

Forensic DNA Analysis: Development State and Prospects in Ukraine

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This research purpose is to summarize information on the main directions of using DNA analysis in the practice of detection and investigation of crimes used in different countries, consider possibilities of these areas and the state of their implementation in domestic investigative and forensic expert practice and formulate the author's vision of prospects for the further development of theoretical and applied aspects of forensic DNA research in Ukraine.

Traditional DNA profiling methods based on STR locus analysis and mtDNA SNP research are described, information on the application of the latest technologies for searching relatives by DNA profile bases and determining the age and biogeographical origin of human DNA, as well as methods of mass parallel DNA sequencing and performing rapid DNA profile tests. It was noted that main obstacle to the further development of DNA analysis in Ukraine is the lack of proper legal regulation that hinders formation of effective national database of DNA profiles. Attention is drawn to the obvious lack of scientific support for DNA research in Ukraine.

Ways to solve existing issues in this area are proposed, in particular: promote relevant knowledge among law enforcement officers to minimize typical errors in handling of traces of biological origin; make changes in the criminal procedural legislation of Ukraine for the purpose of proper adjustment of issues of sampling of biological samples and carrying out rapid analyzes on a DNA profile;

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take measures to expand the tool base and real capabilities of forensic genetics laboratories.

Keywords: *forensic technique; forensic DNA analysis; DNA profiling; DNA database; DNA phenotyping.*

Research Problem Formulation

More than 35 years have passed since mankind learned about possibility of using DNA analysis to identify a person ¹. During this period, significant results have been achieved in world science and forensic practice related to development of effective DNA analysis technologies and their use while investigation of crimes and forensic evidence. Possibilities of DNA analysis in research on biological traces, identification of living persons and corpses, establishment of biological paternity and biological kinship of people have significantly expanded.

Original techniques of DNA fingerprinting performed by making *DNA fingerprints* on X-ray film, have given way to the method of polymerase chain reaction and modern computer technologies. In many countries, powerful automated databases of DNA profiles have been set up to generate matching genetic traits from detected traces to genetic traits of individuals being sampled, thus revealing many crimes committed in evidence unavailability. Effective technologies for determining the DNA profile from traces of contact (contact traces), forensic research on mitochondrial DNA (hereinafter referred to as mtDNA), forensic analysis of genes

containing information about appearance, biogeographical human origin, etc.

In scientific community, perceptions of forensic DNA analysis range from acknowledging accuracy of obtained results to skepticism about errors in evidence due to misinterpretation of results and discussions about compliance of collecting, storing and using genomic human information with respect for privacy, family life. However, the very introduction of DNA analysis was a turning point for the forensic sciences, as it contained only a predetermined probability of the coincidence of genetic traits that was crucial for the evaluation of data. The success of DNA evidence has changed scientists' views on and expectations of forensic science ².

Effectiveness of DNA analysis in crime detection and investigation has been convincingly proven by many years of practice. At the same time, the errors in law enforcement practice that have sometimes occurred are not due to inaccurate methods of examination but to subjective factors: for example, incorrect evaluation of the results of DNA analysis of a small amount of trace material. This is due to the likelihood of contamination of traces or indirect DNA transfer, especially when it comes to establishing

- 1 Jeffrey A. J., Wilson V., Thein S. L. Individual-specific «fingerprints» of human DNA. *Nature*. 1985. Vol. 316. P. 76–79. DOI: 10.1038/316076a0 (date accessed: 20.11.2021).
- 2 Bell S., Sah S., Albright T. D., Gates S. J., Denton M. B., Casadevall A. A call for more science in forensic science. *Proceedings of the National Academy of Sciences of the United States of America*. 2018. Vol. 115 (18). P. 4541–4544. DOI: 10.1073/pnas.1712161115 (date accessed: 20.11.2021).

a DNA profile from contact traces. Modern devices are able to determine complete DNA profile in just 100 DNA picograms³. However, such a small amount in the trace is not necessarily the result of direct contact of the person with the trace surface. Because a small amount of DNA can be easily and ubiquitously transferred, there has been a shift in the evaluation of DNA analysis results from the question “Whose DNA is this?” to the question “How did she get there?”⁴. There are also some difficulties in separating mixed traces of several people, legal and ethical problems of gene research to solve research issues etc.

These aspects are actively discussed and solved. Typical causes of errors in proof due to erroneous evaluation of DNA analysis results are analyzed and ways to solve relevant problems are proposed⁵. It was emphasized that it was desirable to question DNA-related evidence each time and to consider it primarily as a means of corroborating other types of evidence in a particular case⁶. Much attention is also paid to the legal and ethical aspects of the use of DNA analysis technologies in law enforcement. The result is the implementation of appropriate standards⁷. In connection with the above, there can be no skepticism about the future prospects of forensic DNA

analysis. This area remains one of the most important in the theory and practice of forensic science and criminalistics, demonstrates outstanding results of evidence in criminal cases and continues to develop dynamically.

Despite extreme popularity of forensic DNA analysis as a method of identification in the world and domestic investigative and forensic expert practice, in Ukraine there is almost no relevant research. In fact, its place in criminalistics has not even been determined yet. There is no holistic idea of the possibilities of this area, its practical effectiveness, prospects for further development in both theoretical and applied aspects. This not only leads to low effectiveness of the use of DNA analysis tools in the practice of law enforcement agencies but also reduces efficiency of spending budget funds intended for the provision of state expert laboratories of forensic genetics and law enforcement agencies.

These circumstances necessitate a comprehensive scientific analysis of current possibilities of forensic DNA research in practice of criminal investigation, the state of their implementation in investigative and expert practice of Ukraine, as well as the level of scientific support in this area and outline prospects for its further development.

- 3 Cale C. M. Forensic DNA evidence is not infallible. *Nature*. 2015. Vol. 526. P. 611. DOI: 10.1038/526611a (date accessed: 20.11.2021).
- 4 Biedermann A., Champod C., Jackson G., Gill P., Taylor D., Butler J., Morling N., Hicks T., Vuille J., Taroni F. Evaluation of Forensic DNA Traces When Propositions of Interest Relate to Activities: Analysis and Discussion of Recurrent Concerns. *Frontiers in Genetics*. 2016. Vol. 7. P. 215. DOI: 10.3389/fgene.2016.00215 (date accessed: 20.11.2021).
- 5 Gill P. DNA evidence and miscarriages of justice. *Forensic Science International*. 2019. Vol. 294. P. e1-e3. DOI: 10.1016/j.forsciint.2018.12.003 (date accessed: 20.11.2021).
- 6 Machado H., Granja R. DNA Technologies in Criminal Investigation and Courts / Forensic Genetics in the Governance of Crime. Singapore, 2020. Pp. 45–56. DOI: 10.1007/978-981-15-2429-5_4 (date accessed: 20.11.2021).
- 7 Wallace H. M., Jackson A. R., Gruber J., Thibedeau A. D. Forensic DNA databases — Ethical and legal standards: A global review. *Egyptian Journal of Forensic Sciences*. 2014. Vol. 4, Is. 3. P. 57–63. DOI: 10.1016/j.ejfs.2014.04.002 (date accessed: 20.11.2021).

Analysis of Essential Researches and Publications

In domestic scientific literature, the content of DNA analysis technologies in forensic science activity was studied by forensic physicians (H. F. Kryvda ⁸, R. H. Kryvda ⁹, N. Ye. Kozhukhov and others ¹⁰) and professionals of the Expert Service of the Ministry of Internal Affairs of Ukraine, who developed methods for conducting molecular genetic researches (N. M. Diachenko and others ¹¹, R. H. Abbasov and others ¹²). These researches are mostly applied in nature, devoted to the development of certain methods of DNA analysis in forensic science and are intended primarily for direct practical use in forensic science. At the same time, the issue of systematization of existing technologies and determining the

state and prospects of their development in Ukraine has not been studied.

On the other hand, in foreign sources, topical issues of current level of forensic DNA analysis technologies and ways of their development in the future are covered quite widely and different views on this issue are given. For example, in scientific reviews of the state and prospects of research and practical implementation of both traditional and new technologies, in particular, *STR*-profiling ¹³ and maintaining DNA profile databases ¹⁴, analysis of mitochondrial DNA ¹⁵, research on Y-chromosome ¹⁶, forensic phenotyping ¹⁷ etc. ¹⁸. These research papers are especially useful for our research and drawing conclusions about prospects of forensic DNA analysis in Ukrainian forensic theory and law enforcement practice.

- 8 Кривда Г. Ф. ПЛР-аналіз молекулярно-генетичного поліморфізму людини в судовій медицині : дис. ... д-ра мед. наук. Київ, 2003. 295 с.
- 9 Кривда Р. Г. Ідентифікація особи в судовій медицині на основі ПЛР-аналізу геномної ДНК кісткової тканини : дис. ... канд. мед. наук. Київ, 2009. 171 с.
- 10 Кожухова Н. Є., Кривда Г. Ф., Кривда Р. Г., Сиволапа Ю. М., Суліма Ю. Ю., Чеботар С. В. Використання аналізу ДНК у судово-медичних експертизах : наук.-практ. вид. ; за ред. Ю. М. Сиволапа та Г. Ф. Кривди. Одеса, 2001. 92 с.
- 11 Дяченко Н. М., Ольшовець С. О., Лагус В. І. Дослідження ДНК з об'єктів біологічного походження методом полімеразної ланцюгової реакції : метод. рек. Київ, 2003. 38 с.
- 12 Аббасов Р. Г., Повх А. С., Романчук С. М. Методика проведення молекулярно-генетичних досліджень. Київ, 2018. 75 с.
- 13 Butler J. M. The future of forensic DNA analysis. *Phil. Trans. R. Soc.* 2015. DOI: 10.1098/rstb.2014.0252 (date accessed: 20.11.2021).
- 14 Wallace H. M., Jackson A. R., Gruber J., Thibedeau A. D. *Ibid.* DOI: 10.1016/j.ejfs.2014.04.002 (date accessed: 20.11.2021).
- 15 Melton T., Holland C., Holland M. Forensic Mitochondria DNA Analysis: Current Practice and Future Potential. *Forensic Science Review.* 2012. Vol. 24 (2). P. 101–122.
- 16 Kayser M. Forensic use of Y-chromosome DNA: a general overview. *Human Genetics.* 2017. Vol. 136. P. 621–635. DOI: 10.1007/s00439-017-1776-9 (date accessed: 20.11.2021).
- 17 Samuel G., Prainsack B. Forensic DNA phenotyping in Europe: views “on the ground” from those who have a professional stake in the technology. *New Genetics and Society. Critical Studies of Contemporary Biosciences.* 2019. Vol. 38. Is. 2. P. 119–141. DOI: 10.1080/14636778.2018.1549984 (date accessed: 20.11.2021).
- 18 Yang Y., Xie B., Yan J. Application of Next-generation Sequencing Technology in Forensic Science. *Genomics, Proteomics & Bioinformatics.* 2014. Vol. 12. Is. 5. P. 190–197. DOI: 10.1016/j.gpb.2014.09.001 (date accessed: 20.11.2021).

Article Purpose

This article purpose is to summarize information on the main directions of using DNA analysis in the practice of crime detection and investigation used in different countries, considering possibilities of these areas and their implementation in domestic investigative and forensic expert activities and formulate the author's vision of further development of theoretical and applied aspects of forensic DNA analysis in Ukraine.

For achieving this goal, foreign academic literature is analyzed, describing the current possibilities of forensic DNA analysis (used by law enforcement agencies of different countries) and the main issues and prospects for the development of this field of forensic science. Domestic scientific sources have also been studied in Ukraine to assess the degree of scientific development of this issue.

For establishing current state of practice in the field of forensic molecular genetic expertise, statistical and analytical information of Expert Service of the Ministry of Internal Affairs of Ukraine, materials of criminal proceedings for DNA analyses and practice of the molecular genetic research and accounting department of Kharkiv SRFC of the MIA of Ukraine.

Main Content Presentation

Given complexity of the outlined issues, we propose to consider basic principles and some of the most important, in our opinion, problematic aspects of forensic DNA analysis that seem to be the most relevant for Ukraine.

Brief overview of current opportunities for forensic DNA analysis in the world of investigative and forensic expert practice

Currently, DNA analysis in the world is recognized as the most reliable tool for identification and determination of biological paternity. It also makes it possible to solve some other issues: in particular, determine the sex of biological traces, biological kinship of people, make assumptions about outward appearances of human DNA etc. Technologies of forensic DNA analysis available nowadays are characterized by varying degrees of accuracy are recognized and applied to varying dimension in world forensic practice.

In general, in forensic molecular genetic examination it is established to distinguish two basic technologies: analysis of polymorphism of length of amplified fragments and analysis of polymorphism of nucleotide sequence¹⁹. In the analysis of polymorphism in the length of DNA fragments as genetic markers use short tandem repeats (hereinafter referred to as *STR*) and while analysis of differences in the sequence of nucleotides: single nucleotide polymorphism (hereinafter referred to as *SNP*). Therefore, in the forensic literature, terms are also used for convenience *STR analysis* and *SNP analysis* to distinguish between relevant technologies.

For forensic purpose, we can identify some of the most common methods of DNA analysis and areas of their implementation of which three can be called traditional and the rest are the latest.

Traditional methods include *STR*-profiling by autosomal loci of DNA, analysis *STR*-loci on the Y-chromosome and study of mitochondrial DNA (mtDNA). These methods have been tested in practice in

19 Мішалов В. Д., Хохолева Т. В., Бачинський В. Т., Войченко В. В., Кривда Г. Ф., Костенко Є. Я. Судова медицина : підручник ; за заг. ред. В. Д. Мішалова. Чернівці, 2018. С. 485.

many countries and are widely used in forensic science. The first two of them are based on technology *STR*-analysis and the third on *SNP*-analysis.

The newest methods are to use tools that have been invented relatively recently and that are not yet widely used as traditional ones: although they are gradually being introduced into forensic practice, they have many limitations and reservations of legal, ethical and methodological nature. These include: DNA phenotyping, searching for relatives in DNA databases, rapid testing for DNA profile and the use of the latest sequencing platforms of the next generation (hereinafter referred to as *NGS*) to solve complex issues of forensic DNA analysis. Most of these methods are based on technology *SNP*-analysis. On the one hand, they have significantly expanded the possibilities of forensic DNA analysis, on the other hand, the relevant methods have not yet achieved a sufficient level of accuracy of the results.

Traditional methods

The main methods today *STR*-profiling that is often called the “gold standard of identification”²⁰. Scientists pay special attention to the fundamental importance of research methods *STR* in forensic practice and their prospects²¹.

STR-profiling is to determine the individual genetic profile of a person by DNA isolated from human cells with nuclei, by analyzing a specific set of autosomal *STR*-loci. This method makes it possible to identify a person by the biological traces left, and (using additional tools) to determine paternity and biological kinship. The DNA profiles created with its

help are the basis of DNA databases all over the world.

In forensic practice, various commercial kits are used for analysis *STR*-loci that allow you to use 15 or more loci. Efficiency of using this tool is significantly increased by the functioning of the national database of DNA profiles (automated forensic accounting of human genetic traits). Otherwise, it can be used only for identification in a separate criminal proceeding by comparing the DNA profile from a trace of biological origin with the DNA profile of a person established by investigation or operation. In contrast, if a DNA profile database is in place, it is possible to identify an unknown person who is being investigated (sample or specimen) (criminal, unidentified corpse, etc.) by checking the database.

Except *STR*-profiling, in forensic genetics there are a number of other traditional tools that are now ancillary. Their use allows to expand the possibilities of forensic DNA analysis, as they provide additional information about the person whose biological trace or sample is being studied.

Thus, *STR*researches on Y-chromosome (hereinafter referred to as *Y-STR*) makes it possible to distinguish the DNA of men and to determine the biological kinship of men in the male line. Relevant methods have been successfully developed since the 1990s and are now routine in forensic genetics laboratories around the world in addition to the standard panel of autosomal loci. In criminal cases, they are especially useful while analyzing a mixture of male and female cells, for example, in the case

20 Lynch M. God's signature: DNA profiling, the new gold standard in forensic science. *Endeavour*. 2003. Vol. 27. Is. 2. P. 93–97. DOI: 10.1016/S0160-9327(03)00068-1 (date accessed: 20.11.2021).

21 Gill P. Role of Short Tandem Repeat DNA in Forensic Casework in the UK — Past, Present, and Future Perspectives. *Biotechniques*. 2002. Vol. 32 (2). P. 366–385. DOI: 10.2144/02322rv01 (date accessed: 20.11.2021).

of sexual violence²². All possible areas of application of the forensic research on Y-chromosome, in particular, to exclude from the suspect men, determine the paternal line of male criminals, provide investigators with information to search for unknown male criminals, resolve paternity disputes, etc. are given in a scientific review by M. Kayser²³.

It is important to emphasize that the analysis of Y-STR in criminal cases does not allow to identify a person, but only helps to determine his biological kinship, which significantly limits the importance of this area²⁴. On the other hand, in modern conditions, when in many countries databases of DNA profiles are created and filled, Y-STR analysis of can serve as additional tool to search for relatives of an unknown person who has left a trace, if relevant information is available in a specific DNA database.

Currently traditional method is to study the sequence of mtDNA. It makes it possible to determine biological kinship through the maternal line. It is also important that mtDNA can be isolated even when the cells with the nucleus are not preserved, so STR-loci of nuclear DNA cannot be investigated. This is especially true for research on objects in which DNA has partially degraded (for example, burnt or skeletal corpses, hair without a bulb, etc.). Because all maternal relatives have

the same mtDNA, appropriate methods are helpful in forensic DNA analysis. Current opportunities and prospects for further development of mtDNA forensic research analyzed by foreign scientists²⁵.

Latest Methods

The latest methods of forensic DNA analysis that are gradually being introduced into the practice of DNA profiling include those that allow to establish the phenotype (appearance, age and biogeographical origin) of a person by his genes, as well as to use means to find relatives studied, according to state and open databases of DNA profiles.

Forensic DNA phenotyping as a section of forensic DNA analysis combines three main areas, namely the definition of human outward appearances, his *Biogeographical ancestry* and assessment of biological age by DNA²⁶.

These methods allow the analysis of DNA found while investigation to make a reliable prediction of the color of the eyes, hair and skin of the person who left a mark, as well as its origin from a particular part of the world (America, Oceania, Africa, East Asia, South Asia, Southwest Asia and Europe). Quite high accuracy ($\pm 3-4$ years) of DNA age determination has also been reported²⁷. Professionals are exploring the possibility of determining the height, facial appearances and alopecia by DNA²⁸. Appropriate technologies can help solve

- 22 Roewer L. Y chromosome STR typing in crime casework. *Forensic Sci Med Pathol*. 2009. Vol. 5 (2). P. 77–84. DOI: 10.1007/s12024-009-9089-5 (date accessed: 20.11.2021).
- 23 Kayser M. Forensic use DOI: 10.1007/s00439-017-1776-9 (date accessed: 20.11.2021).
- 24 Syndercombe Court D The Y chromosome and its use in forensic DNA analysis. *Emerg Top Life Sci*. 2021. Vol. 5 (3). P. 427–441. DOI: 10.1042/ETLS20200339 (date accessed: 20.11.2021).
- 25 Melton T., Holland C., Holland M. *Ibid*. P. 101.
- 26 Schneider P. M., Prainsack B., Kayser M. The Use of Forensic DNA Phenotyping in Predicting Appearance and Biogeographic Ancestry. *Deutsches Ärzteblatt International*. 2019. Vol. 51–52. P. 873–880. DOI: 10.3238/arztebl.2019.0873 (date accessed: 20.11.2021).
- 27 Parson W. Age Estimation with DNA: From Forensic DNA Fingerprinting to Forensic (Epi)Genomics: A Mini-Review. *Gerontology*. 2018. Vol. 64. No. 4. P. 326–332. DOI: 10.1159/000486239 (date accessed: 20.11.2021).
- 28 Marano L. A., Fridman C. DNA phenotyping: current application in forensic science. *Research*

target tasks while searching for unknown people.

Proponents of introduction of forensic genetic phenotyping methods call for their use for investigative purposes, bypassing the problems of personal data protection²⁹. However, it should be noted that their practical application is complicated by problems of methodological, ethical and legal nature, namely: 1) lack of reliable techniques for these technologies; 2) ethical issues related to the use of DNA coding regions, in contrast to traditional DNA analysis technologies that use non-coding regions (*Non-coding DNA*); 3) formulation of extremely reliable conclusions; 4) social sensitivity of issues (for example, regarding migrants); 5) inadmissibility of determining for ethical reasons any information about the state of health of a person, due to which they test only for external (morphological) characters³⁰.

As of December 2019, DNA phenotyping technologies have been clearly regulated and allowed in the EU only in the Netherlands and Slovakia. They are also used in forensic practice in the United Kingdom, Poland, the Czech

Republic, Sweden, Hungary, Austria and Spain. In Germany in November 2019, these technologies were also allowed to be used, except for determination of biogeographical origin according to DNA³¹.

The latest technology of forensic DNA analysis is considered to be methods of searching for relatives of an unknown person whose biological trace or sample is being studied on the basis of DNA databases. They were first used in the UK in 2006 to identify the perpetrator of a series of rapes in the 1980s.³² However, the real boom in opportunities in this area has begun recently.

Thus, in April 2018, it was reported that serial killer and rapist Joseph James DeAngelo was arrested due to an unconventional innovative method of determining a person's kinship relations using the *GEDmatch* website. This contributed to introduction of a new search direction according to kinship relations, investigative genetic genealogy³³.

Investigative genetic genealogy has quickly become a highly effective tool for using DNA to identify unidentified criminals and unidentified corpses³⁴. It

and Reports in Forensic Medical Science. 2019. Vol. 9. P. 1–8. DOI: 10.2147/RRFMS.S164090 (date accessed: 20.11.2021).

- 29 Kayser M., Schneider P. M. DNA-based prediction of human externally visible characteristics in forensics: Motivations, scientific challenges, and ethical considerations. *Forensic Science International: Genetics*. 2009. Vol. 3. Is. 3. P. 154–161. DOI: 10.1016/j.fsigen.2009.01.012 (date accessed: 20.11.2021) ; Kayser M. Forensic DNA Phenotyping: Predicting human appearance from crime scene material for investigative purposes. *Forensic Science International: Genetics*. 2015. Vol. 18. P. 33–48. DOI: 10.1016/j.fsigen.2015.02.003 (date accessed: 20.11.2021).
- 30 Samuel G., Prainsack B. Ibid. DOI: 10.1080/14636778.2018.1549984 (date accessed: 20.11.2021).
- 31 Schneider P. M., Prainsack B., Kayser M. The Use of Forensic DNA DOI: 10.3238/arztebl.2019.0873 (date accessed: 20.11.2021).
- 32 Suter S. M. All in the Family: Privacy and DNA Familial Searching. *Harvard Journal of Law & Technology*. 2010. Vol. 23. No. 2. P. 310.
- 33 Butler J. National DNA Day and the Birth of Investigative Genetic Genealogy / National Institute of Standards and Technology : Taking Measure. Just a Standard Blog. 25.04.2019. URL: <https://www.nist.gov/blogs/taking-measure/national-dna-day-and-birth-investigative-genetic-genealogy> (date accessed: 20.11.2021).
- 34 Greytak E. M., Moore C. C., Armentrout S. L. Genetic genealogy for cold case and active investigations. *Forensic Science International*. 2019. Vol. 299. P. 103–113. DOI: 10.1016/j.forsci-int.2019.03.039 (date accessed: 20.11.2021).

is based on creating a personal genetic profile based on *SNP*, entering it in the genealogical database of open source DNA (for example, databases *GEDmatch*, *23andMe*, *Family Tree DNA*, *AncestryDNA*, *MyHeritage* etc.), further automatic comparison with DNA profiles of people who have voluntarily provided their DNA profiles to relevant genealogical bases and assessment of possible kinship relations between individuals using computer algorithms³⁵.

Currently, forensic tools for searching for family ties include three main approaches: a) *Familial searching*, in other words, detection in the DNA database that partially coincide with the one being tested, and may belong to the biological relatives of the person who left the trace; b) search in the database by *Y-STR*; c) investigative genetic genealogy (hereinafter referred to as *IGG*). The first two approaches are used in government databases of DNA profiles and the third uses databases managed by individuals or companies³⁶.

Relevant technologies have identified the identity of particularly dangerous criminals in some countries around the world, including serial killers and rapists. For example, in United States in 2018–2019 while 18 months more than 50 criminal cases were successfully investigated,

thanks to the methods of investigative genetic genealogy³⁷.

At the same time, introduction of technologies for searching relatives on the basis of DNA databases, as well as technologies for genetic phenotyping, is accompanied by a number of legal, ethical and social problems, primarily related to interference in personal and family life. Thus, they are a powerful tool for searching for unknown criminals on the trail of biological origin³⁸, however, require proper legal regulation in order to define clear rules and limits of use.

Currently, professionals are actively exploring the possibility of introducing forensic science into practice *NGS*, or, as it is also so-called method of mass parallel sequencing (hereinafter referred to as *MPS*). Unlike the traditional *STR*-analysis, method *MPS* allows you to read a lot at once *STR* and *SNP* on autosomes, sex chromosomes and *mtDNA*. Accordingly, there is a potential opportunity to greatly simplify the distinction of mixed DNA samples, analyze cases of complex paternity, to determine the origin and phenotype of the person, recognize the DNA of monozygotic twins, etc.³⁹. It is expected that in the future new platforms on the base *NGS* will revolutionize forensic DNA analysis⁴⁰. however there are some obstacles to their widespread use. For

35 Mehar P. A. Forensic Genetic Genealogy: An Investigative Aid. *International Medico-Legal Reporter Journal*. 2021. February. P. 126–138. URL: <https://legaldesire.com/wp-content/uploads/2021/02/Download-and-Read-Full-Text-12.pdf> (date accessed: 20.11.2021).

36 Ge J., Budowle B. Forensic investigation approaches of searching relatives in DNA databases. *Journal of Forensic Sciences*. 2021. Vol. 66. Is. 2. P. 430–443. DOI: 10.1111/1556-4029.14615 (date accessed: 20.11.2021).

37 Callaghan T. F. Responsible genetic genealogy. *Science*. 2019. Vol. 366. Is. 6462. P. 155. DOI: 10.1126/science.aaz6578 (date accessed: 20.11.2021).

38 Kim J., Mammo D., Siegel M. B., Katsanis S. H. Policy implications for familial searching. *Investigative Genetics*. 2011. Vol. 22. Is. 2. DOI: 10.1186/2041-2223-2-22 (date accessed: 20.11.2021).

39 Yang Y., Xie B., Yan J. *Ibid.* DOI: 10.1016/j.gpb.2014.09.001 (date accessed: 20.11.2021).

40 Sobiah R., Syeda R. H., Zunaira E., Nageen Z., Maria K., Syeda A. Z., et al. Implications of Targeted Next Generation Sequencing in Forensic Science. *Journal of Forensic Research*. 2018. Vol. 9. Is. 1. P. 1–8. DOI: 10.4172/2157-7145.1000416 (date accessed: 20.11.2021).

example, the difference between mtDNA and nuclear DNA in orders of magnitude in the number of copies per cell interferes with the routine combination of autosomal STR and mtDNA and accordingly reduces reliability of obtained results ⁴¹.

Analysis of the use state of this direction in European laboratories gave grounds to J. M. Butler and S. Willis to state that, although appropriate technical devices have been purchased, their active use is hampered by four main issues : a) lack of harmonized nomenclature and standards; b) incompatibility with existing national DNA databases; c) lack of population data for statistical calculations; d) lack of adequate legal framework ⁴². Therefore, traditional methods STR-analysis will remain the main in the field of forensic DNA research for a long time.

From the point of view of technical equipment, in the field of forensic methods of DNA analysis there is another specific direction, namely: rapid testing for DNA profile. *rapid DNA*). Its development was facilitated primarily by the practice of American law enforcement that (due to legal requirements) required equipment that would allow to determine the DNA profile and check it on DNA databases for a short period allowed to detain a person. To establish a DNA profile from a sample of human buccal epithelium, specific equipment has been developed: on the one hand, more compact and faster than standard laboratory, on the other hand, more expensive to maintain due to the high cost of materials for its conducting.

An important feature of rapid testing systems for DNA profile is their use exclusively for research on samples provided by a particular person and not traces removed from the scene or while the rest of investigation. In particular, such devices are used in police stations, in case of crossing the state border, in embassies and forensic laboratories ⁴³.

Genesis and current state of practical use of forensic DNA analysis technologies in Ukraine and prospects for its development

In Ukraine, technologies of forensic DNA analysis began to be introduced in the early 1990s in the practice of the Expert Service of the MIA of Ukraine and forensic science institutions of the Ministry of Healthcare of Ukraine.

In the system of Forensic Expert Service of the MIA of Ukraine in SSRFC of the MIA of Ukraine (Kyiv) in 1992 the first forensic molecular genetic examination was conducted, in 1993 a decision was made to establish a laboratory. Since 1994, this laboratory has been systematically conducting forensic examinations using DNA analysis, at the first stage by analysis of VNTR-loci.

New systems have been used since 1997 STR-primers, since 1999 automatic systems STR-profiling ⁴⁴, since 2012, method of mtDNA research, since 2015, approbation of methods NGS. In 2019, a system of rapid DNA analysis was tested *RapidHIT ID* that is now used in some laboratories for rapid determination of DNA profiles from biological samples of individuals.

41 Butler J. M. The future DOI: 10.1098/rstb.2014.0252 (date accessed: 20.11.2021).

42 Butler J. M., Willis S. Interpol review of forensic biology and forensic DNA typing 2016–2019. *Forensic Science International: Synergy*. 2020. Vol. 2. P. 352–367. DOI: 10.1016/j.fsisy.2019.12.002 (date accessed: 20.11.2021).

43 Butler J. M., Willis S. Interpol review DOI: 10.1016/j.fsisy.2019.12.002 (date accessed: 20.11.2021).

44 Дяченко Н. М. Основні етапи розвитку молекулярно-генетичної експертизи в Державному науково-дослідному експертно-криміналістичному центрі МВС України. *Криміналістичний вісник*. 2011. № 1 (15). С. 165–169.

Since 2002, Forensic Expert Service of the MIA of Ukraine has been a member of the European Network of Forensic Science Institutes (ENFSI). As of today, its system includes a network of laboratories of DNA testing, in particular in the SSRFC of MIA of Ukraine, SSRFC of the Ministry of Internal Affairs of Ukraine in Vinnytsia, Volhynia, Zaporizhzhia, Ivano-Frankivsk, Lviv, Mykolaiv, Poltava, Kyiv, Kharkiv and Donetsk regions. More than 12,000 forensic examinations are conducted in this network every year, and this number is constantly increasing.

Forensic Expert Service of the Ministry of Internal Affairs of Ukraine is the administrator of automated forensic accounting of human genetic traits. It is conducted at the central and local levels. The national DNA database includes DNA profiles of: persons (with their voluntary consent) suspected of committing crimes detained and convicted; biological traces seized during investigative actions and criminal investigation measures; unidentified corpses, as well as relatives of missing persons and employees (with their voluntary consent) of institutions of the Ministry of Internal Affairs of Ukraine participating in the scene inspection. For a long time, the database of DNA profiles functioned using the system *EMCILAB*. Concurrently a combined system of DNA indexing is gradually being introduced hybrid DNA *CODIS* system ⁴⁵.

The state of filling the national DNA database in Ukraine is unsatisfactory, primarily due to the lack of a relevant law. The draft law: *On State Registration of Human Genomic Information* was

submitted to the Verkhovna Rada of Ukraine in 2020 but it has many comments of substantive and technical and legal nature, so the prospects for its adoption and deadlines for practical implementation of its provisions are still unclear. Currently, domestic legislation contains only the provisions of paragraph 7 of Part 1 and Part 2 of Art. 26 of Law of Ukraine: *On National Police* ⁴⁶, providing for the police to fill the databases of the unified information system of the Ministry of Internal Affairs of Ukraine with DNA samples of persons detained on suspicion of committing offenses. Until now, in fact, the database of DNA profiles is replenished only on the basis of departmental acts of the Ministry of Internal Affairs of Ukraine. It is not surprisingly; its weak content does not allow us to boast of efficiency in generating matches of DNA profiles from traces of biological origin from unsolved crimes.

Concurrently with introduction of methods of forensic DNA analysis in forensic science institutions of the Ministry of Internal Affairs of Ukraine, corresponding methods began to be used by forensic medical institutions.

In 1992, H. F. Kryvda, forensic medical examiner introduced a modern method of identifying biological objects using molecular genetic analysis ⁴⁷. As of today in the system of the Ministry of Health of Ukraine (hereinafter referred to as *Ministry of Healthcare of Ukraine*) conduct molecular genetic research in the departments of forensic genetics in the Main Bureau of forensic medical examination of the

45 Степанюк Р. Л., Перлін С. І., Кікінчук В. В. та ін. Криміналістичне дослідження ДНК: технології та можливості : навч. посіб. Харків, 2019. С. 64.

46 Про Національну поліцію : Закон України від 02.07.2015 р. № 580-VIII (зі змін. та допов.). URL: <https://zakon.rada.gov.ua/laws/show/580-19#Text> (date accessed: 20.11.2021).

47 Плевінскіс П. В. Кривда Григорій Федорович (до 70-річчя від дня народження). *Судово-медична експертиза*. 2018. № 1. С. 132.

Ministry of Healthcare of Ukraine, Odessa, Dnipro regional and Kyiv city bureau of forensic medical examination ⁴⁸.

Forensic DNA testings are still not conducted in forensic science institutions of the Ministry of Justice of Ukraine. However, in the near future it is planned to open a laboratory in National Scientific Center «Hon. Prof. M. S. Bokarius Forensic Science Institute» (Kharkiv).

In general, currently law enforcement practice in Ukraine uses two procedural forms of applying special knowledge in the field of forensic DNA analysis in criminal proceedings: involving professional in investigative actions and involving forensic expert (forensic DNA testing assignment and conducting). In addition, forensic scientists, biologists and forensic pathologists assist the investigator while detecting and removing traces of biological origin at the scene and in taking biological person samples. By means of forensic DNA testing, a person is identified by biological traces and samples, biological paternity and biological kinship are established. Both of the above forms of specific expertise use are to some extent interrelated, as quality of application of methods for detecting and recording traces of biological origin at the stage of pre-trial investigation directly affects further effectiveness of DNA testing.

In earlier research, my colleagues and I tried to evaluate the effectiveness of forensic DNA testing in the investigation of premeditated murder, rape, and traffic accidents ⁴⁹. Efficiency was low due to certain legal, organizational and

methodological issues. Among such issues is the failure of pre-trial investigation officers to comply with the methodological requirements for the treatment of traces of biological origin, which primarily leads to contamination of traces or removal of background DNA that does not belong to the event under investigation. Mistakes by investigators and prosecutors in taking biological samples and formulating tasks for experts are common. The investigation speed is hampered by inability to perform rapid analysis of DNA profiles without appointment of a forensic examination ⁵⁰.

The main reasons for this situation are insufficient training of law enforcement officers to deal with traces of biological origin, lack of systematic training of such employees in this area, lack of scientific and educational literature, as well as the lack of proper legal framework in Ukraine for obtaining and using human genomic information for crime counteraction.

State of scientific support of forensic DNA analysis in Ukraine and prospects for its development

In recent years, fundamental research in the field of forensic genetics has been conducted in world science, which has made it possible to develop and implement effective tools and methods of forensic DNA analysis. Of particular note are the contributions of institutions, individual scholars and research teams from the United Kingdom, the United States, Austria, Spain, Denmark and New Zealand to this

48 Степанюк Р. Л., Перлін С. І., Кікінчук В. В. та ін. Зазнач. твір. С. 70–71.

49 Степанюк Р. Л., Щербаковский М. Г., Кикинчук В. В., Лапта С. П., Гусева В. А. Проблемы применения судебной молекулярно-генетической экспертизы в уголовном производстве Украины. *Georgian medical news*. 2019. № 5 (290). С. 157–163.

50 Shcherbakovskiy M., Stepaniuk, R., Kikinchuk V., Petrova I., Hanzha T. Assessment of the conclusions of molecular genetic examination in the investigation of crimes. *Amazonia Investiga*. 2020. Vol. 9. No. 25. P. 479–486. URL: <https://amazoniainvestiga.info/index.php/amazonia/article/view/1097> (date accessed: 20.11.2021).

field⁵¹. In general, in recent decades, the technology of DNA analysis and digital evidence research has advanced in the field of forensic science⁵².

Unfortunately, the same cannot be said about Ukrainian forensic science. With rare exceptions the field of forensic DNA analysis is not in the orbit of scientific interests of domestic criminalists.

Such rare exceptions can be considered scientific publications on the formation of forensic DNA testing in State forensic science institutions (N. M. Diachenko⁵³, O. V. Dunaiev⁵⁴). Some applied aspects

of formation and use of forensic DNA databases in Ukraine (V. V. Bilous) aroused some interest of scientists⁵⁵, S. M. Lozova and O. V. Matarykina⁵⁶, O. V. Horpyniuk⁵⁷, V. O. Husieva⁵⁸), as well as some problems associated with the use of DNA analysis in forensic practice (A. S. Povkh and S. M. Romanchuk⁵⁹, O. Yu. Kanava⁶⁰, N. Ye. Kozhukhova and others⁶¹, A. V. Kofanov and N. M. Erhard⁶²). In addition, it is worth noting population-genetic research on Ukrainian population that contribute to ensuring the appropriate level of statistical evaluation of the results

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- 51 Butler J. M. The future DOI: 10.1098/rstb.2014.0252 (date accessed: 20.11.2021).
 - 52 Ibidem. Decades of Developments in Forensic Science. *Forensic Science Review*. 2020. Vol. 32. No. 2. P. 101.
 - 53 Дяченко Н. М. *Op. cit.*
 - 54 Дунаєв О. В. Актуальні питання судово-медичної генетики в Україні. *Український медичний альманах*. 2013. Т. 16. № 1. С. 179—181.
 - 55 Білоус В. В. Законодавче забезпечення генетичної ідентифікації в Україні: проблеми теорії і практики криміналістики. *Право і суспільство*. 2015. № 5-2. Ч. 3. С. 216—224.
 - 56 Лозова С. Н., Матарькіна Е. В. Использование возможностей криминалистического учета генетических признаков человека во время досудебного расследования. *Судебная экспертиза Беларуси*. 2019. № 2 (9). С. 38—43.
 - 57 Горпинюк О. В. Міжнародні стандарти накопичення та використання біометричних даних (зразків ДНК) у діяльності правоохоронних органів. *Юридичний науковий електронний журнал*. 2019. № 2. С. 245—249. URL: http://www.lsej.org.ua/2_2019/70.pdf (date accessed: 20.11.2021).
 - 58 Гусєва В. Перспективи впровадження зарубіжного досвіду використання ДНК-обліків у практику України. *Науковий вісник Національної академії внутрішніх справ*. 2021. Вип. 119 (2). С. 121—131. DOI: 10.33270/01211192.121 (date accessed: 20.11.2021).
 - 59 Повх А. С., Романчук С. М. Контамінація під час молекулярно-генетичного дослідження. Причини її виникнення та наслідки. *Криміналістичний вісник*. 2018. № 2 (30). С. 106—115. DOI: 10.37025/1992-4437/2018-30-2-106 (date accessed: 20.11.2021).
 - 60 Канава О. Ю. Проблемні питання проведення молекулярно-генетичних досліджень при ідентифікації безвісти зниклих осіб. *Юридичний науковий електронний журнал*. 2019. № 5. С. 298—300. DOI: 10.32782/2524-0374/2019-5/71 (date accessed: 20.11.2021).
 - 61 Кожухова Н. Є., Сиволап Ю. М., Кривда Г. Ф. Проблеми ПЛР-аналізу: деградація і модифікація ДНК, інгібування, контамінація : огляд. *Український судово-медичний вісник*. 2002. № 1. С. 26—32.
 - 62 Кофанов А. В., Ергард Н. М. Судово-експертна характеристика геному людини та його ідентифікаційних ознак. *Наукові праці Національного авіаційного університету. Серія: Юридичний вісник «Повітряне і космічне право»*. 2021. Вип. 1 (58). С. 185—193. DOI: 10.18372/2307-9061.58.15327 (date accessed: 20.11.2021).

of forensic DNA testings (M. Melnyk-Sikorska and others⁶³, S. Serha and others⁶⁴, A. Yanchukov and others⁶⁵, O. Kozeretska and others⁶⁶). At the same time, a comprehensive analysis of the current state and prospects for the development of forensic DNA analysis in Ukraine has not been conducted.

Currently, textbooks on criminalistics do not present the topic of DNA analysis, it is not studied in higher education law institutions. As a result, future lawyers (including prosecutors, investigators, lawyers and judges) do not even have a general idea of the possibilities of forensic DNA testing and do not acquire basic skills in dealing with traces of biological origin and are not aware of the principles of DNA evidence evaluation. Obviously, this situation does not meet the needs of practice or development of the theory of criminalistics and forensic science.

In order to close this gap, a textbook on forensic DNA testing has been prepared with our participation⁶⁷ and introduced the relevant topics in the course of criminalistics of Kharkiv National University of Internal Affairs. In addition,

specialists of Kharkiv SRFC of the MIA of Ukraine introduced trainings with forensic professionals, investigators and prosecutors on the specific expertise use in the field of forensic genetics in criminal proceedings and developed a practical guide⁶⁸. However, these measures are clearly not enough to solve topical issues in forensic didactics. We believe that there is a long-standing need to radically change approaches to the development of forensic science in Ukraine, especially in its natural and technical component.

We have already drawn attention to the shortcomings of understanding the structure and content of forensic technology as part of the science of forensics in Ukraine due to the lack of new industries, including DNA analysis⁶⁹. The main reason for this situation is the outdated notions of the exclusively legal nature of criminalistics that has prevailed since Soviet times and does not correspond to the approaches of most developed countries. In recent years, many scholars have recognized the fallacy of this understanding and are trying to define criminalistics as a synthetic, multidisciplinary science. Unfortunately,

63 Mielnik-Sikorska M., Daca P., Woźniak M., Malyarchuk B. A., Bednarek J., Dobosz T., Grzybowski T. Genetic data from Y chromosome STR and SNP loci in Ukrainian population. *Forensic Science International: Genetics*. 2013. Vol. 7. Is. 1. P. 200–203. DOI: 10.1016/j.fsigen.2012.05.007 (date accessed: 20.11.2021).

64 Serga S. V., Dombrovskiy I. V., Maistrenko O. M., Ostapchenko L. I., Demydov S. V., Krivda R. G., Kozeretska I. A. Allele frequencies for 15 STR loci in the Ukrainian population. *Forensic Science International: Genetics*. 2017. Vol. 29. e40-e41. DOI: 10.1016/j.fsigen.2017.05.004 (date accessed: 20.11.2021).

65 Yanchukov A., Mykhaliuk V., Kryvda R. G. Analysis of allele frequencies of 15 STR loci in a large population dataset from Ukraine at the regional level. *Australian Journal of Forensic Sciences*. 2021. Vol. 53. Is. 4. P. 400–406. DOI: 10.1080/00450618.2020.1749930 (date accessed: 20.11.2021).

66 Kozeretska O. I., Maistrenko O. M., Serga S. V., Dombrovskiy I. V., Ostapchenko L. I., Demydov S. V., Kozeretska I. A. Allele frequencies for 15 forensic STR loci in a population sample from the Kyiv region, Ukraine. *Ibid.* 2020. Vol. 52. Is. 4. P. 387–392. DOI: 10.1080/00450618.2019.1581255 (date accessed: 20.11.2021).

67 Степанюк Р. Л., Перлін С. І., Кікінчук В. В. та ін. Знач. твір. 144 с.

68 Перлін С. І., Шевцов С. О., Іонова В. В. Генетичний фінгерпрингінг: вилучення та дослідження слідів біологічного походження : практ. порад. Харків, 2019. 64 с.

69 Степанюк Р. Л., Перлін С. І. Напрями розвитку структури і змісту криміналістичної техніки в Україні. *Криміналістичний вісник*. 2019. Вип. 32 (2). С. 6–14.

formation of some scientific schools in Ukraine continues on an organizational basis established in Soviet times. It is difficult for a person without legal education to prepare and defend a forensic research and a lawyer without biological education is not a specialist in forensic genetics. In the field of biological sciences, the “judicial” direction is practically not developing. All these circumstances, formed during the period of totalitarianism, have led to the fact that the scientific provisions of forensic DNA analysis have not yet found their place in domestic scientific field.

We fully support the position of V. M. Shevchuk that the issues development and formation of innovative principles of law enforcement forensic support in modern conditions is one of the most important tasks of forensics⁷⁰. In our opinion, forensic DNA analysis (as one of the most innovative areas) should take a worthy place in the forensic system of Ukraine. It should be considered as a separate branch of forensic technology, which studies the individual genetic characteristics of cellular organisms in order to solve the problems of criminal justice. Formation of this field will help not only to take an important step towards modernizing the domestic system of forensic science, but also to significantly improve the state of practical activities. In addition, it is important to return to the recognition of the dual nature of criminalistics as a science that contains two components: natural and technical (forensic technique) and legal (forensic tactics and methods) ones. This will make it possible to conduct research in the field of criminalistics not only in law but in biological, chemical, technical and physical and mathematical sciences. We

believe that to meet the scientific needs of criminalistics should be considered as an independent science branch that obtains degrees and academic titles, and not as one of the components of a separate specialization of law, as is currently the case in Ukraine.

Conclusions

Currently, traditional methods of DNA profiling based on analysis are widely used in forensic practice. *PSTR*-loci (both autosomal and Y-chromosome) and analysis *SNP* mtDNA. At the same time, the latest technologies are being actively developed (to search for relatives based on DNA profiles, determine human appearance, age and biogeographical origin of DNA, use of mass parallel sequencing methods of many DNA fragments and perform rapid tests on DNA profile). New methods are gradually being introduced in different countries, but they need further research for technical and methodological improvement, as well as proper legal regulation.

In Ukraine, technologies of forensic DNA analysis have been used since the early 1990s in forensic science institutions. Technical equipment of domestic laboratories of forensic genetics allows to apply all modern traditional and newest methods of forensic DNA analysis. However, in reality, law enforcement practice uses only traditional tools, moreover, not fully but only to identify individuals on the basis of traces and to determine biological paternity and biological kinship in the presence of biological samples. The main obstacle to further development of this area is the lack of proper legal regulation of content and use of forensic accounting

70 Шевчук В. М. Інноваційні засади криміналістичного забезпечення правозастосовної діяльності: проблеми формування концепції. *Теорія та практика судової експертизи і криміналістики* : зб. наук. пр. 2021. Вип. 23. С. 18. DOI: 10.32353/khrife.1.2021.01 (date accessed: 20.11.2021).

of human genomic information, which preventing formation of effective national database of DNA profiles.

For quality improving of practical activities in the field of forensic DNA analysis, it is important to promote relevant knowledge among law enforcement officers to minimize common mistakes in the preparation of objects for forensic research. It seems appropriate to amend criminal procedure legislation of Ukraine in order to properly regulate the selection of biological samples of a person, the use of human genomic information, implementation of rapid testing (rapid analysis) for DNA profile. It is necessary to take measures aimed at expanding the tool kit accordingly real capabilities of existing forensic genetics laboratories, creation of such laboratories in those regions of Ukraine where they currently do not exist.

We consider the state of scientific support of DNA analysis issues in Ukraine to be insufficient due to the lack of a clear idea of the role and place of this industry in the forensic system, as well as the relevant comprehensive research. The main directions of improving this state are: a) real recognition of criminalistics as a science that has a multidisciplinary nature, and providing opportunities to obtain degrees in criminalistics in the field of biological sciences; b) careful theoretical handling issue of the ratio of forensic and forensic medical directions in DNA analysis; c) supplementing structure of forensic science with the *Forensic DNA Analysis* section with a corresponding improvement of the content of educational and methodological literature on criminalistics.

Криміналістичний ДНК-аналіз: стан і перспективи розвитку в Україні
Руслан Степанюк

Мета дослідження — узагальнити відомості про основні напрями використан-

ня ДНК-аналізу в практиці розкриття та розслідування злочинів, застосовувани у різних країнах світу, розглянути можливості цих напрямів і стан їх упровадження у вітчизняну слідчу й експертну практику, а також сформулювати авторське бачення перспектив подальшого розвитку теоретичних і прикладних аспектів криміналістичного дослідження ДНК в Україні.

Схарактеризовано традиційні методи ДНК-профілювання, засновані на аналізі STR-локусів і дослідженні SNP мтДНК, наведено інформацію про застосування новітніх технологій для пошуку родичів за базами ДНК-профілів та визначення віку й біогеографічного походження людини за ДНК, а також методів масового паралельного секвенування численних фрагментів ДНК і виконання швидких тестів на ДНК-профіль. Зауважено, що основною перешкодою на шляху подальшого розвитку ДНК-аналізу в Україні є відсутність належного правового регулювання, що заважає формуванню ефективної національної бази даних ДНК-профілів. Звернено увагу на явний брак наукового забезпечення ДНК-досліджень в Україні.

Запропоновано шляхи розв'язання наявних проблем у цій сфері, зокрема: популяризувати відповідні знання у середовищі правоохоронців для мінімізації типових помилок у поводженні зі слідами біологічного походження; унести зміни до кримінального процесуального законодавства України з метою належного врегулювання питань відібрання біологічних зразків і здійснення експрес-аналізів на ДНК-профіль; ужити заходів для розширення інструментальної бази й реальних можливостей лабораторії судової генетики.

Ключові слова: криміналістична техніка; криміналістичний ДНК-аналіз; ДНК-профілювання; база даних ДНК; ДНК-фенотипування.

Криминалистический ДНК-анализ: состояние и перспективы развития в Украине

Руслан Степанюк

Цель исследования — обобщить сведения об основных направлениях использования ДНК-анализа в практике раскрытия и расследования преступлений, применяемых в разных странах мира, рассмотреть возможности этих направлений и состояние их внедрения в отечественную следственную и экспертную практику, а также сформулировать авторское видение перспектив дальнейшего развития теоретических и прикладных аспектов криминалистического исследования ДНК в Украине.

Охарактеризованы традиционные методы ДНК-профилирования, основанные на анализе STR-локусов и исследовании SNP мтДНК, приведена информация о применении новейших технологий для поиска родственников по базам ДНК-профилей и определения возраста и биогеографического происхождения человека по ДНК, а также методов массового параллельного секвенирования многочисленных фрагментов ДНК и выполнения быстрых тестов на ДНК-профиль. Замечено, что основное препятствие на пути дальнейшего развития ДНК-анализа в Украине — отсутствие надлежащего правового регулирования, мешающего формированию эффективной национальной базы данных ДНК-профилей. Обращено внимание на явную недостаточность научного обеспечения ДНК-исследований в Украине.

Предложены пути решения имеющихся проблем в этой сфере, в частности: популяризовать соответствующие знания среди работников правоохранительных органов для минимизации типичных ошибок в обращении со следами биологического происхождения; внести изменения в уголовное процессуальное законодательство Украины с целью надлежащего урегулиро-

вания вопросов отбирания биологических образцов и проведения экспресс-анализов на ДНК-профиль; принять меры к расширению инструментальной базы и реальных возможностей лабораторий судебной генетики.

Ключевые слова: криминалистическая техника; криминалистический ДНК-анализ; ДНК-профилирование; база данных ДНК; ДНК-фенотипирование.

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Contributors

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Declaration of Competing Interest

The author declares that he has no conflict of interest.

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