JOURNAL OF FORENSIC SCIENCES

J Forensic Sci, January 2012, Vol. 57, No. 1
doi: 10.1111/j.1556-4029.2011.01912.x
Available online at: onlinelibrary.wiley.com

TECHNICAL NOTE

ANTHROPOLOGY

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Forensic Scatology: Preliminary Experimental Study of the Preparation and Potential for Identification of Captive Carnivore Scat

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ABSTRACT: Carnivore scats recovered from animal attack and/or scavenging contexts frequently contain forensic evidence such as human bone fragments. Forensic cases with carnivore involvement are increasingly prevalent, necessitating a methodology for the recovery and analysis of scat evidence. This study proposes a method for the safe preparation of carnivore scat, recovery of bone inclusions, and quantification and comparison of scat variables. Fourteen scats (lion, jaguar, lynx, wolf, and coyote) were prepared with sodium-acetate-formalin fixative; analytical variables included carnivore individual, species, body size, and taxonomic family. Scat variables, particularly bone fragment inclusions, were found to vary among carnivore individuals, families, species, and sizes. The methods in this study facilitate safe scat processing, the complete recovery of digested evidence, and the preliminary identification of involved animals. This research demonstrates that scat collected from forensic contexts can yield valuable information concerning both the victim and the carnivore involved.

KEYWORDS: forensic science, scatology, carnivore scavenging, bone fragmentation, taphonomy, sodium-acetate-formalin fixative

Many wild and domesticated animals have been known to attack humans or scavenge human remains. With modern urban development and ecotourism infringing on predator territories, the attacks by wild animals such as wolves, coyotes, dingoes, lions, tigers, cougars, and bears have increased in frequency (1–3). However, of all the incidences of human predation, domestic dog attacks are the most frequent and account for the majority of animal-related injuries each year (2,4–6). Although fatal dog attacks are relatively rare (2), their occurrence necessitates the development of techniques capable of dealing with these unique forensic scenarios. As long as humans share land with wild animals, and homes with domesticated ones, specialized methodologies for evidence recovery must be actively applied to all cases with suspected animal involvement.

Animals are capable of causing considerable damage to human remains during both attack and feeding events, often ingesting or removing skeletal elements (and other important evidence) from the scene (7–12). Based on the co-author's personal forensic experience, animals can also return to the scene to feed, depositing previously consumed evidence such as human bone fragments, fingernail polish, and items of clothing or accessories (Skinner M, personal communication, 2010).

Scatology, the "study and analysis of feces" (13), is introduced in this research as a vital method for the recovery of evidence in cases where animal involvement is suspected. This research suggests that the sodium-acetate-formalin (SAF) method of fecal preparation, normally employed for medical assessments of human health (14,15), be applied to all animal excrement associated at and around crime scenes. The SAF prepared scat will be analyzed, and the preliminary variability among samples discussed. This research emphasizes the importance of animal fecal analysis to the complete and thorough forensic recovery of remains and evidence at crime scenes.

Previous research has postulated that certain animal artifacts such as tooth marks (e.g., Haglund et al. [7]), digestive damage (e.g., Horwitz and Goldberg [16]), and disarticulation patterns (e.g., Haglund et al. [7]) can be used to identify carnivore taxa and/or species. Experimental scat studies have been undertaken to define species-specific characteristics to clarify archeological site formation processes (e.g., Brain [17]), reconstruct paleoenvironments (e.g., Horwitz and Goldberg [16]), and recover forensic evidence (e.g., Pickering [18]). For example, baboon bones in captive leopard scat and regurgitations have been analyzed to define animal-induced taphonomic changes to human remains (18–20). Of special relevance to this manuscript is Terry's (21) research concerning the bone content of scats. That study determined that scats are identifiable at the taxonomic order level based on the preservation of skeletal elements and their proportional fragmentation; there was limited success in classifying scat by species (21). The research presented in this manuscript builds upon Terry's (21) work by assessing the scat bone inclusions in a slightly different manner (viz. precise fragment measurements and scat compositions).

Using the preparation methods suggested, bones preserved in scats could be more completely collected. Specifically, this method of scat preparation and evidence collection will greatly benefit the collection of small bones from infant and juvenile victims, a demographic group at high risk of animal attack (2,22,23). Additionally, bone fragments in scat might help identify the carnivore involved, thus assisting in cases where the associated scats are completely desiccated and no longer taxonomically identifiable (i.e., in situations where considerable time has passed

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Received 4 July 2010; and in revised form 24 Oct. 2010; accepted 21 Nov. 2010.

between the attack/scavenging incident and the recovery of the remains). Overall, this research stresses the importance of feces recovery in forensic contexts while adding to previous studies of scat variation (e.g., Carlson and Pickering [19], Terry [21]) and predator identification.

Materials and Methods

Fourteen carnivore scat samples were collected fresh in the spring of 2006 from the Greater Vancouver Zoo in Aldergrove, British Columbia, Canada. To prevent degradation of the scat samples, they were frozen at *c.* −15°C, in a household deep-freezer, shortly after collection. The predators included in this study represent a variety of species and sizes in the Canidae and Felidae families: gray wolf (*Canis lupus*), coyote (*Canis latrans*), African lion (*Panthera leo*), jaguar (*Panthera onca*), and lynx (*Lynx rufus*) (Table 1) (24–34). Multiple animals (of both sexes) were present in each enclosure, but it was not possible to associate the scats with specific individuals or sexes. In the days prior to scat collection, the study species were fed chicken in quantities appropriate to the particular animal's size and feeding habits (Dorgan J, personal communication, 2008).

Preparation Procedure

The SAF methodology was used to prepare the carnivore fecal material. SAF is an excellent fecal preservation method often employed in parasitological investigations of human stool (35). This method ensures that the fecal material can be safely handled and studied in the long term, while maintaining the integrity of delicate inclusions such as small parasites and eggs (14,15,35). The SAF fixative was prepared in large quantities, proportional to the original formula: 1.5 g sodium, 2.0 mL glacial acetic acid, 4.0 mL formaldehyde solution, and 92.5 mL water (14).

The scat samples were thawed in a fume hood prior to the administration of the SAF fixative. When scats returned to their original consistencies, the original mass of every scat (wet weight) was recorded. Next, each scat was mixed with the SAF fixative at a 3:1 SAF to scat ratio. The fecal material was completely submerged in the SAF fixative, agitated, and left to stand for 24 h. For full dissolution and liquefaction, heavier scats, weighing *c.* 150 g or greater, required a second 24-h administration of fresh SAF fixative (36).

Following the 24- to 48-h dissolution period, the SAF fixative was strained from the fecal matter with 1.5 and 1.0-mm aperture sieves. Each scat was repeatedly washed and re-sieved with water to remove any remaining chemicals. Finally, a 4:1 water diluted bleach solution was combined with the scat and agitated for 5 min to destroy any lingering contaminants; the bleached scat was repeatedly mixed and strained with water to remove extraneous bleach. The remaining material was thoroughly air-dried, and the mass recorded (scat dry weight).

The dry fecal material was dissected (bone and feather fragments were separated) using a dissecting microscope at 10× magnification with forceps and dental picks. For each scat, the number and total weight of the bone fragments were recorded. The maximum length and width of each fragment were measured to a precision of 0.1 mm using H&H Industrial dial calipers (Pasadena, CA) calibrated to 0.02 mm; the approximate area for each bone fragment was calculated by multiplying the fragment length by the width (36). Although relatively large, the calculated observer errors were not significant: intra-observer error was 6%; inter-observer error was 7.5% (36).

Descriptive and inferential statistics were used to identify relationships among the 14 scat samples. Each scat sample, or an average among samples in the same group, was compared against the other samples to assess the variability present within a single species. For statistical comparisons, the data were averaged for species (lion, jaguar, lynx, wolf, and coyote), taxonomic family (Canidae and Felidae), and carnivore size (large and small). Carnivore size classifications were based on average body masses: carnivores with body masses >25 kg were arbitrarily classed as large and carnivores with body masses <15 kg as small. To normalize the distribution of bone fragment measurements (length, width, and area) and account for natural variation in carnivore size and body mass, *z*-scores were calculated for all the fragment data (37); all statistical tests on bone fragment measurements were conducted on *z*-score standardized data. SPSS16 for Macintosh (SPSS Inc., Chicago, IL) was used to evaluate the measurement, count, and weight data using both differential and nonparametric statistical methods including Mann–Whitney *U*- and Kruskal–Wallis tests. Statistical significance was set at $p \leq 0.05$.

Results

Individual Animals

Small sample sizes at this level of analysis inhibited the application of inferential statistics, limiting the understanding of the significance of these findings. Scats of the same species varied considerably in their wet weights, the number of bone fragment inclusions (Table 2), and the proportion of bone present (% B/DM). The "proportion of bone present" was calculated by dividing the weight of the bone in grams (B) by the weight of dry scat matter in grams (DM), the sum of which was then multiplied by 100 (Table 3). Among the scats of a single species, the mean bone fragment length is similar, but the actual fragment size ranges and number of bone inclusions can vary greatly. Both the number and size of bone fragments in a scat appear to be related to scat mass; heavy scats tend to have large bone fragments in great numbers. However, these variables (number and size of bone fragments) are not related to each other; a scat with a large number of bone fragments need not also possess the smallest-sized fragments.

TABLE 1—*Carnivore and scat sample details.*

Species	Number of Individuals per Enclosure	Average Body Mass Range (kg)*	Number of Scat Samples	Mean Wet Weight (g)	Range Wet Weight (g)
Lion	4	122.3–191.4	4	222.0	141.8–299.4
Jaguar	1	86.5	4	193.5	161.3–237.6
Lynx	2	11.3	2	80.9	53.8–108.0
Wolf	5	26–45	3	184.6	132.1–257.4
Coyote	1	10.6–13	1	29.2	–

*Carnivore mass data adopted from: Christiansen and Adolfssen (24), Davis (25), Earle (26), Gittleman (27), Guintard and Arnaud (28), Kiltie (29), Lindstedt et al. (30), Thomason (31), Wiersma (32), Van Valkenburgh (33, p. 182), and Van Valkenburgh (34).

TABLE 2—*Bone fragments—descriptive statistics for individual scats. Averaged bone fragment data collected from each scat during processing.*

Scat Sample	Number of Bone Fragments	Mean Length (mm)	Median Length (mm)	Length Range (mm)	Mean Area (mm)	Median Area (mm)	Area Range (mm)
L1-1	244	10.1 ± 7.6	7.9	2.6–58.1	62.4 ± 95.2	26.5	3.1–935.4
L2-2	0	0	0	0	0	0	0
L3-3	113	10.5 ± 6.8	8.4	3.2–47.2	77.7 ± 114.3	36.3	7.7–675.0
L4-4	80	8.3 ± 4.3	7.0	2.2–22.5	33.0 ± 38.1	22.4	3.5–281.6
J1-5	85	8.1 ± 4.4	7.6	1.9–23.4	33.1 ± 43.2	21.1	0.7–290.2
J2-6	91	9.9 ± 5.4	8.9	3.0–37.3	59.6 ± 55.8	44.8	3.2–358.1
J3-7	164	8.3 ± 4.7	6.6	2.2–32.3	44.3 ± 45.4	28.7	3.7–224.4
J4-8	206	9.1 ± 5.3	7.6	2.0–37.3	51.2 ± 62.0	29.1	3.8–424.8
X1-13	337	6.0 ± 3.3	5.1	0.5–22.8	21.0 ± 23.8	12.8	1.3–174.7
X2-14	84	7.5 ± 4.5	6.3	2.3–21.6	26.2 ± 24.4	17.0	2.1–102.7
W1-10	166	7.7 ± 4.2	6.7	1.0–28.5	39.0 ± 52.7	24.9	3.9–513.0
W2-11	14	4.7 ± 1.8	5.6	1.7–8.8	9.9 ± 6.1	9.5	1.6–20.5
W3-12	9	7.3 ± 2.8	9.6	2.5–11.8	37.8 ± 37.2	28.6	4.3–132.2
C1-9	67	5.8 ± 2.9	5.2	2.2–18.5	18.9 ± 17.1	15.0	2.6–106.6

L, lion; J, jaguar; X, lynx; W, wolf; C, coyote.

TABLE 3—*Descriptive statistics for individual scat samples.*

Sample	Wet Weight (g)	Dry Weight (g)	Bone Weight (g)	% B/DM* (%)
L1-1	224.4	23.3	11.2	48
L2-2	141.8	16.1	0.0	0
L3-3	299.4	56.2	7.2	13
L4-4	222.5	27.1	1.5	6
J1-5	161.3	16.0	1.6	10
J2-6	194.6	19.5	3.4	17
J3-7	180.4	25.0	4.3	17
J4-8	237.6	25.1	7.4	30
X1-13	108.0	17.8	3.6	20
X2-14	53.8	7.0	1.0	14
W1-10	132.1	18.2	4.4	24
W2-11	164.3	13.8	0.1	1
W3-12	257.4	27.9	0.5	2
C1-9	29.2	3.9	0.6	15

L, lion; J, jaguar; X, lynx; W, wolf; C, coyote.
*Percent of dry matter mass comprised of bone (g).

TABLE 4—*Descriptive statistics for scat samples averaged by species. All deviations presented at 1 standard deviation (SD).*

Species	Wet Weight (g)	Dry Weight (g)	Bone Weight (g)	% B/DM* (%)	N_{Bone}/DM[†]
Lion	222.0 ± 64.4	30.7 ± 17.6	5.0 ± 5.2	17 ± 22	3.5 ± 4.6
Jaguar	193.5 ± 32.4	21.4 ± 4.5	4.2 ± 2.5	18 ± 8	6.3 ± 1.6
Lynx	80.9 ± 38.3	12.4 ± 7.6	2.3 ± 1.8	17 ± 4	16.9 ± 4.9
Wolf	184.6 ± 65.1	20.0 ± 7.2	1.6 ± 2.4	9 ± 13	3.2 ± 4.9
Coyote[‡]	29.2	3.9	0.6	15	17.2

*Percent of dry matter mass comprised of bone (g).

[†] Average number of bone fragments present in each gram of dry scat matter.

[‡] No SD available for coyote scat as only one sample was available for study.

TABLE 5—*Descriptive statistics for bone fragment data averaged by species.*

Species	Number of Bone Fragments	Mean Length (mm)	Median Length (mm)	Mean Area (mm)	Median Area (mm)
Lion	108.5 ± 100.3	9.9 ± 6.9	7.9	61.0 ± 94.3	27.4
Jaguar	136.3 ± 58.5	8.8 ± 5.0	7.6	47.7 ± 54.1	28.9
Lynx	210.5 ± 178.9	6.3 ± 3.6	5.2	22.1 ± 24.0	13.8
Wolf	63.0 ± 89.2	7.4 ± 4.1	6.5	36.7 ± 50.6	24.1
Coyote*	67	5.8 ± 2.9	5.2	18.9 ± 17.1	15.0

*No SD available for coyote scat as only one sample was available for study.

TABLE 6—*Matrix of Mann–Whitney U-test p-values* for species bone fragment lengths and areas.*

		Coyote	Wolf	Lynx	Jaguar	Lion	
	Coyote		0.002	0.586	0.000	0.000	*p*-Values for Length (*z*-score)
	Wolf	0.001		0.000	0.001	0.000	
	Lynx	0.986	0.000		0.000	0.000	
p-Values for Area (*z*-score)	Jaguar	0.000	0.001	0.000		0.117	
	Lion	0.000	0.001	0.000	0.940		

*Significant at $p \leq 0.05$.

Species Differences

All five carnivore species had similar fecal compositions in terms of the relative proportion of bone, dry matter, and wet matter present. Despite the proportional similarities, differences among the species were evident in average scat wet weights, the number of bone fragments per scat, and the bone fragment lengths (Tables 4 and 5). Scat wet weights and average bone fragment lengths both decreased in mass and size from the largest to the smallest carnivore species (lion, jaguar, wolf, lynx, to coyote). The greatest actual numbers of bone fragments were present in the felid scats, followed by the canid; within these family clusters, species were ordered from largest to smallest (lion, jaguar, lynx, followed by wolf and coyote). However, relative to the dry matter weight, the greatest quantities of bone fragments were present in the scats of the smallest animals (lynx and coyote).

The Kruskal–Wallis test was used to determine whether any differences were present among the bone fragment lengths and areas (standardized with *z*-scores) of the five study species. Among all the tested species' scats, significant differences were identified for both bone fragment lengths ($p \leq 0.000$) and areas ($p \leq 0.000$). Additionally, Mann–Whitney *U*-tests indicated that the differences in bone lengths and areas of all the species were statistically significant, with the exception of two pairs of animals: the coyote and lynx, and the lion and jaguar (Table 6). Jointly, these findings indicate that although the scats of small and large species possess relatively similar bone masses, the smaller species' scats display greater fragmentation (more bone fragments of significantly smaller size) compared with larger species.

Body Size Differences

The scat samples were divided into the large (lion, jaguar, and wolf) and small (lynx and coyote) carnivore groups to determine whether scat variability is contingent on carnivore body size. The average large-carnivore scat wet weight is 137.7 g greater than that of small carnivores (Table 7), but the scat compositions (proportion of bone, dry matter, and wet matter relative to the initial scat wet weight) are relatively similar. The small and large carnivores had comparable masses of bone in their dry scat matter, but small carnivores had 3.5 times more bone fragments (per gram of dry scat matter) than large carnivores (Table 8). A Mann–Whitney *U*-test found the differences between bone fragment lengths and areas of large and small carnivores to be statistically significant (length: $p = 0.001$, area: $p = 0.011$), suggesting that small-carnivore scat contains bone fragments of disproportionately smaller size than those of large carnivores. We suggest that regardless of size, carnivores expel relatively similar amounts of bone, but the scats of small carnivores possess more fragments of smaller size than those in large-carnivore scats.

Taxonomic Family Differences

For the final analyses, the data were averaged for taxonomic family (Canidae and Felidae). The average wet weight of felid scat was 36.6 g greater than the canid (Table 9). Despite a high variability among the individual felid scats, on average they have 2.2 times the absolute number of bone fragments per scat than canid (Table 10). Additionally, felid scats have 1.7 times more bone mass in dry matter than canid. Despite these differences, there is almost no difference (<1) in the calculated number of bone fragments per gram of dry scat matter (Table 9). Significant differences between the lengths ($p = 0.001$) and areas ($p = 0.011$) of bone fragments in canid and felid scats (Table 10) were indicated by a Mann–Whitney *U*-test, suggesting that compared with canids, felids have disproportionately large bone fragments in their scat. Together, these findings indicate that felid scats contain more bone in relatively fewer, yet larger fragments, than canid scats.

TABLE 7—*Descriptive statistics for scat samples averaged by carnivore size.*

Carnivore Size	Wet Weight (g)	Dry Weight (g)	Bone Weight (g)	% B/DM* (%)	N_{Bone}/DM†
Large	201.4 ± 51.8	24.4 ± 11.6	3.8 ± 3.6	15 ± 15	4.6 ± 3.7
Small	63.7 ± 40.3	9.6 ± 7.3	1.7 ± 1.6	17 ± 3	16.0 ± 8.5

*Percent of dry matter mass comprised of bone (g).

†Average number of bone fragments present in each gram of dry scat matter.

TABLE 8—*Descriptive statistics for bone fragment data averaged by carnivore size.*

Carnivore Size	Number of Bone Fragments	Mean Length (mm)	Median Length (mm)	Mean Area (mm)	Median Area (mm)
Large	106.2 ± 81.0	9.0 ± 5.8	7.6	50.9 ± 71.8	27.6
Small	162.7 ± 151.2	6.2 ± 3.5	5.2	21.6 ± 23.2	14.0

TABLE 9—*Descriptive statistics for scat samples averaged by taxonomic family.*

Taxonomic Family	Wet Weight (g)	Dry Weight (g)	Bone Weight (g)	% B/DM* (%)	N_{Bone}/DM†
Canidae	145.8 ± 94.1	16.0 ± 10.0	1.4 ± 2.0	10.3 ± 11.2	6.9 ± 7.9
Felidae	182.4 ± 70.3	23.3 ± 13.0	4.1 ± 3.5	17.5 ± 13.5	7.1 ± 5.6

*Percent of dry matter mass comprised of bone (g)

†Average number of bone fragments present in each gram of dry scat matter.

TABLE 10—*Descriptive statistics for bone fragment data averaged by taxonomic family.*

Taxonomic Family	Number of Bone Fragments	Mean Length (mm)	Median Length (mm)	Mean Area (mm)	Median Area (mm)
Canidae	64 ± 72.9	7.0 ± 3.9	6.0	32.1 ± 45.0	19.2
Felidae	140 ± 98	8.4 ± 5.6	7.0	44.1 ± 65.7	23.3

Discussion

The results of this research indicate that the scat variables of weight, bone content, and fragment size are influenced by differences in carnivore individuality, species, body mass, and taxonomy. Owing to the small number of scat samples available for examination, this study's results are preliminary.

This research utilized the scat of captive carnivores, which are known to differ slightly from wild animals in both morphology and behavior. Compared with natural habitats, captive enclosures are constraining and encourage caged animals to adopt less physically demanding and inactive lifestyles. In captive environments, habitual hunting and feeding behaviors are discouraged, regulated, and altered, resulting in diminished muscle mass and strength. Changes in musculature can greatly affect a growing animal's skeletal morphology, especially evident in a carnivore's skull (38–40). It is possible that this captivity-induced variability in animal morphology and mass could also affect the properties of scat.

Although captive animals may differ slightly from their wild counterparts, they are still the best control subjects available to answer the questions of this preliminary research. Nevertheless, future research should assess differences between captive- and wild-carnivore scat for the more accurate application of scatological techniques to the forensic sciences. The ability to recognize morphological differences, caused by captivity, may help distinguish among attacks involving, for example, feral and domestic dogs.

The results of this research indicate that the scats of (captive) carnivores can differ because of variations in both animal size and family. To begin with, significant carnivore size-related differences were evident in scats when grouped by both species and size. In particular, this study found that, compared with large animals, bone was more highly fragmented in the small animal scats. In particular, small animals had relatively similar bone to dry matter masses, yet greater numbers of smaller-sized fragments than were recovered from larger animal scats.

The greater bone fragmentation present in small-carnivore scats could be explained by the anatomical size limitations of the animal. For example, carnivore anatomy (e.g., maximum jaw gape) will limit what a carnivore can hold in its mouth, swallow, and pass (19). Anatomically large carnivores should be more capable of ingesting larger bits of bone than physically smaller carnivores. The carnivores in this experiment were fed the same prey species. Therefore, the smaller animals may have had to more thoroughly masticate what a larger animal could swallow whole, resulting in the production of more highly fragmented bone. Further research into the impact of carnivore body size on fecal properties might clarify how smaller-scale size variations (e.g., sexual dimorphism) influence scat properties. These differences, if accurately defined, could help to establish the size of an animal involved in forensic contexts.

In addition to carnivore size differences in scat, family differences were apparent in scat wet weights, and the number and size of bone fragments. Specifically, felid scats were found to have a greater bone mass, but contain fewer, yet larger, bone fragments than canid scats. Distinct, family-specific feeding and morphological adaptations, especially in the cranium and dentition, best explain these results. Canids possess strong jaws and postcarnassial teeth that aid in the grinding and crushing of bone (19,41), whereas felids, lacking postcarnassial dentition, have sensors called propioceptors in their jaws and teeth that help them to adjust their bite when they encounter bone (2,42). With these specialized sensors, felids are less inclined to masticate bones (34,41) and therefore might more frequently swallow whole skeletal elements than a bone-crushing canid.

Although masticatory habits likely play a strong role in the size and number of bone fragments present in scats, it is possible that digestive efficiency is also a factor. Digestive chemistry can vary among individuals, as well as temporally within a single animal (43). Variability in stomach environments could result in different digestive efficiencies, reflected in the quality of bone preservation in scat. For example, bone-crushing canids have a more destructive digestion (19), better adapted to ingesting, digesting, and dissolving highly fragmented bits of bone than felids.

To accurately interpret the differences observed among scats, it is important to understand influencing factors (e.g., carnivore size, family, and digestive efficiency). If these factors governing scat variability are clarified, it could be possible to determine a carnivore's size, family, and/or species solely from fecal properties and inclusions. If perfected, scatology and the analysis of digested bone fragments will be especially advantageous to cases where the associated scats are degraded and the conventional ecological scat identification methods are not practical. Further investigation into scat differences, particularly concerning the bone fragment inclusions, is required to clarify this research's findings for their application in forensic cases.

Conclusion

This research has demonstrated that variability in scat can be related to differences among carnivore individuals, families, species, and sizes. Scat properties varied predominantly by carnivore size and family. Smaller animal scats possessed more highly fragmented bone (large numbers of small-sized fragments) than large animal scats. Additionally, felid scats had overall greater bone masses, comprised of fewer, yet more complete bone fragments than canid scats. Further experimentation and insight into these findings could allow standards to be developed that could identify carnivores based solely on scat properties such as bone fragment inclusions.

Scatology will benefit forensic research in terms of understanding site formation processes and identifying carnivore/human interactions. The method of analysis introduced in this study could aid in the identification of the carnivore type (i.e., family, species, and size) involved in the creation of a scavenging or attack site. Establishing the identity of a carnivore could then guide forensic scientists to locations where further evidence might be recovered (e.g., habitat areas, ranges, and dens specific to the carnivore type). With further research, this methodology might also help to isolate and identify the exact animal involved. The ability to establish the specific animal will be particularly useful in cases where the animal poses a continual threat, requiring it to be terminated.

The scat preparation method suggested for bone recovery may be of greatest benefit to cases involving infants and children, the demographic most susceptible to carnivore attack. The thorough preparation of suspected carnivore scats using this method will aid in the collection of these small, juvenile skeletal elements that may normally be overlooked, although they are more likely to survive ingestion and digestion intact (22). Overall, the method of scat preparation and bone extraction discussed in this study will help to ensure that a victim's remains are completely recovered, analyzed, and eventually returned to his or her family.

Acknowledgments

The staff at the Greater Vancouver Zoo, especially Animal Care Manager, Jamie Dorgan, made this research possible; their help and professionalism are acknowledged with gratitude. Heather Robertson and Shannon Wood, staff in the Department of Archaeology at SFU, assisted with laboratory support. Finally, thank you to the anonymous reviewers whose constructive comments strengthened the final document.

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