Dr. Bartges' final report on the Dal stone survey:
Commissioned by the Dalmatian Club of America Foundation (DCAF)
Published in the DCA magazine, The Spotter, Summer 2006

Part I: On-line web-based survey of Dalmatian owners

GENERAL INFORMATION

Information was received on 2,118 Dalmatians owned by 1,031 owners. Unfortunately, many of the records were incomplete and required follow-up in an attempt to fill in the missing data. Many of the questions defaulted to a specific answer, which may skew some of the information obtained from this survey. Regardless, the results are as follows:

Of 2,118 dogs, gender distribution was available for 2,112:

Intact Females	299	(14.1%)	Total Females	1032	(48.9%)
Spayed Females	733	(34.7%)			
Intact Males	362	(17.1%)	Total Males	1080	(51.1%)
Castrated Males	718	(34.1%)			

[Editor's note: It has been argued that this study is biased because Dal owners were more likely to participate if their dog was a stone former. If that were the case, we would not expect to see an even breakdown of the sexes, since males are in this study 6.5 times as like to have symptoms of stone disease as females.]

Dietary information was available for all 2,118 dogs. Many brands of dog foods and many different recipes of homemade diets were fed. The diets were categorized into the following types for statistical purposes: BARF (raw food diets), homemade (cooked diets), commercial vegetarian, commercial low protein (for example, a "renal failure" diet), general adult dog foods, and Prescription diet U/D.

Dogs consumed the following:

Type of diet	Number of dogs
BARF (raw food diets)	145
Homemade (cooked diets)	54
Commercial adult dog food	1,875
Commercial vegetarian dog food	24
Commercial low protein dog food	8

Prescription diet u/d
12

Information was also requested concerning medications given to dogs (for stone-forming dogs, information was requested for what was given prior to the first stone episode), specifically the following:
* Allopurinol: NO = 2,101, YES = 17
* Potassium citrate: NO = 2,110, YES = 8
* Sodium bicarbonate: NO = 2,113, YES = 5

Information was also requested concerning the following (for stone-forming dogs, information was requested for what was done prior to the first stone episode):
* Home monitoring of urine pH: NO = 1,860, YES = 219 (information available for 2,079 of 2,118 dogs)
* Routine urinalysis performed: NO = 1,452, YES = 603 (information available for 2,055 of 2,118 dogs)
* Type of water: CITY TAP WATER (default) = 1,615, WELL WATER = 503
* Add water to dog food: NO = 1,210, YES = 874 (information available for 2,084 of 2,118 dogs)
* Use bottled water: NO = 1,823, YES = 201 (information available for 2,024 of 2,118 dogs)

INTERPRETATION OF RESULTS: In this survey, information is available for approximately equal number of males and females. Although most dogs were fed commercial adult dog foods, approximately 10% were fed homemade diets (raw foods or cooked). I found it interesting the number of owners that not only monitored urine pH at home, but had a urine sample analyzed at least one time per year. I also found it interesting the number of owners that added water to their dog's food.

URINARY STONE FORMATION INFORMATION

Of 2,118 dogs, 1,635 (77.2%) had no history of stone disease while 483 (22.8%) had a history of stone disease. The mineral composition of the 483 stones were reported as:
* Urate 317 (65.6%)
* Don't know 133 (27.5%)
* Struvite 14 (2.9%)
* Calcium oxalate 9 (1.9%)
* Cystine 8 (1.7%)
* Xanthine 2 (0.4%)

[Editor's note: 317 of the 350 stones of known composition are urate, for a proportion of 90.6%.

If we pro-rate the unknown stones in the same proportions, then 120 of the unknowns would be urate. This would result in a projection of 20.6% of the population with urate stones. See below for incidence by sex.]

Owners were asked for the mineral composition of the first stone that the dog had formed, which is this data. Age information was given for 435 of the 483 dogs. The mean ? standard deviation for age of first stone formation was 4.8 ? 3.5 years; median age was 4.0 years with a range of 6 months to 16 years. Distribution of first stone occurrence by age was:

Age range	Number of dogs
0 to 1 year	15
1 to 2 years	53
2 to 3 years	81
3 to 4 years	47
4 to 5 years	52
5 to 6 years	42
6 to 7 years	28
7 to 8 years	24
8 to 9 years	18
9 to 10 years	14
10 to 11 years	15
11 to 12 years	19
12 to 13 years	14
13 to 14 years	8
14 to 15 years	4
15 to 16 years	1

Gender distribution was available for 449 of 483 dogs that formed stones:
Female intact
8

(1.8%)
Female total
58 [+ 4.4]
(12.9%)
[Incidence = 6.0%]
62.4/1032

[Urate = 5.5%]
56.5/1032
Female spayed
50
(11.1%)
Male intact
83
(18.5%) Male total
391 [+ 29.6]
(87.1%)
[Incidence = 39.0%]
420.6/1080

[Urate = 35.3%]
381/1080
Male castrated
308
(68.6%)

[Editor's note: Males are 6.5 times as likely to report stone disease in this study.]

Owners were asked how the first stone episode was resolved. The responses for 467 dogs (out of 483 stone-forming dogs) were:

Management Number of dogs
Dissolved without surgery
161 (34.5%)
Removed surgically
255 (54.6%)
No treatment given
51 (10.9%)

Dissolution without surgery was accomplished utilizing Prescription diet u/d with allopurinol in 154 of the 161 dogs and a "renal failure diet" with allopurinol was used in 7 of 161 dogs. No information was requested for whether dissolution had been tried but unsuccessful.

Additional information was requested (as presented before) concerning primary diet consumed (for stone forming dogs information concerning diet fed prior to first stone occurrence was requested), whether medication was given prior to stone formation (allopurinol, potassium citrate, and sodium bicarbonate), what type of water did the dog drink (city or well – the default was city tap water), whether water was added to food, whether bottled water was added to food, whether urine pH was measured at home, and whether urine from the dog was analyzed routinely by a veterinarian. This information was used to determine whether there were protective or causative effects for stone formation using logistic regression and Chi-square analysis; 95% confidence intervals were also calculated as a means to evaluate risk/benefit. For the logistic regression model, only dogs identified as having URATE or DON'T KNOW for mineral composition were included; dogs identified with CALCIUM OXALATE, CYSTINE, STRUVITE, and XANTHINE as the mineral composition of their first stone were excluded.

The significant results were as follows:

Factors associated with increased risk of urate stone formation:
* Feeding a commercial adult dog food (p = 0.05: 95% confidence interval = 1.000-5.356)
* Feeding a homemade cooked diet (p = 0.0475; 95% confidence interval = 1.014-11.652)
* Measuring urine pH at home (p = 0.001; 95% confidence interval = 1.795-6.250)
* Routinely monitoring urinalysis (p = 0.0024; 95% confidence interval = 1.204-2.371)
* Being a male: intact male dog (p < 0.0001; 95% confidence interval = 5.015-24.688);
* castrated male dog (p < 0.001; 95% confidence interval = 9.500-43.237)
* Adding water to food (p < 0.001; 95% confidence interval = 0.003-0.021)

INTERPRETATION OF RESULTS: As previously reported, urate stones predominantly, but not exclusively, affect male Dalmatians. Average age of first stone occurrence is around 4 years, which has been reported previously. I also note that not all stones from Dalmatians are urate, as there were a few other metabolic stones (calcium oxalate and cystine), and struvite (caused by a urinary tract infection). In managing urate stones, medical dissolution was successful in approximately 1/3 of Dalmatians (although no information was obtained concerning failure of medical dissolution). It is interesting, that we have published a similar success rate utilizing Prescription Diet u/d and allopurinol. More interesting are the results from the logistic regression. Feeding an adult dog food is a risk, but that is not surprising as most dogs were eating a commercial adult dog food and the confidence interval included 1. Identifying feeding a homemade cooked

diet was unexpected, but may reflect a heightened awareness by the owner that this particular dog was at risk for urate stone formation. Likewise, dogs that formed urate stones were more likely to have their urine pH monitored at home and to have routine urine analysis performed; again, possibly reflecting a perception or knowledge by the owner that this individual dog was at higher risk. Even more interesting was the observed protective effect of adding water to the diet, regardless of what diet was fed. This may increase urine volume and dilute out the urate and other compounds that might precipitate and form stones. This may be a very reasonable, and obviously safe and inexpensive, method of decreasing stone formation in some Dalmatians.

RECURRENCE OF URATE STONES IN DALMATIANS

As part of the questionnaire, owners were asked to answer questions related to measures taken to prevent urate stone recurrence in their dog. Data was analyzed for the 451 Dalmatians identified as having formed stones composed of either URATE or DON'T KNOW; dogs with calcium oxalate, cystine, and struvite stones were excluded. From these 451 dogs, information on recurrence was available for 348 dogs:
NO RECURRENCE = 223 (65.2%);
RECURRENCE = 125 (34.8%).
The majority of the recurrences were urate stones; only 5 of the 121 were identified as xanthine (although information was not given for mineral composition for more than one-half, 73 dogs).

Diet information was requested, and the following diets were primarily fed to dogs that had formed a urate stone; information was available for the 348 dogs:

Diet Number of dogs
BARF (raw food)
20
Homemade diet (cooked)
18
Commercial adult dog food
68
Commercial vegetarian dog food
23
Commercial low protein dog food
17
Prescription diet s/d
1
Prescription diet u/d
201

Information on allopurinol administration was available for the 348 dogs (the default answer was NO): NO = 183 (52.6%), YES = 165 (47.4%)

Information on potassium citrate administration was available for all 348 dogs (the default answer was NO): NO = 330 (94.8%), YES = 18 (5.2%)

Information on sodium bicarbonate administration was available for all 348 dogs (the default answer was NO): NO = 336 (96.6%), YES = 12 (3.4%)

Information was asked as to whether TREATS had been discontinued after diagnosis of the first stone composed of urate. Information was available for 336 of the 348 dogs: NO = 255 (75.9%), YES = 81 (24.1%)

Owners were asked if water was added the food. Information was available for 345 of the 348 dogs: NO = 104 (30.1%), YES = 241 (69.9%).

Owners were also asked if dogs were given bottled water. Information was available for 345 of the 348 dogs: NO = 249 (72.2%), YES = 96 (27.8%).

Owners were asked if they monitored urine pH at home. Information was available for 345 of the 348 dogs: NO = 237 (68.7%), YES = 108 (31.3%).

Finally, owners were asked if they had urine from their dog routinely analyzed by a veterinarian. Information was available for 345 of the 348 dogs: NO = 134 (38.8%), YES = 211 (61.2%)

This information was used to determine whether there were protective or causative effects for stone formation using logistic regression and Chi-square analysis; 95% confidence intervals were also calculated as a means to evaluate risk/benefit. For the logistic regression model, only dogs identified as having either URATE or DON'T KNOW as the mineral composition of the first stone and for whom the owners answered YES or NO to the question of whether was recurrence or not were included..

The significant results were as follows:

Factors associated with increased risk of urate stone recurrence or xanthine stone formation:
* Administering sodium bicarbonate ($p = 0.041$; 95% confidence interval = 1.054-12.301)

Factors associated with decreased risk of urate stone recurrence or xanthine stone formation:
* Giving bottled water ($p = 0.0223$; 95% confidence interval = 0.284-0.908)

No particular diet was shown to increase or decrease risk of stone formation; however, the majority of dogs, 201 out of 348 dogs (57.8%) were fed Prescription diet u/d.

Likewise, administration of allopurinol or potassium citrate neither positively nor negatively impacted stone recurrence.

INTERPRETATION OF RESULTS: As with risk of stone formation, changing water was associated with decreasing risk of stone recurrence. This could be explained by the dogs consuming more of the bottled water even if it was not directly added to the food. There is some evidence that distilled water may have a positive effect on preventing calcium oxalate stone recurrence in some humans; perhaps we are seeing a similar benefit in this group of Dalmatians. It is interesting that administering sodium bicarbonate increased risk of stone recurrence. Sodium bicarbonate is an alkalinizing agent that has been recommended for preventing recurrence in Dalmatians. Sodium bicarbonate has been shown to increase urinary uric acid excretion; therefore, this may explain the observed association. It is interesting that the recurrence rate in the dogs included in this survey was approximately 1-in-3. Historically, recurrence has been reported as being 85-90%. In our studies, Prescription Diet u/d alone resulted in a 10-15% recurrence rate. Although the recurrence rate in this survey is higher than that and the majority of dogs received Prescription Diet u/d, there were too few dogs in other dietary groups and too many different types of food were fed in the other groups to provide meaningful comparisons. Furthermore, owners were asked to provide information as to when stones recurred, but very few (< 10%) provided this information.

OVERALL SIGNIFICANCE OF THIS STUDY

This was a large study attempting to find associations between diet, drugs, and water intake with risk of urate stone formation and recurrence of stones in stone-forming Dalmatians. Although a large amount of data was collected, many records were incomplete and attempts to fill in the holes in these records were for the most part unsuccessful. Feeding homemade cooked diets increased risk of urate stone formation in Dalmatians; however, no specific conclusion could be made as to whether these diets contained cooked meat or whether they were vegetarian in nature (similar to the Lowry diet). However, in Dalmatians, and certainly in Dalmatians that may be at risk for urate stone formation, increasing urine volume (presumably) by adding water to the food or by using bottled water decreased risk of stone formation and stone recurrence. Past recommendations of using sodium bicarbonate as an alkalinizing agent should probably be changed as sodium bicarbonate administration to urate stone-forming Dalmatians increased risk of stone recurrence. Dissolution and preventative protocols appear somewhat effective, but less than desired. Alternative diets and protocols should probably be evaluated in prospective controlled studies. Furthermore, the role of urinary crystal and stone inhibitors has been largely overlooked in Dalmatians, except for one study by Carvello. I think study showed the variability in stone formation in Dalmatians, which is not unexpected. All Dalmatians excrete "increased amounts of uric acid" relative to other breeds of dogs, yet the incidence of stone formation is nowhere close to 100%; therefore, there are other factors than the metabolic make-up of the individual Dalmatian that result in urate stone formation. Furthermore, although urate was the

most common mineral found in this study, other types of minerals (calcium oxalate, cystine, and struvite) occurred.

Part II: Necropsy study for kidney stones

This information has not changed from my e-mail dated September 19, 2005. No further specimens or information has been received. As of September 2005, I had information on 13 dogs. Eight of these dogs had developed stones during their lifetime prior to euthanasia and all 8 dogs were male Dalmatians. Of the remaining 5 dogs that did not form stones, none had stones at necropsy. Of the 8 Dalmatians that had formed stones, 6 dogs had stones at time of death and necropsy; 5 of these dogs had stones in 1 or both kidneys (this includes 2 dogs that had been diagnosed previously with kidney stones). The stones from 5 of the dogs were 100% ammonium urate, while 1 dog had stones composed of 80% xanthine and 20% ammonium urate; this dog had been receiving allopurinol. In the 8 dogs with stones, 5 dogs had been fed u/d and 1 dog was fed a vegetarian diet; the 2 dogs diagnosed with kidney stones prior to death were not fed u/d and were not given allopurinol. Four of the remaining 6 dogs had been given allopurinol and one of these dogs had stones composed of 80% xanthine and 20% ammonium urate. I did pull records of Dalmatians seen here at The University of Tennessee that also had post-mortem examinations. There were 15 dogs. None of these dogs had been evaluated here for urinary tract disease – most were neurological disease (seizures or intervertebral disk disease) and a couple were due to trauma (dog fight or hit by car). None of these dogs had stones at necropsy; none were receiving a low purine diet or receiving allopurinol as none had a history of stone disease.

INTERPRETATION OF RESULTS

Although this is a very small number of dogs, these results suggest that Dalmatians that have formed urate bladder stones may be at increased risk for developing kidney stones over time. This may mean that they eventually develop them if they live long enough and are evaluated. The dogs with kidney stones were greater than 13 years of age at the time of death. The kidney stones could have been present for some time, but undetected as urate stones do not typically show up on plain abdominal x-rays. None of the dogs with kidney stones had a history of kidney failure and none of the stones were causing a ureteral obstruction. There was no evidence for kidney disease grossly or microscopically in these 6 dogs. Five of the 6 dogs were receiving nonsteroidal anti-inflammatory drugs for arthritis at the time of death and necropsy. Some nonsteroidal anti-inflammatory drugs do increase urinary uric acid excretion and so could increase risk of stone formation; however, this has not been evaluated in Dalmatians. It is unfortunate that more samples and information were not collected. Perhaps with ultrasonography, more information could be ascertained without the need for a post-mortem study.