Age population of Norway, in *Philosophical Transactions of the Royal Society B: Biology*. 2015. 370 p.
- Kulikov, Evgeniy Evgenyevich. Molecular Genetic Characteristics of Medieval Populations of the Russian North, in *Russian Journal of Genetics*. 2004. Vol. 40. Pp. 1–9.
- Matsvay, Alina Dmitriyevna; Alborova, Irina Eduardovna; Pimkina, Ekaterina Vladimirovna; Markelov, Michael Leonidovich, Khafizov, Kamil; Mustafin, Kharis Kharrasovich. Experimental approaches for ancient DNA extraction and sample preparation for next generation sequencing in ultra-clean conditions, in *Conservation Genetics Resources*. 2018. Pp 1–9. (URL: <https://doi.org/10.1007/s12686-018-1016-1> (last visited — 21.12.2018)).
- Molchanova, Anna Anatolyevna. *Baltiyskie slavyane i Severo-Zapadnaya Rus' v rannem srednevekov'e [Baltic Slavs and North-Western Russia in the Early Middle Ages]*. Ph. D. dissertation. Moscow, 2008. (in Russian).
- Mustafin, Kharis Kharrasovich; Alborova, Irina Eduardovna; Vishnevsky, Vladimir Igorevich; Semenov, Alexander Sergeevich. The first results of Y-DNA haplogroup testing for a medieval Russian burial of the 16–17 centuries in Radonezh (Moscow area) // *Rusin*. 2017. № 1 (47). P. 106–110.
- Reusink, Paul. *Determination of biological relationships within the medieval and post-medieval cemetery of the St. Plechelmus church in Oldenzaal using ancient DNA*. Master thesis Human Osteology and Funerary Archaeology at the Faculty of Archaeology, Leiden University, 2014 (URL: <https://openaccess.leidenuniv.nl/bitstream/handle/1887/28495/Binder1.pdf?sequence=1> (last visited — 21.12.2018)).
- Sikora, Martin et al. Ancient genomes show social and reproductive behavior of early Upper Paleolithic foragers, in *Science*. 2017. Vol. 5. Pp.1–15.
- Vishnevsky, Vladimir Igorevich. Old Radonezh (according to the archaeological excavations of 1980-ies), in *Sergiev Posad State History and Art Museum-Preserve. Reports, 1995*. Moscow. 1995. Pp. 12–30 (in Russian).
- Vishnevsky, Vladimir Igorevich. *The Report about the Excavations of the expedition of Zagorsk State History and Art Museum-Preserve in the Zagorsk district in 1989*, in The Archive of the Archaeology Institute of the Russian Academy of Sciences. P-1. No. 1396. (in Russian).