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How performance testing of working dogs can be adapted to evaluate working ability in Komondor dogs

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1 Introduction

Among the many dog breeds that exist today, many were originally bred to do a certain type of work, for example hunting, guarding or herding. Nowadays it may seem like most dogs are bred to be good companions or do well in shows, and traits that favour these aims are more important to those breeding dogs, rather than traits which are needed for the dog to perform any type of work. In some breeds, the difference between dogs bred for show and for work is quite evident in the exterior, e.g. working German shepherd and show German shepherd. If the dog breeds were developed on basis of their ability to perform certain tasks, it is likely that these behavioural traits are inherited to some degree, and one question that might arise is if the dogs which are bred on basis of their conformation still possess the original working traits of the given breed, or if these behaviours are lost in the process of breeding dogs to fit into a certain conformation standard.

The livestock protection dogs are a group of dogs utilised for their ability to protect livestock on pasture. One of the breeds belonging to this group of dogs is the Hungarian Komondor. As far as this thesis is concerned, no study has been carried out in order to investigate if the working ability of the Komondor breed differ among dogs bred for show and dogs bred for working.

This thesis aims to give an insight into the domestication of the dog, and how this process has led to a diversification into show lines and working lines within breeds of dogs today. The main traits of livestock protection dogs in general, and the Komondor specifically will be presented. Further, a description of some methods of assessing the behavioural traits in working dogs and how they differ in the various test situations will be described. Finally, it aims to give a suggestion on how dogs of the Komondor breed can be tested to investigate if this breed also shows a distinction into show lines and working lines, on the basis of available data from tests of other types of working dogs.

2 Literature review

2.1 Domestication of dogs

Man's best friend, the dog, comes in many shapes and varieties, differing largely in size, colour, type of fur, ears, tail and face, and today several different breeds of dog exist. In fact, 300-400 breeds are recognized by the different dog societies around the world (King et al., 2012, Gehring et al., 2010, Spady and Ostrander, 2008). In modern society dogs are kept and bred for several tasks, such as guardians, stock herders, assistants, companions and sports (Cobb et al., 2015), and it has been shown that both humans and dogs benefit psychologically from the relationship that exists between these two species (Payne et al., 2015).

The dog was the first animal to be domesticated (Galibert et al., 2011). Domestication is “the process and condition of a genetic and environmentally induced developmental adaptation to humans and captivity” (Spady and Ostrander, 2008), and it causes a genetic separation from the founder animals due to sexual isolation from the wild population. Over time the domesticated animal will differ from the wild population both genetically and phenotypically (Galibert et al., 2011). There have been some debate regarding the origin of the dog but several studies have now clarified that the wolf, *Canis lupus*, is most likely the main ancestor of the present-day dog (King et al., 2012, Savolainen et al., 2002). Archaeological evidence suggests wolves were living in proximity to humans in China 300000 years ago, and in France 150000 years ago but this merely shows that there was a coexistence (Savolainen et al., 2002, Spady and Ostrander, 2008). The oldest evidence of differentiation of the dog from the wolf dates back 31700 years, to a skull discovered in Belgium (Galibert et al., 2011). Several remains from different parts of the world dating back to 7000-14000 years ago gives strong evidences of dog and human living together (Galibert et al., 2011) and suggests that domestication took place over a period between 15000 and 30-40000 years ago (Galibert et al., 2011, Savolainen et al., 2002).

2.2 Development of breeds

Clearly, the domestication of the dog did not just happen overnight, and neither did the development of the different breeds of dog that exists today. It is believed that the domestication of the dog started with wolves living in proximity to human's due to easy access to food by means of scraps. This in turn led those wolves to be acclimatised to human presence and occasionally taming of wolf pups by the people (Galibert et al., 2011). The events of humans developing more sophisticated hunting methods and the shift from a

hunter gatherer lifestyle to a settled lifestyle relying on agriculture were important factors in the further development of the dog into different breeds. Whether it was hunting, protection, herding or other working roles, the dogs would be selected for certain traits, behaviours, temperament and physical characteristics which made them superior to their conspecifics with regards to the selected task (Spady and Ostrander, 2008, King et al., 2012). As shown by the fox-farm experiment by Dmitri Belyaev (1979, cited in King et al., 2012) where foxes were selected for breeding based on their behaviour towards humans, selection for behaviour also caused a change in the physical phenotype of the fox, and there is reason to believe the same thing occurred during the domestication of the dog and lead to the fact that many breeds of dog looks nothing like the wolf ancestor and also the enormous variation we see in dog breeds today (King et al., 2012). The artificial selection by humans of dogs with different traits led to the development of different breed types some time 3000-7000 years ago (King et al., 2012). Although there were breed types among dogs early on, the development of breeds happened over time, mainly based on the dog's ability to perform a certain type of work. Traits which are highly desirable in one breed may not at all be desirable in another breed. In the recent centuries hundreds of breeds have been created by selective breeding, most of which have traits highly adapted to the task the breed was originally intended for. For example, different breeds of herding dogs have different ways of accomplishing their task. Some breeds nip at the feet of animals, some stare at the animals they herd (Galibert et al., 2011), whereas different breeds of hunting dogs, may point, track, chase, hold at bay, retrieve and flush, according to Spady and Ostrander (2008).

In the 19th century the dog breeds were formalised and Kennel clubs were founded. The Kennel clubs set the standards for the different breeds and are involved in showing, breeding and registration of dogs (Farrell et al., 2015, Galibert et al., 2011). With the establishment of kennel clubs a uniformizing of dog breeds developed, with selection and pedigree breeding of dogs that conformed to a set standard (Pedersen et al., 2013), thus creating a somewhat closed genetic pool (Pedersen et al., 2013). Today the UK Kennel club recognizes 215 breeds and classifies them into seven different groups based on the original function of the dog. These groups are Hounds, Gundogs, Terriers, Utility dogs, Working dogs, Pastoral dogs and Toy dogs (Farrell et al., 2015), whereas the Federation Cynologique Internationale (FCI) recognizes 344 breeds, classified into 10 groups; Sheepdogs and cattle dogs, Pinscher, schnauzer, molossoid and Swiss mountain and cattle

dogs, Terriers, Dachshunds, Spitz and primitive types, Scent hounds and related breeds, Pointing dogs, Retrievers, flushing dogs and water dogs, Companion and toy dogs and Sighthounds (“Fédération Cynologique Internationale”, 2017).

2.3 Differences in conformation and working performance bred dogs

2.3.1 Modern dog breeds

There are vast differences both morphologically and behaviourally in the various breeds of dogs. Modern dog breeds differ greatly in behaviour (Saetre et al., 2006) and appearance due to different selection pressures through time (Saetre et al., 2006), and they evolved through inbreeding for the expression of certain phenotypic traits, such as working behaviour (Fadel et al., 2016). With the recent breeding of dogs for show and companionship, rather than for work, many breeds which were originally bred for a certain type of work, and thus selected based on their performance, are now bred for conformation and instead selected on basis of performance in dogs shows (Pedersen et al., 2013) and their compliance with breed standards. With the change towards keeping dogs for companionship the main aim of breeding is no longer the working ability but rather the looks of the dog. The same trend is true for the breeding for show dogs, where a conformation within the standards set by kennel clubs is the main goal of the breeding, and it can be hard to imagine some of these breeds originally evolved because of their working traits. For both of these uses of dogs, the original behaviour of the breed might be somewhat watered out, in order for the dogs to be better suited for the environment they are supposed to live in, and there not being any need for them to perform any working tasks (King et al., 2012). Breeding for performance does not cause an excessive change in the morphology, whereas the breeding for conformation has led to changes in both appearance and performance (Pedersen et al., 2013), in addition to many breeds exhibiting quite extreme morphologies, several which are linked to various disorders (King et al., 2012).

If a dog is to be registered in the American Kennel Club, both parents must be registered members of the same breed, and as such modern breeds can be considered closed breeding populations, often with high genetic homogeneity (Spady and Ostrander, 2008). Bottleneck events in the evolution of dog breeds have happened several times, first during the development from wolf to dog, then during the selection of dogs based on their working skills, later in the development of breeds in the last centuries, and in the recent breeding on certain lines (Pedersen et al., 2013). When there was a development of breed

standards and rules related to the selection of breeding stock in order to ensure breeding within the breed (sire and dam of same breed), each breed became somewhat genetic isolated populations (Farrell et al., 2015, Saetre et al., 2006). Many dog breeds today have low genetic diversity, due to a small number of founder individuals (Galibert et al., 2011), and the use of relatively few sires increases the risk of spreading inherited disorders which are passed down by simple inheritance (Pedersen et al., 2013, Farrell et al., 2015, Galibert et al., 2011). The use of relatively few sires, breeding on specific lines, only allowing dogs with registered parents belonging to the breed in question to be registered within the breed, inbreeding to maintain the standards and selection for certain traits has led to a loss of genetic variation within breeds (Pedersen et al., 2013, Calboli et al., 2008).

2.3.2 Differences in genes and behaviour of show bred and working bred dogs

There is a belief that selection of working dogs should be based on their performance in trials (Hradecká et al., 2015), and the selection of dogs for different types of work should have led to behavioural differences between the breeds if there is high heritability of behavioural traits (Fadel et al., 2016). In modern time, much of the breeding is based on morphology in accordance with the breed standards instead of selection on basis of function. (Svartberg, 2006). Svartberg (2006) suggests that the modern selection pressure on breeds, for morphology rather than behaviour, has led to a change in the breed-typical behaviour for several breeds. The selection for conformation rather than performance may even have caused the behavioural differences to be higher within a breed than between breeds (Fadel et al., 2016). In the breeding of some breeds there is a distinction between the selection for show and the selection for performance, which have led to the divergence into show lines and working lines. This selection within breeds is possibly causing dogs bred for show to become more similar regardless of breed, whereas those bred for working behaviour are still well separated (Fadel et al., 2016). The behavioural differences between breeds of dogs and also between different lines within a breed are well documented by several sources (Hradecká et al., 2015).

A study by Pedersen et al. (2013) aimed to investigate the genetic influences of conformation and performance breeding on eight dog breeds compared to indigenous village dogs. They chose breeds that are bred mainly for show, mainly for performance, and breeds that are bred separately as lines for either show or performance. Access to the pedigrees of all the dogs in the study were obtained, DNA was extracted and by sequencing the mitochondrial DNA, haplotypes were identified. What they found was that genetic

diversity differed among the dogs based on their present selection criteria. The village dogs had the greatest amount of heterogeneity, which should be expected since these dogs have not been subject to much human intervention with regards to their breeding. The village dogs were followed by the performance breeds. Conformation breeds showed the lowest level of heterogeneity. The findings support the thought that breeding for conformation causes the breeds to lose some of its genetic diversity due to inbreeding. This is probably caused by both the overuse of certain individuals or lines, and the fact that conformation traits are often easier to genetically fix due to the relative simple inheritance. The inheritance of performance traits on the other hand is more complex and the selection depends on how the traits in question are tested for (Pedersen et al., 2013).

According to Svartberg (2006) there is evidence for variation in the behaviour of different breeds of dog, and there is suggestion of this being the result of the selection during the development of the breeds. In a study carried out by Svartberg (2006), data was collected from dogs that had been subjected to a standardised behavioural test with 10 subtests when they were 12-24 months old. The subtests were the same as described by Svartberg and Forkman (2002, cited in Svartberg, 2006), following the same scoring system. 31 different breeds of dogs were tested, from the groups herding dog, working dog, gun dog, hounds and terriers. Based on the previous studies by Svartberg and Forkman (Svartberg, 2006), traits can be collectively divided into chase-proneness, distance-playfulness, playfulness, curiosity/fearlessness, sociability and aggressiveness. The four last ones were used in this study, as they are considered to be reflecting characteristic behaviour strategies (Svartberg, 2006). The overall breed score for each trait was calculated, based on the scores each dog achieved. To investigate the recent selection of the dogs in the study, merits by the breeding stocks from dog shows, tests and trials relating to the historical use of the breed were considered as a reflection of selection criteria. However, it was only in the herding dog group the dogs were used in show and working dog trials to the same degree, for most of the dogs used in the study the breeding stock investigated had merits mainly from dogs shows. With regards to the traits tested, the breed scores for all breeds had a significant negative correlation with the number of show merits for each breed both for sires and dams. For each breed, the number of show merits of sires and dams had a significant negative correlation with the breed scores for playfulness, sociability and aggressiveness. The curiosity/fearlessness trait had a negative correlation with the show merits for sires. On the contrary, a positive correlation could be

found between the number of merits in working dog trials and the scores for playfulness and aggressiveness, in addition to a non-significant positive correlation to curiosity/fearlessness, and no correlation to sociability. These correlations were although true only for sire merits, no correlation was found between the trait scores and the merits of the dams. Interestingly, no significant difference was found between breed groups, and in fact, a cluster analysis found that breeds across groups were distributed in several clusters, thus not falling into the groups based on original use. These traits have moderate to high heritability, and the findings suggests that the typical behaviour of the breeds have been changed by the modern selection of breeding dogs (Svartberg, 2006).

The same conclusion was reached by Fadel et al. (2016) in a study on the behavioural differentiation between and within breeds in relation to conformation breeding and performance breeding. Using the Dog Impulsivity Assessment Scale (DIAS) and questionnaires they investigated the rate of impulsivity in pure bred Border collies and Labrador retrievers of working lines, show lines, mixed lines and unknown lines. The overall score of the three factors behavioural regulation, aggression threshold and response to novelty and responsiveness gave the overall score of impulsivity. The line had a significant effect on impulsivity, behavioural regulation and responsiveness, whereas breed had a significant effect only for aggression threshold and response to novelty. Border collies scored significantly higher than Labrador retrievers in all the traits except responsiveness when excluding mixed and unknown lines. This was also true when comparing only the working lines across the two breeds. In both breeds the working lines had significantly higher scores for responsiveness than show lines. In comparison of the show lines, only the aggression threshold and response to novelty showed a significant difference between breeds, implying that the show lines are more similar across the breeds than are the working and show lines within a breed (Fadel et al., 2016). This corresponds to the results in the study by Svartberg (2006), which found significant differences between the breeds in all traits but also variations within breeds, and the results indicate that the breeding selection on a conformation basis has led to loss of some of the behaviour related to the traditional work of the breed. (Fadel et al., 2016).

2.3.3 Heritability of behavioural traits

The behaviour of a dog is influenced by the environment it lives in and its previous experiences (King et al., 2012) but the breed typical behaviour is presumably also controlled by genetics, although the inheritance of behavioural traits is complex. Evidence

suggests that the behavioural predispositions in dogs are relatively stable and many are heritable to some extent (Spady and Ostrander, 2008), although there is evidence that the heritability of behavioural traits is low (Hradecká et al., 2015). If the behaviour can be measured it should be possible to identify preferred behaviour and select breeding stock based on these behaviours (King et al., 2012), provided heritability of these traits exists. Based on the results of these studies and the significant differences between show lines and working lines in several breeds, it seems quite evident that behaviour is inherited to some extent.

Saetre et al. (2006) conducted a study to investigate the heritability and genetic correlation of some behavioural traits in two breeds. They based the study on five composite personality traits defined by Svartberg and Forkman (Saetre et al., 2006) and aimed to predict the genetic correlation pattern, and further compared it to the observed genetic correlation. All the traits used to define the playfulness trait were all strongly positively correlated. Also, the traits used to describe chase-proneness and aggressiveness showed positive and significant correlations. The 16 traits had heritability values ranging from 0.04 to 0.19. In addition, they found that the overall trait shyness-boldness had a heritability of 0.25 and 0.27 in the two breeds, suggesting that this trait can explain much of the behaviour in all the test situations and that the behaviour in one test situation might be genetically related to the behaviour in a different test situation.

In contrast to these studies, Hradecká et al. (2015) found that the high heritability values of traits or within a breed disappeared when they conducted a meta-analysis across studies on the heritability of behavioural traits.

2.4 Livestock protection dogs

2.4.1 History of the Livestock protection dogs

One of the many tasks a working dog can be utilized for is that of protecting livestock. A dog bred for this purpose is considered to belong to the pastoral group of dogs according to the UK Kennel club (Farrell et al., 2015). Dogs of breeds belonging in this group are utilized for the herding and guarding of livestock (Gácsi et al., 2009). In contrast to the herding dogs the livestock protection dogs (LPD's) are used for guarding grazing livestock against predators, and not for herding them. These types of dogs are usually large dogs which are intelligent and stubborn, and they work on their own, without much intervention from the herder. They follow the herd they are meant to protect if they have formed a bond with them (Rigg, 2001).

It is likely that the sheep and goat were domesticated 7000-8000 years ago, and when these animals were kept for the production of wool, milk and meat there was a need to be able to protect them from predators such as bear and wolf (Gehring et al., 2010). This led to the development of the livestock protection dogs. The ancestors of the LPD's are believed to have originated from mastiff-like dogs in Mesopotamia and the surrounding regions, and there are archaeological evidences dating back to 3585 BCE of dog and sheep together. In a Roman farm-management treatise, two types of dogs are mentioned; hunting dogs and livestock protection dogs, and even in Job 30:1 in the Old Testament there is mention of a dog with a flock of livestock (Gehring et al., 2010). This type of dog has been in use for thousands of years in Central- and South Europe and in Asia (Rigg, 2001). Spreading of these dogs happened through migration, either with the people keeping them or with merchants. Nomadic shepherds most likely brought dogs with them to guard their flocks during the transhumance between Mesopotamia and the area which is today Hungary (Gehring et al., 2010), and the first LPD's probably arrived in this area together with nomads from Caucasus (Rigg, 2001). The early LPD's were most likely dogs which were raised with livestock, and thus suited to this type of work (Gehring et al., 2010), and the early selection of the LPD's was not breeding per se as we know it today and these dogs were not sexually isolated from other dogs. Instead, the shepherds would favour and care for those dogs that were able to outperform other dogs due to their morphology and behaviour, and thus they more or less knowingly urged forward the creation of breeds with a specific function (Galibert et al., 2011). This early selection, in addition to the spread to new regions and inclusion of new genetic material to improve and adapt the dogs to different areas laid the foundation for the diversity we see in the more than 40 LPD breeds with somewhat different characteristics that exist today (Gehring et al., 2010).

During the last 200 years, there has been a decline in numbers of large carnivores in Europe, much due to human activity, and accordingly the use of LPD's has declined. In recent years however, there has been a shift towards a preference for using non-lethal methods in the conservation of these carnivore species and in several areas their numbers are increasing, thus making the use of LPD's again highly relevant (Gehring et al., 2010). Several investigations on LPD's working in different areas of the world are described in Rigg (2001). Although the original use of LPD's was to protect the livestock from predators, nowadays they may also be used as a tool for disease control. By reducing deer activity close to the livestock, diseases such as bovine tuberculosis, brucellosis,

keratoconjunctivitis and neosporosis in livestock may be reduced (Gehring et al., 2010)

2.4.2 Behaviour of livestock protection dogs

A livestock protection dog needs to exhibit three overlapping behaviours in order to be able to protect livestock. These behaviours are considered being trustworthy, attentive and protective, and the model describing these behaviours has been utilised for analysing the behaviour of dogs used for the protection of livestock. Most studies have been done on breeds originally used for livestock guarding but almost any type of dog can do the task if it is raised and trained right (Coppinger et al., 1983).

Lorenz & Coppinger (1986, cited in Rigg, 2001) described these three traits as follows:

Trustworthy. The absence of predatory behaviour is the basis of trustworthiness. Livestock-guarding dogs are selected to display investigatory and submissive behaviours that do not threaten sheep or other livestock. Approaching sheep with ears back and squinted eyes, avoiding direct eye contact and lying on the back are called submissive behaviours. Sniffing around the head or anal areas is called investigatory behaviour. Both are desirable behaviours, signs that your dog has the right instincts and is working properly.

Attentive. The attraction of a guarding dog to a home-site and to surrogate littermates is the basis of attentiveness. Flock guardians are selected for their ability to follow other animals. Following a moving flock and sleeping and loafing among the sheep are signs of attentiveness to sheep. A dog that retreats to the flock at the approach of a stranger is showing another good sign of a sheep-attentive dog. Researchers have shown a direct correlation between attentiveness to livestock and a reduction in predation. Therefore, success depends on training your pup to follow sheep.

Protective. The basis of protectiveness is your dog's ability to react to deviations from the routine. Consequently, flock guardians are selected for their ability to bark at new or strange activities. Typically, a young pup will respond to a new or strange situation by rushing out and barking with tail raised over its back. It will retreat to the sheep or home-site, if challenged, with tail between its legs. This is called approach-withdrawal behaviour. A predator, let's say a coyote, usually avoids the threatening approach-withdrawal behaviour of a guarding dog. Attacking a predator, which is generally unnecessary, rarely occurs. Interactions with potential predators

often involve complex behaviours that are difficult to interpret. Approach-withdrawal behaviour may quickly shift to an aggressive display of dominance or a hasty retreat to the sheep. It might be coupled with defence of food or maternal-like defence of a young lamb. The distance of the approach toward strange activity increases as the dog matures. The distance a dog travels varies with individuals but rarely extends beyond the boundaries of the property. Because protective behaviour develops as a result of good trustworthy and attentive behaviours, it doesn't require specific training.

2.4.3 Problem behaviour

Studies of success by the use of LPD's are somewhat limited in that they are often based on the experience of the owner and not on objective testing of specific behaviour and control of the testing environment (Gehring et al., 2010). Some breeds were investigated for their success as LPD's in a LPD program in the United states. The breeds used in this program were Great Pyrenees, Anatolian shepherd, Akbash dog and Kuvasz. The dogs were rated on four criteria; frequency of occurrence of significant problems, evidence of guarding behaviour, apparent effect on predation and producer's satisfaction. They were raited good, fair or poor on all the criteria. The conclusion from the study was that the different breeds differed in their guarding behaviour, and there were differences among breeds in the behaviours trustworthiness, attentiveness and protective ability. Problem behaviour may be due to environment, or it can be of genetic origin and therefore breed related, and may be more evident in some lines, and as such it is important to select dogs from known and well performing working lines when acquiring a LPD (Green and Woodruff, 1990). Unwanted behaviour can be classified as not trustworthy, not attentive and not protective (Green and Woodruff, 1990), and these are further elaborated by Rigg (2001).

Not trustworthy. Nearly half of all dogs from 4 litters observed by Arons (1980) seriously injured a sheep during their first year, although they were more trustworthy with adult sheep and large lambs, which were less likely to initiate a chase by running. Obnoxious behaviours included chasing, biting, mounting and pulling wool. This is usually play but must be corrected as it can become a serious problem if sheep respond fearfully and/or run (Lorenz and Coppinger 1986). A stick attached to a chain on the dog's collar and hanging 8 -10 cm above the ground inhibits play chasing. Play can also be reduced by lowering calorie intake (but not

quantity of food), such as with a 2-week diet of cooked oats. Sick, old or odd sheep may be attacked by otherwise trustworthy LGDs. If stalking-type behaviour is observed, the dog should be replaced.

Not attentive. Very few dogs are 100% attentive and most sleep during the day (Lorenz and Coppinger 1986). Not all dogs observed by Arons (1980) stayed with the sheep at all times, although they were more attentive at night. Lack of shelter against bad weather, mosquitoes, heat and humidity all seem to affect attentiveness. Summer heat may reduce attentiveness; brushing out under-fur, shearing longhaired dogs and giving plenty of water can help. Basic needs must be provided to allow LGDs to do their job (Coppinger and Coppinger 1987). In Romania, for example, dogs leave their flocks to seek food (Mertens and Promberger 2000b). Leaving the flock can also be associated with sexual activity so neutering may decrease wandering (Lorenz and Coppinger 1986; Andelt 1999a citing Green and Woodruff 1988). The most common problem is, however, dogs returning to areas of human activity (Lorenz and Coppinger 1986). Seriously inattentive dogs tend to be those treated as pets or allowed to develop social relations with pet dogs (Coppinger and Coppinger 1987). Nevertheless, even dogs attentive to people can be useful in some situations, such as where a shepherd is always present, within an electric fence, where pastures surround a house or barn (Lorenz and Coppinger 1986) or where other LGDs are present (Coppinger and Coppinger 1987).

Not protective. Most protectiveness problems are associated with poor attentiveness. Protectiveness also depends on aggressiveness (in turn a function of age, sex and individual dog), density of predators, flocking behaviour of sheep, etc. More than one dog may be needed to protect widely scattered sheep (Lorenz and Coppinger 1986) and this will also reduce the impact of a deficient animal. Having the company of other dogs tends to lower the threshold of protective behaviour categories (Coppinger and Coppinger 1987), i.e. gives LGDs the courage to be more protective. In addition, anxiety in novel surroundings is reduced (Coppinger and Coppinger 1995).

2.5 Komondor

2.5.1 History of the Komondor

With the domestication of sheep came the need for having dogs able to protect the flock from predators such as wolf and bear, and there is evidence of spreading of Kuvasz sized dogs with the spreading of domestic sheep in what is today Northern Iraq and Eurasia. Evidence suggest that the sheep guarding dogs of Eurasia are of the same stock, and their origin is North-Iraq. The Komondor breed is believed to stem from the Owtcharka. The word Komondor is of Cuman origin, meaning shepherd dog. The Cumans were nomads living on the steppes of Eastern Europe, and are believed to have started settling on the Great Hungarian Plains in Hungary during the 13th century (Kincses-Nagy, 2013), and they brought the Komondor dog with them (Kovács, 2012). During the second World War the breed was almost made extinct, and in 1960 only 1000 dogs were registered in Hungary (Rigg, 2001).

2.5.2 Komondor breed characteristics

The Komondor is a breed for guarding flocks, not herding (“American Kennel Club”, 1994). It is rated as one of the 100 rarest breeds in the UK, with less than 20 dogs being registered each year (Farrell et al., 2015). It is a strong looking, courageous, large and muscular dog with a coat of long cords, which by two years of age should have started cording. It is a breed that matures slowly, reaching around three years of age before it is fully mature. The working Komondor mostly lives outside, and the coat helps to protect the dog from weather conditions and from predators, in addition to giving the dog the ability to blend in with the sheep flock. The Komondor was originally used for the protection of large sheep flocks on open plains, and was expected to protect the flock on its own, without close contact with the shepherd (“American Kennel Club”, 1994), and it is considered an independent working breed (Gácsi et al., 2009). It will protect what it sees as belonging to it and is devoted to its flock or family, and ideally it does not wander far from them. The use of heavy-handed training is not desirable when training a Komondor, as it will cause a stubborn and unhappy dog. The individuals of the breed should be large, well-muscled dogs with strong bone structure. Reasons for disqualifications only regards colour of eyes, colour, length and cording of coat, colour of nose and missing teeth (“American Kennel Club”, 1994). According to the FCI the Komondor is an old Hungarian breed of Asiatic origin. It is suspicious by nature and will guard its territory. If it attacks it should do it silently, and continuously. At daytime, the breed will be laying down in order to keep control of the territory, and at night the dog will be on the move. The breed is not known to

have many genetically linked diseases (Rigg, 2001), and the FCI breed standard also notes that “Only functionally and clinically healthy dogs, with breed typical conformation, should be used for breeding.” (“Federation Cynologique Internationale”, 2000)

2.5.3 Using the Komondor as a livestock protection dog

Not any Komondor can be a LPD, despite the fact that this is what the breed is intended for. Rather, a dog which possesses the breed characteristics and is trained properly may become a successful LPD. Early socialisation, obedience and flock management are areas in which training and human contact are essential (McGrew and Blakesley, 1982). The Komondor is considered an aggressive and protective breed, and to avoid this behaviour towards strangers it is preferable to ensure early socialisation with people. In order to accustom the Komondor to the presence of sheep or other livestock, they should be introduced to the animals it is to protect at an early age. 6-10 months of age is a good age to start this socialisation process (McGrew and Blakesley, 1982), but as early as 8-16 weeks has also been suggested, since the socialisation becomes harder after the age of 16 weeks and the best time to start socializing the pup with livestock is around eight weeks old (Rigg, 2001). There are especially two characteristics of the Komondor behaviour on which training should focus. The breed is “very conservative in nature. They adjust to the initial situation and react to change or novelty. This conservative nature is reflected in the traits we see in the breed: intelligence, stubbornness, aggressiveness, shyness, and strong habit formation” (McGrew and Blakesley, 1982). Also “Adult Komondorok have a low inclination to chase. Sheep accept them because they do not act like other dogs. Because they can stay close to the flock, Komondorok become attached to sheep (strong habit formation)” (McGrew and Blakesley, 1982). By leaving the Komondor with the flock for the whole production cycle and letting every sheep in a flock be accustomed to the presence of the dog, this conservative nature can be best put to use (McGrew and Blakesley, 1982).

There are some recommended steps to follow when introducing a Komondor to training, suggested by McGrew and Blakesley (1982), nicely presented in Rigg (2001).

1. Place the dog with sheep immediately upon arrival at the farm or ranch and leave it there. The area should be large enough for the dog to move freely, but secure enough to prevent escape. It should include a sheltered place where the dog can retire from the sheep.
2. Choose the sheep to complete the dog’s personality. We have found that yearling

ram lambs do well with large, aggressive dogs, while bummer lambs are more suitable for small or shy dogs.

3. Supervise early contacts with sheep very carefully. Do not leave the dog unattended for long periods of time until it is clearly adjusted to the situation. Concentrate on building confidence by praising and rewarding desirable behaviour.
4. Ignore (not punish) undesirable behaviour unless it threatens the sheep. Chasing especially must be curbed since it can carry over into adulthood if learned as a puppy. Chewing ears and pulling wool are other traits which cannot be tolerated.
5. Give the dog at least basic obedience training. For the safety of sheep and humans the owner must have control over the dog. Obedience training also provides an opportunity for development of an affectionate dog-human bond. Work with the dog on a regular basis in the pasture with the sheep so that training becomes associated with the pleasure of the owner's company and with sheep.
6. As the dog matures and becomes accustomed to being with sheep, move it to situations which provide progressively more freedoms and opportunities for independent action. Continue to monitor it carefully, encouraging good behaviour and showing displeasure at bad behaviour.

2.6 Behavioural testing of working dogs

2.6.1 The use of behavioural testing

Due to mainly behavioural differences, some working dogs are better suited to their tasks than others (Sinn et al., 2010, Svartberg, 2002), and many different methods are in use in order to test and predict behaviour of working dogs by assessing their overall behaviour through a series of tests (Sinn et al., 2010). The testing of working dogs is useful for several reasons. It can provide a helpful method in selecting which young dogs are suited for future work and to further select dogs during their training. Breeding of working dogs may be carried out on basis of their results in working dog behavioural trials. The testing may also be used as a tool to select which type of work a dog is fitted for (Wilsson and Sundgren, 1997). Behavioural testing of dogs has existed since about 1940, in order to help select the better fitted dogs for work and breeding (Wilsson and Sundgren, 1997). In most studies, many traits are measured in order to give an overall insight in the personality of

the dog, and as such be able to predict its ability to perform certain tasks, but the results regarding the predictability of behaviour these tests provide are not in unison (Sinn et al., 2010).

2.6.2 Methods of behavioural testing and the information they can provide

Behaviour testing is used as a tool to help select dogs for different types of work and in the breeding of dogs. German Shepherd dogs (GSD) and Labrador retrievers tested at the Swedish Dog Training Centre (SDTC), which train and breed service dogs for police, protection, narcotics or as guide dogs, has been investigated to uncover how those results compared to the dog's future as service dogs by Wilsson and Sundgren (1997). These dogs were tested in the age 450 to 600 days old. During the study, they were given the same preconditions by giving them an acclimatisation period of two weeks, have the same daily handler as they had during the test and testing each dog once. 10 characteristics were tested and subjectively evaluated by the test leader. The test situations were;

- approachability and tendency to compete for objects,
- two startling tests,
- reaction to loud noise,
- reaction to a successively approaching threat,
- attack on the handler (only GSD's were tested) and
- reaction to gunfire.

The 10 characteristics tested in these situations were;

- courage, sharpness, defence drive, prey drive, nerve stability, reaction to gunfire,
- temperament or energy level, hardness, ability to cooperate and affability.

The characteristics were scored and an index value was calculated for each dog to be able to evaluate and compare the dogs based on breed, sex, age and type of service dog. The different characteristics did not follow the same scoring interval, e.g. reaction to gunfire was scored 1-3, whereas affability was scored 1-12, and higher scores indicate desirable behaviour. The characteristics were combined into four new characteristics by doing a factor analysis; 1 - courage, nerve stability and hardness, summarised into mental stability, 2 – temperament and ability to cooperate, summarised into cooperation or willingness to please, 3 and 4 – for GSD's and Labrador retrievers respectively, contain only affability. Factor 4 for GSD's, and factor 3 for Labrador retrievers is combined from sharpness,

defence drive and prey drive, or sharpness and defence drive, for GSD's and Labrador retrievers respectively, and called ardour (Wilsson and Sundgren, 1997). Another method of using several behaviours to calculate an overall trait is the use of the shyness-boldness factor (Svartberg, 2002). The shyness-boldness trait can explain the behavioural response over a range of test situations (Saetre et al., 2006). It is considered a major trait that influence behaviour and learning, and it is believed to be a higher order factor that is calculated from scores relating to the behaviours playfulness, chase-proneness, curiosity/fearlessness and sociability (Svartberg, 2002), all of which are traits tested in some working dog assessments and could also possibly be tested by the characteristics and behaviours previously described. It might be more useful to collect the behavioural traits into groups, as this provides a more efficient way to assess the behaviour and personality of a dog and allows for a better prediction of the possibility of the dog being certified or not (Sinn et al., 2010).

The Swiss shepherd breeding club has carried out tests on Swiss shepherds since 1949. In this form of behavioural testing the different tests are being called

approaching the handler, behaviour in friendly situations, reactions to different environmental stimuli, reaction to gunfire, play with a toy, handler defence, self-defence and fighting drive.

The behaviour is evaluated in accordance with eight traits called

self-confidence, nerve stability, reaction to gunfire, temperament, hardness, sharpness, defence drive and fighting drive.

Each trait is scored subjectively and the overall score calculated. The lower the score, the more desired the behaviour is (Ruefenacht et al., 2002).

A study of data originating from testing of GSD's and Belgian shepherds of the Tervuren variety that had been tested in accordance to a standardised behavioural test used by the Swedish Working Dog Association (SWDA) aimed to investigate how the shyness-boldness factor relates to learning performance. Nine subtests scoring 23 behavioural variables to test the personality of the dog, and further on a performance test consisting of four trial types at four levels where the dog was tested for obedience and function were carried out. In this study, every subtest was given a score which was multiplied by a coefficient, and the scores were added to give a trial score (Svartberg, 2002). Some of the tests used are the same as those previously mentioned, but interestingly they are named

somewhat differently and the scoring follows a different standard. For example, in Wilsson and Sundgren (1997) the first subtest is called approachability and tendency to compete for objects, and the dogs reaction to a stranger and its engagement in a game of tug is tested and the nine characteristics are scored. In Svartberg (2002) on the other hand, subtest number one investigates the dogs reaction to a stranger and is called social contact, subtest number two is called play and involves a game of tug. As opposed to the scoring system in the study by Wilsson and Sundgren (1997), Svartberg (2002) scores all subtests from 1 to 5. Yet another method of testing working dogs is the testing scheme in use by the Lackland MWD program. In this program 15 traits in four working domains are tested. In this behavioural testing, as in the previous mentioned ones much of the same test elements can be found, although here the testing is more focused on the qualities needed in a Military working dog. The dogs were judged by one or two expert observers and rated with points from 1-6 on each trait (Sinn et al., 2010).

The study in relation to the shyness-boldness score indicates that the boldness score differs between the breeds and between the sexes, and that the higher performing dogs in general scores higher for boldness. Interestingly, in the high performing dogs no significant difference between neither breed nor sex is evident (Svartberg, 2002). This is supported by Wilsson and Sundgren (1997), which found differences between the males and females both within one breed and between the breeds. Also, Ruefenacht et al. (2002) found significant differences between genders, in addition to differences between age, judges and kennels, and that younger dogs in general seems to be scoring better than older dogs. In contrast to this result, the dogs tested by the Lackland MWD did not display any significant difference between males and females with regards to passing certification, possibly because of the small number of females in the study (Sinn et al., 2010). But the dogs were assessed before starting the training, and those that did not have a satisfactory score were not purchased. It might be speculated that because of previous selection of dogs before purchase, lower performing dogs were actually not included in the testing, and this might be a partial explanation to the fact that no significant differences between sexes were found. Regarding breed differences, there seems to be marked differences, possibly relating to the tasks the breeds were originally bred for. Differences in the mentality of the GSD and the Labrador retriever are evident, with the GSD's generally scoring higher for sharpness and drive and the Labrador retrievers being calmer and more stable dogs (Wilsson and Sundgren, 1997). The shyness-boldness factor is related to learning

performance, hence there is a relationship between personality, which can be tested, and the trainability and performance later in life (Svartberg, 2002), and dogs that are selected for further training to become working dogs achieve better scores in behavioural testing than those that are not (Wilsson and Sundgren, 1997).

To conclude, the testing of behaviour and personality of possible working dogs may be a useful tool for early selection of dogs to train for a task (Svartberg, 2002), although it might be valuable to retest them later in the training, since there is an age difference in the scoring on behavioural tests. When calculating scores of behavioural tests, the characteristics of the breed must be considered, and when doing so the selection of dogs for working dog training can be made simpler and more reliable, in addition to aid in the progeny testing (Wilsson and Sundgren, 1997).

2.6.3 Aspects of carrying out a behavioural test

Many behavioural tests for dogs, aimed at investigating several types of behaviour, exist. There are four requirements that must be fulfilled for a test to be valid. Firstly, only the animal being tested should be a variable. Also, the test must be reliable and the scoring should be sensitive and allow for the tested behaviours to be scored precisely. Lastly, the test should actually measure the intended behaviours which are representative for the traits to be tested. Although behavioural tests are in use in many working dog communities, the terminology which is used in different test may not necessarily correlate entirely, such as different terms being used for basically the same traits. Slightly different test situations might be named the same or differently, while measuring much of the same behaviour, or different behaviours. Some tests investigate several behaviours, whereas others only aim to test a few, and others again combine several behaviours into composite traits. This makes it harder to compare the results of dogs that have been subject to different forms of the tests (Diederich and Giffroy, 2006). The recording of the behavioural response of a dog in a test can also be carried out in different ways. It can be done by simply observing if the behaviour is occurring or not, or it can be ranked on a scale according to the strength of the behavioural response (Sinn et al., 2010). Coding is an objective manner to measure the behavioural response, noting frequency or duration of a discrete behaviour, whereas rating is conducted by grading the dog according to the intensity of a behaviour (Diederich and Giffroy, 2006, Wilsson and Sinn, 2012). The rating method can be further divided into behavioural ratings and subjective ratings (Wilsson and Sinn, 2012). These methods are further described in Wilsson and Sinn (2012). Rating scores are useful for rating specific

behaviour or the degree of which a broader behaviour is exhibited but they usually involve more interference by the observer than other types of scoring. Rating methods can be less time consuming and therefore may be preferred if the time is limited (McGarrity et al., 2016). If the behaviours are to be recorded subjectively it is necessary to describe the behaviours and their intensities as exactly as possible (Diederich and Giffroy, 2006). As with the testing, there is no standard regarding the values of scoring. In some behavioural tests the preferred behaviour scores higher, whereas in others it scores lower, and also, the range of scoring varies. The results in behavioural testing with the rating methods and the coding method often correlate but they have different predictive validity (Wilsson and Sinn, 2012), although both of the methods have a high predictive value (McGarrity et al., 2016). The two different rating methods does not have significantly different predictive value, and which method to use is mainly a matter of choice. However, to measure specific traits it may be beneficial to use the behavioural rating method, whereas broader behaviours can effectively be measured by the subjective ratings (Wilsson and Sinn, 2012). There would be several advantages of developing a standardised method where terminology, methods and scoring to test dog behaviour follow the same guidelines but at this point no such method exists (Diederich and Giffroy, 2006). Still, research is needed to investigate if the different methods are equal in all behavioural test settings, and if they for example are able to measure the same aspects of a given behaviour (McGarrity et al., 2016). It might also be necessary for the test results to be interpreted differently depending on the type of work the dog is intended for (Wilsson and Sundgren, 1997).

2.7 The ability of Komondors to protect livestock

A few studies have been carried out specifically to investigate how effective Komondors are at protecting livestock. One study on Komondors and their ability to protect sheep from coyotes had a three-month long training phase where they trained basic obedience, being together with sheep, showing aggressiveness towards coyotes and to stay within a fenced pasture. The field study lasted for four months and took place on three ranches. Two Komondors were placed together on each pasture, and the number of sheep killed by coyotes was recorded for a 20 day period before dogs were put with the sheep, 20 days during the presence of the dog and 20 days after removal of the dogs (Linhart et al., 1979). Another study by McGrew and Blakesley (1982) was conducted as field trials over three years, starting in 1980 in the United states, to investigate the effectiveness of using Komondor dogs as sheep flock guardians against predation by coyotes. Nine Komondors at

the age of 26 months were investigated, in two 65 hectares enclosures. Around 25 lambs were in each enclosure, and in addition to these, one coyote was released into each enclosure. Each trial consisted of two phases, an introductory phase and a performance phase. In the seven days long introductory phase the dog was introduced to the flock of sheep, and they were allowed to grow accustomed to one another in a pen in the enclosure. Then followed a 14-day long performance period, where the dog and the sheep had access to the whole enclosure (McGrew and Blakesley, 1982). This period might be somewhat short, as the Komondor may need up to 15 days to settle at the territory they are to guard, and it also takes some time for the sheep to become accustomed to the presence of the dogs (Linhart et al., 1979). The enclosures were only visited by people to ensure there was sufficient food and water, and to remove sheep carcasses, otherwise no intervention occurred (McGrew and Blakesley, 1982).

The results from the studies showed that the Komondors are indeed capable of protecting the livestock they are set to guard, although the results were somewhat mixed. It was observed that the Komondors patrolled, barked and scent marked around the sheep, without any of these behaviours permanently keeping the coyotes away. It was also observed that the dogs actively defended the sheep flocks by standing between the coyote and the sheep, or chasing the coyote away, and that sheep were staying with or running to the dog in case of coyote interactions (McGrew and Blakesley, 1982). On the contrary, Linhart et al. (1979) could not observe the dogs following the sheep on the pasture during the day, something that is actually how the breed is described (“Federation Cynologique Internationale”, 2000), nor could they observe the dogs actively defend the sheep from coyote attacks.

In an artificial setting the dogs, the sheep and the coyotes adapt their behavior to one another. Coyotes adapt to the presence of the dog, and choose to kill sheep when these are not close to the dog, whereas the sheep adapt to the presence of the dog by seeking out its company for protection. The Komondors react differently to coyote attacks. Some are markedly affected by interactions with coyotes and will stay away after an encounter, whereas other dogs chase the coyotes on every occasion without seeming negatively affected. In general, the Komondors do not chase the coyote for a long distance, something that is probably a breed characteristic. The dogs did improve their guarding abilities during the trials (McGrew and Blakesley, 1982), and it can be speculated if this was due to having spent more time at their territory, becoming more accustomed to the

sheep, or just the dogs becoming more mature. It is probably better to raise the dogs at the farm where they are to be used, and to start training and accustomisation to livestock from an early age (Linhart et al., 1979). In addition, an artificial setting with the sheep, Komondors and coyotes together in an enclosure may affect the quality of the results of a study (McGrew and Blakesley, 1982). In general, the Komondor does not chase or harass the livestock they are to protect (McGrew and Blakesley, 1982, Rigg, 2001) but they have been observed to chase, harass and kill sheep. In order to avoid such behavior early socialization with livestock and training is of importance (Linhart et al., 1979).

3 Discussion

3.1 Why carry out a testing of working behaviour in the Komondor?

In many breeds of dog there is a division into show lines and working lines, and a tendency for difference between dogs bred for show and dogs bred for work in the livestock protection types of dogs can also be observed, for example show bred dogs being smaller than working bred (Rigg, 2001). Studies have shown that in some breeds the intra-breed differences are more pronounced than inter-breed differences, and many of these differences can be explained by the recent change in the utilization of dogs. The shift of focus towards companion animal and showing of dogs has led to a breeding practice paying more attention to looks and conformation of the dog rather than the working behaviour the breed was intentionally bred for, and accordingly some of the behaviour that was part of the characteristics of the breed is lost, in addition to a change in the appearance of the dogs. The later change in use of LPD's, aimed more at showing or companionship, has led to the selection for other traits than those which are important in a working LPD (Rigg, 2001). As described previously some studies have been carried out to test the ability of LPD's to protect livestock from predators, mainly comparing different breeds of LPD's. There are few available English publications specifically describing the working ability of the Komondor. With the recent desire to utilize LPD's for the management of predators it would be interesting to investigate not only the Komondors ability to protect livestock but also if the breed has had a division into clear show and working lines such as in other breeds, and if it has, if any differences in working ability developed.

3.2 Acquiring dogs

When aiming to set up a study to investigate the working ability in the Komondor dog, several considerations will have to be made in order to collect reliable and useful information and produce a valuable study. Behavioral testing of working dogs can be executed in a variation of manners and it might be useful to base a study on Komondors on already existing studies. A minimum of aspects to consider would be the characteristics of the dogs to be tested, how to test the behavior and how the study should be carried out practically.

It has been pointed out that there is an age range in which the LPD's should be socialized with sheep or other livestock they are intended to protect, as it would be harder to acclimatize them to the livestock later in life. Therefore, it would be beneficial to acquire Komondor dogs for study purposes at an age younger than 16 weeks, and preferably at

eight weeks of age, as this is believed to be the optimal age for starting the socialization with the livestock. Since the main aim of a study would be to identify the possible differences in working ability between show bred and working bred Komondors, it would be necessary to acquire dogs for the study from breeders of Komondors for both of those purposes, or at least be able to verify by pedigree that the dogs are from a line bred for those particular purposes for some generations. If obtaining older dogs, it would be advisable to at least provide equal living conditions and testing methods for all the dogs. In this case, it would also be of importance to obtain information about their past, such as living conditions, if they have previously been used for any type of work, if they have been trained, if they have had any socialization with sheep or other livestock and also their pedigree.

3.3 Training

If choosing to acquire dogs from both show and working lines as puppies, it will be crucial that all dogs are raised and tested under the same conditions, to obtain feasible results and avoid bias. It will also have to be decided if the dogs will receive training prior to testing or if the study shall focus on the instinctive behaviors of the breed. If choosing to train the dogs the type of training must be considered, and all dogs should receive equal training under the same conditions. The training should be based on positive reinforcement methods, as the use of heavy handed method will cause the Komondor to become hard to work with. For example, the methods for training a Komondor mentioned in Rigg (2001) could be considered a basis for training and adjusted to a fit in a study setting. If choosing to train the dogs it might be worth paying attention to the study by Demant et al. (2011), which shows that training in short sessions 1-2 times a week provides the optimal set up of a training regime.

3.4 Testing the behavior and personality

There are several methods in place for testing the behavior and temperament of working dogs. Many of these tests have been developed in order to test the suitability of dogs to work in the military and police and the traits to be tested are based on the future work to be carried out by these dogs. The studies that have been carried out on LPD's are of a more limited character, and often carried out through questioning farmers/owners about their experiences with the use of LPD's. Several of the previously mentioned studies points out the limitations of this type of study. A few studies have been carried out on the Komondor specifically. To carry out a study on the working ability in show bred and working bred

Komondor dogs, it would be valuable to set up a study which takes into consideration the type of work the breed is originally bred for, in addition to aiming to standardize it to the greatest extent possible. One approach to setting up a test could be to base it on the already developed working dog trials but accommodate it to the testing of Komondors on the basis of the previously mentioned studies of LPD's, and Komondor specifically. An on-site testing of young dogs could be performed, and as the dogs mature, further study of behavior could be carried out with the dogs as guardians on pasture. The previously described traits trustworthiness, attentiveness and protectiveness are pointed out as being important traits for a LPD, and therefore it would likely be useful to break down these traits into behaviors which can be tested, much like traits are broken down into components to be tested in the behavioral assessment of other working dogs. The traits trustworthy, attentive and protective are well described by Lorenz and Coppinger (Rigg, 2001), and it should be possible to use these descriptions as a basis for the breakdown into components. If possible the traits should be broken down into sub tests which can be graded objectively but it might be necessary to also consider a subjective approach to the grading of behavior. One option could be to carry out the first testing upon acquirement of the dogs, and as such this would be a test for instinctual behavior, then all dogs would receive the same training over a period and being retested periodically. Since the Komondor is known to mature slow it would most likely be advisable to retest the dogs more times over several years.

Trustworthy. The trait trustworthiness is based on predatory behavior. The Komondor should not be showing any predatory behavior towards the sheep but should rather be investigatory and submissive. Testing the trustworthiness of the dogs would be an important issue to evaluate, since a LPD which show predatory behavior towards the animals it is supposed to protect would be useless. This could be tested using the already described test methods assessing predatory behavior in working dog trials, or it could be tested with sheep directly. Maybe even a combination could be developed, utilizing the somewhat already developed test methods from working dog trials as a starting point, then moving on to test methods developed specifically to assess LPD's as the testing of the dogs proceeds.

Attentive. Based on the description, the assessment of the attentiveness trait can also be broken down into at least two different sub tests. When the dogs are young it could be recorded simply as the dog's desire to contact and stay close to the sheep. As the dogs

mature and can be left with the sheep it could possibly be recorded how much time they spend with the sheep on pasture, how far away from the sheep the dog wanders and if they follow the sheep everywhere or prefer to stay in certain areas. One possibility of collecting data about time spent with sheep is to have someone record the movements manually, either all the time or at certain times a day. Another possibility could be to fit the dogs and sheep with GPS trackers, to continuously record their whereabouts, like has done in studies of other LPD's (van Bommel and Johnson, 2014). This would probably provide more reliable data which could easily be transformed into statistical data. Furthermore, the reaction to a stranger approaching the flock of livestock could be tested. Also in this case, it could be recorded manually based on a scale of possible behaviors and scoring according to the reaction of the dog, or the use of GPS trackers could be implemented.

Protective. Since the protective behavior is believed to come about as a combination of trustworthiness and attentiveness it could be interesting to calculate the expected protectiveness from the results of the two other traits. But the protectiveness of the dogs should most likely also be tested directly. This could probably be carried out by developing tests based on the “ghost tests” in working dog trials. The behavior of the dogs could for example be recorded as how long it takes for the dog to engage with the threat, how close to the threat the dog moves, for how long the dog interacts with the threat, what distance will the dog follow the threat, and if the dog will retreat to the livestock after engaging with the threat. In one of the studies described previously, the use of live coyotes in an enclosure with the dogs and sheep was practiced. A similar method of testing the protective behavior would probably not be advised, since a number of animal welfare and ethical questions could be raised. It would probably be best to use artificial threats to start with, and maybe the tests could be further developed by using other dogs of non-herding breeds as threats under controlled conditions, in order to avoid physical damage to any of the animals involved in the study.

In addition to testing these traits which are of importance in LPD's, it could be beneficial to incorporate some of the traits which have been described for other types of working dogs. For example, some of the studies on LPD's have concluded that the Komondor is a rather aggressive breed, so it would likely be wise to test for aggressiveness, a trait which is incorporated into working dog trials. Further, it would be interesting to divide the aggressiveness trait into aggressive behavior towards livestock, predators or human, since aggressiveness towards sheep and human is not desirable, whereas some extent of

aggressiveness towards predators is necessary for the dog to perform its task as a LPD. The shyness-boldness factor is believed to be a major trait consisting of the behaviors playfulness, chase-proneness, curiosity/fearlessness and sociability. These are all behaviors which could quite possibly influence the three traits trustworthiness, attentiveness and protectiveness which are desired in a LPD, hence basing some of the behavioral tests on these might be useful in order to obtain an overall view of the working ability and personality in the Komondor.

After deciding which traits and behaviors to test for, it must be determined how the scoring will be carried out. As described earlier it may be difficult to carry out a scoring which gives a reliable assessment of the dog. It might be a possibility to choose one of the scoring systems used in working dog trials and adapt it to the study of Komondor behavior. Quite possibly, it could be beneficial to incorporate both objective and subjective scoring of the dogs, i.e. coding and rating, depending on the complexity of the behaviors to be tested. A decision also should be made about the way of scoring. Is the scoring solely going to relate to the behavior the dog shows or should the behaviors be classified as desirable and non-desirable behaviors? Should the scoring be done by coding, rating or both? Should desirable behavior result in a higher or lower score and vice versa?

3.5 Practical aspects of testing

It will have to be decided whether the dogs shall be kept on the test site and handled only by people involved in the study, or if they should be placed with farmers, such as has been done in some of the previously mentioned studies on LPD's. Keeping the dogs on site would undoubtedly provide the most controllable environment and help to ensure all dogs being raised, trained and tested in equal conditions. If a larger number of dogs are to be tested, keeping them on site may not be feasible. If allocating the dogs to farmers or other people it must be ensured that the conditions are as similar as possible, and to give clear instructions to the people involved what is expected of them and what activities they are and are not supposed to engage in with the dogs. Providing a clear plan regarding aspects of housing, training, socialization and other aspects of the dog's life, in addition to requiring a sort of diary regarding the dog may provide a minimum of control if keeping the dogs off site.

Furthermore, it will have to be decided if the only distinction of dogs made will be into show bred or working bred lines, or if other aspects such as male/female, neutered/non-neutered, trained/not trained or differences between litter mates should be taken into

consideration when conducting the study. The more aspects that are controlled and investigated, the more reliable the study will be.

4 Conclusion

The dog as a species has lived in close contact with humans for many thousand years and has been and still is utilized for several different tasks such as herding, protection, hunting and companionship among others. Hundreds of breeds of dogs exist today, with vast morphological and behavioral differences. Many people choose their dogs because of the way they look, and keep the dogs as companions or for showing. Working dogs are chosen on basis of their performance in the working tasks they are chosen to participate in, whereas companion or show dogs are largely selected for breeding based on their conformation and morphology. It is likely that in the beginning of the relationship between dogs and human, the dogs were selected based on their ability to perform a certain task, and slowly the development of types more or less specialized for a type of work followed. The types eventually evolved into different breeds with highly specialized skills due to artificial selection. In the 19th century kennel clubs were formed and breeds were standardized. As the use of working dogs has declined over the last centuries there has been a shift of focus with regards to dog breeding. As utilizing dogs for showing has become more popular, the selection of breeding animals has become more focused on the conformation and fitting into the breed standard rather than selecting the breeding animal based on their suitability to perform the work they were originally bred for. In several breeds, it has been reasonable to divide the dogs into show lines and working lines due to their differences. Studies have discovered that the differences between show bred and working bred dogs within a breed are in fact larger than the differences between either show bred or working bred dogs of different breeds in some cases.

In order to score and select working dogs for future work and for breeding, behavioral tests are carried out to assess the wanted working ability and personality in relation to the job the dog is meant to do. Several methods for assessing the behavior of working dogs exist. Although the existing methods of testing the behavior of dogs have many similarities, no single standardized method is available for all behavioral testing. In the various working dog assessments, similar behaviors are given different names, the same terminology are used on different behaviors, the tests are carried out in slightly different manners and are scored either by coding or rating and the scores are given according to different scales. The testing of LPD's has not been carried out to such a degree as testing of other working dogs and many of the available studies are based on the opinion of the person keeping the dog, with questionnaires being a main tool of collecting information

about the behavior. A few studies have aimed to specifically investigate how LPD's behave in a working setting in a controlled environment.

The Komondor is a Hungarian livestock protection dog breed which has developed from dogs brought to what is today Hungary by nomadic people. It is a large, stubborn and intelligent breed which is rather reluctant to change in its environment. The breed is rather rare outside of Hungary and there was a genetic bottleneck event in the breed during the second world war. In addition, the use of LPD's has been low in recent decades. All of these features could have possibly affected the selection of breeding animals and thus the behavior of the Komondor breed. Therefore, it would be interesting to study the possibility of there being differences in the working behavior in lines bred for show and for working in the Komondor breed.

Several considerations should be made before assessing the behavior of Komondors. By setting up a valid study, where aspects from both working dog trials and studies of LPD's are incorporated into reliable and measurable behavioral tests in order to not only be able to test the actual behavior of the Komondor with regards to guarding livestock but also to compare the working ability of working bred and show bred dog, it should be possible to investigate if the Komondor breed, like other dog breeds, show a distinction into show lines and working lines. When choosing and describing the behaviors and traits to be tested in the Komondor dogs it should be an aim to as far as possible use already described behaviors from working dog trials, in addition to the behaviors which are specifically needed in a LPD. It should also be carefully described what each tested trait is considered to consist of, how the behavior is tested and how the scoring is carried out, in order to avoid confusion. The study could be carried out by conducting the tests at several occasions, preferably starting with dogs at a young age, since the socialization with livestock early on is important for the bonding and hence the future desire to protect the livestock. There is also reason to believe young dogs do better in behavioral tests, which further reinforce the usefulness of testing at different ages. In relation to studies carried out on other breeds of dogs, which show a significant difference in the behavior between show bred and working bred dogs, it would be interesting to investigate if this division has also happened in the Komondor, or if lines bred for conformation and for performance are still exhibiting the same level of the behaviors that can be contributed to the work they were originally bred for.

5 Abstract

How performance testing of working dogs can be adapted to evaluate working ability in Komondor dogs

The dog was the first animal to be domesticated, from a wolf ancestor some 15000 to 30-40000 years ago, and has during the process of breed development gone through several genetic bottlenecks. During the process of domestication individuals would be utilized for different forms of work according to their behaviour and ability to perform certain tasks, and this formed the basis for future development into breed types which were adapted to different types of work. The breed types were further developed into breeds when human would interfere and breed dogs with similar behavioural traits, in order to enhance the desired behaviour. Several hundreds of dog breeds have been recognised by the kennel clubs today, and they have been divided into groups based on the work they were originally bred to perform. In recent times, there has been a shift of focus towards selecting breeding stocks on basis of the dogs conformation rather than their working ability. In many breeds, the change of focus has led to a differentiation into working lines and show lines, with quite different temperament and ability to perform working tasks. The livestock protection dogs belongs to the group of pastoral dogs, and have originally been used to protect livestock on pasture. The Komondor is a Hungarian breed which is considered to belong in this group, and has been used for protecting livestock since the 13th century. This breed has also gone through genetic bottlenecks and it would be of interest to investigate if there are differences in the working ability of working bred and show bred Komondor dogs.

Several tests exist to assess behavioral traits in dogs, many which have been developed to predict future performance of working dogs. These tests, in addition to traits described specifically for the livestock protection dogs and previous studies carried out on livestock protection dogs, should form a basis for the development of tests aimed at testing the working behavior in Komondor dogs. When performing a study on the behavior of the Komondor, it should be of importance to adapt the testing situation to assess the behavior which is necessary for a livestock protection dog to possess. By combining the use of already existing methods of testing behavior in working dogs, and developing tests to specifically assess the traits of importance for a livestock protection dog, the suitability of Komondor dogs to perform their task could be investigated. By using these methods to perform a study of the behavior in Komondors with known pedigree it should be possible to assess whether the recent focus on breeding for conformation has affected the working ability in Komondor dogs bred for work and for show.

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