SCENT — K9's Reason for Being

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FOREWORD

This document is based in large part on William Syrotuck's Scent and The Scenting Dog. It has been compiled with the permission of the copyright holder, Jean Syrotuck-Whittle. She has graciously given free use of the material for educational purposes for those who use dogs in public service. Although nearly 30 years old, many still consider this book the most useful available on scent work. In terms of information per page, it is unsurpassed. If you don't own a copy, buy one and study it thoroughly.

Other portions come from public domain work done by various researchers working under the auspices of the Department of Defense. Thanks to Doctors Regina Dugans (Defense Advanced Research Projects Agency), Jim Johnston (Institute for Biological Detection Systems), and Larry Meyers (Auburn University) for sharing research data with us.

INTRODUCTION

It is common knowledge dogs can follow a scent trail undetectable to humans. However, a problem arises when we try to bring this information before a court of law. Courts should not accept evidence that may be based upon unreliable information. We must be able to describe the dog's ability in specific factual terms to be acceptable. At a minimum, every handler must qualify as an expert witness in the use of his or her dog, otherwise tracking evidence testimony will inadmissible.

Beyond courtroom purposes it is helpful to understand what the dog does when managing scent or odor. The dog is unable to tell us what he or she perceives so we are left to examine whatever evidence we find. The goal of this class is to help you understand and apply the evidence.

Thoughtful application of this material will improve your training and handling. Understanding the dog's ability, and what scent is, it will assist you in reading your dog's reactions to the environment. Only then you can assist your dog in solving problems he does not understand. In short, mastery of this material will make you a better team.

SCENT — K9's Reason for Being

1 THE SENSE OF SMELL

Dogs live in an entirely different scent world than we do. They are profoundly affected by odors we can not detect. The dog's ability to perceive scent is so far beyond human ability it is difficult for us to comprehend. The dog's ability to smell compares to ours like our power of reason compares to his.

In the natural state the dog's sense of smell, olfaction, is used to obtain data important to his survival. The smell of a rabbit stimulates the drive to hunt and therefore nourish himself. The smell of a female in heat stimulates procreation. The smell of an enemy stimulates fight or flight behaviors.

The dog learns to pay attention to odors for which he associates negative or positive consequences. Using this capacity of the dog we can train him to detect odors we want detected or followed. Generally speaking positive reinforcement and incentives are used.

In nature the dog may never become interested in these odors, but we can engineer his experience to modify or shape his behavior to serve our needs. To do so we must understand the dog's learning process and how he perceives scent. The following anatomical information will be helpful toward this end.

2 ANATOMY AND PHYSIOLOGY

Understanding the structure and function of the dog's olfactory system and how it differs from ours will help in both training and application of the dog.

Structure and Function

Nasal Plane - The hairless part of the nose. Serves as the entry way for scent. It controls the size of the nostril entry passage.

Vomeronasal Organ (VNO) - This organ is not functionally present in the human. (Recent research brings this statement into question and indicates humans may well have a functional vomeronasal organ.) In the dog it is a scent-associated organ located in the roof of the mouth. Nerve fibers connect the vomeronasal gland directly to the olfactory lobes of the dog's brain.

Turbinates - These are bony ridges located inside the nasal passages. They serve several purposes. They slow the movement of the in-coming air, warm it, moisten it, and spread it out over the scent reception area of the nasal chamber. The turbinates are covered with mucous membrane containing the scenting cells.

Sinuses - The sinuses are cavities in the bones near the muzzle of the dog. They are lined with mucous-like cells that may have olfactory capability. The exact purpose and function are not known. It is speculated their purpose is saving scent for comparison or "memory".

Nerves of Olfaction - These nerves are comparatively large and very numerous. They connect the reception cells/sites with the olfactory lobes of the brain.

Nasal Mucosa - A mucous membrane covers the entire surface of the nasal chambers. The membrane secretes a fluid that serves to moisten incoming air and the surface of the chambers, and acts as a solvent. It also traps particles from the air sample. The mucous is produced by goblet cells.

Olfactory Cells - These cells are critical to the olfactory process. However, it is not known exactly how they interact with the scent particles that reach the nose. There are a number of theories. What is known is that they are present in the nose and linked with the olfactory region of the brain.

Sustentacular Cells - These cells are present where the olfactory cells exist. They appear to have a part in the perception of scent. Some practitioners believe with darker pigmentation do better at scent perception. The dark color of sustentacular cells may support this belief, but for Man's purposes most dog's olfactory capacity meets our needs. The sustentacular cells' exact role in not completely understood.

Basal Cells - As suggested by their name the basal cells underlie the sustentacular and olfactory cells. Their function is not clearly understood.

Comparison of Human vs. Dog

The olfactory system is comprised of the nasal chambers, receptor cells, olfactory nerves, and the olfactory lobes of the brain. It is in the olfactory lobes that scent is recognized, processed, and filed to memory.

Almost 12% of the dog's brain and 50% of the nasal chambers are devoted to olfaction. In comparison the olfactory lobes of the human brain are much smaller

than the dog's. This is also true of the square area of olfactory receptor cells in the human nasal chambers. In the human this area is about the size of a postage stamp compared to about one square yard in a German Shepherd dog. The human receptor site contains approximately 5 million cells where the German Shepherd dog has approximately 220 million cells.

Dividing the 5 million into the 220 million would indicate the dog's ability to scent is 44 times greater than the human. However, it may not be that simple. You must take into account the dog has a larger processing capacity. When the larger processing capacity is coupled with a data collection system that is 44 times greater the difference may be an exponential of the 44. Since the dog's ability to indicate, if not detect, an odor increases with training this will also widen the gap between man and dog.

3 THEORIES OF SCENT

The summation of this chapter is that there is no clear understanding of how the sensation of scent is perceived by the body. However, there are two general categories of theories: chemical contact and vibration; both occurring at the molecular level. It must be emphasized there is no proof of the mechanisms that take place between the environment and the olfactory system.

Although the mechanism is not understood there is ample empirical data to demonstrate the dog has a keen sense of smell that is greater than man's. Although Syrotuck was inclined toward the "Lock and Key" theory, more recent research lends credence to electro-chemical theories.

4 THE HUMAN BODY AS A SCENT SOURCE

As a person walks through the environment he leaves a scent-trail. That scent-trail is unique to the track-layer. This chapter examines evidence left behind as a person passes-by.

Heredity – It is now a well-known fact that a persons genetic make-up is unique to each individual. If we can collect a person's DNA from a crime scene we can later have it matched to that person much in the same way that a fingerprint is matched to a specific person.

Health and State of Mind – With changing health the body's chemical structure

also changes. It is now known a dog can be trained to discriminate schizophrenics from healthy people by their odor. Dogs can also alert an epileptic to an on-coming seizure before the epileptic can feel the onset of the impending seizure. In the same way a dog can learn to recognize an abnormality or change in body chemistry due to the persons state of mind.

Racial Variations - There are several differences in the structures and secretions of different races. For example the oriental race has fewer sweat glands than Caucasian or blacks and the earwax secretions of the races are different. Scout dogs in Vietnam could be trained to be race specific in their alerts.

Cultural and Dietary Variation - The foods we eat, the clothes we wear, cosmetics, and the things we handle all have an effect on our odor.

Cells and Skin - Each cell of the body contains the genetic make-up of the person and the by-products of the person's food and environment.

The skin of a person contains glands that deposit, body chemistry on the skin. These by-products of the glands are individual to the person. Toiletries and other products in the person's environment also contaminate skin.

Eccrine Sweat Gland - These glands cover the entire body. Their primary purpose is thermoregulation of the body. Heat is the primary stimulus to activate these glands. However, emotional stress may also activate them.

Apocrine Sweat Glands - Apocrine sweat glands are located at the base of hair follicles in particular areas, such the arm pits, genitalia, and around the nipples, anus, and navel. These glands are specialized and trigger upon emotional responses such as fear. The components of apocrine sweat are produced differently than eccrine sweat and tend to be much more odorous.

Hair follicle and Sebaceous Gland - All hair follicles have an associated sebaceous gland. There are also sebaceous glands that open directly to the skin. They are most prominent on the face, scalp, and upper torso. The secretions of the sebaceous glands are fatty oils. The secretion is called sebum and it spreads over the skin, mixing with other skin secretions.

Toiletries - Each product that is used on the human body carries its own scent from its chemical make-up. These products also effect the bacterial colonies that reside on and in the skin. Some of the antiperspirants block the flow of perspiration. Some are anti-bacterial.

Inhabitants - Each human has colonies of bacteria living on and in their skin.

There are also other living organisms such as mites, fungi, yeasts and viruses.

The bacterial colonies are by far the most common and plentiful. Each person has more than one type of bacteria residing on their skin. Each colony has a different population density. Each type of bacteria affects the host in a different way.

Bacteria eat the nutrients of the skin. Some are specific to the type of food they eat, others are not. As the bacteria eat the nutrients of the skin cells and skin secretions they breakdown the nutrients and produce gaseous by-products. These by-products are available to the dog. Since the bacteria are acting upon the specific make-up of the host the by-product is specific to the host and the concentration of bacteria, which further individualizes the scent to that person. This is so because each person has different types and concentrations of bacteria.

It is estimated that skin has almost the same bacterial content as soil. The varying combinations by subspecies and population densities could account for most individual variations. When these organisms interact with the genetically varied by-products of the host body, even more individuality occurs.

Bacterial activity is affected by several factors:

Temperature – Each bacterium has its own growth rate temperature preference. Universally lower temperatures retard activity. As the temperature rises to the maximum growth range the colony flourishes and then dies off rapidly as the temperature goes past the maximum growth range.

Humidity – Each cell is comprised of about 80% water. Without water the cell cannot survive. As the humidity of the environment decreases so does the growth rate of the bacterium.

Light – Bacteria are susceptible to ultra-violet light.

Chemical Agents – Each product that a person comes into contact with becomes a part of their clothing or person. This additional odor assists the dog in individualizing a person by scent.

All of these things add to our odor and tend to individualize us. The dog is capable of smelling these differences and recognizing the combination.

5 TRANSMISSION

The previous chapter expressed the source of individual scent. This chapter describes the transmission of that scent to the environment where it is available to the dog.

Rafts - The epidermal layers of the human skull is constantly replenishing itself, because a skin cells life span is about 36 hours. As the cells age they flatten into a flake. They are then shed from the body. Some fall from the body by themselves and others are shed fixed to one or more other cells. The discarded cells are called "rafts". Each raft carries the genetic make-up of the person, secretions, toiletries, etc. The rafts also carry microbial passengers that continue to feed on the nutrients of the rafts producing a cloud of by-products around each raft.

The average raft is .014mm in diameter, and weighs approximately .07 micrograms (.0000000245 oz.). Rafts are shed at a rate of approximately 40,000 cells per minute, or 50 Million per day. Skin rafts are the most common component of house dust.

Body Air Current - The human body is usually in an air mass cooler than itself. The body is heating the air adjacent to itself. The heated air rises along the surfaces of the body at a rate of approximately 1.5 miles per hour (a slow walk). As the heated air rises it carries rafts along. As the heated air clears the body it is caught in the wind.

Some rafts are less aerodynamic than others and fall to earth sooner than aerodynamic rafts.

Rafts are also expelled from the lungs and upper respiratory tract in the same manner and exhaled into the atmosphere.

As rafts disperse into the atmosphere they spread and fall to earth where they are caught in cracks and crevices. The rafts continue to produce scent as long as the moisture and nutrients last, which will be determined by the environmental conditions.

The dispersion of rafts can be visualized by picturing a man throwing handfuls of flour into the air as he walks along. The flour will be separated by the air and fall to earth as individual grains or in small clumps. The breadth of the dispersal will depend upon the velocity of the wind and the velocity of the track-layer. The velocities will effect the density (rafts per area) of the particles.

6 ATMOSPHERIC FACTORS AND AIRBORNE SCENT

While we are discussing this chapter keep in mind that there is a narrow focus on airborne scent. In the next segment we will discuss ground scent and in the following segment how the two blend.

Wind - If wind were a constant movement of air in one direction at a steady velocity it would be simple to project where the rafts and other spoor would likely come to rest: They would be down stream from the source. The heavier rafts falling close to the source while lighter ones drift farther away. The distance the rafts travel from the source is directly related to wind speed.

This phenomenon is now known as the Scent Plume. It is so called because it tends to be narrow near the source and to widen with curling tendrils farther downwind. These tendrils vary in density and proximity to teach other, so it is entirely possible for there to be near complete gaps of "scentless" air between them. For this reason the plume metaphor is more accurate than the cone used in the past.

The movement of air is affected by many factors, which is a study in itself. However, the following principles apply as you analyze a scent problem.

1. Hot air rises.

2. Rising air creates a void pulling other air in to fill the void. The resulting movement of air is called convection current.

3. Friction with the ground slows the air traveling at ground level.

4. Stationary objects impede the movement of air. This causes the air to divide and flow around the object.

5. Each object will create an eddy behind the object where there will be both areas of turbulence and calm. In the calm area near the backside of the obstruction scent particles will settle more quickly.

6. The air traveling around an object will be more dense and/or traveling faster than the ambient air. In this area the scent particles will settle slower and tend to travel farther than the particles caught in the eddy or the ambient air.

7. When the ground is warmer than ambient air it warms adjacent air causing it to rise. If this air meets a mass of significantly cooler air a thermal layer may form two or three feet off the ground in which there will be turbulence. This will keep the rafts airborne for protracted periods.

This condition occurs when the general air mass is calm. Thermal layers do not occur when it is windy.

8. Ground cooler than ambient air will cool the air causing it to sink. This tends to pull rafts to the ground.

7 THE GROUND SCENT PICTURE

When a person walks through an area he leaves two types of evidence: *1)* the airborne rafts and other debris coming to rest on the ground, and 2) the physical disturbance of the earth as the result of footfalls. The combination of the two is called the ground scent picture.

The Footstep- As a person steps onto the ground the soil is compressed and rearrange according to the makeup and condition of the soil. Any vegetation caught in this action may be crushed.

Soil is heavily contaminated with bacteria. As the soil is disturbed by the footfall the habitat of the bacteria is altered. Bacteria not previously exposed to light or moisture may now be. The disturbance may increase or decrease bacterial activity. This represents a change from the surrounding area. It becomes a slue to the dog.

The chemistry of the soil will be exposed by the footfall bringing about additional change.

The crushed vegetation will expose nutrients to be acted upon by bacteria. The process of putrefaction will begin.

Bacteria in the soil will breakdown vegetable and animal matter. This process will be ongoing when the footfall occurs. The by-products of putrefaction will be more exposed to the atmosphere by the disturbance.

As the shoe or foot strikes the earth there will be an exchange of matter from one to the other. In this way scent from the person will be directly deposited on the footstep. This scent may contain the person's individual scent from his perspiration and contaminates from his environment and the shoe chemistry.

The more vegetable matter in the soil when moisture is present the more bacteria will be present. When there is less nutrients available there will be less bacteria. When there is no moisture present, bacteria will be less active.

Rafts On The Ground - When a raft falls to the ground resident bacteria will be

affected by the new environment. If the location is shaded from direct sunlight and has sufficient moisture and tolerable temperature the bacteria will continue to thrive as long as the nutrients last.

If the raft falls where the temperature, ultra-violet light and/or moisture are not conducive the bacterial activity will decrease or stop depending upon the severity of the conditions. The raft that lands on a hot concrete road on a mid-summer day will not last long. If the raft were to land in the same place in pre-dawn dew it may thrive for an extended time.

8 ANALYSIS OF THE GROUND SCENT PICTURE

Three things occur when a foot impression is made: a release of vegetative fluids rafts coming to rest on the ground, and the bacterial decomposition of the exposed plant cells. The rafts may be separate from the actual footfall.

Ground disturbance – Absent vegetation, each foot fall still results in changes in the ground surface. Bacteria are disturbed, soil may be uncovered, and there is transference of shoe or foot material to ground.

Vegetative fluids – Each foot fall on any form of plant life results in damage to the plant, and a resulting immediate release of odiferous vegetative fluids. This produces an initial burst of odor, which dissipates quickly as the fluids evaporate.

Vegetative Putrefaction – After plants are crushed by footfalls, they begin to decay as they are consumed by bacteria. This decay produces odor, which varies with time, type of plant, types of bacteria, and environmental conditions.

Human scent – Some skin rafts fall close to footfalls, whiles others fall relatively far away. Human by product vapors

Time – Time is an important factor: the scent components will develop and diminish at different times. The scent picture is ever changing. When the rafts fall they are active. Conditions as described earlier will dictate their activity level and duration. As soon as the vegetable matter is crushed the odor of the plant chemistry will be present and in the same way the conditions will dictate how long and how strong the odor will be present. The strength and timing of the different components of the scent picture will not necessarily coincide. The odor left by the shoe or foot may well last the longest and at the same time be the faintest. Bacterial odors may rise and fall with the moisture or the temperature.

A point to remember is the track will be different from the ambient area. This in itself is a clue to the dog. However, the degree to which he can differentiate one track from another is another question.

That will be determined by the presence of the components that individualize scent.

9 WORKING DOGS ON SCENT

For the purposes of this class we need to define some term so that we are talking the same language.

Tracking Dog - A purist tracking dog is one that is trained to follow the track foot step to foot step. This dog stays close to the actual path the tracklayer traveled and does not pay attention to the scent that is available down wind from the track. This dog tracks at a slower pace and keeps his head down sniffing the ground. He is the stereotyped bloodhound type tracker as seen in movies.

Trailing Dog - The trailing dog is oriented to the scent particles that have settled down wind from the track and pays little attention to the ground-borne scent at the foot impressions. He typically travels faster than the purist tracker and keeps his nose off the ground most of the time.

Air Scent Dog - This dog works the scent from the still airborne rafts and the gas cloud that accompanies the rafts that have recently fallen to the ground. He casts back and forth with his nose high in the air searching for scent. This type of dog may well ignore the ground scent picture.

The point of this chapter is one of learning to which evidence you should orient your dog. The key to the answer of where the dog should be oriented is to analyze what evidence will be most available to the dog during his average search.

From the perspective of time delay between the tracklayer's departure and the dog's start the air scenting dog would be the first dog to use. If the average track is one of short to moderate delay then the trailing dog would be the better option. If your average delay is longer, then a purist tracker would be better suited to fill your needs. On the other hand if the delay is so long that the track is no longer workable, or a starting point on the track is unknown then the air scenting dog applied as a area search would be a better option.

Dogs are never truly oriented completely to one type of scent to the exclusion of all others. Each dog becomes oriented according to his experience and natural propensity.

The important thing is to determine what kind of training you need to produce the

most appropriate skills in the dog.

Environment - Humidity and temperature will also play a role in this decision. In areas where there is little vegetation or moisture and often has high temperatures tracking dogs are not likely to be very successful. In this circumstance a trailing dog may be the best option if not an air scenting dog. The same would be true in an inner city with a high population density and mostly covered with pavement. In these circumstances it would be best to judiciously apply an air scenting dog.

10 SNOW

Dogs can track in snow. Their ability to do so depends on their training, the condition of the snow, and temperature. In fact, there are many trainers who advocate initial training for tracking dogs occur in snow to minimize the vegetative component of the scent picture.

The primary evidence available to the dog is the rafts left by the track-layer. It is therefore advisable to orient the dog towards this type of evidence.

Since snow temperature is low the bacteria activity level is low. The low level of available scent is difficult for the dog to detect. However, this is mitigated by the otherwise sterile environment so the dog will not have as many or as strong of scents from which to sort the proper odor.

The consistency of snow is different. Generally speaking new snow and colder snow has a low specific gravity and therefore more air is in the snow and flowing through the snow. Conversely, warmer snow is denser and contains less air.

In most instances the ground below snow is warmer than the snow. This creates a rising movement of the air within the snow. This current will transport rafts and/or vapor to the surface of the snow. A person buried in snow is warmer than the snow even after death. This temperature difference will cause the scent to rise to the surface. There is one case in Austria where a dog detected an avalanche victim buried 24 feet under the snow (five to six feet is a more realistic depth to expect detection).

11 EXPERIMENTS

Austrian experiment – A track was laid with a series of 90 turns. After the fourth turn the track-layer was suspended 15’ off the ground and deposited back on the ground several hundred feet later,

where upon he completed two more legs of the track. Tracking dogs were unable to complete the track. The experiment was repeated with the suspended tracklayer leaving impressions on the ground with a 150 pound wheel with artificial "feet." The tracking dog completed the track "successfully."

From these results, the originators of this experiment concluded that there was no individual human scent, and that tracking dogs followed only the ground disturbance created by the tracklayer's passing.

However, since that time others (including Syrotuck and SPD) have achieved very different results in similar experiments using dogs trained to rely on the human component of the scent picture.

Double V experiment – Two track-layers of equal weight laid tracks configured as opposing Vs, meeting at the apex of the Vs before turning **90** away from each other. Dogs trained to track only ground disturbance failed to negotiate the turns, and continued straight along the second tracklayer's route as if it was the first's. If the weight of the tracklayers varied by 25% or more, some tracking dogs were able to follow the first tracklayer's path. Again, the experiment designers reached the conclusion that there was no individual human scent, and that the dogs' correct discrimination was based on the difference in ground disturbance created by the tracklayers of different weights.

Syrotuck and others have since found that properly trained trailing dogs successfully negotiate such turns and discriminate correctly regardless of the weight of the track-layers.