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Genomic Registration Issues in Eurasia and Ways of their Solution

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The article discusses the condition and perspective of DNA identification (genomic registration) in Russia and Eurasia. The authors outline the main issues in the development of forensic registration, such as: lack of introduction of modern technologies, low level of interaction between the institutions, inadequacy of statutory regulation of genomic registration, dependency on foreign supplies. Gaps in the state regulation of genomic registration are noted, issues of legal regulation and law enforcement practice related to the protection of genomic information are highlighted. Due to the increased migration process the DNA identification is an extremely relevant issue for Russia and Eurasia. The aim of the article is to study the theoretical aspects of the legislative policy aimed at DNA identification of the population. It is also aimed at detection and prevention of extremist crimes and at the study of registration practices. Extended analysis revealed that the existing laws and regulations in Russia are not fully effective, it is proposed to introduce additional measures to improve the legal support for genomic registration of the population of Russia and the countries of Eurasia. The possibilities of DNA identification are shown, the prospects of its improvement are analyzed.

Keywords: DNA identification of the population in Eurasia, genomic registration, forensic identification, detection and prevention of crime.

Research area: criminalistics, forensic activities, operational search activity.

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1. Introduction

The study analyses the use of modern methods of genetic identification for organization of DNA identification (genomic registration) of Eurasian population. Methods from different sciences for DNA identification are used – molecular genetics, biochemistry, mathematics, computer science, when they are transformed they are converted into special, forensic techniques (Perepechina, 2015). At the same time, special attention is paid to the issues of DNA data bank establishment in different countries.

The advantages and disadvantages of the main approaches to genomic registration based on the theory of forensic identification are considered. Considerable interest is shown in computer processing of primary data obtained by various methods used for genomic registration. The prospects for dealing with the issues of DNA identification which will be possibly refocused on another type of carrier of genetic properties in the form of SNPs (short for Single-Nucleotide Polymorphism, that stands for variations in DNA sequences that serve as markers for gene encoding) are presented. It will enable to establish an automated genomic registration database for the detection, investigation and prevention of crimes.

2. Theoretical Framework

Eurasia is a unique continent as there are densely populated countries there with a large number of nations and populations with a wide variety of DNA polymorphisms (differences in the DNA sequence in the genome, that allow to distinguish people and identify them) (Chemeris et al., 2018). Therefore, for DNA identification of personality in different populations throughout Eurasia, different sets with non-coincident marker loci are used. Another drawback of this approach is the non-deterministic level of polymorphism inherent in currently used carriers of genetic information. Emphasis is put on the types of polymorphism of DNA molecules used for DNA identification of personality and on some methodological issues related to their identification. At the same time, due to the inevitable DNA identification of the population, science and practice seek for solutions to reduce the amount of DNA information in the data bank. The main criterion for the formation, processing and use of the DNA data bank (or forensic genotyposcopic records) is the maximum digitization of genomic registration, provided that the absolute individualization of each person is unconditionally ensured.

3. Statement of the problem

Currently, in at least 60 countries the scientists are engaged in the national genomic data bank establishment built on the use of DNA polymorphism (Chemeris

et al., 2018). The first genomic registration data bank has been formed since 1987 in the UK (Werrett, 1997). The most numerous DNA data is loaded in the data bank of the People's Republic of China (PRC), there are 40 million samples (DNA profiles), in the US there are more than 17 million (the DNA databank was established in 1990), in the UK there are more than 6 million samples, in Thailand there are 145 thousand, in Russia there are 140 thousand samples (Chemeris et al., 2018). Although over the past years DNA identification methods in Europe, Asia and North America have been converging, there are still challenges of databanks merging. In this regard, it has to be admitted that the current approaches to the creation of DNA databanks do not meet the needs of society. Despite the widespread use of well-known STR-loci, SNPs are being actively studied as potential markers, including the SNPs analysis in different ethnic groups. One of the reasons of the research relevance is the opportunity to detect shorter DNA sections with their subsequent introduction into the data bank. Therefore, in order to achieve DNA identification of personality and DNA passportization of the population, it is necessary to focus on the solution of the following issues: introduction of modern technologies that will provide a high level of DNA digitalization; increasing the level of interaction between the institutions involved; improving the legal regulation of genomic registration, exemption of dependence on foreign supplies towards the extensive import substitution.

4. Methods

In order to implement the transition to SNPs for DNA identification and mainly for DNA passportization of the entire population of Russia it is necessary to have bioinformatic analysis of human genomes to determine the most optimal sites for the DNA polymorphism detection of different people from different ethnic groups. It should be noted that despite the fact that the ethnic characteristics of people inhabiting Eurasia will inevitably manifest themselves, more combinations of polymorphic SNPs should be chosen in order to completely eliminate the genetic barcodes coincidence.

5. Discussion

The currently used process of DNA identification of personality based on STR polymorphism implies that it is necessary to know the frequency of occurrence of the loci used and their combinations among the population groups the offender supposedly belongs to and therefore, while developing such a databank, particular attention should be paid to the matching of population groups by STR-loci for all ethnic groups of the

world. The extensive research including the study of DNA polymorphism among the population of Western and Eastern Siberia was carried out in our country and all over the world (Smolyanitsky, 2003; Stepanov et al., 2010; Zaumsegel et al., 2013). However, the introduction of massive parallel DNA sequencing as a method of identifying genetic traits in forensic practice in recent years has not justified itself, due to the fact that this method does not provide effective search in extensive data banks due to the large degree of ambiguity (Parson et al., 2016). So the level of DNA digitization of the obtained databanks will be even lower than currently provided. The examples from the practice of DNA analysis prove the relevance of DNA certification method towards SNP. The method made it possible to take 44 thousand tests to identify the remains of almost three thousand victims who were severely damaged in the World Trade Towers in New York during terroristic attack in 2001 (Biesecker et al., 2005).

The above-mentioned DNA identification method proposed for the genomic registration establishment has a number of advantages:

- wide representation and prevalence of these elements in the genome;
- better heritability;
- the possibility of establishing some phenotypic (external, important for the forensic data search work) human signs;
- inter-population (geographical) differences;

It provides opportunities not only for identification, but also for diagnostic studies. Thus, the 21 DNA fragments complex (SNP) proves to be sufficient for the differentiation of European, African and Asian populations (Zaumsegel et al., 2013). When using this method for DNA identification, it should be taken into account that it has ethnic and racial characteristics and some SNPs for one nation will be variable, while for the other nation the same SNPs will be almost invariant, but some other SNPs from the panel used will show an absolutely opposite result for this or other group. It is quite possible to do without preliminary establishment of the population features having only 100 SNPs when holding DNA identification based on multi allelic building codes. At the same time, studies of 175 snips of 729 Chinese people showed that the probability of random coincidence of SNPs test results of different people can be expected with an extremely low frequency – from 4.77×10^{-71} to 1.06×10^{-64} (Li et al., 2017).

It seems that DNA digitization carried out using the above-mentioned method will be extremely convenient and fixed due to the fact that the boundaries of SNPs digitization are determined by nature and can not change accidentally, it is very important for the compilation and maintenance of databanks (Lee et al., 2018).

The Institute of Biochemistry and Genetics of UFIC RAS has developed an original method of digitization in the binary format of four nucleotides in each SNP, which has a number of important advantages, including the formation of data banks (Garafutdinov et al., 2015).

This method will lead to the maximum level of digitalization, since the amount of information entered into the data bank during DNA identification with the help of SNPs will be no more than one kilobyte per one person. In addition, SNPs provide information about some peculiarities of a person's appearance e.g. skin pigmentation, hair, iris. Thus, the proposed approach assumes the highest level of DNA-digitization, since it is enough to have four digits to encode any SNPs in the form of primary data represented as a binary machine code. It is important to use neutral information about the polymorphism of DNA SNPs of a person making the genomic registration of the population and establishing relevant data banks for forensic purposes, in order to exclude any personal information, such as diseases and predisposing factors. Ethical weapons based on the genomic registration data of the Russian people cannot be created because the SNPs that come from parts of the genome are physically very far apart and it is impossible to use such information for targeted human exposure. Another issue concerns people whose information refers to personal data of restricted access (personnel of law enforcement agencies, state secret services, etc.). It can be solved by placing the DNA information about them into a separate block of digital media (disk) and the access should be determined by the Russian Federation Government (similar to dactyloscopic registration by the AFIS "Papillon" system). It appears that SNPs are the only type of DNA polymorphism that enables to hold genomic registration of the Russian population on its basis. Moreover, this method allows us to move away from the costly approaches offered by the US and UK companies. Therefore, we believe it makes sense to apply a different approach to DNA identification of a new generation on the basis of single-nucleotide polymorphism in Russia, which enables to hold genomic registration of the entire population of the country with the maximum level of DNA digitalization. Moreover, in such an important issue, the country can overcome its dependency on foreign technologies and advance the import substitution.

The genomic registration of the entire population is not just a state task but a supranational importance, in view of the fact that the international terrorism, transboundary organized crime, military conflicts know no boundaries. It will be possible to hold unified genomic registration of the population of these countries and

create international genomic barcode by organizing the interaction of bodies involved in forensic registration in different countries of Eurasia.

In the Republic of Kazakhstan, for example, in accordance with the Law “On dactyloscopic and genomic registration” dated December 2016, which shall be enforced from 01.01.2021, persons convicted of grave or particularly grave crimes are subject to mandatory genomic registration (On dactyloscopic and genomic, 2016). Kazakhstan also discusses the issue of legally subjecting all citizens to genomic registration (Tagaibekova, Al’zhanova, 2018). We strongly believe that the same decision should be made in the Russian Federation.

The People’s Republic of China is successfully developing key domestic technologies for the STR-PCR amplification kit, mitochondrial DNA sequencing equipment, consumables and reagents used to create a DNA profile data bank (Gao 2018; Liu, 2017; Mo, 2018; The New Resplendence).

Similar measures for establishing a databank of DNA profiles are also being taken in the Republic of Turkey (Osman, Mehmet, 2018), the Republic of Tajikistan (Ganiev et al., 2017), the Republic of Uzbekistan (Iskandarov, Tazhibaeva, 2017) and other countries of the Eurasian continent.

Since 2006, authorities of internal affairs of the Russian Federation keep track of the DNA data of biological material (genotype-recording) for identifying the persons who left biological traces at the accident scene and also for identification of corpses.

At the same time, it is necessary to amend the Federal law No. 242-FZ of December 3, 2008 “About the state genomic registration in the Russian Federation”. It will contribute to the full direction of all biological materials (blood, sperm, saliva, hair, etc.) in the laboratory of Forensic centers of the country’s regions for genotype registration, qualitative verification of persons on this account and the use of the results of such tests in the investigation of crimes. The DNA data bank can become the main type of recording in the automated system of integrated forensic recordings.

At the same time the implementation of the idea of creating an integrated genomic registration system in the Eurasian countries will contribute to the solution of the main issues: to achieve the convertibility of different DNA identification systems of different countries; to introduce programs for obtaining greater compression ratio of the information entered into the system; to use the latest types of scientific and technical means of accumulation and processing DNA information; to solve the issues of legal and organizational support for genomic registration.

Conclusion

Thus, during the genomic registration of the population of Eurasia, the following problems will be solved:

- with the help of developed algorithm and the appropriate software program for searching individual parts of the DNA molecule, the most optimal SNPs that meet the necessary requirements for DNA identification of personality and genome registration of the entire population by genomic bar coding based on high polymorphic SNPs will be identified;

- resulting from scientific research a set of SNPs which can be used for genomic registration of the Russian population will be selected;

- creation of prototypes of databases where genetic barcodes of citizens of the Russian Federation and the countries of the former CIS will be stored;

- preparation of a new Federal draft law on DNA certification of the entire population of the Russian Federation, as well as migrant workers and a number of other legal acts;

- it is necessary to explain to the population the positive moments of genomic registration of the whole population in order to allay the fears;

- we believe that for effective genomic registration of our population, it is necessary to intensify international cooperation in the field of DNA research. The idea of establishing a unified system of genomic registration of the population of Eurasia and then in all over the world is fruitful.

And objecting to those who believe that genomic registration violates a person's right to privacy it is possible to present the following reasons: there are many forms of state registration of citizens for identification of the person: passport, at the place of residence, marriage, birth, death, and no one objects to it. To support legally confirmed genomic registration of the population we can quote the prominent Russian forensic scientist S.S. Pankratov: "The law tramples on the only right: to violate it" (Pankratov, 1997).

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Проблемы геномной регистрации в Евразии и пути их решения

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В статье рассмотрены состояние и перспективы ДНК-паспортизации (геномной регистрации) в России и странах Евразии. Авторы выделяют основные проблемы развития этого направления криминалистической регистрации, такие как: недостаточность внедрения современных технологий, низкий уровень взаимодействия задействованных ведомств, неудовлетворительный уровень законодательной регламентации геномной регистрации, зависимость от зарубежных поставок. Отмечены пробелы в государственном регулировании геномной регистрации, выделены проблемы правового регулирования и правоприменительной практики, связанные с защитой геномной информации. ДНК-паспортизация населения является весьма актуальной проблемой для России и для стран Евразии, в том числе из-за усиленного в последние годы процесса миграции. Цель настоящей работы состоит в том, чтобы исследовать теоретические аспекты законодательной политики, направленной на геномную регистрацию населения, в том числе в целях раскрытия и предотвращения преступлений экстремистского характера; в исследовании практики регистрационных действий. Установлено, что существующие нормативные правовые акты в России не в полной мере эффективны, предложено введение дополнительных мер по совершенствованию правового обеспечения геномной регистрации населения России и стран Евразии. Показаны возможности ДНК-идентификации, проанализированы перспективы ее совершенствования.

Ключевые слова: ДНК-паспортизация населения в Евразии, геномная регистрация, криминалистическая идентификация, раскрытие и предотвращение преступлений.

Научная специальность: 12.00.12 – криминалистика, судебно-экспертная деятельность, оперативно-розыскная деятельность.
