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Faecal cortisol metabolites as indicators of stress during training and search missions in avalanche dogs

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Summary

Avalanche dogs are specially trained to use their sensitive sense of smell to find buried people in avalanches. Emotional and physical stress factors before and during a search, as well as nervousness felt by the dog handler, negatively influence the efficiency of search dogs. To improve the performance of avalanche dogs and to enable the dogs to operate over longer time periods, a better understanding of the physiological consequences of possible arousal, disturbance and stress occurring during a search mission are needed.

In this study faecal glucocorticoid metabolites were analysed. Faecal samples from privately owned avalanche dogs (n = 11) of different breed and age before, during and after 2 separate training camps, each 1 week in length, were collected and the results combined. An enzyme-immunoassay to analyse faecal cortisol metabolites was used to evaluate the stress response during training and search. Compared to baseline concentrations (measured during the weeks before and after the training camp, when dogs were at home), cortisol metabolites increased when dogs were in the training camp. The type of activity in the training camp influenced stress hormone levels significantly (Friedman test, $p < 0.001$). In descending order, helicopter flights, actual training and the days of arrival/departure caused levels to rise, but there was no significant difference between basal cortisol metabolite concentrations and resting days in the camp. In a real emergency, an experienced dog did show a 2.5 times increase in cortisol metabolite concentration, but 12 h later levels had returned to normal.

Age, temperament in terms of being prone to stress, as well as previous experience with training camps were considered to be important factors influencing cortisol metabolite concentrations. Basal hormone levels were significantly and positively correlated with a temperament more prone to stress ($r = 0.817$, $p = 0.002$). The number of previously attended training courses affected mean cortisol metabolite concentrations during training, but the observed negative correlation was statistically not significant. A questionnaire was used to investigate whether the dog handlers could realistically estimate the arousal and amount of stress the dogs were exposed to. However, no correlation was found between faecal cortisol metabolites and the estimated stress, indicating that handlers overestimated the amount of stress for the dogs most of the time.

In summary results of this study indicate that experience and training are the primary factors in reducing stress during search missions in avalanche dogs.

Schlüsselwörter: Lawinenhunde, Stress, Training, Sucheinsatz, Persönlichkeit, Kortisol.

Zusammenfassung

Kortisolmetaboliten im Kot von Lawinenhunden als Indikatoren für Stress während Training und Sucheinsatz

Lawinenhunde werden speziell ausgebildet, um Personen unter Lawinen zu lokalisieren. Sie schaffen das mit ihrem ausgeprägten Geruchssinn. Die Belastung vor und während der Suche sowie ein nervöser, menschlicher Partner können die Suche negativ beeinflussen. Um den Einsatz zu optimieren ist es nötig, dass die Hundeführer die verschiedenen Faktoren verstehen, die die Hunde während der Suche belasten. Mit diesem Wissen wird es für die Hundeführer möglich, die Suchbelastung der Hunde zu reduzieren, beziehungsweise die Suchdauer zu verlängern.

Für die Untersuchung wurden von in Privathaushalten lebenden Lawinenhunden (n=11) Kotproben eine Woche vor, während und eine Woche nach einem Trainingskurs gesammelt. Die Ergebnisse von 2 Trainingskursen in aufeinanderfolgenden Jahren wurden miteinander kombiniert. Mit Hilfe eines Enzym-Immunoassays wurden Kortisolmetaboliten aus dem Kot analysiert, um den Stress der Lawinenhunde während des Trainings und eines Sucheinsatzes zu quantifizieren. Die Konzentration der Kortisolmetaboliten war während des Trainings im Vergleich zu den Werten von zuhause deutlich erhöht. Die Art der Belastung beeinflusste die Konzentration der Kortisolmetaboliten signifikant (Friedman Test, $p < 0,001$). Am höchsten war die Konzentration an Tagen mit Hubschrauberflug, gefolgt von Trainingstagen, beziehungsweise An- und Abreise. Es gab allerdings keinen signifikanten Unterschied zwischen dem Basiswert der Kortisolmetaboliten zuhause und den Werten während des Ruhetags im Trainingslager. Während eines Echteinsatzes zeigte ein erfahrener Lawinenhund eine ca. 2,5-fach erhöhte Konzentration der Kortisolmetaboliten im Kot, nach 12 Stunden war der Basiswert allerdings wieder erreicht.

Alter, Temperament ausgedrückt als Stressanfälligkeit der Hunde, sowie Erfahrung in Form der Anzahl bereits absolvierter Trainingskurse zeigten einen deutlichen Einfluss auf die Konzentration der Kortisolmetaboliten. Es bestand ein signifikanter Zusammenhang zwischen dem Basalwert und der Stressanfälligkeit der Hunde ($r = 0,817$, $p = 0,002$). Die Anzahl bereits absolvierter Trainingskurse beeinflusste die mittlere Konzentration der Kortisolmetaboliten während des Trainings. Die festgestellte negative Korrelation zeigt einen deutlichen Trend, war allerdings statistisch nicht signifikant. Mit Hilfe eines Fragebogens wurde untersucht, ob die Hundeführer die Stressbelastung der Hunde realistisch einschätzen können. Es konnte allerdings kein signifikanter Zusammenhang zwischen der

Konzentration der Kortisolmetaboliten im Kot der Lawinenhunde und der durch die Hundeführer geschätzten Stressbelastung festgestellt werden. Dabei zeichnete sich ab, dass die Hundeführer die Belastung meist überschätzten.

Zusammenfassend zeigen die Ergebnisse, dass Erfahrung und Training die wichtigsten Faktoren für das Ausmaß der Stressbelastung von Lawinenhunden im Einsatz sind. Mit entsprechendem Training kann diese Belastung reduziert und somit der Sucheinsatz der Hunde entsprechend optimiert werden.

Introduction

Avalanche dogs are specially trained to find people buried in avalanches. At present there are still no technical devices that can replace avalanche dogs to locate and rescue people buried in avalanches. The dogs use their sensitive sense of smell which man exploits not only to rescue people but also to locate explosives, drugs or weapons (ALMEY and NICKLIN, 1996). The ideal search dog has a pronounced sense of smell, loves to work, is healthy, agile, shows a consistency of behaviour from day to day and has the ability to learn from being rewarded. But reality shows a quite different picture, health and excitability differ between the perfect and the actual search dog (ROONEY et al., 2004); these 2 factors can be influenced or caused by stress.

Emotional and physical stress during the search together with the nervousness of the dog handler, are all part of the work of avalanche dogs. Avalanche dogs which live at the bottom of a valley are transported quickly to higher elevations, where they search in periods of 15 to 30 min, to find buried persons. The dogs are transported under spatial restrictions, mainly by means of noisy helicopters or snowmobiles. During a search mission avalanche dogs are always confronted with new and stressful situations, i.e. unknown persons, search in unknown terrain, etc. As a consequence heart rate and body temperature increase (KÖHLER, 2004) resulting in prolonged search times and reduced efficiency to locate persons (GRANDJEAN et al., 1998). Similar results have been described for dogs detecting explosives; sniffer dogs showed a reduced level of efficiency after strenuous physical activity (GAZIT and TERKEL, 2003).

There is no standard definition of stress (HOFER and EAST, 1998), and stress in its broadest sense can be defined as the biological response elicited when an individual perceives a threat to its homeostasis (MOBERG, 2000). A physical stressor is an external challenge to homeostasis. A psychosocial stressor is the anticipation, justified or not, that a challenge to homeostasis looms. Both types of stressor activate an array of endocrine and neural adaptations (MOBERG, 2000; SAPOLSKY, 2005). Stress can be quantified by behavioural or physiological reactions. For dogs, however, it is hard to quantify stress according to behavioural patterns because only minimal and hardly visible changes in posture occur (BEERDA et al., 1998).

Stress is not inherently negative and can actually have a positive effect by making energy available at critical moments (MOBERG, 2000). One consideration to estimate whether the stress response is mild or severe, is the actual degree of elevation of glucocorticoids. Also, the duration of the stress must be taken into account, as distinctions need to be made between mild (in terms of arousal or disturbance), acute or chronic stress and responses to each. The biggest distinction between stress and distress is considered to be the biological cost of the stress to the animal. In mammals experiencing mild stress or stress of a relatively short duration, only reserve biological resources, which can be readily replenished without a significant recovery period, may be necessary to cope with the stress (MOBERG, 2000; KEAY et al., 2006).

One of the main mediators of the stress response is the hypothalamic-pituitary-adrenal axis regulating the release of glucocorticoids (TOUMA and PALME, 2005). Cortisol levels in blood, faeces or urine are considered good indices of stress in vertebrates. Measuring cortisol metabolite concentration in faeces is a non-invasive method where samples are easy to obtain. With this method not only acute arousal, disturbance or stress, but also longer lasting and chronic stress can be investigated, as has already been shown in several animal species (WASSER et al., 2000; MÖSTL and PALME, 2002; TOUMA and PALME, 2005; PALME et al., 2005; KEAY et al., 2006). A number of authors have analysed faecal glucocorticoid metabolites in an array of carnivore species like the wolf, african wild dogs, spotted hyenas, numerous cat and bear species using different types of corticoid assays (CREEL et al., 1997; MONFORT et al., 1998; GOYMANN et al., 1999; TERIO et al., 1999; WIELEBNOWSKI et al., 2002; HUNT and WASSER, 2003; SANDS and CREEL, 2004; YOUNG et al., 2004). The assay for measuring faecal glucocorticoid metabolites used in this study has been validated for its use in dogs in a study by SCHATZ and PALME (2001).

To optimise the performance of avalanche dogs, handlers need to understand the stress in terms of arousal or disturbance factors their dogs are exposed to. In this study we evaluated to what extent avalanche dogs are “stressed“ during training and during a real search mission by measuring faecal cortisol metabolite concentrations. We also investigated whether handlers were able to realistically estimate the stress their dogs were exposed to. In general, our results provide important data that can help to optimise search missions using rescue dogs by training them to get used to the arousal caused by spatial restrictions or unknown situations.

Material and methods

Dogs, training programme and collection of samples

Faecal samples were collected from privately owned

Tab. 1: Individual characteristics of dogs investigated; * number of previously attended training courses; ** years when samples for this study were collected

Name	Sex	Birth	Breed	Courses*	Samples**
Aaron	male	12.8.1999	mixed breed	3	2002
Aiko	male	12.9.2001	Golden Retriever	1	2002
Baggy	female	11.9.1995	German Shepherd	6/7	2001/2002
County	male	21.3.1999	White Shepherd	2	2002
Eilif	male	17.12.1998	mixed breed	3	2002
Fee	female	29.3.1999	Malinois	1	2002
Fenja	female	17.5.1996	German Shepherd	5/6	2001/2002
Fly	female	4.6.1998	mixed breed	3/4	2001/2002
Sam	male	21.7.1991	Border Collie	7	2001
Spot	male	10.1.1996	Border Collie	5/6	2001/2002
Tasso	male	9.9.1999	mixed breed	2	2001

avalanche dogs (n = 11) and analysed for faecal cortisol metabolite concentrations. The individual characteristics (breed, sex, age) of the dogs investigated in this study and the number of previously attended training courses are listed in Tab. 1. Faecal samples were collected during morning and evening walks, and were frozen within 30 minutes after collection. Samples were collected for 1 week before, during and 1 week after a training course. Samples collected in the weeks before and after the training, when dogs were at their private homes, were used to calculate the baseline concentrations of faecal cortisol metabolites.

Results from 2 one-week training courses carried out in January 2001 and January 2002 were combined; both training courses were conducted by the same trainers and were similar in content. Data of dogs participating in both years were handled separately. The training camp was situated in the Federal Province of Salzburg in the Austrian Alps at 1,200 m above sea level. To describe activities during the week's training, we distinguished between days of arrival, days of departure, days with search training, days with helicopter flight, and resting days (days without work for the dogs).

The assay for the measurement of faecal glucocorticoid metabolites used in this study has been validated for its use in dogs by SCHATZ and PALME (2001). The authors investigated the metabolism and excretion of glucocorticoids in dogs via the application of radioactive cortisol and by analysing its faecal metabolites. Different assays tested by the authors identified a cortisol enzyme-immunoassay using an antibody against cortisol-3-CMO:BSA as being suitable for the measurement of faecal cortisol metabolites. Assay validation by SCHATZ and PALME (2001) also included the application of ACTH and dexamethasone to respectively boost and suppress endogenous cortisol production. Samples analysed in our study followed the protocols described by SCHATZ and PALME (2001). Faeces (0.5 g) were extracted with methanol and analysed in the cortisol enzyme-immunoassay mentioned above.

Questionnaire

At the end of each day during the training week, each handler was asked to estimate the overall demand of the day for himself and for its dog, respectively. We used a 10 cm long bar and handlers were asked to mark the bar with a dot to estimate the actual demand of the day.

The left end of the bar signified 0 % and the right end indicated 100 % demand. For analysis the length between the left end and the dot given was used.

At the end of the training week, 5 trainers knowing all dogs were asked to rank the dogs according to their ability to handle new situations. Dogs were classified as "stress-prone" or "non-stress-prone" according to the widely-used method described by VINCENT and MICHELL (1996). The handlers ranked the dogs as being hectic and stressed, or as being confident, cool and calm when confronted with new or unknown situations during a search. Our classification of the stress-proneness corresponds to and summarises the temperament categories: reactivity/excitability vs. stability and fearfulness vs. courage/confidence used in the review by JONES and GOSLING (2005). In addition, our classification is comparable to the shyness-boldness axis described by SVARTBERG (2002).

Statistical analysis

Immunoreactive cortisol levels in a dog's faeces increase 12 to 24 h after a stressful situation (SCHATZ and PALME, 2001). Therefore, to characterise the cortisol metabolite concentrations of the day, we calculated the mean from results of the evening and the following morning. This value was used to compare individual differences of the investigated dogs.

Because values were not normally distributed, we only used non-parametric tests. To analyse differences between the 2 study years and individual differences in faecal cortisol metabolite concentrations, the Kruskal-Wallis test was used. For this analysis data were divided between home and training. In order to test the influence of sex, age and the number of training courses attended, only mean values of different individuals were used and tested with the Kruskal-Wallis test and the Spearman rank-correlation test. The relation between the rank in handling novice situations and the mean basal value of faecal cortisol metabolite concentrations were tested using the Spearman rank-correlation.

In order to compare differences between individuals, the percentage rate of the concentration of cortisol metabolites in relation to a baseline concentration (100 %) was calculated. For this calculation the mean cortisol metabolite concentration of each dog at home was set as the 100 %, and the increase during training was then calculated as a percentage and used for further comparison. The increase in

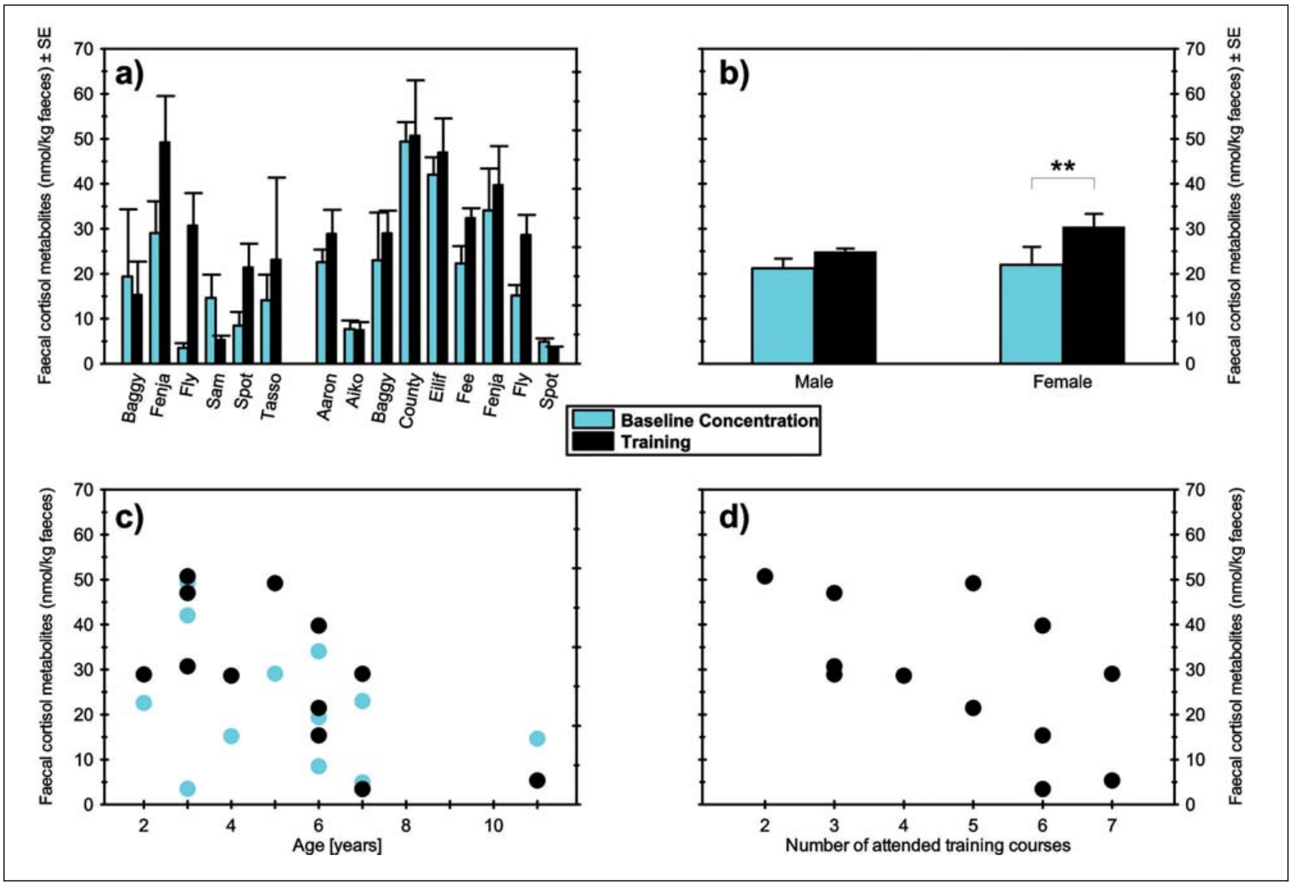

Fig. 1: Parameters influencing mean cortisol metabolite concentrations in the faeces of avalanche dogs

a) Baseline and training cortisol metabolite concentrations differed significantly between individual dogs (Kruskal-Wallis test; home $p < 0.001$; training $p < 0.001$), and were significantly elevated during training. Data from the study years 2001 and 2002 are shown on the left and right side of Fig. 1a, respectively.

b) Sex had a significant influenc on training (Kruskal-Wallis test, $p = 0.008$) but not baseline concentrations (Kruskal-Wallis test, $p = 0.568$).

c) Age had a significant influence on training values ($r = -0.766$; $p = 0.027$).

d) Experience (number of previously attended training courses) indicated a trend for a negative correlation with faecal cortisol metabolites ($r = -0.461$; $p = 0.097$).

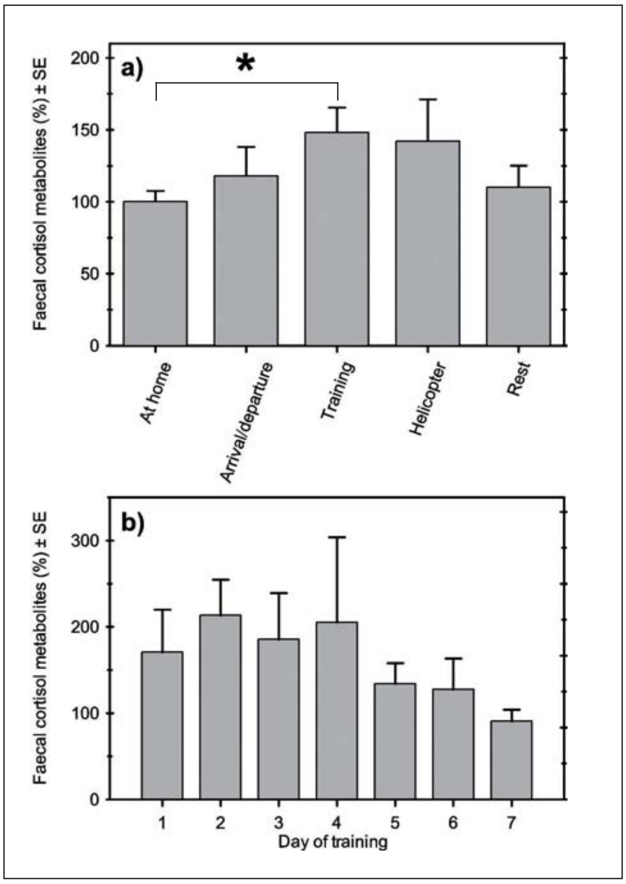

Fig. 2: Influence of activity and day of the training week on the percentage rate of faecal cortisol metabolites.

a) Variation according to activity (Friedman test, $p < 0.001$); the * indicates a significant difference in the Dunn's test.

b) Mean levels during the days of training; differences between days were not significant (Dunn's test).

the percentage was compared with repeated measurements using the Friedman test and the Dunn's posthoc test. The demand per day, as indicated on the 10 cm bar, was compared to the daily cortisol metabolite percentage rate of individual dogs and tested using the Spearman rank-correlation.

Results

Individual differences

No significant difference was found between the 2 training weeks conducted in 2001 and 2002 (baseline concentration, Kruskal-Wallis test, $p = 0.191$; training, Kruskal-Wallis test, $p = 0.102$). Therefore, for further analysis, the data of the 2 study years were combined. There were clear individual differences in faecal cortisol metabolite concentrations between the different dogs at home (baseline concentration, Kruskal-Wallis test, $p < 0.001$) and during the training week (Kruskal-Wallis test, $p < 0.001$) (Fig. 1a). In addition, the mean baseline cortisol metabolite concentrations correlated significantly with mean levels during training ($r = 0.693$; $p = 0.004$).

Sex had no significant influence on baseline cortisol metabolite concentrations (Kruskal-Wallis test, $p = 0.568$), but females responded with higher values during training (Kruskal-Wallis test, $p = 0.008$) (Fig. 1b). There was a significant correlation between age and cortisol metabolite concentrations during training ($r = –0.766$; $p = 0.027$) (Fig. 1c), but not so for baseline concentrations ($r = -0.313$; $p = 0.322$). There was also a tendency that the number of previously attended training courses reduced mean cortisol metabolite concentrations during training, but this negative correlation was statistically not significant ($r = -0.461$; $p = 0.097$) (Fig. 1d). Age and number of attended training courses were highly correlated ($r = 0.963$; $p < 0.001$).

Stress caused by activity

To adjust for individual differences, the mean cortisol metabolite concentration of each dog at home was set as 100 % (baseline concentration) and the increase during training calculated. During the week in the training camp, cortisol metabolites increased significantly (Friedman test, $p < 0.001$), but there was no significant difference between any one day of the course (Dunn's test) (Fig. 2b). Nor was there any significant difference between the baseline concentrations and the resting days in the camp (Dunn's test, $p = 0.871$). However, the type of activity was observed to be a significantly influencing factor (Friedman test, $p < 0.001$) (Fig. 2a). The percentage of cortisol metabolites was highest during days with training. These days differed significantly from days at home (Dunn's test, $p = 0.025$). There was also an increase of cortisol metabolite concentrations during arrival/departure and helicopter flights but all these differences (Dunn's test) were not significant.

Estimation of stress by the handler

A significant correlation was found between baseline cortisol metabolite concentrations and the ability of the dogs to handle new situations as evaluated by 5 trainers ($r= 0.817$; $p = 0.002$) (Fig. 3). However, no significant correlation was found between the percentage rate of faecal cortisol metabolites and the estimated demand on the dogs or the handlers (Fig. 4). When separating data according to type of activity (arrival/departure, training, helicopter, resting), no correlation was found. Nevertheless results graphed in Fig. 4 indicate that most of the time handlers overestimated the stress the dogs were exposed to.

Difference between training and search mission

Only few data are available to document differences of cortisol metabolite concentrations between a search during training and a real search mission (Fig. 5). For comparison between training simulating a real search mission and a real emergency in an avalanche accident data from the experienced dogs Baggy, Fenja and Spot were collected. For the simulation the dogs were placed together in limited space in a car and driven for 2 hours to an unknown area. There the dogs met unknown persons, were stressed by a helicopter landing and take off and then they had to search. In all 3 dogs investigated, no increase in cortisol metabolite concentrations during training was observed (Fig. 5).

In contrast, in a real emergency dog teams were called for a search mission at 11 p.m. and then searched for a missing person until 3 a.m. The experienced dog "Spot" showed a 2.5 times increase in the cortisol metabolite concentration 6 h after the search, but 12 h later his cortisol metabolite concentration was back to baseline (Fig. 5). For the dog "County" this was the first search mission. In a faecal sample collected 6 h after the search, the cortisol metabolite concentration had nearly doubled and this level decreased only slowly; 12 h later it was still 1.5 times above normal.

Discussion

Rescue dogs are always confronted with and stressed by unknown, new situations which in general results in increased heart rate and cortisol levels (BEERDA et al., 1998; PALESTRINI et al., 2005). Cortisol and its faecal metabolites have been shown to be reliable indicators of stress in a variety of animal species (TOUMA and PALME, 2005; KEAY et al., 2006) and results of this study in avalanche dogs are in line with previous findings (KIRSCHBAUM and HELLHAMMER, 1989; KOLB, 1993; BEERDA et al., 1996, 1997; KÖHLER, 2004). In contrast to the use of cortisol, it is difficult to determine the level of stress in dogs based on behaviour, as only chronic stress has been shown to be related to changes in behaviour and health of the dog (BEERDA et al., 1997).

Our results were influenced by factors such as sex, age, personality and temperament, training and search experience of the dog, as well as the dog handler himself. Differences in the concentration of cortisol between the sexes are well known; compared to male dogs, bitches show higher levels (GARNIER et al., 1990; BEERDA et al., 1999; SCHATZ and PALME, 2001). Nonetheless, handlers do not consider the difference of sex in the ability and suitability of search dogs (ROONEY and BRADSHAW, 2004). It has been shown that older dogs react with higher levels of cortisol after a stressful situation (ROTHUIZEN et al., 1993). In this line are findings in rescue dogs during work (KÖHLER, 2004); salivary cortisol levels after stress in older dogs were higher than those in young dogs. However, after a period of rest, salivary cortisol levels in the older dogs were lower than those in young dogs (KÖHLER, 2004).

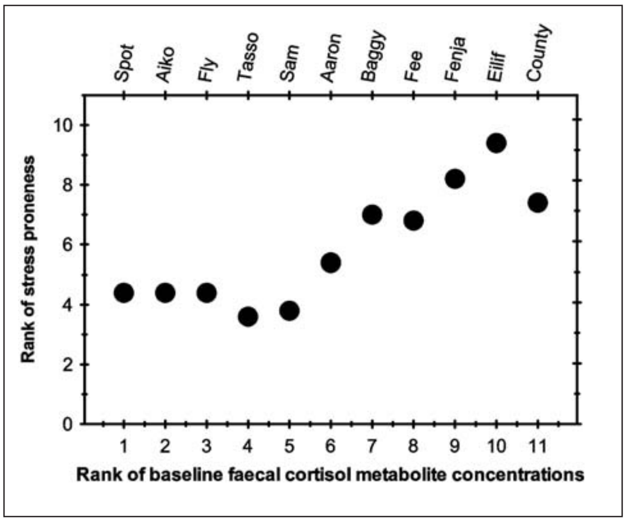

Fig. 3: Mean baseline faecal cortisol metabolite concentrations of individual dogs were significantly correlated (r = 0.817; p = 0.002) to their ranking in stress proneness as evaluated by 5 trainers (1 = not stress-prone, 11 = very stress-prone).

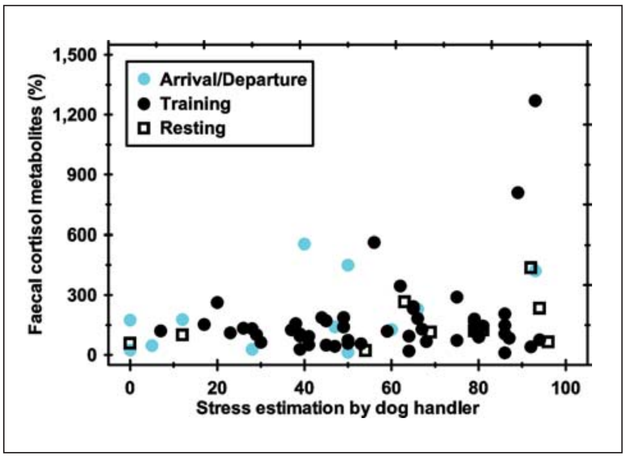

Fig. 4: Relationship between the stress for the dogs as estimated by their handlers and the relative increase above baseline concentrations; data were divided by activity (arrival, departure, training and resting); for helicopter flights not enough stress estimation data were available. Faecal cortisol metabolites were not significantly correlated to stress estimation, indicating that handlers mostly overestimated the stress of the dogs.

Our results show that age and the number of previously attended training courses are highly correlated. Therefore we cannot differentiate between the effect of experience and the effect of age. Both factors influence cortisol levels: firstly, the physiological factor expressed by age influences the production and metabolism of cortisol within the body, and secondly, the personality, training and search experience of the individual dog expressed by the number of attended courses also have to be considered as possible influences (ROTHUIZEN et al., 1993).

Compared to other investigations (BEERDA et al., 1997), our results show that the individual characteristics of dogs result in quite different responses to stress. The personality of a dog determines its performance during work and behaviour in daily life and the shyness-boldness dimension is directly related to working performance (SVARTBERG, 2002, 2005). In this study, the dogs were classified according to their proneness to stress (VINCENT and MICHELL, 1996). Dogs rated as calm, experienced and excellent in handling new situations had lower cortisol metabolite concentrations than very hectic dogs considered as having difficulties in handling such situations. Comparable results by KÖHLER (2004) found higher salivary cortisol levels in more hectic versus calmer dogs. This might be a question of temperament, however, this does not imply that more temperamental dogs necessarily have higher cortisol levels. Because of less experience, younger dogs are more nervous and jumpy during resting time. In contrast, experienced dogs anticipate what will happen, they spare their energy and effectively use the breaks between searches to relax and recover. Older, experienced and well socialised dogs can be very temperamental, but they know how to use their energy more efficiently in order to carry out a search as efficiently as possible.

Experience with training camps was found to be an important factor in reducing stress in dogs during work, as cortisol metabolites decreased with the number of courses attended. In relation to the duration of the training, cortisol metabolite levels decreased and after 3 to 4 days were comparable to those measured at home. This ability to adapt was also observed in dogs kept in a public animal shelter, where cortisol decreases after the second day (HENNESSY et al., 1997, 2001). Comparable results were seen during a training week for therapy dogs (HAUBENHOFER et al., 2005). Comparable results have also been seen in other animals species, i.e. during transportation (for reviews see MÖSTL and PALME, 2002; TOUMA and PALME, 2005; KEAY et al., 2006).

This study shows that handlers tend to overestimate the stress for avalanche dogs caused by search and training. Even experienced handlers working with a dog for years, knowing the performance of his dog in a search mission, did not estimate stress realistically. However, this also has a positive side effect, as in this way the dogs are kept in perfect condition and are operational during a search as long as possible. Avalanche dog handlers take environmental factors, such as low temperatures or wind into account and try to compensate the stress during search missions with high-energy food and enough time for rest and sleep.

In addition to all the factors mentioned above, the handlers' confidence plays a vital role in controlling the amount of stress for the dog (TOPÁL et al., 1998; PRATO PREVIDE et al., 2003). Reducing the stress caused by psychological factors like new situations or spatial restrictions can be achieved by sufficient training. We observed a considerable difference in the stress level between realistic training and a real search mission, although the only difference between these 2 situations for the dog was the stress the handler experienced and displayed. During training the handler knows what happens and what will happen next, whereas during a real search mission the handler cannot always anticipate what comes next. Dogs know their handlers very well and by the nervousness shown obviously estimate whether a situation is dangerous. Dogs orientate themselves to the handler and include him in problem solv-

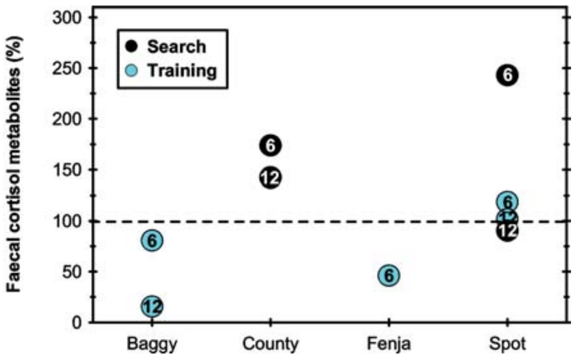

Fig. 5: Percentages of faecal cortisol metabolites in individual dogs during training and during a real search mission in relation to their baseline values; the time (h) of sample collection after the search mission and training, respectively, is indicated by numbers. Stress hormone levels in the experienced dogs Baggy, Fenja and Spot did not increase during training.

ing (MIKLÓSI et al., 2000, 2003). This means that it is important for the handler to remain cool and calm in stressful situations. It is also necessary that the team regularly trains unknown situations where the handler is nervous too, and in this way both handlers and dogs learn how to deal with such situations.

In conclusion, avalanche dogs are exposed to a variety of environmental and psychological factors which arouse, disturb and cause stress as part of their work. The stress is influenced by individual factors like sex, age, experience and personality. In addition to strenuous physical activity, the stressful situation during realistic search missions may have a negative influence on an ideal and successful outcome of a search. To guarantee the success of a search mission, it is important to minimise the stress dogs are exposed to. Our results indicate that the most important factors in reducing stress in avalanche dogs during search missions are experience and training for both, the dog handler and the dog itself.

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