SELECTION OF DOGS FOR LAND MINE AND BOOBY TRAP DETECTION TRAINING (U)

FINAL TECHNICAL REPORT

VOLUME I

by

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Contract No. DAAK02-73-C-0150

September 1976

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

ACKNOWLEDGEMENTS

The elaboration and documentation of the canine selection guidelines presented herein would not have been possible without the continuing efforts and assistance of Messrs. Raymond V. Nolan, Gaspar Messina, and Dwight Gravitte of USAMERADCOM, Ft. Belvoir, Virginia, whose encouragement and suggestions represented an invaluable contribution to the development of this manual.

The author also wishes to express his gratitude to Mr. James J. Polonis of the Southwest Research Institute professional staff for his assistance in the preparation of this document and to the various handlers/trainers who contributed many of the observations, ideas, and concepts contained herein.

The skillful assistance of Mrs. Wanda M. Gentry in the typing and organization of the manuscript is also gratefully acknowledged.

INTRODUCTION

While the tracking, sentry, and patrol capabilities of trained canines have long been exploited in various military contexts, the use of dogs for olfactory detection of concealed ordnance devices remains a relatively recent innovation. The latter application of dogs (Canis familiaris), largely the result of modern scientifically-oriented operant and Pavlovian conditioning techniques, represents a significant addition to the repertoire of valuable services performed by talented canines, and the increasing use of such animals by police and military agencies throughout the world for detection of controlled substances and dangerous devices attests to the utility of canines trained for such tasks.

Previous research (e.g., 1, 2) has demonstrated that olfactory discrimination training attained in canines by application of established principles of operant reward conditioning appears to constitute an ideal approach to the problem of detection of land mines, booby traps, and related ordnance devices. The dogs' olfactory sensorium has been shown to be highly selective and appears to be sensitive to small quantities of the relevant target substances. Furthermore, most breeds of dogs are intelligent, motivated to perform, respond reliably to verbal and nonverbal commands, and can be trained to execute complex tasks.

Carefully controlled evaluations of canine detection performance have served to demonstrate that specially trained canines can function effectively as detectors of land mines and allied surprise-firing devices

— at least under non-extreme climatic circumstances (1). Overall detection rates, frequency of false alerts, and speed of traverse compare favorably with alternate detection systems. In light of these and related findings, the feasibility of the biodetector concept appears relatively well proven. Indeed, for certain types of devices (e.g., non-metallic mines, trip wires) and in certain scenarios of deployment (e.g., trails over rough terrain, railroads, buildings), canines and other mammalian species which have been specially trained for explosive detection would appear to comprise the most effective general-purpose detection system currently available.

While the potential capabilities of land mine/booby trap detector canines have been well documented, the successful training of such animals requires the application of a series of complex and sophisticated operant conditioning techniques by a knowledgeable, experienced handler/trainer. The training sequence is both time-consuming and expensive, and it is an inevitable fact of biological variability that not all canine candidates will successfully complete the program of mine/booby trap detection training. A certain proportion of potential trainees must be rejected for physical and medical reasons; others fall victim to an inherent lack of intelligence, others to poor motivation, and still others to unacceptable vagaries of temperament.

For example, recent statistics prepared by the Military Dog Training Center at Lackland Air Force Base indicate that 3 to 4 thousand German Shepherds must be examined yearly to fulfill annual procurement requirements of 1,500 to 2,000 new dogs (3); and not all of the animals which meet the initial screening will successfully master the assigned training program.

In view of these considerations, it is imperative that all dogs considered for enrollment in a land mine/booby trap detection training program be submitted to a thorough screening process prior to acceptance. Only those animals which meet the criteria herein specified are selected for formal training. Numerous physical and behavioral dimensions must be weighed during the course of selection, and, unfortunately, many aspects of the decision-making process remain largely subjective in nature; considerable further research is needed to identify and validate an appropriate set of purely objective performance predictors. The potential value of carefully-applied selection criteria is graphically illustrated by the experiences of the Guide Dogs for the Blind organization which, by the use of painstakingly-developed physical and behavioral tests (in conjunction with a sophisticated selective breeding program), has improved its training success rate from a dismal 9% in 1949 to a remarkable 90% fourteen years later (4). Regrettably, a dedicated pool of breeding stock is not available to supply military users except

on a limited scale, and in any event, it is not clear that the set of traits necessary in a Guide Dog are necessarily the same as those required for a proficient detector in military applications.

Current channels and procedures of military dog procurement impose certain restrictions on the scope of the selection process. For example, many private sources from whom the majority of military canines are acquired would be reluctant to release their dogs to a military selection center for the period of time required to complete a truly comprehensive screening protocol. Medical problems and certain undesirable characteristics of temperament can of course be identified almost immediately, but assessment of training aptitude may demand more elaborate and time-consuming tests. Accordingly, a two-stage approach is recommended for selection of canine mine/booby trap detection training candidates. Physical, medical, and frank behavioral traits should be evaluated during the first stage. Animals which fail to pass the initial screening process are rejected from further consideration whether offered for sale or volunteered for contribution. Those dogs which are found suitable for actual procurement should then be submitted to a more exhaustive evaluation sequence; candidates which fail to achieve second-stage criteria should be disposed of via appropriate channels. In this way, valuable training manpower can be concentrated exclusively on those dogs which demonstrate the greatest promise of

successfully completing the required training regimen.

Breed. Early U. S. programs employed a diverse array of canine breeds for general military service. TM 10-396, "Technical Manual - War Dogs, 1943," lists over 30 distinct breeds considered suitable for military applications ranging from Airedale Terrier to Wire-haired Pointing Griffon (5). However, the German Shepherd and Labrador Retriever have gained almost universal acceptance in recent years. The German Shepherd enjoys particular favor for patrol and sentry duties due to its size, strength, agility, fearless disposition, and inherent distrust of strangers. However, for mine/booby trap and related olfactory detection tasks, where sheer physical strength and aggressiveness are relatively unimportant, there is reason to believe that breeds other than the German Shepherd might be used to advantage. Indeed, excessive aggressive tendencies could be regarded as an undesirable trait in a detector animal deployed on short notice in an area occupied by naive and unsuspecting friendly troops. The use of the Labrador Retriever, a breed possessing good olfactory acuity and a generally docile nature, may eliminate this unwanted characteristic without sacrificing detection proficiency. Labrador Retrievers are currently carried in military inventory primarily for tracking applications, and during World War II the English employed Labradors and other smaller breeds such as the Fox Terrier and Cockerspaniel for bomb and mine clearance with good results (8). Furthermore, previous explosives detection research

conducted under USAMERADCOM contract (2) has tentatively identified several canine breeds with olfactory acuity apparently equal to that of the German Shepherd (e.g., Australian Dingo, Rhodesian Ridgeback). Some of these breeds might be expected to function more effectively than the German Shepherd or Labrador Retriever in certain climatic extremes; for example, the Norwegian Elkhound (or Alaskan Husky) in arctic or near-arctic environments, and the Rhodesian Ridgeback in conditions of extreme heat. However, data available to date are insufficient to permit scientifically-based decisions regarding selection of canine breeds for land mine/booby trap detection tasks, and the potential advantage of these and other alternative breeds for deployment in climatic extremes represents a meaningful area for future research. Pending the outcome of such investigations, the use of German Shepherd and Labrador Retriever dogs is recommended in light of their well-proven capabilities.

Sex. Although some trainers may prefer males because they tend to be larger, bolder, and more independent than females, sex appears not to be an important variable with respect to the performance of land mine/booby trap detection tasks. However, temporary deterioration in operant performance has been noted in some female dogs during estrus (6). Therefore female dogs should receive a complete ovario-hysterectomy prior to the initiation of training to minimize this cyclic variability in

performance and to eliminate a potential source of distraction for male trainees. Consistent with USAF procurement specifications (7), it is recommended that spaying be accomplished at least 60 days prior to acquisition.

Age. Training for sentry and patrol duties is generally not undertaken before the dog has achieved at least 12 months of age since it is difficult to elicit a sufficient degree of aggressiveness in younger animals. To this end, a quick and useful assessment technique is to observe the urination pattern in male dogs. Males which have not outgrown the squatting urination posture characteristic of immature dogs have generally not yet developed a sense of dominance and territorial protection and the associated aggressive behavioral tendencies. However, as has already been indicated, it is not clear that an overly strong aggressive disposition is required or even desirable for olfactory detection tasks, and a good argument can be made for initiating preliminary training of land mine/booby trap detector dogs at a much earlier age. Indeed, the Australian military forces frequently commence such training at an age of 12 weeks, and research conducted by Southwest Research Institute (6) has demonstrated that conditioning for detection of concealed weapons can be undertaken with good results in puppies 6-8 weeks old.

Although formal experimental data regarding an optimal age for initiation of training for ordnance detection tasks are quite limited, the accumulated experience of non-military professional dog trainers as

well as an established body of knowledge concerning the dog's psychosocial development suggest that early acquisition of canine training candidates may be highly advantageous. In the latter regard it is well known that most species, including dogs, progress through several critical stages of development. The major phases of behavioral development in the dog have been described by Scott (9,10), Fox (11), Whitney (12) and others. These periods have been divided into Neonatal (birth-13 days), Transitional (13-19 days), and Socialization (19 days - 12 weeks), each characterized by distinct behavioral patterns limited by degree of sensory and motor development. The onset of a new critical period and the associated changes in behavior are correlated with underlying developmental changes in sensory-motor abilities. Although there is considerable overlap between the termination of one stage and the beginning of the next, the critical period of socialization commences at about three weeks of age and reaches a peak at 5-7 weeks. During the latter period, visual and auditory abilities develop rapidly, and mature patterns of locomotion begin to appear. With the emergence of these abilities, the pup becomes more independent, is able to explore its environment, and is thus capable of forming primary social relationships (11).

It is important that a young pup not be removed from its dam and litter mates until it is at least seven weeks old to assure appropriate socialization with members of its own species, and total isolation during

the first weeks of life can result in profound and potentially irreversible behavioral aberrations (11). Periodic interaction with humans during the third critical period will favorably influence the development of handler/dog social relationships, and some authorities argue that brief training sessions conducted at this time will facilitate subsequent training progress (4).

In view of these considerations, it is recommended that dogs intended for land mine/booby trap detection tasks be acquired between the ages of 8 and 12 weeks even though formal detection training might not commence for an additional 10-12 weeks. The interim period may be used to advantage for additional behavioral screening, obedience training, and formation of the strong human/canine social bond so important in a maximally effective handler/dog detection team working relationship.

A further advantage of early procurement is that the learning history and early environment of the animal are well known and can be carefully controlled. In this way, the development of bad habits and the potential acquisition of task-competing behaviors can be minimized. Furthermore, certain abnormal behaviors and undesirable activities sometimes seen in adult dogs (e.g., agonistic behaviors and fear-biting; sexual deviations and displacement activities; at-epimeletic or care-seeking behavior; eliminative, excretory, and ingestive abnormalities)

often can be precluded by early training but are difficult to control once established (11).

Finally, while it has been indicated that effective training (especially basic obedience) may be initiated in puppies as young as 4 weeks of age, such activities should be limited to 5-10 minute sessions since the attention span of young dogs is quite brief.

Physical Characteristics. Military procurement specifications for German Shepherd dogs require that the animal weigh a minimum of 27-24 kgm (60 lb.) and stand at least 58.42 cm (23 in.) measured from the ground to the top of the shoulder blade (7). However, while physical stamina is needed in land mine/booby trap detector canines, sheer size and weight are of secondary importance.

Regardless of breed selected, the animal should meet generally-accepted standards for breed (conformation). Good bone structure, deep chest, and properly-proportional body and limbs are required. Musculature should be firm and well-developed. The animal's feet should be properly positioned, and the forepaws should turn neither markedly inward nor outward. Footpads should be tough and resilient.

Gait, both walking and running, should fall within generally accepted breed standards, and although minor deviations do not necessarily provide cause for rejection, the evaluating personnel should examine such animals with particular care. Abnormalities in locomotor

pattern may reflect underlying defects in skeletal or muscular development and function arising from genetic or pathologic origins.

Medical Considerations. Good health is an absolute prerequisite in a working dog, and thus all candidates for land mine/booby trap detection training should receive a thorough screening by a qualified veterinarian prior to acceptance, including a radiologic examination for coxofemoral pathology and/or elbow dysplasia. German Shepherds appear especially prone to hip dysplasia.

U. S. Air Force procurement procedures require that all prospective dogs receive a physical examination prior to shipment to military training centers, and a second physical is performed upon arrival. Recent records (13) indicate that about 30% of the potential candidates are rejected on medical ground prior to shipment. Nearly 70% of these rejections are due to hip dysplasia, about 10% because of filariasis, and 8% due to bad teeth. Of those dogs which pass the preshipment physical, an additional 45.8% are rejected during the second examination conducted upon receipt at the military center, approximately half for medical reasons and the remainder due to undesirable characteristics of temperament. Of those found unacceptable on medical grounds, the majority (55%) are because of hip dysplasia; other major problems, listed in terms of decreasing frequency, include broken or worn teeth, undersize or underweight, filariasis, elbow dysplasia, and eye problems

(13). These high rates of rejection underscore the significance of a detailed physical examination in the overall selection process.

a) General Examination. The examination should begin with a general examination of the animal when gross evidence of injury, disease, or other physical abnormalities will be detected. Any abnormalities of conformation or stature should receive careful attention.

While the state of the dog's skin and coat are affected by the climate of origin and whether or not the animal has been groomed, dogs in good health generally possess an even, glossy coat. In febrile conditions the hairs of the coat tend to stand erect, and as a result the coat assumes a harsh "staring" appearance. In wasting diseases, the coat looses its luster, presents a dull lifeless appearance, and can easily be pulled out. The presence of ectoparasites such as lice, leads to itchiness sometimes reflected in broken hairs and bald patches caused by constant scratching and rubbing. In addition, many skin diseases lead to loss of hair; among these are mange and ringworm. Loss of hair may also be caused by certain metabolic disturbances. For example, pregnant and lactating bitches frequently lose a great deal of hair, and as a consequence the coat assumes a very shabby appearance. Finally, the skin of a dog suffering from diabetes mellitus is especially susceptible to the effects of minor injuries and offers little resistance to infection (14).

Inspection of the conjunctiva and the mucous membranes of the mouth may provide much useful information regarding a dog's physical health. The conjunctiva is examined by depressing and slightly everting the lower eyelid, and both eyes should be inspected so that abnormalities due to local disease are appreciated as such and not confused with general clinical symptoms. The normal conjunctiva of the dog is pale roseate in color. The conjunctival mucous membrane may become pale and watery in appearance in the case of anemia resulting from either wasting diseases or defective blood formation. Intense infection of the conjunctiva may be correlated with acute pulmonary congestion. Cyanosis (bluish-grey discoloration) may occur as a result of improper oxygenation of the blood due to diseases or dysfunction of the lungs or circulatory system. Yellowish staining of the mucous membrane (jaundice) may reflect hepatitis.

The presence of any conjunctival discharge should be noted. The discharge may be serous, mucoid, mucopurulent, or purulent in character. Such discharges are frequently of diagnostic significance, being associated with various specific diseases, e.g., canine distemper (14).

The condition of the mucous membranes of the tongue, gums, and cheeks should be inspected; a bright red color is normal. A coppery discoloration of the tongue may occur in severe toxaemic conditions such as acute nephritis, and a brown foul-smelling film on the teeth and

gums is frequently correlated with chronic interstitial nephritis. In acute gastritis and acute intestinal blockage the tongue may become coated with a dark brown film. Gingivitis is often symptomatic of alimentary toxaemia, and necrosis and ulceration of the gums and buccal mucosa and necrosis of the tip of the tongue may occur in cases of acute nephritis or leptospiral jaundice.

The number and condition of the teeth should be carefully inspected. Missing or badly broken canine teeth are cause for rejection. In healthy dogs, the teeth are clean and of a clear white color. Distemper during puppyhood may interfere with enamel formation. In such cases, the teeth may possess an enamel tip, but lower portions of the enamel are absent. A foul-odored brown film covers the teeth in some forms of distemper, in acute gastritis, and in acute forms of intestinal toxaemia (14).

Clinical examination of the abdomen involves inspection, percussion, and palpation. Percussion can in many cases reveal the presence of tumors, and palpation is of value in the diagnosis of diseases of the abdominal organs. If the presence of a tumor or other foreign body is suspected, a radiologic examination may be warranted.

The anal glands should be examined for evidence of infection.

b) Hip and Elbow Dysplasia. The larger breeds of dogs, especially the German Shepherd, appear particularly prone to hip and elbow dysplasia, and these conditions constitute the largest single cause for rejection of prospective military working dogs. Hip dysplasia is also a leading cause of premature disability in trained animals.

Hip dysplasia in dogs was first reported formally by Schnelle (15, 16) who described the characteristic changes of the hip joint involving shallow hip sockets and bony overgrowths of the femoral head. The term "hip dysplasia" is derived from "dys" (i.e., bad) and "plasia" (i.e., form); thus, a badly formed hip joint. Typically, the hip joints appear normal at birth both physically and radiographically, and the disease process begins shortly thereafter when the bones are still cartilagenous. The maintenance of proper shape and development in the cartilagenous hip joint after birth depends upon correct contact between the femoral head and the acetabulum (hip socket). Dysplasia develops if and when the femoral head fails to maintain full contact with the socket. Varying degrees of displacement between the femoral head and socket may occur and are termed "subluxation" if the displacement is slight and "luxation" if the femoral head becomes dislocated entirely out of the socket. (Dysplasia is a recognized precursor to subsequent degenerative joint disease such as osteoarthritis, exostosis, or osteophyte formation (17)).

In dogs which ultimately develop severe hip dysplasia, evidence of the disease generally begin to appear at 8 to 20 weeks of age. Milder cases may not be detectable even by radiologic examination until six months or more of age, and occasionally final judgment must be deferred until the animal is at least one year old (18).

Most authorities agree that hip dysplasia is a polygenic trait, meaning that genetic as well as environmental factors are involved in the production of the defect. Although most common in larger, fast-developing breeds, no breed, family, or strain of dogs yields pups which are consistently free of hip dysplasia with the possible exception of the American Greyhound (19). Characteristic symptoms of well defined hip dysplasia include restricted motion of the hip joint, limited exercise tolerance, and atrophy of the thigh muscles (17).

Accurate diagnosis and grading of hip dysplasia require careful radiologic examination. Positioning of the animal is critical and interpretation of X-ray films is a matter for a qualified and experienced veterinarian. The degree of dysplasia seen radiographically may range from minor to severe, and a system of grading has been formulated by the American Veterinary Medical Association to score degree of involvement. These gradings range from "Normal" through grades I, II, III, and IV. The crippling effects of hip dysplasia vary considerably with the individual dog, and it is sometimes difficult to effect an accurate prediction of the extent of disability that may be expected in a dog with a given grade

of dysplasia. Some dogs with severe lesions display little outward evidence of disability, while others with similar lesions may be badly crippled.

Current military procurement specifications permit acceptance of dogs with Normal and Grade I hips, and the same guidelines are recommended for selection of land mine/booby trap detector candidates. It should be noted that military experience has shown that German Shepherds acquired at grade Normal typically remain Normal, whereas dogs rated Grade I at purchase tend to degenerate to Grades II or III over a variable period of service (13).

Prospective dogs should be examined for evidence of elbow dysplasia prior to purchase. The elbows may be palpated for crepitation (crackling sounds) or reduced arc of flexion with the animal under anesthesia; dogs in which pathology is suspected should be submitted to appropriate radiographic examination.

c) Endoparasites. All dogs being considered for acquisition for land mine/booby trap detection training should be examined for common canine endoparasites including hookworms, roundworms, whipworms, tapeworms, and heartworms. Except in the case of heartworms, the presence of parasites does not necessarily eliminate an otherwise acceptable dog since most types respond favorably to treatment.

1) Hookworms (Ancylostoma caninum, Anacylostoma braziliense, Uncinaria stenocephala). Ancylostoma caninum is the most

common hookworm of the dog in the United States; adults range from 9.5 to 20 mm in length, and the anterior end is bent dorsally. Both A braziliense and U stenocephala are smaller than A caninum, having a maximum length of about 13 mm. U stenocephala is found mainly in the northern U.S. and Canada, while A braziliense occurs mainly in southern states.

Adult hookworms attach to the mucosa of the small intestine, normally in the jejunum but occasionally from the pylorus to the colon. The female deposits large quantities of eggs which, depending on temperature, hatch 12 to 24 hours after passing in the feces. Infection occurs by ingestion, penetration of the skin, or by prenatal infection.

It has been shown that the dog in which an acquired immunity has developed may carry a small number of hookworms without serious effects. If these adult worms are removed by treatment and the dog continues to be exposed to infection, a small number of larvae may develop to maturity, but the infection will not progress beyond this level barring other pathologic or debilitating influences.

The symptoms of hookworm infection range from those associated with mild enteritis in mild infections to severe hypochromic microcytic anemia, circulatory collapse, debilitating hemorrhagic diarrhea, shock, and death in severe cases. The visible mucous membranes of infected dogs are often pale, but rarely cyanotic or icteric (20).

The diagnosis of hookworm infection may be confirmed by demonstration of the eggs in feces, and oral anthelmintics frequently used in the treatment of canine ancylostomiasis include tetrachloroethylene, n-butyl chloride, methylbenzene, diphentlane-70, and hexylresorcinol. Other effective agents are dithiazanine, bephenium hydroxynaphthoate, and thenium p-chlorobenzene sulphonate. One of the most effective and least toxic drugs used for the treatment of canine ancylostomiasis appears to be disophenol (DNP) (20). In any event, therapy will be of little value unless appropriate measures to prevent reinfection are maintained.

2) Roundworms (Toxocara canis, Toxascaris leonina). Adults of both roundworm species range in length from 40 to 180 mm and possess cervical alae. The life cycle of Toxocara ssp involves an obligatory intermediate host (e.g., mice, earthworms, roaches). Larvae ingested by facultative hosts tend to complete their life cycles without migration to the lungs, while the majority of larvae ingested in eggs migrate through the lungs before completing their development. The life cycle of T leonina differs in that extensive migration normally does not occur. The larvae burrow into the wall of the intestine where they remain for 9 to 10 days following which they return to the lumen and mature.

Large roundworms are usually clinically evident only in young dogs in whom they produce three types of damage: mechanical

interference with normal peristalsis, sometimes resulting in obstipation; interference with metabolic processes to the extent of producing inanition; and production of pulmonary lesions due to larvae migration (20). Emaciation with distention of the abdomen and severe respiratory distress are evident in puppies. The visible mucous membranes are usually pale and variably cyanotic.

As in the case of hookworm disease, the diagnosis of roundworms is established by finding characteristic eggs in the feces. In some instances, the diagnosis is readily apparent because adult parasites are present in the feces or vomitus. Roundworms may also lead to a dull coat in adult dogs (20).

A large variety of anthelmintics is available for treatment of ascariasis. They include n-butyl chloride, santonin and calomel, oil of chenopodium, tetrachloroethylene, and hexylresorcinol. The piperazine compounds have also been widely used in the treatment of roundworms and may be preferred over other therapeutic agents on the basis of efficacy and lack of toxicity.

3) Tapeworms (many species). The life cycle of members of the order Cyclophyllidea follows a generally similar pattern with variations occurring in the larvae stage and with respect to the intermediate host employed. The eggs may be free when passed in the feces or may remain enclosed within the proglottid. Following ingestion by

the intermediate host, the larvae are freed and penetrate the intestinal wall. The definitive host becomes infected by ingestion of an intermediate host containing the infective larvae stage.

Save the occasional passage of mature proglottids, clinical symptoms of tapeworm infection are normally vague or absent, but may contribute to inanition, persistent diarrhea, alternating diarrhea and constipation, anorexia, hyperesthesia, and nervousness (20).

Tapeworm infection is typically diagnosed by detection of individual segments or chains of segments in the feces or on the perianal area. Drocarbil is widely used in the treatment of tapeworms, but other drugs are also effective (e.g., hexachlorophene, dichlorophene, bithionol, and bunamide hydrochloride). All must be repeated several times, and, regardless of treatment used, prevention of contact with or elimination of the intermediate host is required for complete control.

4) Whipworms (Trichuris vulpis). The whipworm is typically found in the cecum and colon of the dog. The anterior portion of the body is thin and comprises most of the parasite's total length of 50 to 75 mm.

Whipworm eggs pass in the feces, and given favorable conditions, begin embryonation within 24 to 30 hours. The infective stage is reached after 2 to 4 weeks depending on temperature. The larvae hatch as soon as 30 minutes following ingestion and within 24 hours

penetrate the intestinal mucosa. Adult whipworms may be found after 2-3 months with the whiplike anterior portion embedded in the mucosa of the cecum or colon.

Many dogs passing whipworm eggs demonstrate few clinical symptoms, although severe infections may cause loss of weight, urticaria, emaciation, anemia, and profuse diarrhea. If the latter persists, fresh blood may appear in the feces (20).

Orally and rectally administered n-butyl chloride has been found to be relatively effective in the treatment of whipworm infection. Other useful agents include dithiazanine, glycobiarsol, and dichlorvos. Phthalofyne, a preferred drug, is effective and relatively nontoxic, but may produce transient side-effects.

5) Heartworm (Dirofilaria immitis). The adult heartworm is slender and measures up to 300 mm in length, the female typically being larger and longer than the male. The posterior portion of the male is spirally coiled for several turns. Adult heartworms normally live in the pulmonary arteries and right ventricle, but on occasion may be located elsewhere (e.g., bronchioles, venae cavae, brain, femoral arteries). The female heartworm is ovoviviparous; that is, the embryos are freed in the uterus. The latter are called microfilariae and can be differentiated from larvae in that a digestive system is lacking.

Dirofilariasis is known to be enzoatic along the Gulf Coast and the Atlantic seaboard, although some reports suggest that it has spread throughout North America.

Completion of the life cycle of D immitis requires 8 to 9 months. The adult females, located most commonly in the pulmonary arteries, release numerous microfilariae which inhabit the peripheral blood where they may remain active for 2 to 3 years. The microfilariae must be ingested by a suitable host before they can develop further. Several species of mosquitoes in the genera Aedes, Culex, and Anopheles can serve as intermediate hosts.

After the microfilariae are ingested by mosquitoes, they enter the malpighian tubules and penetrate the lining cells where they develop into the infective larval stage. They subsequently break free into the body cavity and progress anteriorly through the thorax into the labium. The infective larvae are introduced into the final host as the mosquito feeds.

The larvae live in the host's subcutis, fat, and muscles for 85 to 120 days and then penetrate the lumens of veins and pass into the heart. Upon reaching the right heart and adjacent vessels, approximately 120 days are required for the worms to mature.

Signs of heartworm infection exhibited by infected animals vary considerably. Quick tiring during exercise is an early

symptom; dyspnea, collapse, and convulsions may be observed in severely infected dogs. A hacking cough frequently accompanies the infection. Ascites and congestive cirrhosis are seen occasionally and are related to chronic passive congestion. Evidence of nephritis and anemia may appear in cases of heavy infection. Additional clinical signs include skin lesions, dehydration, peripheral edema, epistaxis, and hematuria (20).

A modified Knott's test is recommended by many parasitologists for detection of circulating microfilariae and permits a differentiation of the microfilariae of D immitis from those of other innocuous filarial parasites (21). A preferred therapy consists of Na Caparsolate bid at 1 cc per 4.54 kgm (10 lb.) body weight given IV for two days followed by a microfilaricide (e.g., Dizan, Talodex) at two-week intervals continued until four weekly negative Knott's tests are obtained.

In view of the fact that treatment is tedious and not always effective and because the longevity of microfilariae in host animals presents a constant threat of infection in other dogs, diagnosis of heartworms in prospective animals provides sufficient cause for rejection.

It should be pointed out that there are no totally effective control measures for dirofilariasis, and in the absence of adequate mosquito control practices the problem of heartworm infection is always present. However, certain prophylactic measures may be

worthwhile. For example, there is evidence that the piperazine compound, diethylcarbamazine, will prevent microfilariae from developing if given for a sufficient length of time (22).

d) Ectoparasites. Dogs are susceptible to infestation by a variety of arthropods (fleas, lice, mites, ticks) of which some are parasitic only as adults, some parasitic in all developmental stages, and others parasitic only as larvae. The presence of ectoparasites does not necessarily preclude acquisition of an otherwise acceptable dog unless the infestation is severe or if dermatitis or other secondary infections have developed. Animals displaying symptoms of persistent scratching, biting, head-shaking, restlessness, etc. should be examined carefully for ectoparasites; most can be eliminated by appropriate treatment (23).

1) Fleas (Ctenocephalides canis, Ctenocephalides felis, Echidnophaga gallinacea, Xenopsylla cheopis). Fleas may be identified by inspection as adults or by tiny clots of blood attached to the hair and skin.

2) Lice (Trichodectes canis, Heterodoxus spiniger, Linognathus piliferus). Pediculosis (infestation by lice) is readily diagnosed by careful examination of the haircoat and skin. In particular, the eggs or nits are easily found if the presence of lice is suspected.

3) Mites (Demodex canis, Otodectes cynotis, Sarcoptes scabier, Cheyletiella parasitovorax, Eutrombicula alfreddugesi,

Neoschongastia americana). Demodex canis and Sarcoptes scabier, the causes of demodectic and sarcoptic mange, respectively, may be specifically diagnosed by microscopic examination of skin scrapings. Otodectes cynotis (ear mite) infestation typically results in a foul-smelling odor emanating from the ear; specific diagnosis is made by examination of debris removed from the external ear canal.

4) Ticks (Dermacentor variabilis, Rhipicephalus sanguineus, Otobius megnini). Ticks are diagnosed by discovery of the adult and developmental stages on the animal. Particular care should be taken to examine the ears, neck, back, tail, and toes.

e) Vaccinations. When obtaining dogs from private sources, screening personnel should request proof that obligatory innoculations are current (canine distemper, infectious canine hepatitis, leptospirosis, rabies). A certification of vaccination signed and dated by a licensed veterinarian is required.

Olfactory Acuity. Since olfaction appears to be the primary sensory modality underlying the detection of concealed ordnance devices by trained canines, a successful mine detector dog must possess average, or, preferably, better than average olfactory acuity. This is clearly a relative consideration, and most writers agree that the behavior of all normal dogs is under intense olfactory control with the sense of smell ranking as the most highly elaborated modality. Behavioral observations have

demonstrated that the dog's sense of smell is highly matured at birth (24), and Pampiglione (25) using EEG recording techniques found that the K complex (alteration of EEG activity due to afferent sensory stimuli) could be reliably detected during the first week of life with olfactory stimili but not until 3 to 4 weeks with auditory and visual stimulation. There is no question that dogs possess exquisite olfactory acuity and remarkable abilities to discriminate differing odors, and varying claims that the dog's olfactory sensitivity may range from 1 to 100,000,000 times that of man have been reported (24).

Bipolar cells embedded in the olfactory mucosa constitute the transducer elements of the olfactory system. They are specialized nerve cells from which several cilia issue at the apical end, and a fine axon at the basal end. The number of olfactory receptors is extremely large; densities as high as $1,500,000/cm^2$ in the middle portions of the dog's olfactory epithelium have been reported (26). The olfactory receptor cells are surrounded by rod-shaped sustentacular cells which also have cilia but no axons. Olfactory glands opening into the epithelium secrete a mucous substance that covers the cilia; it is generally assumed that this is the site of the olfactory transduction process.

The axons of the bipolar cells pass directly to the central nervous system in the olfactory nerve. These axons are of very small diameter (0.1-0.4 micra), and conduct impulses of long duration (3-5 milliseconds)

at an extremely low velocity (0.2 meters per second). They terminate in the olfactory bulb, a complex laminated structure analogous to the retina of the eye. In the olfactory bulb the widely branched processes of the axons of the bipolar cells synapse with the dendrites of the secondary neurons, the mitral cells, in specialized regions, called glomeruli. The axons of the mitral cells form the bulk of the lateral olfactory tract, which proceeds to the brain. In addition to the mitral cells, several other types of neurons are found in the olfactory bulb. Among these are the tufted cells whose axons cross to the opposite olfactory bulb by way of the anterior commissure. The olfactory bulb also contains several types of short-axoned neurons, together with granular cells with rich dendritic networks but no axons (27).

Volatile substances dispersed in air or dissolved in water are the adequate stimuli of olfaction. Nasal inhaling and sniffing are the accessory functions which serve in forcing air past the olfactory epithelium.

It is often assumed that behavioral responses to odors are mediated solely by olfaction, but there are several chemosensory systems which may participate in odor perception. That is, olfactory, trigeminal, and vomeronasal chemoreception may all contribute to nasal chemoreception (28). In the dog the vomeronasal organ is situated on the roof of the mouth behind the front teeth; it is absent in man (24).

With notable exceptions (e.g., 29, 30) little quantitative information exists with respect to the absolute olfactory threshold of dogs, and even less is known concerning difference thresholds for qualitatively different odorant substances. Suffice it to say that carefully-conducted field tests have demonstrated that trained canines can reliably detect land mines and booby traps deployed in simulated tactical environments (e.g., 1). The possibility remains that sensory modalities other than olfaction contribute to the overall detection process.

Unfortunately, there is no simple method for assessing the absolute olfactory acuity of dogs being considered for land mine/booby trap detection training. Determination of lower olfactory thresholds requires an extremely sophisticated olfactometer and elaborate training and testing procedures. Furthermore, such threshold data appear unusually prone to confounding due to potential experimenter bias and problems of motivation (28). Finally, the process is time-consuming and expensive and thus beyond the scope of a practical selection protocol. Some writers have suggested evaluation of olfactory function by presentation of volatile oils, but this procedure is unreliable and can detect only severe impairment of function (31).

In view of these complexities, screening personnel must rely on relatively crude indicators of olfactory capability. Actual loss of the sense of smell is quite rare in the dog. However, mechanical

obstruction of the nasal cavity by inflammation of the mucous membrane, foreign bodies, and polyps or other tumors sometimes impair sensitivity (31). The presence of any of these conditions provides immediate grounds for rejection. Behavioral observations are of only limited utility since practically all dogs spend large amounts of time engaged in olfactory exploratory activities. However, the trailing test described on p. 45f may be employed as a measure of gross olfactory dsyfunction.

Auditory Acuity. Although the exact mechanism of detection of booby trap trip wires by trained canines remains unclear, one theory holds that subtle auditory cues created by vibrations of the wire serve in part to alert the animal to the presence of these devices. Assuming this hypothesis to be true, good auditory acuity represents a valuable attribute in a potential detector dog.

The dog's hearing is markedly superior to that of man not only in terms of acuity but also with respect to frequency range. Laboratory investigations have shown that a dog with normal hearing can detect pure tones ranging from below 100 Hz to at least 55,000 Hz with greatest sensitivity between 700 and 30,000 Hz (32). Dogs can also localize the source of sounds with extreme accuracy (e.g., $\pm$ 5°); noises emanating from the body plane are localized more accurately than those originating above the animal's head (12).

Routine tests for hearing in the dog are far from precise, but two simple tests may be applied by screening personnel.

a) Startle reflex. The startle reflex is elicited by sudden presentation of a moderately loud noise (hand slap, Galton whistle, metal party "clicker") close to the ear. The normal response is a bilateral blink; perking of the ears, flexion of the head, or abduction of the limbs may also occur (31, 33).

b) Auditory Orientation. Essentially a test of auditory localization, a series of noises of modest intensity are presented from a variety of positions surrounding the dog. Turning the head toward the source of the noise represents the normal response (33). Best results will be obtained if the dog is engaged in some nonintensive activity or being distracted by a second individual when the auditory probe stimuli are presented. Delivery of numerous test stimuli in rapid succession should be avoided to prevent habituation.

Visual Function. Several useful tests of visual function may be performed by screening personnel.

a) Blindness. An expedient test for blindness involves presentation of a threatening gesture such as a rapid hand movement toward the eye. The use of a Plexiglas or glass shield is recommended. Absence of a defensive reaction suggests blindness.

b) Optic/Oculomotor Nerve Function. Introduction of a bright light (e.g., penlight) into one eye normally results in bilateral miosis. This consensual reflex is used to evaluate both optic and

oculomotor nerve functions. The absence of bilateral pupillary constriction suggests optic nerve failure in the eye first tested if miosis occurs in response to light in the contralateral eye; bilateral response to stimulation of the latter eye indicates that both oculomotor nerves are functional. Bilateral miosis in response to a light beam in the right eye but not the left indicates loss of the left optic nerve's function. Unilateral miosis of the right eye in response to light in each eye indicates left oculomotor nerve failure (31).

c) Visual Tracking. Visual tracking may be assessed by dropping a feather or ball of cotton and observing the dog's ability to follow its downward path.

d) Visual Orientation. Visual orientation may be tested by placing the animal in a darkened room and presenting a flashing light to the lateral aspects of the visual field. A dim, punctate source is preferred. The normal response entails turning the head toward the source of illumination (33).

Gunshyness. Gunshyness cannot be tolerated in any military dog regardless of the task to which the animal may be assigned. Typical responses of gunshy dogs to gunshots or similar reports include cowering, attempts to escape the situation, or, on rare occasions, fear-induced biting of the handler. Severe trauma produced by the firing of a weapon in close proxity to the animal's head may antedate the latter behavior.

Gun-green dogs are those which have not previously been exposed to gunfire and therefore have not learned to fear gunshots or similar loud reports. Such animals may be accepted if appropriate testing does not reveal symptoms of frank gunshyness. Most gun-green dogs can be trained to remain calm during gunfire through a process of gradual adaptation and conditioning.

Testing for gunshyness involves discharging a small caliber weapon at progressively decreasing distances from the dog. The initial shots should be fired at a distance of at least 75 yards. If no evidence of alarm is noticed, the testing personnel may advance about 10 yards and discharge a second series of shots. This procedure is continued until the dog displays definite symptoms of fear and anxiety or until a distance of approximately 15 yards is attained. Animals which tolerate repeated intermittant gunfire at the latter range with little or no reaction (other than curiosity and orienting responses) are acceptable; those which do not are rejected.

It should be emphasized that weapons must never be discharged at close distances to the dog; to do so may produce abject and potentially irreversible fear of gunfire, and can also traumatize the auditory mechanism. Furthermore, the weapon must never be pointed directly at the dog even if blank ammunition is being employed. This practice intensifies unnecessarily the loudness of the report, and injuries can be caused by

wadding materials at closer ranges.

The majority of nongunshy dogs can be adapted with relative ease to accept the stresses and acute sensory insults characteristic of modern battlefield scenarios through a process of gradual acclimatization during training. The possibility remains, however, that a few animals, found otherwise to be consistently good workers, may become confused or traumatized under such circumstances with a consequent lapse in performance. It would appear feasible to develop a relatively straightforward empirical test of battlefield tolerance in order to identify such stress-prone animals. For example, at an appropriate point in training and following initial stress acclimatization, the dog could be required to negotiate (in the company of his handler) a specially-designed infiltration course complete with overhead automatic weapons fire and detonation of artillery and booby trap simulators. Animals which fail to successfully negotiate such a course (as reflected in evidence of panic, attempted escape, refusal to continue, and related behavioral indices) would be discontinued from further detection training.

Motivation. Eagerness to please is an especially valuable asset in any working dog, and many dogs appear motivated to perform complex tasks by the sheer desire to fulfill the wishes of their handler. Animals possessing this trait respond to verbal praise and affection with clearly

recognizable positive reactions. In contrast, dogs which reject the overtures of friendship of screening personnel and which remain unresponsive or aloof to gestures of affection will in most cases prove difficult to train and control.

The incentive value of food rewards is also an important consideration in the overall selection process since food reinforcement constitutes a principal feature of current land mine/booby trap detection training procedures. Thus, dogs which are finicky eaters or which do not eagerly seek and accept food rewards similar to those used during training (see Volume II of this series for details) may not respond favorably to training protocols based on food reinforcement techniques.

Temperament. Temperament comprises one of the most important characteristics of a successful detector canine, and potential candidates should be screened carefully on this complex dimension. General curiosity, alertness, vigor, and physical energy are desirable traits and should be afforded considerable emphasis in the selection of a potential trainee. As a rule, gregariousness and a friendly, if perhaps guarded, acceptance of an approaching stranger are also useful predictors of success in training. However, this does not mean that animals displaying an air of confident aloofness will not develop into excellent performers.

In any event, shy and timid dogs which cower or attempt to escape when approached should be rejected.

It has already been indicated that animals displaying strong aggressive tendencies are not necessary for ordnance detection applications. However, unusual passiveness and fear of novelty represent undesirable characteristics. Such animals may be difficult to train and often tend to be highly distractable in the field. Degree of aggressiveness can be assessed by teasing and agitation. To perform this evaluation, one individual approaches and repeatedly strikes at the animal with a rolled burlap sack, loosely rolled newspaper, or some other harmless object. Dogs of acceptable temperament will growl, bark, attempt to seize the offending object, or perhaps attempt to bite the agitator. Overly aggressive animals will become extremely excited, lunge against restraint, attempt to bite the tormentor or other nearby personnel, and continue to remain aggressively aroused after agitation has ceased. Underaggressive dogs react to agitation by cowering, hiding, or attempting to flee; such animals are not acceptable. Note that the dog should be restrained on a leash by assisting personnel during tests of aggressiveness to prevent possible injury to the agitator or bystanders.

Other characteristics of temperament important in a good detector dog include sensitivity, willingness, self right (self assertion), and confidence. Sullivan (34) has provided a very useful category rating scale

for evaluating these dimensions as summarized below.

A) Sensitivity.

1) Superior: Responds actively to praise; enjoys physical play; enjoys and encourages touching, scratching, etc. Responds to sounds, call of name, verbal praise; eager to investigate strange sounds. Watches activities of handler; watches strangers; reacts inquisitively to novel sights.

2) Average: Accepts physical praise; does not resent physical play; appears to enjoy touching and scratching, but does not seek same by nuzzling. Responds to strange sounds, but is not actively inquisitive. Notices handler activities, but remains unconcerned; does not react to approach of strangers; moves independently of handler and does not seek direction.

3) Marginal: Appears cautious with handler; flinches; may want to engage in physical play, but unsure; appears unwilling to make up to handler or stranger. Knows sound of name but appears cautious; flinches at strange noises; attends to source of strange sounds cautiously, seeks protection of handler. Becomes anxious upon approach of strangers, watches handler for encouragement and reassurance; follows rather than leads; shys away from novel sights.

B) Willingness.

1) Superior: Appears to understand instruction;

accepts correction; performs sit and heel with assistance in three attempts.

2) Average: Appears willing to try; understands instruction, correction and praise.

3) Marginal: Appears cautious; resents correction; seems handshy; displays fear at jerk of choke chain.

4) Definite Reject: Frankly leash or handshy; fearful of correction; urinates, displays fear, self-protection or fear-biting upon correction.

C) Self Right.

1) Superior: Stands ground regardless of what approaches; appears willing to defend right to hold position; does not give ground to another dog, but does not challenge.

2) Average: Appears willing to hold ground but needs encouragement; may break for another dog if challenged.

3) Marginal: Retreats if challenged by man or dog, but responds with active encouragement.

4) Definite Reject: Retreats quickly, drops to ground, seeks protection, rolls on back, cowers and drops tail, urinates.

D) Confidence.

1) Superior: Willing to make friends with strangers on sight.

2) Average: Will not make up with strangers who make advances, but makes up on own after investigation.

3) Marginal: Will not make friends unless allowed period of time to gain assurance.

4) Definite Reject: Obviously timid and manshy; refuses to make up; retreats when approached; fear-bites.

Supplemental Behavioral Screening. The following behavioral tests represent an attempt to predict the general intelligence and trainability of adult dogs based on observations made during puppyhood; as such they are relevant only in situations involving selection of young dogs. Several of these tests are relatively time-consuming which may impose a further constraint on their utility. If practical, however, these assessment devices can contribute meaningfully to the overall selection process and have proven useful in other screening applications (e.g., Guide Dogs for the Blind).

The tests described below represent modifications of techniques developed by Fox and Pffaffenberger and are discussed in detail in the citations accompanying each procedure.

A) Approach Behavior Test (33). This test requires a runway apparatus and an enclosed start box separated from the runway by a sliding door. Pups may be tested between the ages of 5 and 16 weeks. One observer operates the door and a second, toward whom

the dog approaches, is stationed at the end of the runway. The procedure involves four stages:

1) Confine dog to start box; note barking, whining, and crying in distress and record as 1, 2, or 3, respectively.

2) Open door and record time to emerge from start box; score 1 = 0 - 2 sec., 2 = 2 - 10 sec., 3 = greater than 10 sec.

3) Note whether pup approaches human at end of runway, vascillates between approach and withdrawal, or retreats; score 1, 2, and 3, respectively.

4) Note reaction to aggressive hand clapping; score 1 = retreats or crouches but returns and wags tail when coaxed, 2 = returns slowly, 3 = retreats and hides in start box.

B) Timidity Test (33). The purpose of this test is to obtain a rating of the pup's timidity when placed in a strange environment and confronted with a novel object (for the latter Fox suggests a small fish placed in a food bowl). The test begins by positioning the food bowl on the floor and allowing the dog to see and smell the fish (dog held by handler). The dog is then placed on the floor and its reactions noted; immediate body attitude is of particular interest. (It should also be noted whether or not the puppy snapped at or attempted to eat the fish upon initial presentation). Time until the pup first begins to move about should be recorded. General activity and rate of movement throughout the

period of testing is evaluated and scored on a 0-4 scale (timid-confident). Presence or absence of defecation or urination should be noted. Curiosity and investigatory activities directed toward the fish should be observed and any attempt to play with or eat this novel food item are recorded.

C) Obedience Test (33). As described by Fox (33), the purpose of this test is to assess the dog's response to inhibitory training in a nonreward situation. If placed atop a low stand, the normal response of an unrestrained dog is to leap down after a few seconds. The handler attempts to exert control over the animal so that jumping is inhibited even when the experimenter is too far away to administer punishment. Some pups train readily (i.e., become obedient), while others do not within time limits allowed. The former make good training prospects, the latter may not.

The obedience test requires a low stand approximately 0.5 m high and 0.5 m x 0.5 m on top, a choke collar, and a short leash. About 20 minutes per day for 4 days is needed to complete the test.

On the first day the dog is fitted with choke collar and leash, placed on the stand, and given the command "Stay". The leash is held above the animal's head such that it is choked if it jumps off the box. Each time the pup is choked is counted as one trial, and

training on the first day should be limited to 20 trials. When the animal has learned to stay on the stand for 15-20 seconds, training for responding to "Down" is begun. Upon issuing the command the trainer gives a gentle tug on the lead and steps away from the stand.

When the dog stays up to 20 seconds and jumps promptly at "Down" with only a token force applied to the collar, training without a collar is begun. The dog is placed on the stand with the collar in place. The collar is gently removed and the command "Stay" is given. The handler stands within 0.5 m of the stand, but does not touch the dog or restrain him from jumping. If the dog jumps, the collar and leash are dropped so as to loop over the dog's back.

The remainder of the training is devoted to increasing the degree of control which the handler can exert over the subject. This is done by having the trainer move off at greater distances and observing the response of the dog to "Stay" and "Down." A Stay of 30 seconds is required at each distance. At 30 seconds the trainer orders "Down" in a clear voice, and gestures with his hand as though pulling the dog down by a lead.

The ultimate objective of the obedience test is to have the dog remain on the stand for 30 seconds while the observer backs away to the required distance, and then to jump down promptly at "Down." If the dog does this when the control distance is 0.5 m, the distance on the

next trial is increased to 1.0 m. After each successful trial the control distance is increased by 0.5 m to a maximum of 4 m.

If the dog remains on the stand between 10 and 30 seconds he is retested at the distance at which he failed. If he remains less than 10 seconds he is given two choke collar trials and tested at the level below the one at which he failed.

The maximum number of daily free trials (i.e., non-choke trials) is ten (counting 2 choke collar trials equal to one free trial).

After an animal has learned to stay 30 seconds at the greatest distance, no further trials are given on that day. On the next day training begins at the highest level successfully passed on the previous day. Three days are used for training.

On the fourth day the animal is tested at all distances from 0.5 to 4 m; the choke collar may be used for two preliminary refresher trials. Test data include:

a) The total number of seconds which the dog spends on the stand after the handler releases him and moves away.

b) The number of spontaneous, immediate, and delayed (estimate length of seconds) downs.

c) The number of choke collar trials required to inhibit leaping from the box.

d) The maximum duration of stay at each distance (whether achieved in training or on the test day).

e) The behavior of the dog between trials, particularly whether it resists being led up to the stand, whether it avoids the handler, and its posture on the stand.

D) Retrieving Test (4). Although the precise behavioral dimension reflected in the retrieving test is not clear, it has proven to be an effective predictor of successful Guide Dogs for the Blind; Pfaffenberger (4) has argued that the retrieving test represents an index of the animal's willingness to perform for its handler. Equipment required includes a collar, leash, and tennis ball. (Some dogs demonstrate little interest in tennis balls; a pheasant or duck wing may be more effective in such cases). The training and testing sequence involves 10 trials per day for 5 days.

On the first day, the dog is lead into the testing situation (preferably a large open room with no distracting objects) and allowed to become familiarized with the area and with the ball. Thereafter, with the dog on leash at the handler's side, the ball is thrown a short distance (e.g., 4 m) as the command "Fetch" is given. On the first two days the leash is used to direct the dog to the ball and back to the starting area; lavish verbal praise and petting are administered if

the pup goes to the ball, picks it up, and/or returns it to the handler; failures to fetch should not be punished in any way.

Off-leash retrieving is begun on the third day. Additional trials on leash are conducted only for refresher purposes or if the dog fails to perform off leash. Data to be collected include:

a) Careful observation of behavior on first few trials. Dog ignores ball (score 4); dog runs to ball and investigates (score 3); dog runs to ball and picks up (score 2); dog goes to ball, picks up, and returns to handler (score 1).

b) Total number of on leash trials.

c) Number of successful off leash retrievals.

d) Number of first successful off leash retrieval.

e) Number of incomplete trials (i.e., trials on which dog starts toward ball but becomes distracted and wanders off, trials on which dog picks up ball but fails to return to handler, etc.).

Dogs which have not learned to retrieve reliably by the end of the fifth day should be considered for rejection since they may prove to be slow learners in land mine/booby trap detection training.

E) Trailing Test (33). The trailing test is designed to assess the speed with which the young dog can locate an object given a set

of unfamiliar olfactory and visual cues. Both types of cues are relatively salient and thus are well within the sensory capabilities of the animal, but the olfactory elements provide the most reliable information regarding location of the goal object (food). The trailing test provides a useful test of sensory-motor skills and therefore appears particularly relevant with respect to selection of land mine/booby trap detection training candidates.

Equipment required includes trailing boards (boards approximately 2.5 cm thick, 5 cm wide, and 4 m in length with small metal plates attached at 1-m intervals), two small metal food dishes, pieces of fish (goal object), and leash. Five successive daily sessions of about 1 hour in length each are conducted.

On the first day, one food dish containing a small portion of fish is placed in one corner of the test room. Starting near this point, the dog is lead on leash around the room in a figure 8 pattern ending at the goal dish. It should be noted whether the dog discovers the food dish himself or has to be shown, and whether or not it eats the fish.

On the second day, a scent trail approximately 8 m long is prepared by laying down scent boards starting at the position occupied by the food dish on day 1. The trail is scented by lightly rubbing each metal plate with fish. The starting portion of the scent trail should

be enclosed between low wooden barriers approximately 4 m long and 1.25 m apart to insure that the dog passes in close proximity to the first half of the trail. A small piece of fish is placed into the food dish at the end of the trail, and a trial is initiated by releasing the dog at the start of the scent trail. The handler observes the path taken by the dog from start to food dish and notes whether the latter was found by random circling, position memory, or actual trailing along the scent board. Total elapsed time per trial is recorded; if the animal has not located the food dish within 2 minutes, it is lead along the trail on leash. Two trails are conducted on day 2.

The procedures of day 3 are the same as those of day 2 save that the wooden guidance barriers are removed.

On day 4 a "V" is added to the end of the scent trail. The right-hand arm of the "V" is scented and provided with a baited food dish; the other arm is unscented and fitted with an empty food cup. On the second trial, an additonal "V," with the left arm scented and baited, is added starting at the previous goal point.

Finally, on day 5 a "Y" arrangement is set up in a new test area. The right arm is scented and baited on the first trial, the left arm on the second. This procedure permits a test of task generalization.

Scoring consists of computing percentage of trials

successfully followed and elapsed time per trial.

Sources of Dogs. Dogs for training and deployment as detectors of land mines and booby traps may be obtained from three potential sources: private owners and/or breeders, a dedicated inhouse breeding facility, and other military programs. For practical reasons it is assumed that most animals will be acquired from private sources.

A) Private Sources. Dogs may be obtained from private owners and/or breeders either by purchase or donation. Most private owners have legitimate reasons for disposing of personal pets, e.g., the animal has become too big and costly to maintain, nonavailability of adequate housing and exercise facilities, moving to a new location, bothers neighbors, etc. However, it is only reasonable for procurement personnel to exercise a realistic degree of caution in such cases since a few unscrupulous individuals may attempt to take advantage of an opportunity to rid themselves of a problem dog (habitual biters, temperamental or otherwise unmanageable, etc.). Such animals should be avoided.

Proof of ownership is desirable, and certification of maintenance of obligatory vaccinations by a licensed veterinarian is mandatory. A certificate of pedigree is also desirable if available.

B) Dedicated Breeding Facility. If feasible, the establishment and operation of a dedicated inhouse breeding facility would

undoubtedly provide the most effective source of potential training candidates. The value of this approach has been well documented by the Guide Dogs for the Blind Association who, by virtue of a carefully developed breeding program, have improved their training success rate from an initial one dog per litter to a situation in which only one animal per litter fails to make a proficient Guide Dog (4). A controlled breeding program would also allow the opportunity for a much more extensive pretraining screening protocol thereby minimizing the subsequent drop-out rate during formal training. It is recognized, however, that a full-blown breeding program would prove cost-effective only during periods of moderate - to large-scale tactical warfare in which large numbers of detector animals would be required.

Expected Rejection Rate. Considering both medical and temperamental factors, an overall rejection rate in excess of 50% is not unrealistic for dogs being screened for land mine/booby trap detection training, and it is inevitable that a proportion of those accepted will not successfully complete the training program.* Many factors must be considered in the selection process, and no dog is expected to achieve a superior rating on all dimensions.

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*Forty-five percent of the dogs originally enrolled in a recently-concluded canine land mine/booby trap detection training and evaluation program conducted by Southwest Research Institute for USAMERADCOM failed to complete the associated training sequence due to medical problems, unsatisfactory performance, and related difficulties (1).

Since many aspects of canine evaluation involve subjective judgments on the part of trained and experienced observers, it is not possible to compute on overall "passing" or "failing" score in a purely quantitative sense. In lieu thereof, it is recommended that screening personnel prepare a rating form for use in evaluating each dog's positive and negative attributes; the format presented below may be used or adapted for this purpose. Given a knowledgeable and experienced trainer, any animal which is characterized by an overall combination of high scores has an excellent probability of becoming a valuable and proficient detector of land mines and booby traps.

EVALUATION SUMMARY

Dimension of Evaluation	Acceptable Characteristics	Unacceptable Characteristics
1) Age	3 years or less	Over 3 years.
2) Physical characteristics	Meets normal breed conformation; stance and gait normal for breed.	Anomalous or ill-proportioned body development; ill-developed musculature; locomotor abnormalities.
3) Medical	Absence of pathology, gross injury, disease, or physical abnormalities; Normal or Grade I dysplasia; normal dentition; obligatory vaccinations current (rabies, DHL).	Presence of pathology, illness, gross injury, or physical abnormality; Grade II-IV dysplasia; missing, broken, or severely worn teeth; heartworm infection; advanced endoparasite infestation; advanced ectoparasite infestation; visual, auditory, or olfactory dysfunction.
4) Gunshyness	Tolerates gunfire.	Frankly gunshy.
5) Motivation	Responds positively to verbal praise and attention.	Abnormally aloof; unresponsive; rejects gestures and overtures of friendship.
6) Temperament		
a) General	Curious; alert, displays physical vigor	Lethargic, excessively timid and shy; fear of

EVALUATION SUMMARY, CONT'D

Dimension of Evaluation	Acceptable Characteristics	Unacceptable Characteristics
	and energy; gregarious; demonstrates normal aggressiveness.	novelty; fear-bites; overly aggressive; under aggressive (cowers, hides, or flees in response to aggression testing).
b) Sensitivity	Superior or average rating (see p. 37).	Marginal rating (see p. 37).
c) Willingness	Superior or average rating (see p. 37).	Marginal or definite reject rating (see p. 37).
d) Self Right	Superior or average rating (see p. 38).	Marginal or definite reject rating (see p. 38).
e) Confidence	Superior or average rating (see p. 38).	Marginal or definite reject rating (see p. 38).

Finally, it should be recognized that the criteria detailed in the present document are designed as guidelines for the selection of land mine/booby trap detector dogs; some of the standards enumerated herein may not be appropriate in the screening of animals for other military applications.

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