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The Effect of Repeated Physical Disturbance on Soft Tissue Decomposition—Are Taphonomic Studies an Accurate Reflection of Decomposition?*

ABSTRACT: Although the relationship between decomposition and postmortem interval has been well studied, almost no studies examined the potential effects of physical disturbance occurring as a result of data collection procedures. This study compares physically disturbed rabbit carcasses with a series of undisturbed carcasses to assess the presence and magnitude of any effects resulting from repetitive disturbance. Decomposition was scored using visual assessment of soft tissue changes, and numerical data such as weight loss and carcass temperature were recorded. The effects of disturbance over time on weight loss, carcass temperature, soil pH and decomposition were studied. In addition, this study aimed to validate some of the anecdotal evidence regarding decomposition. Results indicate disturbance significantly inversely affects both weight loss and carcass temperature. No differences were apparent between groups for soil pH change or overall decomposition stage. An insect-mediated mechanism for the disturbance effect is suggested, along with indications as to why this effect may be cancelled when scoring overall decomposition.

KEYWORDS: forensic science, forensic taphonomy, decomposition, disturbance

Forensic taphonomy is generally concerned with the relatively short-term processes that occur after death and during decomposition. One of the uses of data from decomposition studies is the generation of models for ascertaining the postmortem interval (PMI). Decomposition has been examined in detail across a wide range of mammals in efforts to understand the processes occurring and to generate accurate PMI estimations. Organisms used in well-known studies include: dogs (1), guinea pigs (2), humans (3), pigs (4,5), rabbits, and squirrels (6). The decomposition process itself, and influences that affect it, have also been well documented. Studies observing insect succession, for example, have been conducted consistently for almost 50 years (1,4,6–9), and many authors define stages of decomposition (1,3,4,10–12), and assess their relationship to PMI (3,13–17). Further studies have been conducted on factors shown to have a significant effect on the processes involved. These include temperature (18,19), pH (20), microbiological factors (21,22), carcass size (23), and weather conditions (24,25). Experimental variables are often highly interrelated (3,15) and thus disturbance of one variable may significantly affect others. Some of these factors can be self-perpetuating. Temperature influences insect activity, but in turn a maggot mass generates its own heat and influences carcass temperature (26). Likewise a relationship exists between soil pH and microbial activity (21).

Most, if not all, decomposition studies rely on disturbing the carcass under study in order to obtain various data, such as carcass temperature, soil samples, observational data of the underside of the carcass, and insect specimens. Data collection is intentional and any associated disturbance is unavoidable. While some decomposition studies briefly note that disturbance may affect the process under study (21,27), there have been no attempts in the literature to quantify this effect or indeed, establish that such an effect can be documented empirically. Recent literature would suggest that disturbance effects can be seen; Neher et al. (28) investigated soil disturbance on a gross agricultural scale and concluded that it had a significant effect on wood decomposition. They suggested a mechanism involving changes to soil microbial activity. It may be inferred that this effect, albeit at a reduced level, can alter decomposition rates in smaller scale experiments. Temperature and insect activity effects on carcass decomposition are well documented (7,15,29–32); however, whether repeated physical disturbance changes these parameters when compared with unhindered decomposition remains unknown. This study attempts to identify any effects due to repeated disturbance and, if present, to assess their significance. In this manner, this study aims to assess how accurately existing decomposition studies reflect the *actual* decomposition process.

A key focus of this research is the ability to define particular stages of decomposition that will enable comparison of the advancement of the process across different conditions. Although decomposition is continuous, a variety of authors have broken the process into phases defined by particular characteristics (1,2,4,6,10–12,33). As far back as the early 20th century, Weigelt (10) distinguished between fresh, bloating, and putrefactive stages. In a study of dog carcasses, Reed (1) defined four stages: fresh, bloated, decay, and dry; these were slightly modified by Johnson (6) for his study of variation in insect populations on small mammal carcasses. Bornemissza (2) documented five stages. Other authors (11,12,31) listed stages and then identified further categories within those stages, giving as many as 21 categories in some cases. They also included categories which are not always present, for example mummification (4,12,31).

Despite the variety of classification, all these schemes attempt to describe the same process. Consequently, it is relatively simple

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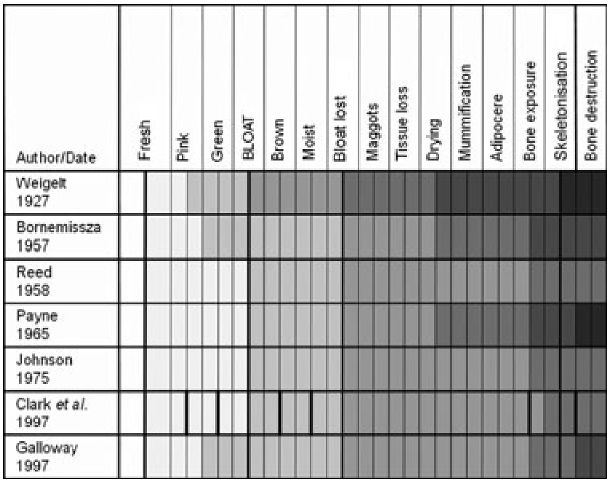

FIG. 1—*Comparison of decomposition stages.*

to compare the different schemes and observe how different authors have divided the process. A visual summary of the comparisons can be seen in Fig. 1, where each shade denotes a separately defined stage (it should be noted that Clark et al. [11] subdivided their stages as indicated by the solid bars within the shades). It has been possible to "synchronize" the descriptions of decomposition by use of consistently definable stages that all authors note, e.g., onset of bloating. It should be noted, though, that as decomposition advances the stages become harder to define or separate, and Fig. 1 demonstrates that the boundaries of each stage become more disparate among authors as the decomposition process advances.

More recently, Megyesi et al. (19) introduced a visual classification of decomposition that ranked observations and allocated a score. This enabled decomposition to be quantified. An important point in their scheme was the scoring of body areas separately, as different areas do not necessarily display the same aspects of decomposition. A limb, for example, was assessed by these authors to neither bloat nor purge fluid (19). Their study was the first instance of decomposition being quantified in itself, rather than as a function of some other quantifiable process.

The assessment of decomposition by means of other related factors has been a common occurrence in taphonomic studies. Many authors, for example, choose to assess decomposition by means of weight loss (4,5,27,34,35). It seems obvious that weight loss and soft tissue decomposition are intricately related; but, as decomposition has remained unquantified until now, a statistical correlation between weight loss and decomposition has not been demonstrated.

Methods

The experimental site was a field located in Dickleburgh, U.K., National Grid ref TM169819. The experiment was conducted at the northern field margin where it was undisturbed by any agricultural activity. The ground was hand dug and leveled 4 weeks prior to the start of the experiment. This interval allowed the land to resettle after being tilled. The soil is of the Beccles 1 series, a stagnogley that is seasonally waterlogged and slowly permeable. Its characteristics are those of a fine sandy loam and it is suitable for winter cereals or grassland (36). The site was ring-fenced with a small-mesh electric fence to prevent the entry of scavengers such as foxes, hedgehogs, and rats.

Rabbit carcasses were obtained as a product of standard pest control procedures. They were each killed with a single gunshot from a shotgun and placed in cold storage until needed. Carcasses were placed in direct contact with the ground. The side with the gunshot wound was laid onto the soil surface in an effort to minimize the activity of flies that may have been attracted by the open wound. Carcasses were placed ~1 m apart and each was covered by a wire cage to further inhibit scavenger access. In addition, small garden canes were placed through the cage into the soil to prevent birds from landing on the cage tops and removing maggots.

TABLE 1—*Data collection strategy.*

Carcass ID	Day 0	Day 3	Day 6	Day 9	Day 12
Disturbed 1	Sampled	Sampled	Sampled	Sampled	Sampled
Undisturbed a	Sampled				
Undisturbed b		Sampled			
Undisturbed c			Sampled		
Undisturbed d				Sampled	
Undisturbed e					Sampled

The study used 24 rabbit carcasses (mean weight 1653 g, SD = 166), in three replicates of eight. In each replicate, a single rabbit was designated "disturbed" and the data were collected from it at three-day intervals. The remaining seven rabbit carcasses in the replicate were used to provide a composite data set, with each carcass being disturbed only once during the experiment (Table 1). A single carcass from this data set was used at day three; a second carcass was used at day six, and so on for the 3-week course of the experiment.

The experiment was conducted for a total of 3 weeks. Previous data (3) allowed calculations indicating that skeletonization would take place in 214.2 degree-days (~14 days given average temperatures at the site). The 3 week duration allowed for a margin of error in this prediction and also for temperature fluctuations.

Environmental data was recorded every 30 min using a Davis GroWeather station and GroWeather software 1.2 (Davis Instruments Corp, Hayward, CA). The data were downloaded into a spreadsheet file for later analysis. Average temperatures over 24 h were totaled to calculate accumulated degree days (ADD) (3). Quantitative data collected on each occasion included carcass

TABLE 2—*Decomposition score (head and neck).*

Stage	Points	Description (head and neck)
Fresh	1	Fresh, no discoloration
Early decomposition	2	No skin discoloration, maggots visible
	3	Some flesh relatively fresh, fur loss
	4	Discoloration, brownish, drying of nose and ears, and heavy maggot activity
	5	Purging of decompositional fluids, wet flesh
	6	Skin brown to black
Advanced decomposition	7	Caving in of flesh and tissues of eyes and throat
	8	Wet decomposition, bone exposure <50% scored area
	9	Dessication, bone exposure <50% scored area
Skeletonization	10	Bone exposure >50% scored area, wet tissue
	11	Bone exposure >50% scored area, dessicated tissue, incisor loss, and disarticulation

TABLE 3—*Decomposition score (abdomen, including pectoral and pelvic girdle).*

Stage	Points	Description (abdomen, including pectoral and pelvic girdle)
Fresh	1	Fresh, no discoloration
Early decomposition	2	Skin appears fresh, fly eggs, few maggots
	3	Flesh appears red-brown, small amount fur loss (<30%)
	4	Bloating, purging of decompositional fluids, heavy maggot activity
	5	Bloat lost, severe fur loss (>70%), heavy maggot activity
Advanced decomposition	6	Wet decay, abdominal collapse where internal structure lost, flesh grey green
	7	Wet decay, bone exposure <50% scored area
	8	Surface mummification, bone exposure <50% scored area
Skeletonization	9	Black skin, bones greasy, body fluids occasionally present
	10	Bones with dessicated black skin over <50% scored area
	11	Bones largely dry and white, mummified skin
	12	Bones beginning to weather

weight, carcass temperature (incorporating maggot mass temperature where appropriate), soil temperature (at 5 cm depth), interface temperature (surface soil temperature directly beneath the carcass), and soil pH (determined using a 1:2.5 weight/volume suspension in distilled water) (21).

In addition, qualitative data on the state of decomposition was assessed visually and recorded. These observations were later converted to a numerical score (Tables 2, 3, and 4) based on a modified scheme of Megyesi et al. (19). Insect identification was made using information from Chinery (37) and Byrd and Castner (38), although as succession did not differ from previously reported studies (1,2,7), this information is not reported here.

Data manipulation and statistical analyses were carried out using Microsoft Excel and SPSS v12.0 (SPSS Inc., Chicago, IL). Equality of variance was tested using Levene's method. Data was analyzed using a two-way ANOVA to assess the effect of disturbance over time on the variables under consideration. It was noticed in preliminary analysis that much of the data from Day 0 (ADD = 0) was unavoidably duplicated between samples (weight = 100%, extensive but equal departure from ambient temperature, equal decomposition scores, etc.). This affected the variability of the data and hence for the ANOVA the data from Day 0 was removed.

TABLE 4—*Decomposition score (limbs).*

Stage	Points	Description (limbs)
Fresh	1	Fresh, no discoloration
Early decomposition	2	Flesh appears fresh, some maggots
	3	Some flesh still fresh, fur loss
	4	Discoloration of skin to brown, drying of extremities
	5	Black skin, leathery appearance
Advanced decomposition	6	Wet decomposition, bone exposure <50% scored area
	7	Wet decomposition, some disarticulation
Skeletonization	8	Bone exposure >50% scored area, dry papery skin
	9	Bones largely dry and disarticulating
	10	Bones dry and white

Results

Skeletonization, predicted to take place around 14 days, was deemed to have been reached using any of the following criteria:

(1) Obvious loss of internal abdominal structure, spine only remaining underneath dried skin.
(2) Substantial unweathered bone exposed (>50%) and no wet decomposition when observed underneath.
(3) Significant areas (>30%) of bleached or weathered bone exposed.

A histogram (Fig. 2) shows time to skeletonization (TTS) for all carcasses. Mean TTS across all samples was 14.25 days (n = 24, SD = 2.97). A one-sample *t*-test comparing the mean TTS (using all data in a single set and not accounting for disturbance) with the predicted TTS showed no significant difference ($t = 0.578$, 95% confidence interval = 13–15.5 days) indicating that results fell well within the predicted range.

Comparing mean TTS between the disturbed and undisturbed groups using a two-sample *t*-test showed no significant difference between the two means (Table 5) ($t = 2.65$, $p = 0.059$). This *p*-value is close to statistical significance ($p \leq 0.05$) and it is possible that a larger sample for the disturbed carcasses (in this study n = 3) would indicate that a significant difference did exist.

Decomposition score was plotted against ADD (Fig. 3). The decomposition curves are based on average decomposition score across the three replicates. Standard deviations range from 0 to 2.08. ANOVA for the interaction of time and disturbance showed no significant effects ($F = 1.124$, $p = 0.298$). This indicates that disturbance, over time, has no effect on the progress of decomposition.

Weight loss curves (Fig. 4) show the sigmoid appearance typical of decomposition in the presence of insects (4). In the absence of insects, mass loss is more linear (4,27). A two-way ANOVA showed the interaction of time and disturbance to have a significant

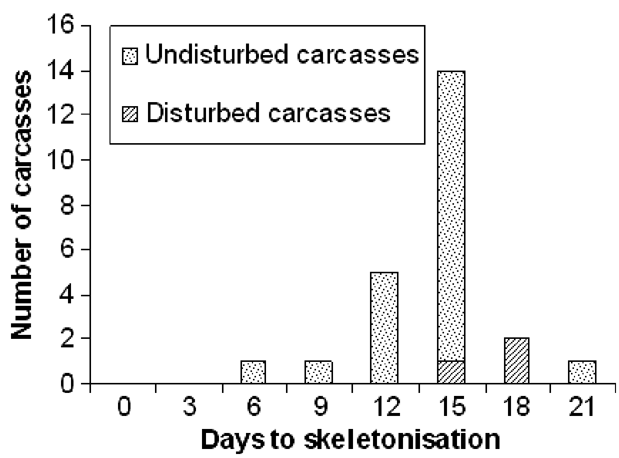

FIG. 2—*Time to skeletonization.*

TABLE 5—*Mean TTS.*

	Mean TTS	SE	95% CI
Disturbed	17.00	1.000	12.70–21.30
Undisturbed	13.86	0.637	12.53–15.19

SE, Standard Error; TTS, time to skeletonization.

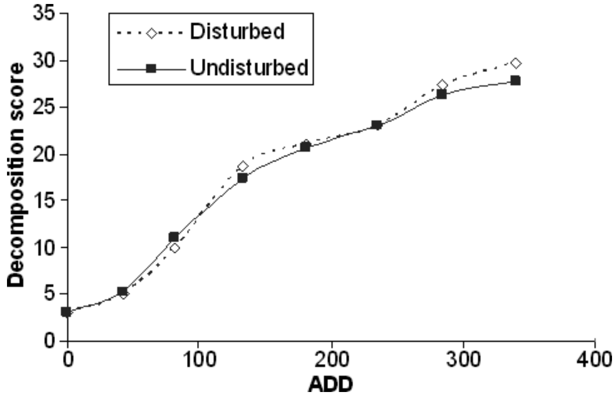

FIG. 3—*Average decomposition curves.*

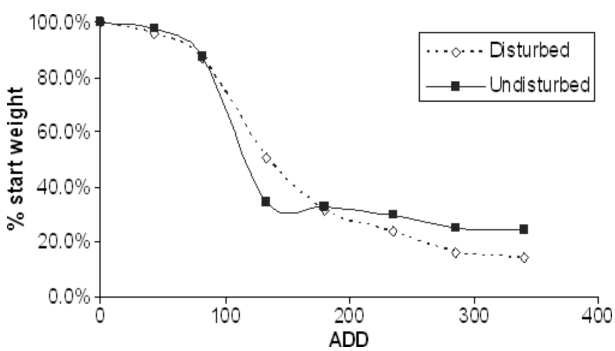

FIG. 4—*Average percentage weight loss.*

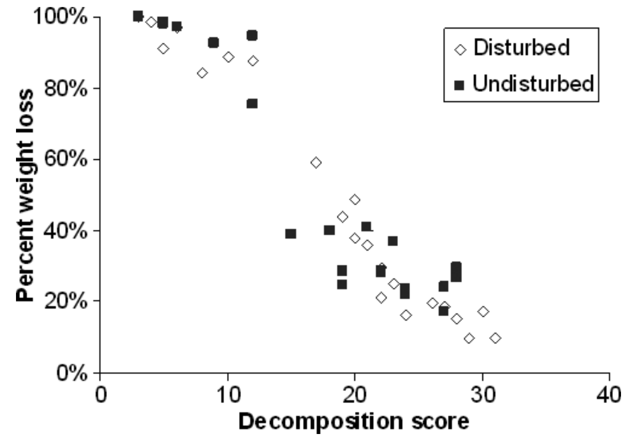

FIG. 5—*Correlation of weight loss and decomposition score.*

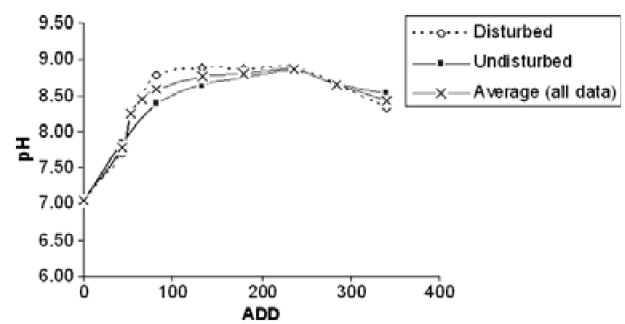

FIG. 6—*Average soil pH.*

effect on weight loss ($F = 2.781$, $p = 0.030$). It can be seen from the weight loss curves (Fig. 4) that these differences take two forms. Firstly, the rate of weight loss differs (the undisturbed samples show faster weight loss) and secondly, the end weight in the undisturbed samples is higher than in the disturbed samples. It was noted in data collection that the undisturbed samples towards the end of the experiment were more difficult to remove from the ground; an accumulation of decomposition fluids and their subsequent drying had the effect of "glueing" the carcass to the ground. On removal of the carcass for weighing, large amounts of soil were still adhering to the carcass and, while this was removed as far as possible, it is believed the end weight result reflects this artifact.

As decomposition had been numerically scored, it was possible to statistically assess the correlation between weight loss and decomposition (Fig. 5). Strong correlations were observed in both disturbed and undisturbed groups. These correlations were negative, demonstrating that as decomposition advanced, so the weight of the carcass decreased. Pearson correlation coefficient for the disturbed samples was −0.98 and for the undisturbed samples was −0.942. Both these figures are significant at $\alpha = 0.01$. When considering the data set as a whole (n = 24) the correlation coefficient was −0.96, also significant at $\alpha = 0.01$.

Changes in soil pH over the course of the experiment are shown in Fig. 6. Two-way ANOVA indicated no significant differences in the effects of disturbance ($F = 0.586$, $p = 0.450$) or disturbance over time ($F = 0.888$, $p = 0.522$). As the curves show no significant differences, they can be treated as a single curve for the sake of comparison to other studies. The soil pH climbs steeply until ADD133.2, and remains high until ADD235.6 before starting to tail away. Correcting the data of Vass (3) for a carcass of 0–50 lb weight, maximum pH is reached at ADD133, and falls steeply beginning at approximately ADD250 (data not shown). Our experimental data is close to these approximate figures and it seems reasonable to assume that these data therefore represent the normal progression of decomposition as documented previously (3).

Average carcass temperatures are shown in Fig. 7. Figure 8 shows the same data but documented as degrees from ambient temperature rather than degrees absolute. This gives an indication of how much extra heat was generated by the maggot mass activity, rather

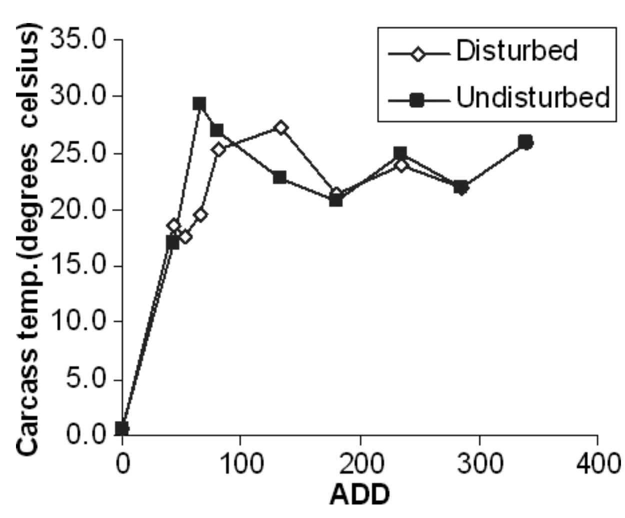

FIG. 7—*Average carcass temperature (absolute).*

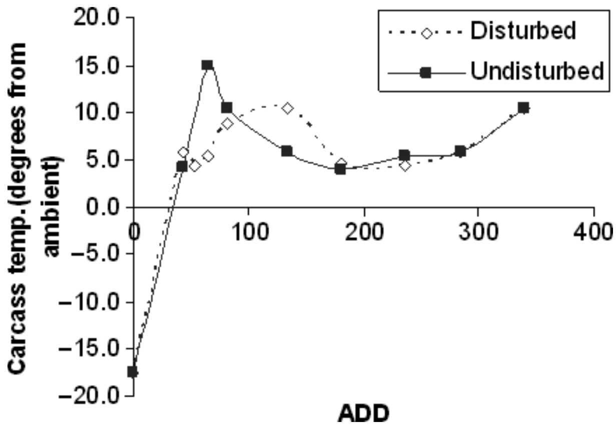

FIG. 8—*Average carcass temperature (degrees from ambient).*

than the actual temperature measured, which is influenced by air temperature. This influence can be seen in the loss (in Fig. 8) of the temperature peak present between ADD200–300 (in Fig. 7). This peak is due to a rise in ambient temperature. The area of interest in these temperature data lies between ADD42 and 180. A two-way ANOVA shows a significant difference ($F = 3.034$, $p = 0.015$) between the disturbed and undisturbed samples. The temperature peak for the undisturbed samples was attained at an earlier time than for the disturbed carcasses. The temperature increase in the disturbed cases was of lesser magnitude but longer duration.

These temperature data are known to reflect maggot mass activity (4,7,26) and the breadth of the temperature peak indicates the duration of this activity. If the assumption is made that the temperature reached is correlated with the quantity of maggots present in the mass (i.e., more maggots will generate a higher temperature), then the height of the peak represents the relative number of maggots present. Maggot activity can thus be quantified using a simple index multiplying the duration and amount of the departure from ambient temperature. This has been designated "Entomological Input Index" (EI Index), and can be calculated from the area under a graph of carcass temperature against time (when measured using ADD). Figure 9 illustrates these measurements, using the departure from ambient temperature and a time interval between 42.8 and 180.6 ADD. This interval was defined by the duration of the average maggot mass temperature peaks. The temperature threshold for this calculation was the average air temperature for the duration

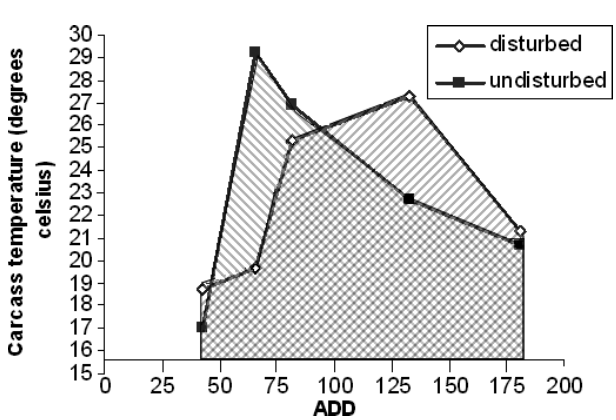

FIG. 9—*Example calculation of Entomological Input Index.*

TABLE 6—*Mean EI index.*

Disturbance level	EI index	Mean EI index	SD
Disturbed	967.22	1101.30	173.02
	968.65		
	1269		
Undisturbed	728.85	1068.29	324.68
	1324.7		
	1250.35		

EI, Entomological Input.

of the given interval. In this case it was 15.6°C. The hatched areas indicate the area calculated for the purposes of EI index.

In order to ascertain whether any significant difference existed between the disturbed and undisturbed samples, EI index was calculated for each disturbance group in all three replicates (Table 6). A two-sample *t*-test for comparison of means showed no significant difference between the indices ($t = 0.155$, $p = 0.884$). This establishes that both the disturbed and undisturbed samples received a similar amount of insect input.

Discussion

In this study, the observed advance of decomposition did not deviate from the accepted progression, although the presence of fur occasionally hampered observation. However, fur loss in itself proved useful in assessing early decomposition and was scored on the basis of the extent of fur loss. Tables 2, 3, and 4 show the scoring system for decomposition, of which fur loss was a part. It is based on the system used by Megyesi et al. (19). Fur loss is comparable with the loosening of hair from hydrolytic enzyme activity in the early PMI (11) in humans, thus giving rise to a "hair mat."

Time to Skeletonization

Recording time as ADD in decomposition studies has been of great benefit to taphonomic research. It enables the comparison of studies across seasons and geographical areas. This study utilized data from Vass (3) in order to predict the TTS for the carcasses. The present study was able to statistically validate those data in terms of the accuracy of the prediction. Similar agreement with those findings was previously demonstrated by Megyesi et al. (19).

Analysis of the TTS figures showed no significant difference between the two groups. Given that no significant differences in the measurement of decomposition were shown between the two groups either, this result is to be expected. It would seem peculiar if TTS should vary significantly when no differences could be shown in the process leading to that point. However, the sample size for the disturbed group in this analysis was small ($n = 3$), and the *p*-value was very close to being statistically significant. A more robust analysis of this particular variable was not practical in this experiment, but a study with the primary purpose of examining TTS conducted on a much larger scale might resolve this issue. As it stands, the assertion of accuracy regarding the TTS data produced by Vass (3) is within acceptable confidence limits.

Decomposition

Analysis of the results showed decomposition over time was not significantly altered by repeated physical disturbance (Fig. 3). This is in agreement with Archer (24), who used this methodology to provide control samples in his study of rainfall and temperature.

His data, however, related only to decomposition stage and he did not assess any constituent factors independently.

This result is of interest because, when decomposition was assessed as expressions of its constituent parts, significant differences in the way disturbed and undisturbed carcasses decompose *were* seen. The results of this experiment showed that, while individual expressions of decomposition (e.g., weight loss, carcass temperature, etc.) responded differently to disturbance, when these factors were combined to give decomposition as a whole, the differences were negated.

The study demonstrates, however, that certain expressions of decomposition (namely, weight loss, and carcass temperature) *are* significantly affected by repeatedly disturbing a carcass. Should either of these factors be used as a measure of decomposition, attention should be paid to ensuring that adequate experimental controls are used.

Weight Loss

Weight loss is frequently used as a marker for decomposition. This experiment was able to show a strong correlation between weight loss and decomposition score, and therefore validated this factor as a suitable indicator for the advancement of decomposition. However, the results also showed a significant difference in the way disturbance affected weight loss. The disturbance may have indirectly delayed insect development. Disturbance may physically disperse the maggot mass and prevent it from establishing so quickly. In the late stages of decomposition, it is possible that the disturbed carcasses had more maggots associated with them than the undisturbed carcasses, if they were developing slower. It is also possible that the disturbance renewed access to the carcass and liberated odors, attracting flies for longer than the undisturbed carcasses, so that overall a greater number of maggots were present in the later stages. Finally, perhaps the disturbance affected the chemical decomposition of the carcass and enabled it to progress further, resulting in increased skin loss, for example, and less mummified tissues present. This would be possible if disturbance had an effect on oxygenation, for example, or temperature, or water loss. It seems plausible that physical disturbance may "mix" the decomposition fluids and more evenly distribute them about the carcass. This could potentially increase autolysis.

Given the magnitude of the weight difference at the end of the experiment, the most likely explanation is that of artifactual data reflecting attached soil to the mummifying remains of the carcass. It seems improbable that the other explanations could account for a weight difference of just over 10% (= 160 g in a 1600 g average rabbit carcass).

The results demonstrated a faster weight loss in the undisturbed carcasses. This would seem to indicate that decomposition was progressing faster in this group. A possible mechanism for this may involve insect activity. It is to be assumed that weight loss and carcass temperature are inextricably linked via this medium. It is interesting to note that carcass temperature was the only other variable to show a significant response to the effects of disturbance over time. In addition to the faster weight loss, the undisturbed carcasses showed a higher internal temperature, which was attained faster than the maximum temperature achieved in the disturbed group. One explanation for both of these findings is that of increased maggot activity. Maggot masses generate heat within a carcass (4,7,26), and the higher temperatures attained in the undisturbed carcasses indicate that more maggots were present and perhaps that they were also more active. This could easily account for the greater weight loss that is seen. Quite simply, more maggots will eat through a carcass quicker. Thus, higher temperatures may be due directly to the lack of physical disturbance, giving the developing insect populations more chance to become established. Repeated disturbance may physically disperse the maggot mass and lead to heat dissipation (delaying development) and a time delay in consumption of the carcass as they have to recongregate. This could explain the slower weight loss and temperature differences in the disturbed carcasses.

Temperature

As already mentioned, disturbance interacting with time caused a significant effect on carcass temperature. The undisturbed samples reached a higher temperature, sooner than the disturbed samples. This disturbed carcass temperature also reached a maximum, but produced a temperature peak over a longer time span than the undisturbed samples. After this initial difference both groups showed similar temperature curves for the remainder of the experiment.

It is well known that maggot masses generate their own heat (4,7,26). This is the cause of internal carcass temperature being above ambient temperature. The difference in data between the two disturbance groups can be attributed to a difference in insect activity in the carcasses. It would seem that, in the absence of disturbance, maggot masses are more quickly established giving the faster temperature increase. It may be that the undisturbed carcasses received more attention from adult flies and consequently had greater numbers of maggots colonize them. This greater activity may account for the higher temperature relative to the disturbed carcasses. Physical disturbance may (i) prevent the adult flies from ovipositing on the carcass as frequently (thus giving rise to fewer maggots and hence a lower maximum temperature) and (ii) prevent hatched maggot colonies from establishing themselves (thus delaying the onset of the temperature peak relative to the undisturbed carcasses).

The effect that the higher temperatures of the undisturbed carcasses would have on the resident maggot population is to speed their development. As the maggots develop faster, so they consume—and leave—the carcass quicker, accounting for the higher temperature of shorter duration (Fig. 8). This increased speed of consumption would be visible in terms of weight loss; the undisturbed carcasses would lose weight quicker than the disturbed ones. This was indeed the case (Fig. 4).

EI Index

A numerical "EI" index was calculated based on the maximum temperature attained multiplied by the duration of that temperature. This index reflects the amount and duration of maggot activity. In this study, the two EI indices did not differ significantly. This indicates that the two disturbance groups received a similar amount of EI. This could account for the overall decomposition of the two groups remaining the same regardless of disturbance. It appears that while the dynamics of the decomposition process may be slowed by repeated disturbance, the overall outcome of the process remains the same.

Conclusion

This study illustrates that the reductionist approach to processes such as decomposition may not always be the best approach; in trying to break the system down into its parts, essential elements of the system as a whole are lost. It would seem that scoring decomposition directly yields a more accurate picture of the process. It is to be hoped that such scoring systems become available in the future, and are easy to use. Just as the use of ADD has "standardized" the measurement of temperature over days, enabling comparison of studies, so perhaps the development of decomposition scoring schemes may do the same.

The importance of using ADD as a time construct in experiments of this type cannot be underestimated. Without it, comparison to other studies becomes impossible. At present, every decomposition study stands in isolation. However, the standard use of ADD will facilitate the comparison of data from *all* decomposition experiments regardless of local environment and season. As Megyesi et al. (19) have already demonstrated, stage of decomposition can accurately predict ADD interval. It is only reasonable to assume that the reciprocal relationship holds and ADD can also predict decomposition stage. This would begin to allow the construction of generic taphonomic models, which will enhance further study of decomposition processes.

Despite differences in some of the marker variables, no overall difference was shown in the decomposition between the two groups. This result was unexpected and the area would benefit from further consideration. As a preliminary study into the effects of disturbance on decomposition; however, this work establishes significant effects in some variables associated with the process. These constituent markers (weight loss and carcass temperature) can both be associated with insect activity and it is believed that this may be one of the keys to understanding the effects of disturbance.

This study demonstrates that repeated disturbance such as that associated with data collection can significantly affect individual variables that contribute to the overall decomposition process. It also shows the precise nature and importance of the relationship between insect activity and decomposition. This relationship needs further exploration in order to more fully understand the interactions taking place. Such understanding will lead to advances in the accuracy of PMI estimations, and the application of this knowledge will thus benefit many forensic practitioners. The increasing use of standardized protocols in taphonomy studies can only enhance the comparability of experiments, which in turn will facilitate subsequent understanding and application.

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