



Nutrition and Physiology

## Typifying the nervous system of small breed puppies and building a behavioral model for them

M. Halil<sup>\*</sup>, R. Dimitrova<sup>1</sup>, I. Stoycheva<sup>2</sup>

<sup>1</sup>Department of Animal Husbandry, Faculty of Veterinary Medicine, Trakia University, 6000 Stara Zagora, Bulgaria

<sup>2</sup>Department of Economics, Faculty of Economics, Trakia University, 6000 Stara Zagora, Bulgaria

(Manuscript received 6 March 2024; accepted for publication 10 May 2024)

**Abstract.** *The temperament of a total of 30 small puppies of 4 breeds in the period of their primary socialization was typified. The number of sanguines, choleric, phlegmatics and melancholics was determined separately according to the breed of the animals along with the possibility of building a successful behavioral model for representatives of different breeds according to their temperament. The fastest socialization was reported in Shih Tzu puppies, followed by Bichon Frise, Pekingese, Dachshund, and lastly Poodle. There was a relationship between temperament and breed in dogs.*

**Keywords:** temperament, puppies, socialization, behavior, typifying

### Introduction

Small breed puppies are one of the common companions of man. Due to the undeniable fact, their behavioral activities have always been of interest to ethologists and pathoethologists (Barnett and Hemsworth, 1990; Adams and Johnson, 1994; AVMAT, 2001; Bodnariu et al., 2007; Burton, 2012). Socialization of animals often does not go well and owners wonder why their companions have not developed the desired behavior. It is known that the dog has 4 types of nervous system (temperament), just like humans - sanguine (strong, balanced type L), choleric (strong and unbalanced type F), phlegmatic (balanced but slow type G) and melancholic (weak and asocial type A). It has already been proven that the socialization of the dog is re-

alized most successfully between the 3<sup>rd</sup> week and the 3<sup>rd</sup> month after its birth (Campbell and Green, 1965; Campbell, 1986; Campbell et al., 1988; Boxall et al., 2004; Bradbury and Vehrencamp, 2011), but both the primary and the secondary inclusion to the environment depend on the type of nervous system of this animal as well. Sanguines and choleric are the easiest and fastest to socialize (Clark et al., 1991; Clark et al., 1997). It is much more difficult for phlegmatics and melancholics, who need more work from the owner to develop a successful behavioral model (DeNapoli et al., 2000; DePalma et al., 2005; Crista et al., 2006; Cozzi et al., 2009). There are no detailed studies on which breeds of dogs give birth to the largest percentage of sanguine, choleric, phlegmatic and melancholic, by typifying their temperament, with a view to forming appropriate behavior (Fuller and Fox, 1969; Eisele,

\*e-mail: mehmed.halil@trakia-uni.bg

2001; Fournier and Geller, 2004; Graham et al., 2005; Gaines, 2006). Bearing this fact in mind, we set ourselves the goal of studying 5 small breeds of dogs used by people as pets-companions (Bichon Frise, Pekingese, Dachshund, Poodle, Shih Tzu), typifying their temperament and calculating which of them show the most sanguine, choleric, phlegmatic and melancholic type of nervous system. We believe that knowing the temperament of their pet, the owner will have the right approach to his dog and the desired behavioral model will be formed more easily and quickly.

## **Material and methods**

As experimental animals, we used 6 puppies of each breed (Bichon Frise, Pekingese, Dachshund, Poodle, Shih Tzu - a total of 5 small breeds) from the same litters (owned by breeding farms), with strict observance of all the rules regarding ensuring their well-being. Our study included a total of 30 animals. They were all raised under the same conditions (in closed premises, together with their mothers) under the microclimatic conditions required for the purpose. Our experiment was conducted after the 3<sup>rd</sup> week - the puppies were separated from their mothers, and continued throughout the period of their socialization - up to the 3<sup>rd</sup> month. To typify their nervous system (temperament) we applied Breteau's method. A mirror large enough so that they could see themselves full-length was used. Their reactions were analyzed when they stood in front of it in an empty room (6 m<sup>2</sup>) on the 25<sup>th</sup>, 45<sup>th</sup> and 85<sup>th</sup> days, i.e. at the beginning, in the middle and at the end of the socialization period. The behavior of each animal (numbered in advance) was analyzed individually for 20 minutes, after which it was returned to the mother. Through the test applied in this way, the level of primary socialization of the puppy (each breed separately), as well as its temperamental characteristics (curiosity, calmness, fear, escape, numbness, physiological aggression - a total of 6 behavioral activities) were studied, based on which a specific behavioral model of companion puppies was formed. Our goal was

to establish the relationship between breed affiliation and type of nervous system with a view to the proper primary socialization of the studied breeds and the successful formation of a corresponding behavioral model, without development of pathological aggression, fear, neophilia, neophobia, etc. The ethological reactions cited above, which collectively form a certain temperament, were analyzed successively by the researcher, an ethologist unknown to the animals, who was also in the room.

The main ethological methods used, apart from Breteau's mirror method, were two:

- Visual, descriptive - observation of the behavioral reactions of the animals studied and their analysis according to the applied test;

- Chronometric - characterization by means of a chronometer of the duration of the relevant behavioral reactions (by time).

We clarify that in an ethological research it is obligatory to have ethograms, which, among other things, allow for a quantitative assessment of individual behavioral manifestations. In this case, however, this was impossible, because the creation of an ethogram requires continuous observation of the behavior for at least 48 hours (as a rule), and the applied methods did not provide this possibility.

In order to assess the character and the degree of dependence between the type of temperament and the breed of the studied animals, we also applied the statistical method of variance analysis.

## **Results and discussion**

According to Table 1, puppies with numbers 1, 2, 3 and 6 showed curiosity (8-10 minutes) because after placing the Breteau's mirror, they immediately rushed to it, demonstrating an undoubted interest. They stood in front of the object and looked around calmly, with no vocalization. They did not run away, were not afraid, did not become numb and did not show aggression (physiological and pathological) - they did not bite the unknown object, did not pass behind it.

**Table 1.** Mirror test results for Bichon Frise breed

Behavioral activities	Puppy No.1	Puppy No.2	Puppy No.3	Puppy No.4	Puppy No.5	Puppy No.6
Curiosity	+	+	+	-	-	+
Calmness	+	+	+	+	-	+
Fear	-	-	-	-	+	-
Escape	-	-	-	-	+	-
Numbness	-	-	-	-	-	-
Physiological aggression	-	-	-	-	-	-

**Legend:** /+/- manifestation of corresponding behavioral activity; /-/- lack of corresponding behavioral activity.

The manifestation of the described ethological reactions gave us reason to typify the temperament of these puppies as sanguine - the strong and balanced type L. Puppy No. 4 showed calmness, but not curiosity, because he did not rush to the mirror, it stood calmly (10 min.) at a distance from it, it was not afraid or numb and did not show aggression. It did not bite the mirror and went to it after about 10

minutes of placing it. A typical phlegmatic or type G nervous system. Puppy No. 5 was neither curious nor calm, it ran away and was afraid of the mirror without ever approaching it (20 min.) - representative of type A nervous system or melancholic.

Therefore, 66.6% of the studied puppies were of sanguine temperament. Phlegmatic and melancholic /asocial/ puppies were, respectively, 16.6% each.

**Table 2.** Mirror test results for Pekingese breed

Behavioral activities	Puppy No.1	Puppy No.2	Puppy No.3	Puppy No.4	Puppy No.5	Puppy No.6
Curiosity	+	+	+	+	+	+
Calmness	-	+	+	-	-	+
Fear	-	-	-	+	+	-
Escape	-	-	-	+	+	-
Numbness	-	-	-	-	-	-
Physiological aggression	+	-	-	-	-	-

According to the Table 2, we found that all puppies were curious because they went to the mirror without vocalization, stood in front of it (15 min.), except for puppies No. 2 and No. 5. The last two were restless, because they were also heading towards the studied object, but they did not stay in front of it and went back. Puppies No. 1, No. 4 and No. 5 showed fear, because after the displayed curiosity, they refused to look around, turned back and no longer approached Breteau's mirror (15 min.). None of the animals tested became numb. According to the behavior of the individual puppies, we could conclude that the animals with numbers 2,

3 and 6 had a sanguine temperament - strong, balanced, quickly socializing, they would easily form the desired behavioral pattern (50%). Puppy No. 1, which was curious, restless and physiologically aggressive (biting the mirror), we assigned to the choleric nervous system type - strong, unbalanced, quickly socializing, but with longer training to form specific behavior (16.6%). Puppies No. 4 and No. 5 should have been in the group of asocial melancholics, due to their demonstrated ethological activities - difficult and slow socializing, with longer-term modeling of their behavior (33.3%). We found no animals with a phlegmatic temperament.

**Table 3.** Mirror test results for Dachshund breed

Behavioral activities	Puppy No.1	Puppy No.2	Puppy No.3	Puppy No.4	Puppy No.5	Puppy No.6
Curiosity	+	+	+	+	+	+
Calmness	+	+	-	+	-	+
Fear	-	-	+	-	+	+
Escape	-	-	-	-	+	-
Numbness	-	-	-	-	-	-
Physiological aggression	-	+	-	-	-	-

The results in Table 3 show that puppies No.1 and No. 4 were sanguine, due to the demonstrated high degree of curiosity - 17 min. (quick pointing to the mirror), calmness (lack of vocalization, escape, numbness and physiological aggression). Therefore, these were sanguine animals, with a strong and balanced temperament, easily and quickly socializing (33.3%). We found puppies No. 2 and No. 6 to be choleric (strong, but unbalanced type of nervous system) - puppy No. 6 demonstrated

fear (short-term vocalization - 2 min.), and No. 2 showed physiological aggression, biting the mirror twice for 3 minutes (33.3%). Puppies with numbers 3 and 5 were classified as asocial melancholics, due to the ethological manifestations they demonstrated - restless, fearful - fleeing in the opposite direction of the mirror (33.3%). They stood far from the object (20 min.). We did not establish a phlegmatic type of nervous system.

**Table 4.** Mirror test results for Poodle breed

Behavioral activities	Puppy No.1	Puppy No.2	Puppy No.3	Puppy No.4	Puppy No.5	Puppy No.6
Curiosity	+	+	+	+	+	+
Calmness	+	-	-	-	+	-
Fear	-	+	+	+	-	+
Escape	-	+	+	+	-	-
Numbness	-	-	-	-	-	-
Physiological aggression	-	+	-	+	+	-

According to the results in Table 4, we found that puppies No. 1, 2, 3, 4, 5 and 6 were curious about Breteau's mirror, because they went to it, some only approached, turned in a semi-circle and went back (17 min.). Puppies No. 1 and 5 were calm because they boldly headed towards the object (there was intermediate vocalization for 3 min.), looked around and stood wiggling in front of it (20 min.). Restlessness was observed in the rest of the puppies, because they barked and did not go to the mirror at the beginning (20 min.). We found marked fear in pups No. 2, 3, 4, and 6, besides barking and growling incessantly.

We observed escape in puppies No. 2, 3 and 4, who ran away as soon as the mirror was placed and stood at a distance from it (20 min.). We did not find numbness in any of the examined animals, and physiological aggression was reported only in puppies No. 2, 4 and 5, who were biting the mirror (2-3 minutes). The demonstrated ethological activities gave us reason to typify the temperaments in the following way: sanguine No. 1 (16.6%); choleric No. 5 and 6 (33.3%); puppies No. 2, 3 and 4 (50%) were melancholic or asocial, and there were no phlegmatics.

**Table 5.** Mirror test results for Shih Tzu breed

Behavioral activities	Puppy No.1	Puppy No.2	Puppy No.3	Puppy No.4	Puppy No.5	Puppy No.6
Curiosity	+	+	+	+	+	+
Calmness	+	+	-	+	-	+
Fear	-	-	+	-	+	-
Escape	-	-	-	-	-	-
Numbness	-	-	-	-	-	-
Physiological aggression	-	-	-	-	-	-

According to the data from Table 5, it can be seen that puppies No. 1, 2, 3, 4, 5 and 6 showed curiosity, because at the very beginning they went to the mirror, some faster, others slower (18 min.). They were all calm, with low-level vocalizations, no growling, whining, or running away from the object. Only puppies No. 3 and 5 showed fear, as they moved away from the mirror faster after the 5th minute, barking, but briefly and not very loudly. None of the puppies ran in the opposite direction, all were very jumpy, mobile and did not

show numbness and physiological aggression. The observed behavior corresponded to the following types of nervous system: sanguine pups No. 1, 2, 4 and 6 (66.6%); choleric No. 3 and 5 (33.3%). We did not find phlegmatics and melancholics.

#### *Inferences and conclusion*

Summarizing these results, we concluded that, according to breed affiliation, the largest percentage of sanguine animals were found in the Bichon Frise (66.6%) and Shih Tzu (66.6%) breeds.

**Table 6.** Results regarding the temperaments of the studied puppies

Breed puppies	Sanguine temperament-L	Choleric temperament-F	Phlegmatic temperament-G	Melancholic temperament-A
Bichon Frise	66.6%	-	16.6%	16.6%
Pekingese	50%	16.6%	-	33.3%
Dachshund	33.3%	33.3%	-	33.3%
A poodle	16.6%	33%	-	50%
Shih Tzu	66.6%	33.3%	-	-

The highest number of choleric were observed in the Dachshund, Poodle and Shih Tzu breeds (33.3% each). Phlegmatics were reported only in Bichon Frise (16.6%), and the most melancholics in the Poodle breed (50%).

Based on these data, we made the following conclusions:

**A)** Sorting the studied breeds according to the type of nervous system, we found that the fastest, easiest and with a shorter duration of training, the desired behavior would be formed where there are the most sanguines, followed by choleric, phlegmatics and melancholics. In this regard, the breeds order is as follows:

1. The Shih Tzu breed - with the largest total number of strong temperaments: sanguine and choleric - 99.9%, lack of phlegmatic and melan-

cholic;

2. Bichon Frise, Pekingese and Dachshund:

- Bichon Frise - sanguine 66.6%, absence of choleric, and phlegmatics and melancholics in total 33.3%;

- Pekingese - total number of strong temperaments /sanguine and choleric 66.6%/ and phlegmatic and melancholic in total 33.3%;

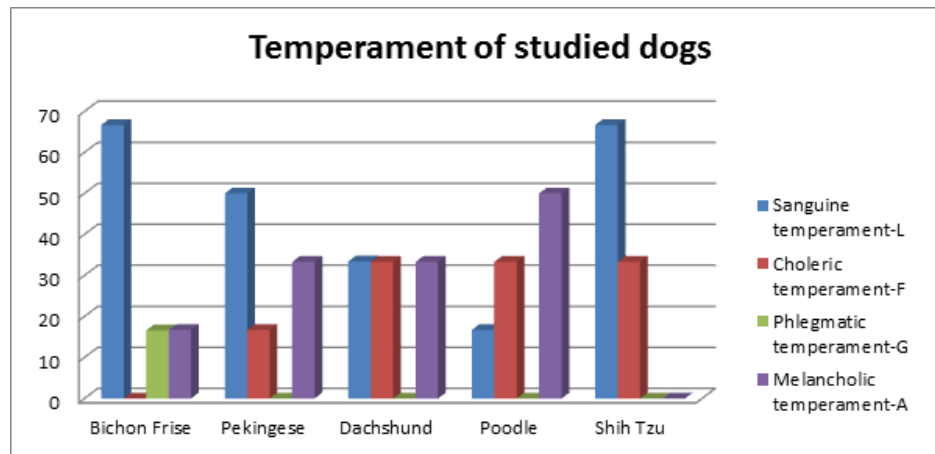
- Dachshund - sanguine and choleric in total - 66.6%, melancholic - 33.3%;

3. Poodles - sanguine and choleric in total 49.9% and presence of 50% melancholic.

**B)** Statistically speaking, out of a total of 30 puppies examined, it was also found that 93.3% of them showed curiosity, 60% were calm and the same percentage of puppies showed no fear.

The relative share of puppies that did not run was 76.7%. No numbness was recorded for all animals observed. With regard to physiological aggression, it was found that 83.3% of them did not show such.

A visual idea of the distribution of individual breeds of puppies according to their temperament can be obtained through Figure 1.



**Figure 1.** Distribution of individual breeds of puppies according to their temperament

When examining the correlation between the individual variables, it was found that there was a statistically significant relationship between the breed of dogs and their temperament, which was positive and of moderate intensity ( $R=0.362$ ,  $p<0.05$ ). The same strength of dependence was found between breed and curiosity ( $R=0.378$ ,  $p<0.05$ ), and a considerable one was reported between dog breed and physiological aggression ( $R=0.426$ ,  $p<0.05$ ). A statistically significant correlation was found between the puppies' temperament and their curiosity ( $R=0.458$ ,  $p<0.05$ ). It was positive, of moder-

ate intensity, and was indicative of the fact that the more dynamic the puppies were in temperament, the more curious they were. A negative moderate relationship was reported between temperament and escape ( $R=-0.394$ ,  $p<0.05$ ), according to which the more dynamic puppies ran away less. The relationship between calmness and fear ( $R=-0.861$ ,  $p<0.05$ ) and between calmness and escape ( $R=-0.577$ ,  $p<0.05$ ) was strong and statistically significant. The correlation coefficients were negative, indicating that calmer pups were less afraid and ran away less.

**Table 7.** Correlations and levels of significance between observed dog breeds and their behavioral activity

	Breed	Curiosity	Calmness	Fear	Escape	Aggression	Temperament	
R	Breed	1.000	<b>0.378</b>	-0.144	0.192	0.250	<b>0.426</b>	<b>0.363</b>
	Curiosity	0.378	1.000	0.055	-0.055	-0.094	0.161	0.458
	Calmness	-0.144	0.055	1.000	-0.861	-0.577	-0.123	0.350
	Fear	0.192	-0.055	-0.861	1.000	0.577	-0.031	-0.175
	Escape	0.250	-0.094	-0.577	0.577	1.000	0.213	-0.394
	Aggression	0.426	0.161	-0.123	-0.031	0.213	1.000	0.129
	Temperament	0.363	0.458	0.350	-0.175	-0.394	0.129	1.000
Sig	Breed		<b>0.020</b>	0.223	0.154	0.091	<b>0.009</b>	<b>0.024</b>
	Curiosity	<b>0.020</b>		0.387	0.387	0.310	0.197	<b>0.005</b>
	Calmness	0.223	0.387		<b>0.001</b>	<b>0.001</b>	0.258	0.029
	Fear	0.154	0.387	<b>0.001</b>		<b>0.001</b>	0.436	0.178
	Escape	0.091	0.310	<b>0.001</b>	<b>0.001</b>		0.129	<b>0.016</b>
	Aggression	<b>0.009</b>	0.197	0.258	0.436	0.129		0.248
	Temperament	<b>0.024</b>	<b>0.005</b>	0.029	0.178	<b>0.016</b>	0.248	

The analysis could be deepened by conducting an ANOVA, since the extent to which a tempera-

ment type pre-determined a particular behavioral activity was of interest.

**Table 8.** Influence of temperament on the behavioral activity of puppies

Dependent variable	Degree of dependence	Averages	F, p-value	t-test
Curiosity	1. Phlegmatic	1.00	F=9.533, p=0.001	$t_{1,2}=-2.530, p=0.035$
	2. Melancholic	1.89		
	3. Sanguine	2.00		
	4. Choleric	2.00		
Calmness	1. Phlegmatic	2.00	F=32.933, p=0.001	$t_{2,4}=2.793, p=0.015;$ $t_{3,4}=3.550, p=0.002$
	2. Melancholic	1.00		
	3. Sanguine	2.00		
	4. Choleric	1.50		
Fear	1. Phlegmatic	1.00	F=19.413, p=0.001	$t_{1,2}=-2.530, p=0.035$
	2. Melancholic	1.89		
	3. Sanguine	1.00		
	4. Choleric	1.67		
Escape	1. Phlegmatic	1.00	F=5.413, p=0.005	$t_{2,3}=3.766, p=0.001;$ $t_{2,4}=2.705, p=0.018$
	2. Melancholic	1.78		
	3. Sanguine	1.14		
	4. Choleric	1.17		

By F-test, a statistically significant influence was found between the type of temperament and the behavioral activity expressed by curiosity (F=9.533, p=0.001), calmness (F=32.933, p=0.001), fear (F=19.413, p=0.001) and escape (F=5.413, p=0.005). No statistical significance was reported for physiological aggression, also the numbness was not tested because there were no varieties for this variable. Using a t-test, statistical conclusions were made regarding the difference between the average values in the individual groups of puppies, according to the varieties of the type of temperament. There was a statistically significant difference between the average values of the behavioral activity curiosity in phlegmatic and melancholic. No significant difference was found between melancholic, sanguine and choleric, which meant that indeed the more dynamic temperament pups showed considerable curiosity. Regarding the average differences between calmness and temperament type, significance was found for melancholic and choleric, as well as for sanguine and choleric, proving that the more emotionally stable puppies were calmer. As

for the fear variable, significant differences were observed between the phlegmatic and melancholic groups, and for the escape variable, there was a statistically significant difference in average values between melancholic and sanguine, as well as between melancholic and choleric. Based on this, it can be argued that the calmer (more emotionally stable) pups showed less fear as well as less behavioral activity expressed by escape.

Therefore, in the first place, through appropriate and targeted training, Shih Tzu puppies would be socialized the fastest. The desired behavioral model would most precisely be formed in them according to the fact that we had the largest percentage of sanguine and choleric - all strong temperaments.

Second were puppies from the Bichon Frise, Pekinese and Dachshund breeds - with an equal number of strong and weak temperaments - they would form the desired behavioral model, but with slightly slower and long-term training than the Shih Tzu breed.

Third were the puppies of the Poodle breed,

where sanguine and choleric were the fewest, and melancholic the most numerous, which meant that they would develop the desired behavior with very hard and long-term training, with a higher probability of secondary socialization if the owner had the wrong approach to the breed. And this often happens because owners do not know the temperament of their animals /lack of mandatory typifying/, which is why they apply training that does not correspond to the type of their nervous system. Many times the owner wishes for the rapid development of a certain behavioral model, but this does not happen if his animals are phlegmatic or melancholic. He begins to apply inappropriate training to them /frequent punishments, etc./, not knowing that what he wants is impossible because they are phlegmatic, for example. As a result, the puppies develop phobias, depression, aggression, etc., a pathoetology that is difficult to treat. That is why, it is mandatory to determine the type of nervous system of small puppies in the period of their primary socialization, with a view to their proper training, successful integration into the environment and development of a corresponding behavioral model.

**C/** According to the conducted scientific experiment, we defined the selection work of the dog breeders (elimination from breeding of phlegmatics and melancholics) as satisfactory (satisfactory, good, very good and excellent), bearing in mind the fact that in most cases we did not find phlegmatics. In percentage, the melancholics were many, when their number should have been negligible or even non-existent if weak temperaments had been promptly eliminated from breeding. This, in our opinion, meant that breeders were not familiar with the details of the relationship between typifying the dog's nervous system, an appropriate approach to it and the formation of the desired behavioral model.

Therefore, it is necessary to work much more persistently and purposefully in this direction.

## References

**Adams GJ and Johnson KG**, 1994. Behavioural responses to barking and other auditory stimuli during night-time sleeping and waking in the domestic

dog, *Canis familiaris*. Applied Animal Behaviour Science, 39, 151-162.

**Bodnariu A, Decun M and Faur A**, 2007. Prevalence of behavior problems in dogs kept as companion animals. LUCRĂRI ȘTIINȚIFICE MEDICINĂ VETERINARĂ, XL, 2007, Timișoara, Romania.

**Burton R**, 2012. Animal Welfare Code of Practice - Breeding Dogs and Cats, New South Wales Government - Department of Planning, Industry and Environment.

**AVMAT**, 2001. American Veterinary Medical Association Task Force on Canine Aggression and Human-Canine Interactions. A community approach to dog bite prevention. Journal of the American Veterinary Medical Association, 218, 1732-1749.

**Barnett JL and Hemsworth PH**, 1990. The validity of physiological and behavioural measures of animal welfare. Applied Animal Behaviour Science 25, 177-187.

**Boxall J, Heath S, Bate S and Brautigam J**, 2004. Modern concepts of socialisation for dogs: implications for their behaviour, welfare and use in scientific procedures. Alternatives to Laboratory Animals, 32, 81-93.

**Bradbury JW and Vehrencamp SL**, 2011. Principles of animal communication (2nd Ed.). Sunderland, MA: Sinauer Associates Inc.

**Campbell FW and Green DG**, 1965. Optical and retinal factors affecting visual resolution. Journal of Physiology (Lond.), 181, 576-93.

**Campbell WE**, 1986. The prevalence of behavioural problems in American dogs. Modern Veterinary Practice, 62, 28-31.

**Campbell SA, Hughes HC, Griffin HE, Landi MS and Mallon FM**, 1988. Some effects of limited exercise on purposebred beagles. American Journal of Veterinary Research, 49, 1298-1301.

**Clark JD, Culpin J and Armstrong RB**, 1991. Influence of type of enclosure on exercise fitness of dogs. American Journal of Veterinary Research, 52, 1024-1028.

**Clark JD, Rager DR, Crowell-DS and Evans DL**, 1997. Housing and exercise of dogs: effects on behaviour, immune function, and cortisol concentration. Laboratory Animal Science, 47, 500-510.

- DePalma C, Viggiano E, Barillari E, Palme R, Dufour AB, Fantini C and Natoli E**, 2005. Evaluating the temperament in shelter dogs. *Behaviour*, 142, 1307-1328.
- Cozzi G, Brscic M and Gottardo F**, 2009. Main critical factors affecting the welfare of beef cattle and veal calves raised under intensive rearing systems in Italy: a review. *Italian Journal of Animal Science*, 8, 67-80.
- Crista L, Coppola R, Enns M and Grandin T**, 2006. Noise in the animal shelter environment: building design and the effects of daily noise exposure. *Journal of Applied Animal Welfare Science*, 9, 1-7.
- DeNapoli JS, Dodman NH, Shuster L, Rand WM and Gross KL**, 2000. Effects of dietary protein content and tryptophan supplementation on dominance aggression, territorial aggression and hyperactivity in dogs. *Journal of the American Veterinary Medical Association*, 217, 504-508.
- Eisele PH**, 2001. A practical dog bed for environmental enrichment for geriatric beagles, with applications for puppies and other small dogs. *Contemporary Topics in Laboratory Animal Science*, 40, 3-38.
- Fournier AK and Geller ES**, 2004. Behavioral analysis of companion-animal overpopulation: a conceptualization of the problem and suggestions for intervention. *Behav. Social Issues*, 13, 51-68.
- Fuller JL and Fox MW**, 1969. The behaviour of dogs. In Hafez ESE (ed): *The Behaviour of Domestic Animals*, 2nd ed. Baltimore: Williams & Wilkins, p. 438.
- Gaines SA**, 2006. Kennelled dog welfare — effects of housing and husbandry. Thesis for PhD, University of Bristol, England.
- Graham L, Wells DL and Hepper PG**, 2005. The influence of olfactory stimulation on the behaviour of dogs housed in a rescue shelter. *Applied Animal Behaviour Science*, 91, 143-153.