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Forensic olfaction employment for solving crimes

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Abstract
The research on the use of forensic olfaction is relevant due to the need to highlight its content and rules of practical application in the analysis of odour traces of a criminal, which ensures improvement of crime solving and investigation. The study aims to analyse the olfaction information properties which individually identify a person about the odour traces left at the crime scene; to study the current possibilities of the methodology for conducting olfaction examinations; and to formulate proposals for improving the process of expert analysis of olfaction information in criminal proceedings. The study uses comparative legal, terminological, systemic, and structural, formal and logical methods, as well as the method of expert experiment. The author confirms the data on the individuality of each person's smell, in particular, based on cases from investigative practice, the author shows the possibility of establishing the individuality of odour traces and their belonging to a particular person, even in the case of a crime committed by two monozygotic twins. The author substantiates the possibility of collecting odour traces from various objects with which several persons had contact, and of isolating those odour particles, allowing detector dogs to identify their specific carrier. The study defines the general conditions and procedure for conducting an olfaction analysis of odour traces of a person being tested in connection with a criminal offence investigation. It is generalised that the work of detector dogs for the most effective odour analysis should be carried out in a special room without extraneous odours at a temperature of +20°C and relative humidity of 60-80%. The study systematises the general prohibitions that should be observed during an olfaction examination, which relate to the non-use of control and auxiliary odour samples of persons familiar to detector dogs; the work of an olfaction expert and a dog handler in a special room is separated to prevent the specialist from obtaining information about the specific location of the storage jar with the odour information that is being installed. The practical significance of the study is determined by the expansion of the ability of law enforcement agencies to identify persons involved in a crime by their odour traces left at the scene and to conduct forensic examinations using the method of forensic olfaction

Keywords:
scent trail; collection of human scent trails; forensic olfaction; dog handler; olfaction expert; specialised knowledge

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Introduction

Criminals are increasingly attempting to conceal their identities by wearing gloves, caps, balaclavas and otherwise hiding their faces from recognition on CCTV cameras, physically destroying traces of their presence at the scene. Such measures to counteract the investigation of crimes are inherent in both traditional mercenary and violent crimes and those committed with the use of digital technologies. At the same time, in the vast majority of cases, the scent trail of the person who committed the crime remains at the scene. Odour traces are also left indoors on office chairs in the hacker's place of work and on peripherals of computer equipment used to commit cybercrime. If it is impossible to stop the release of odour traces into the environment and leave them on various objects, law enforcement agencies receive an important source of traces that allow them to accurately identify the person who touched certain objects or was in a certain place. Olfaction examination is responsible for resolving these issues. At the same time, in some cases, lawyers express doubts in court about the experts' conclusions, claiming that the evidence obtained from olfaction examinations is unreliable, claiming that special dogs used as "biological tools" are not scientific forensic tools and that the evidence obtained as a result of olfaction examinations is unreliable.

In forensic science and forensic examination, a methodology for conducting olfaction research has been developed, which is based on a scientifically developed method of forensic olfaction. Few scholars addressed the problems of forensic olfaction in solving crimes. Most studies address the issues of how special dogs detect scent traces at the scene of an incident, how to pursue a criminal, and how to detect various items prohibited for free circulation with the help of service dogs (Hochrein, 2019).

For instance, O.H. Voloshyn (2020) considered the rules for a dog handler with a sniffer dog to inspect the scene of an incident, provided some recommendations on typical places of detection of olfaction information and rules for the pursuit of a criminal who fled the scene. Scientists addressed the use of scent information by law enforcement dogs in performing various operational and service tasks, in particular during peacekeeping operations (Zarosylo *et al.*, 2020). A.V. Kobets & P.Ye. Antoniuk (2023) considered the procedural problems of using the olfaction research results in criminal proceedings, proposing a set of regulatory, legal, and methodological measures to make appropriate amendments to the legislation in the field of forensic science.

Several researchers addressed the use of olfaction information in law enforcement activities. Scientists classified human odour as a group of chemical compounds that unambiguously identify people. The mechanism of identification of scent traces by dogs was noted, which is not fully understood. The "multiplicity of human scents" was proved, by which dogs could detect the scent traces of a person (Doležal *et al.*, 2019). The issues of searching for missing persons, corpses, and explosives with the help of special dogs were also studied; the role of properly trained dogs in investigating pyromania and arson, searching for computer and electronic materials, locating fugitives, detecting currency, tobacco, and weapons, and combating poaching were highlighted. Recommendations on how special dogs, as special investigative tools, can be used in criminal proceedings were provided (Ricci *et al.*, 2021).

Only V.O. Yashchuk (2023) comprehensively considered the use of odour traces in solving crimes, focusing on the legal basis for the use of odour traces in crime investigation, the importance of odour traces when detected at the scene, the role of olfaction information in the subject of research in weapons science and explosives engineering and the general provisions for conducting olfaction research. The methods of detection, fixation, removal, preservation, and storage of odour traces were studied by V.V. Yusupov & A.O. Antoshchuk (2023).

At the same time, scientists did not address the tools of olfaction research, its central key and main technique – the method of forensic olfaction expertise, which combines the analysis of the physical properties of human odour and the physiological characteristics of the detector dog's identification of the corresponding trace, forensic recommendations on the proper conduct of an olfaction examination to determine whether the evidence obtained by an olfaction expert is reliable, admissible and appropriate in the criminal proceedings under investigation.

To substantiate and verify the effectiveness of the practical application of the forensic olfaction method, various options for conducting olfactory research in practical situations of criminal offences are to be studied. Therefore, the study aims to reveal the essence of the forensic olfaction method in conducting expert experiments to detect odour information on various objects and subsequently identify the persons who bear it with the help of detector dogs.

Materials and Methods

The study used the data obtained during the expert experiment by comparing different odour objects using a statistically valid group of detector dogs. The expert experiment was conducted based on the olfaction laboratory of the Vinnytsia Expert Centre of the Expert Service of the Ministry of Internal Affairs from 20.01.2024 to 25.01.2024. Dog handlers from the District Dog Training Department of the National Police of Ukraine and experts from the forensic olfaction laboratory of the Vinnytsia Expert Centre of the Ministry of Internal Affairs of Ukraine were involved in the olfaction experiment. The study involved 9 cocker spaniel detector dogs, all female, named Astra, Jeta, Dingo, Lutik, Melody, Nessie, Palma, Sarma and Chernysh. Three expert

experiments were conducted with different tasks: the first was to determine the presence of an odour trace on the object and its suitability for identification; the second was to establish the identity of the odour trace of a person removed from the crime weapon with the odour sample taken from the suspect using detector dogs; the third was to identify, the person whose odour trace was found on the crime weapon among three persons using detector dogs. The stages of the experiments depended on the type of task. The first experiment involved two stages; the second and third experiments involved three stages, due to the need to identify odour traces at the third stage. The experiments were conducted under pre-prepared conditions using the existing collections of odour traces from the Vinnytsia Expert Centre. The experiment involved one person (a statistician) who was not involved in the criminal justice system, one olfaction expert, and one dog handler. All of them are representatives of the Vinnytsia region. The experiment was conducted in compliance with ethical standards for all participants – humans and animals. All experimental studies were conducted by modern methodological approaches to the collection of forensically significant objects[1,2] and in compliance with relevant requirements and standards, including the requirements of ISO/IEC 17025:2005[3]. Animals were kept and handled according to the provisions of the Procedure for Experiments and Experiments on Animals[4] by Scientific Institutions and the European Convention for the Protection of Vertebrate Animals Used for Experimental and Other Scientific Purposes[5]. The study was carried out following the rules of the 1975[6] Helsinki Declaration. All participants were informed about how their anonymity was ensured, knew the goal of the experiments conducted, how samples of olfaction information would be used, and the risks involved.

To determine the effectiveness of the forensic olfaction method, three experiments were conducted to test the ability of detector dogs to distinguish between different scent traces and identify the persons who bear them. The experimental methodology was partially based on the developments of V.O. Yashchuk (2021; 2023). The general conditions of the experiment were as follows. Samples of scent traces of individuals known to the detector dogs in previous studies as auxiliary scent traces are not used as additional or control samples during olfaction sampling. Additional employments of the detector dog are carried out after changing the location of the inspected storage bank in the samplings. Before the detector dogs start their "job", the expert places the odour samples in a circle for comparison, performing a random arrangement of these objects. The examiner does not touch the cans with unprotected hands to avoid creating odour cues for the detector dog, and any manipulation of the odour samples is carried out exclusively with protective odourless gloves and alcoholised tweezers. In the course of an olfaction examination, an ethogram of the detector dog's signal response is made, and video is recorded using computer equipment.

The study was carried out in a specially equipped laboratory room, where external influences were excluded as much as possible and optimal conditions for detector dogs were created (temperature from +18 to +22°C, air humidity 65-80%). On the floor of the room, 12 special cones were placed at a distance of one metre from each other. These cones contained the fragrance samples prepared for analysis, as well as auxiliary objects for comparison. The sample storage jars were sterile and had labels explaining their purpose. The auxiliary objects consisted of neutral scent samples that were not detected by the dogs and were obtained from contact traces on the model objects left by persons unrelated to the experiment.

The olfaction sampling objects with odour were identical in appearance, namely: flannel napkins were the same in structure, size and colour and were uniformly packed in jars; cones for placing sampling objects were of the same shape, volume, and colour; sampling objects (storage jars) were installed in identical cones. Fresh (newly collected) samples (or traces) of individual odours of unauthorised persons were used as auxiliary odours, from which the comparison odour sample was taken in a specific sequence. In particular, if samples are taken from the hands before the test, the person must wash them with running water, without soap or any impurities, and dry them with a disposable towel. It is a mandatory rule that scent traces of persons known to the detector dogs in previous studies as auxiliary scent traces are not used. The handler who brings the detector dog into the sampling room should not know the location of the storage jars with the scent samples in the sampling chain. Detector dogs are used in a balanced state of their nervous processes.

Each time a trained dog was released for sampling, it would be given a sit command, which would test its

[1] Guidance for the Implementation of ISO/IEC 17020 in the Field of Crime Scene Investigation. (2008, December). Retrieved from https://docplayer-net.translate.goog/44075680-Ea-5-03-guidance-for-the-implementation-of-iso-iec-in-the-field-of-crime-scene-investigation.html?_x_tr_sl=en&_x_tr_tl=ru&_x_tr_hl=ru&_x_tr_pto=sc.
[2] ISO 21043-2:2021. (2022, September). Retrieved from https://online.budstandart.com/ua/catalog/doc-page.html?id_doc=96758.
[3] ISO/IEC 17025:2006. (2006, December). Retrieved from https://online.budstandart.com/ua/catalog/doc-page.html?id_doc=50873.
[4] Order of the Ministry of Education and Science, Youth and Sports of Ukraine No. 249 "On Approval of the Procedure for Conducting Research and Experiments on Animals by Scientific Institutions". (2012, March). Retrieved from https://zakon.rada.gov.ua/laws/show/z0416-12#Text.
[5] The European Convention on the Protection of for the Protection of Vertebrate Animals, Used for Research and other Scientific Purposes. (1986, Marh). Retrieved from https://zakon.rada.gov.ua/laws/show/994_137#Text.
[6] The Declaration of Helsinki. (1975, October). Retrieved from https://www.wma.net/what-we-do/medical-ethics/declaration-of-helsinki/.

capabilities. If the dog was not complying, it would be replaced by another dog, or the study would be rescheduled for another day or time. Before each dog starts, an expert (a person other than the dog handler working with the detector dog in the sampling room) re-arranges the objects of study in the sampling circle, ensuring that they are placed in a random order. Control over the course of olfaction identification is ensured by techniques based on elements of variation statistics, through multiple selection recognition of the wanted odour when changing the location of its source among a comparative number of objects, first with the help of one detector dog (Fig. 1), then with other dogs.

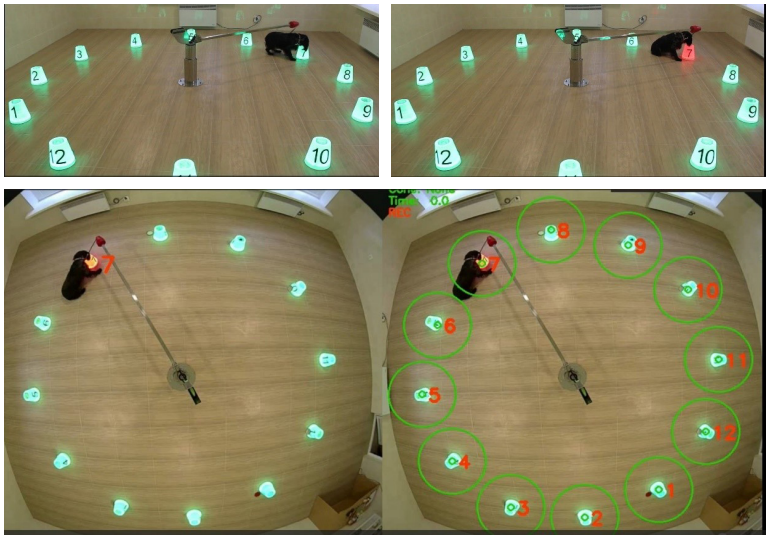

Figure 1. Forensic olfaction examination using a detector dog with the course of the examination recorded by computer equipment

Source: author's archive

A typical algorithm for using a detector dog consisted of the following techniques performed sequentially. At the start, for a minute, the dog was allowed to sniff a napkin in an open glass vessel with the initial odour sample to be searched for, after which it was run past the open vessels (comparison row) to sniff the odour samples contained in them in turn. If an odour sample is found among them that has a common source of origin with the sample given at the start, the dog assumes a signal pose developed by training and sits down near this object.

Results

The problem of olfaction examination in modern forensics. The issues of olfaction employment (the science of smells) in law enforcement practice are considered both in general by Forensic Science and its branches – forensic chemistry, forensic microbiology (Komarov *et al.*, 2015), forensic medicine (Titus *et al.*, 2022), and forensic olfaction. Human odour detection technologies gained attention due to their application in such areas as medicine, biometrics, criminal prosecution, criminal procedure, etc. The latest developments involve the identification of human scent in conjunction with the use of specially trained dogs to search for evidence. The results obtained from various studies have shown that odour can be considered important evidence for investigative purposes (Guleria *et al.*, 2022).

The theory of forensic olfaction is based on the provisions on the individuality of human odour and the possibility of its establishment using scientifically sound methods and means. In particular, technical means in forensic olfaction are its instrumental part. The principle of their operation is based on an analyser of a physical and chemical device that can distinguish between a range of odour molecules, register them in an olfactrogram, and determine individual mixtures of human odour with a high degree of coincidence (Ruvin, 2019). At the same time, at the present stage, there are no technical devices that perform an elementary analysis of the composition of an odour trace to solve a crime. Therefore, in the investigation of criminal offences, the forensic olfaction method is used, which is based on the action of the olfactory organ of detector dogs (Ruvin, 2019).

Odour is a "chemical signature" of a person. Determining the chemical composition of an odour can solve many problems of human identification, including in forensic practice (Titus *et al.*, 2022). Smell individualises a person and is highly stable and unchanging. That is, odour samples characterise the properties of the person who carries it (Basiuk, 2023). The substances responsible for the individuality of a person's smell are free fatty acids, the C_{12} – C_{26} fraction of which is positive when tested by detector dogs and are perceived by them as specific, unique characteristics of a person. The

smell impregnates objects worn by humans – shirts, suits, jackets, shoes, boots, etc. – and gets on various objects, including those that are in the hands or that the person has touched exposed parts of their body with. This leaves grease on the objects, which, when dispersed in the air, creates an odour, an odour trail (Yermolaeva *et al.*, 2009).

The simplicity of obtaining human odour samples, the short time required, and the relatively low cost of consumables are noted by R. Giese and K. Hackner (2020). The identification of odour traces by comparing samples collected from humans is carried out by olfaction sampling using special detector dogs that have previously completed a training course in olfaction research. Dogs of various breeds (German Shepherd, Malinois, Labrador, Rottweiler, Spaniel, etc.) and genders can be used in this area. A sniffer dog, in the course of a properly executed examination, determines the individual totality of a person's scent, ignoring several extraneous factors. The "multiplicity of human odours" is also mentioned by P. Doležal *et al.* (2019). The origin of the smell of a living being is volatile metabolites determined by the DNA code, which are continuously formed by humans and are found in the external traces of a person – in fat, traces of blood and other secretions. It is noted that special detector dogs are highly effective in identifying individuals based on samples of saliva and armpit sweat (Woidtke *et al.*, 2018).

A dog handler is employed at the scene to collect olfaction information. At the same time, a forensic olfaction expert or other veterinarian may be involved in the examination of the scene (Yatsenko, 2022). These persons carry out professional manipulations at the crime scene without the use of detector dogs. Such specialists understand the specifics of collecting scent traces and have the appropriate skills, including working with technical forensic equipment, such as special olfaction suitcases (Fig. 2). The combination of specialist work and technical resources for the collection of human odour traces has been documented in scientific research (van Dam *et al.*, 2019). Forensic experts are not authorised to use their detector dogs to collect scent traces. This is because these special dogs are used during olfaction research. This approach does not comply with the provisions of legal proceedings (in particular, the use of a single biological detector during the examination at the scene and in further investigative (search) actions, conducting an olfaction study, allows lawyers to claim bias of experts and examination tools – special dogs). In this regard, researchers also note the different interpretations of evidence obtained through the use of specially trained dogs by state legislation (Zarosylo *et al.*, 2020).

Figure 2. Selected samples of Ukrainian-made olfaction suitcases (a set)
Source: author's archive

Olfaction research concerns the legality of using detector dogs to search for various objects, such as weapons, drugs, etc., which are subsequently sent for this examination. In this regard, the case law of foreign countries regarding the admissibility of obtaining such objects is ambiguous. In particular, the highest court in the United States, the Supreme Court, found that the detection of drugs found in a man's suitcase at the airport, which took more than an hour, was an unacceptably long restriction on the right to freedom of movement. Determining the contents of a suitcase using a sniffer dog means inspecting it in a closed state, which can be considered biased. This procedure has significant differences from a police inspection of a person's belongings. Therefore, it is believed that sniffing suitcases, packages, etc. by a special dog is neither a procedural inspection nor a search[1]. Similarly, the court explained the cases of checking cars at checkpoints by authorised

[1] Judgment of the Supreme Court of the United States in Case No. 462 U.S. 696. (1983) "United States v. Place". (1983, June). Retrieved from https://supreme.justia.com/cases/federal/us/462/696/.

persons using special dogs, for example, to search for drugs[1]. In another court case (Illinois v. Caballes)[2], the court found that when a car is inspected with a dog specially trained to search for drugs, the authorised persons do not enter the car and do not conduct a procedural inspection. The rule that the car and the police officers are in a public place applies here, so in this case, it is not permissible to talk about the right to private property. In another case, police officers entered the porch of a private house and began searching for drugs using a sniffer dog. Such activity was recognised as entering a person's home or other property for a search, and this, accordingly, requires a court order or written consent of the homeowner[3].

In this regard, it is necessary to develop international standards for the training and expert certification of special detector dogs with a recommendation for optimal training for specific types of law enforcement activities (Fattah & Gharib, 2020; DeChant *et al*., 2020; Fattah *et al*., 2022). This would provide additional guarantees of recognition by the judicial system, including international courts, of evidence of a person's involvement in a committed offence based on olfaction sampling conducted by specially trained biological detector dogs (Brand, 2019).

Forensic olfaction research in Ukraine is an expert speciality within the framework of biological expertise[4]. The methodology for conducting olfaction research contains certain guaranteed principles of objectivity of the results of this expert study. The methodology was developed by experts from the State Scientific Research Forensic Centre of the Ministry of Internal Affairs of Ukraine and Vinnytsia Scientific Research Forensic Centre of the Ministry of Internal Affairs of Ukraine in 2021, and on 28 January 2022, the methodology was state registered (Registration Code 9.7.01)[5]. The content of the methodology is closed to the public due to the content of information for the official use of forensic olfaction experts. Thus, the method of forensic olfaction, which is the basis of the methodology for conducting the relevant research, has a set procedure and rules.

Experiment 1 – determining the presence of an odour trace on an object and its suitability for identification. Odour traces were extracted from the keys to the front door of the office and placed on a gauze napkin. The experiment aimed to determine whether the set of spare keys contained human odour traces and whether these odour traces were suitable for identification.

Two glass containers with olfaction information were obtained in preparation for the experiment. Each storage vessel was marked with explanatory labels and registration numbers: object 1 – a piece of gauze bandage with odour traces; object 2 – two sterile flannel napkins. To make duplicate odour traces, a piece of gauze bandage was placed in a glass container (jar), and flannel napkins were placed in the same jar. The jars were tightly closed with a threaded metal lid. After that, the storage jar was placed in a special temperature-controlled oven for a period of 5 hours and +20°C for the transfer and equilibration of olfaction information. Detector dogs named Melody, Astra and Nessie were used in the olfaction study. Detector dogs were used to detect human scent traces in scent samples collected from keys, and they were trained to respond to scent traces using a specially developed working behavioural stereotype. This stereotype allows the dog to detect human scent traces among other odours in a comparative range of objects.

The initial stage involved checking the availability and suitability of the olfaction information under investigation. To this end, the detector dogs Melody, Astra, and Nessie were given an auxiliary scent sample from another person to sniff in turn, in separate experiments. Then, in the comparison row, where the odour samples taken from the keys and the duplicate odour were placed, they were compared with the auxiliary samples obtained from the clothes of strangers. During the search for the duplicate odour sample, which was presented at the beginning, the presence or absence of a reaction of the detector dog to the odour samples, as well as the nature of this reaction, was determined. During the sampling to check for the presence of odour interference, the odour samples of Object 1 and Object 2 were sensed by the detector dogs Melody, Astra, and Nessie with a visible tentative reaction, indicating the presence of relevant olfaction information in the odour samples taken from the keys and their suitability for further olfaction research.

The next stage took place in the same room, which was ventilated for half an hour and the floor was cleaned without the use of detergents. An expert wearing sterile rubber gloves placed glassware into the cone "5" (Object 2). The detector dogs Melody, Astra, and Nessie were given the odour sample from the set of keys as a search scent at the start of the test. While sniffing glass jars placed in numbered cones, the dogs alternately

[1] Judgment of the Supreme Court of the United States in the Case No. 531 U.S. 32. (2000) "Indianapolis v. Edmond". (2000, November). Retrieved from https://supreme.justia.com/cases/federal/us/531/32/.
[2] Judgment of the Supreme Court of the United States in the Case No. 543 U.S. 405. (2005) "Illinois v. Caballes". (2005, January). Retrieved from https://supreme.justia.com/cases/federal/us/543/405/.
[3] Judgment of the Supreme Court of the United States in the Case No. 569 U.S. 1. (2013) "Florida v. Jardines". (2013, March). Retrieved from https://supreme.justia.com/cases/federal/us/569/1/.
[4] Order of the Ministry of Internal Affairs of Ukraine No. 675 "On Approval of the Regulation on the Expert Qualification Commission of the Ministry of Internal Affairs and the Procedure for Attestation of Forensic Experts of the Expert Service of the Ministry of Internal Affairs". (2020, September). Retrieved from https://zakononline.com.ua/documents/show/492560___753711.
[5] Methods of Conducting Odorological Studies No. 9.7.01. (2022, January). Retrieved from https://rmpse.minjust.gov.ua/search.

marked cones by crouching (positive signalling behaviour) 5, 1, and 8, where the search glass jar with the odour sample was alternately placed (Object 1). Melody, Astra, and Nessie did not demonstrate any other signalling reactions during the olfaction experiment. Thus, the olfaction trace information provided for examination was suitable for identification. Thus, as a result of the olfaction experiment 1, it was established that the odour sample extracted from the surface of the set of keys is suitable for identification of the person who carries it, using detector dogs.

Experiment 2 – identification of a human scent trail removed from a crime weapon with a scent sample taken from a suspect using detector dogs. The first object (Object 1) was a pistol, from the surface of the handle of which an odour trace was recovered (on a square-shaped flannel napkin). Object 2 is a sample of the odour trace taken from the suspect (on a square-shaped flannel napkin) (Fig. 3). The tasks that were consistently solved in the course of the experiment were to establish the presence of odour traces on the instrument of crime – the pistol grip; to establish the suitability of these odour traces for identifying their carrier – a person; to establish the affiliation of the odour trace found on the instrument of crime (pistol grip).

Figure 3. Procedure for sampling the smell of a suspect on a napkin
Source: author's archive

A piece of sterile gauze bandage was used to make duplicate odour samples from Object 1 and Object 2. Four glass jars were prepared: two contained odour traces from the objects submitted for examination (Jar 1 – the main odour from the pistol grip and Jar 2 – the main odour sample taken from the suspect) and the other two glass vessels – Jar 3 (duplicate of the odour extracted from the surface of the pistol grip) and Jar 4 (duplicate of the odour sample taken from the suspect). All four jars were tightly closed with a threaded metal lid. During the second olfaction experiment, detector dogs named Palma, Chernysh and Lyut were employed.

The initial stage is to check the availability and suitability of the olfaction information under investigation. For this purpose, the detector dogs Palma, Chernysh, and Lyutik sniffed an auxiliary odour sample collected from other persons in turn, in separate experiments. During this process, duplicate odour samples taken from the gun grip (Jar 2) and the suspect (Jar 4) were placed in a comparative row consisting of auxiliary odour samples collected from the clothing of unauthorised persons. In the process of sniffing the respective odour sample of an unauthorised person at the start, the dogs did not signal or react to the tested storage jars (Jar 2 and Jar 4) in any way.

The next (second) stage of the olfaction study involved a different test. All glass jars with samples from unauthorised persons were replaced with jars containing olfaction information taken as samples from the forensic record – the odour library of the Expert Centre. The duplicate odour was randomly moved to different cones. In particular, at the beginning of the investigation, it was placed in cone 3 (namely Jar 3) – a duplicate of the main odour sample taken from the surface of the pistol grip, in cone 12 – the storage bank (Jar 4). Palma, Chernysh, and Liutik were allowed to smell Jar 1 (the main odour sample from the pistol grip) and Jar 2 (the main odour sample of the suspect) in turn. During the olfaction experiment, the dogs were alternately marked by crouching (positive signalling behaviour) near cones 4, 2 and 9, where the search glass jar with the duplicate odour sample from the gun handle (namely, Jar 3) was alternately placed, as well as cones 3, 6 and 10, where the Jar 4 (with the duplicate odour sample of the suspect) was alternately moved. Thus, at this stage, the olfaction odour information (detected on the gun handle and obtained from the suspect) was suitable for identification by detector dogs based on the method of forensic olfaction.

The next stage (the third stage of the experiment) involves a test to identify the odour detected on the gun grip with a sample of the odour obtained from the suspect. To ensure proper conditions for this stage of the olfaction experiment, the room was ventilated for half an hour and wet cleaned without the use of detergents. Twelve glass jars with new olfaction information taken from the forensic record – the Expert Centre's olfaction library – were placed in the circle of storage jars. Cone

5 contained a duplicate of the suspect's odour sample (Jar 4). The expert took turns giving the dogs Palma, Chernysh and Liutik a sniff of the duplicate olfaction information taken from the gun grip (Jar 2). During the first lap, Palma, Chernysh and Lyutik alternately showed positive signalling behaviour to cones numbered 5, 10, and 12, in which the suspect's scent sample was alternately placed (Jar 4). This experiment confirmed the common olfaction source of the odour traces (i.e. the suspect's odour) found on the gun grip and obtained as comparative biological samples from the suspect.

Thus, during the olfaction experiment, it was established that the odour trace obtained from the gun grip was suitable for identification from human odour samples. The odour obtained as a sample from a suspect can be used (i.e. is suitable) for identification among odour traces. With the help of detector dogs and the use of forensic olfaction, it was established that the odour sample extracted from the gun handle belonged to the suspect based on an olfaction comparison of the suspect's odour information.

Experiment 3 – identification of a person whose odour trace is found on a crime weapon. The objective of the experiment was to find out to whose person the odour traces found on the instrument of the crime (stocking mask) belonged. For the experiment, several objects were prepared: object 1 – an odour trace from a stocking used as a mask by one of the attackers during a robbery of Citizen R.; object 2 – an odour trace from the victim, citizen R.; object 3 – odour trace from the suspect Mr. T.; object 4 – odour trace from the suspect Mr. Z.; object 5 – odour trace from the metal pipe of the antenna from the scene; object 6 – odour trace of a shoe print on the ground from the scene. Uniform pieces of sterile gauze bandage with duplicate odour information were made, taken out of glass jars in turn and placed in other jars, which were tightly closed with metal lids. A total of 6 storage jars with odour information samples were prepared. The olfaction experiment was conducted at an air temperature of +19°C and relative humidity of 70%. In the third experiment, detector dogs were named: Sarma, Jeta, and Dingo.

At the initial (first) stage, tests were conducted to assess the dogs' ability to compare scent samples. The olfaction information of third parties was placed in the sample circle with the odour samples. Cone 7 contains the storage jar (Object 1) – a duplicate of the odour after adsorption extracted from the stocking; cone 3 contains the storage jar (Object 2) – a duplicate of the odour after adsorption taken from the victim; cone 6 contains the storage jar (Object 3) – a duplicate of the main odour sample after adsorption from the odour of suspect T.; a vault bank (Object 4) was placed in cone 8 – a duplicate of the main odour sample after adsorption from the smell of suspect Z.; the storage jar (Object 5) was placed in cone 10 – a duplicate of the main odour sample after adsorption from the metal pipe of the antenna; the storage jar (Object 6) was placed in cone 12 – a duplicate of the main odour sample after adsorption of the odour trace from the shoe print on the ground. The dog handler participating in the experiment did not give the detector dogs anything to sniff, i.e., during the sampling circle, they randomly sniffed odour objects that could potentially interfere with the comparative olfaction sampling by the detector dogs. When the detector dogs sniffed the glass jars containing the odour samples, the sniffing was carried out without any outside reactions.

At the next (second) stage of the olfaction study, the presence of human odour information in odour samples from objects 1, 5 and 6 was determined. In the comparative circle, samples of non-biological origin were placed among the auxiliary objects as odour samples. Cone 4 contained a storage jar (Object 1), a duplicate of the smell from the stocking; cone 7 contained another storage jar (Object 5), a duplicate of the smell from the metal pipe of the antenna; and cone 10 contained a storage jar (Object 6), a duplicate of the main sample of the smell of the shoe print on the ground. Initially, the detector dogs were not given anything to sniff, i.e. they were free to search for objects. Sarma, Dingo, and Jetta took turns showing a positive signal reaction (sitting) near cones 4, 7, and 10. The investigated odour information was alternately moved to cones 5, 6 and 12. The detector dogs also pointed to cones 5, 6, and 12. Given that dogs are trained to search for human biological odour, the forensic olfaction experiment found that the samples taken from Object 1 (odour trace from a stocking mask), Object 5 (odour trace from a metal pipe) and Object 6 (odour trace from shoes on the ground) contained odour traces of one person as a biological species, after which this stage of the study was terminated.

At the next (third) stage of the olfaction study, the odour information sample taken from Object 1 was compared with odour samples taken from citizens T. (Object 3), Z. (Object 4), and R. (Object 2). The sampling circle included 12 glass jars containing odour samples of unauthorised persons not involved in the criminal offence, with cone 4 containing the storage jar (Object 4); cone 7 containing the storage jar (Object 2); and cone 9 containing the storage jar (Object 3). First, the dogs were given the odour sample taken from Object 1 to sniff in turn. During the sampling circle, the detector dog Sarma pointed to cone 9 (Object 3), in which the storage jar with Mr. T's odour information was placed, with signal behaviour. The studied odour information was alternately moved to cones 1 and 8. During the sampling circle, the detector dogs also pointed to the aforementioned cones 1 and 8.

Thus, using the forensic olfaction method, using detector dogs, established that the odour sample extracted from the mask-stocking (Object 1), which was seized during the examination of the scene of the robbery of citizen R., contained human odour traces. In addition,

this odour trace (Object 1) has a common source of origin with the odour sample in Object 3, taken from Citizen T. The results of olfaction identification were confirmed by three detector dogs. This indicates that the odour trace of Object 1 matches the odour sample taken from Citizen T. (Object 3). The provision of the necessary conditions for the experiment and the identical results demonstrated by the detector dogs can assert that the examination was successful.

Discussion

The successful results of the experiments confirm previous successful cases of using olfaction examination and create a scientific basis for the use of this practice. During the investigation of a staged robbery attack on a judge, a TT pistol was found, from which shots were fired at citizen H. The investigator decided to take odour samples from the suspect, and in the olfaction laboratory, the expert "extracted" the odour trace from the firearm's handle and magazine, as well as from two black socks found at the crime scene and a pair of boots seized from the suspect. According to the conclusions of the dog experts, which were carried out on 22, 23 and 29 October, the comparative odour samples taken from the two black socks and two black boots belonging to suspect H. matched the available odour samples collected from the TT pistol grip and magazine, as well as from two work gloves seized during the inspection of the crime scene and the forest plantation near the crime scene[1].

It is not uncommon for judges to rely on the findings of forensic odour examinations in their decisions on a case. For example, during an investigation into the infliction of severe bodily harm that caused a person's death, a scent trace of the suspect was obtained from a tree branch used as the weapon. The investigator ordered a forensic olfaction examination. Three trained detector dogs were involved in the olfaction examination. Each of the dogs was tested for their memory and response to odours using scent traces from a special collection that is part of the olfaction laboratory. The study found that the scent collected from the blood of citizen O, had a common origin with the odour sample taken from the surface of the branch, as stated in the forensic odour examination report. Among the main evidence of the prosecution was the conclusion of this examination, which, together with other incriminating evidence, formed the basis for the judge's decision on the guilt of Citizen O[2]. This practice of appointing and conducting olfaction examinations demonstrated positive results, which were ensured by the methodologically correct application of the requirements of the Methodology for conducting olfaction examinations[3]. The effectiveness of this methodology was confirmed in this article.

Olfaction research can also identify monozygotic twins by odour traces, which is not possible by DNA analysis. During the investigation of a series of robberies against female postmen in one of the district centres of Vinnytsia region, a hat was torn off the attacker was recovered. An olfaction examination of the seized hat revealed odour traces of one of the two twin brothers who were being checked for involvement in the crime. At the same time, the victim was unable to distinguish with certainty between the twin brother who attacked her during the line-up, and expert DNA testing did not allow to establish which of the two twins had caused the traces of fatty substance on the lining of the hat. The result of the olfaction examination was used to prove the person's guilt in committing the alleged crimes[4]. Given the successful conduct of the 3rd experiment, the use of olfaction examination in such and similar cases is warranted.

The use of detector dogs in law enforcement is based on an in-depth study of the physicochemical and biological phenomena that underlie them. Given that the most similar features, including olfaction characteristics, should be present in close relatives, a special test was conducted to determine the ability of canines to differentiate odour samples collected from the body, hair and blood of people in a family relationship. During experiments with a group of 12 specialised dogs conducted by a group of researchers in 2009 (Yermolaeva *et al.*, 2009), there were no difficulties in separating the odour traces of parents and children, grandparents and grandchildren, and siblings in different variants of their matching (the odour traces of 532 donors were compared). In another series of experiments, a comparative study was conducted with odour traces obtained from the hands, feet and hair of monozygotic twins. Four twin pairs – two female and two male – served as donors of the traces to be compared. In the course of the experiment, the individual odours of each of the four pairs of twins were differentiated. The results of the experiments confirmed that even the closest people, in addition to the well-known differences in papillary patterns, voice, etc., also have individual smells. The use of scientifically based methods of conducting expert experiments considered in this study confirms these conclusions.

However, it is worth noting that not all factors that can affect the course of examinations have been sufficiently studied. Researchers have studied the impact of the type of training, the time of weaning and maternal

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bonding on the effectiveness of drug detection by police dogs. Experiments were conducted during different periods when puppies were taken away from female dogs that fed them milk, and the performance of different groups of dogs in terms of their drug detection skills was studied (Fattah *et al.*, 2022). The use of special dogs to detect people with infectious and non-infectious diseases was also proposed by P. Jendrny *et al.* (2021). However, these research areas are still at an early stage. At the same time, researchers note that the sense of smell of dogs can be influenced by various parameters, such as genetics, environmental conditions, age, hydration, nutrition, microbiome, conditioning, exercise, management skills, diseases, and pharmaceuticals. The need to consider these features when conducting examinations with detector dogs requires further research. During the experiments, as mentioned above, dogs of the same breed showed the same results.

Experiments on the ability of special dogs to detect the smell of drugs and explosives from a set of odour traces (multiple odours) were conducted by E. Lauryn & K. Peranich (2021). Using an improved methodology for training detector dogs, the researchers succeeded in increasing the detection rate of relevant objects from 63% to 72% for pseudo-cocaine mixtures and from 19% to 100% for explosive mixtures. At the same time, the results of the experiments described in this article are aimed at testing the effectiveness of olfaction identification by detector dogs of any odour, and the efficiency was 100%. This applies to both the process of detecting odour traces and the process of establishing a single source of origin of the relevant olfaction information.

Conclusions

Thus, if forensic recommendations for collecting scent traces at the scene of an incident, their proper packaging, transportation and storage are followed, and the conditions and established procedure for conducting olfaction research are met, proper, reliable and admissible evidence is obtained in criminal proceedings. Detector dogs can identify a specific subject among several persons suspected of committing the same crime, who left their scent trail on the instrument of crime, the object of the criminal offence, and obstacles that were overcome during the penetration of the scene.

Expert experiments on the detection of an odour trace on an object and its identification with the help of detector dogs confirmed the effectiveness and efficiency of the identification of the person carrying the odour trace by three detector dogs. The experiments were conducted several times, using different detector dogs, with the odour objects being moved to different storage cones, with the impossibility of extraneous odours entering the sample circle, and with the absence of any possibility of a specialist dog "pointing" to a particular object for a signal response, which confirms the objectivity, reliability of the result obtained, and the sufficiency of its justification.

The effectiveness of the main method of the Methodology for conducting olfaction research – the method of olfaction – was tested and established during the experiments. In particular, its effectiveness in detecting human odour traces on various objects and the possibility of identifying a person by his or her comparative odour samples and odour traces removed from an object at a crime scene has been confirmed. The possibility of establishing the suitability of the odour sample provided for olfaction examination (both the sample from the crime scene and the comparative odour sample of the person taken during the pre-trial investigation) has been proved. The effectiveness of the use of detector dogs in determining the common source of origin of various odour traces (odour traces from different objects; odour traces obtained from several persons) with a specific odour sample has been repeatedly confirmed.

In this direction, it is promising to create technical devices for instrumental diagnostics of detected odour information with the prospect of developing software for identification and diagnostic studies using computer programmes for olfaction research. It should be noted that there is a need to develop and experimentally test new designs of containers for preserving odour traces that would take up less space and allow for safer transportation.

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Conflict of Interest

None.

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Використання методу криміналістичної одорології під час розкриття злочинів

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Анотація
Актуальність дослідження питань використання методу криміналістичної одорології зумовлена необхідністю висвітлення його змісту та правил практичного застосування під час аналізу запахових слідів злочинця, що забезпечує вдосконалення діяльності з розкриття та розслідування кримінальних правопорушень. Метою дослідження є аналіз властивостей одорологічної інформації, що індивідуалізує особу, щодо залишених нею слідів запаху на місці події; дослідження сучасних можливостей методики проведення одорологічних експертиз; формування пропозицій з удосконалення процесу експертного аналізу одорологічної інформації в кримінальному провадженні. У статті використано порівняльно-правовий, термінологічний, системно-структурний і формально-логічний методи, а також метод експертного експерименту. Підтверджено дані про індивідуальність запаху кожної людини, зокрема на підставі випадків зі слідчої практики відображено можливість встановлення індивідуальності запахових слідів та їх належність конкретній особі, навіть у випадку вчинення злочину двома монозиготними близнюками. Обґрунтовано можливість збирання запахових слідів з різних предметів, з якими мали контакт декілька осіб, виокремлення тих запахових частинок, які дають змогу собакам-детекторам провести ідентифікацію конкретного їх носія. Визначено загальні умови й порядок проведення одорологічного аналізу слідів запаху особи, які перевіряють у зв'язку з розслідуванням кримінального правопорушення. Узагальнено, що роботу собак-детекторів для проведення найрезультативнішого одорологічного дослідження необхідно здійснювати в спеціальному приміщенні без сторонніх запахів за підтримання температури +20 °С та відносної вологості повітря 60-80 %. Систематизовано загальні заборони, яких слід дотримуватися під час проведення одорологічної експертизи, що стосуються невикористання контрольних і допоміжних запахових проб осіб, знайомих собакам-детекторам; відокремлено роботу експерта-одоролога та кінолога в спеціальному приміщенні з метою унеможливлення отримання інформації спеціалістом про конкретне місце розташування банки-сховища із запаховою інформацією, яку встановлюють. Практичне значення полягає в розширенні можливостей правоохоронних органів виявляти осіб, причетних до злочину, за їхніми запаховими слідами, залишених на місці події, та проведення судової експертизи за допомогою методу криміналістичної одорології

Ключові слова:
запаховий слід; збирання запахових слідів людини; криміналістична одорологія; інспектор-кінолог; експерт-одоролог; спеціальні знання