The Effect of Various Soil Types on Decomposition Rate

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Edited by Gillian Lane and Adrienne Brundage

Abstract: The decomposition rate of soft tissues can vary depending on different environmental factors, including soil content. Prior knowledge suggest that it would take longer for a carcass to decompose in sand than it would in manure. However, it is difficult to estimate the degree at which these changes would affect the decomposition rate and process. Three chicken carcasses were placed in plastic bins containing sand (S), topsoil (T), and a compost/manure mixture (M). The decomposition rates of chicken carcasses in the various soil types were observed over a four-week period. The recorded data was analyzed and used to determine any major differences in how soft tissue decomposes in various environments. After the four-week period, it was determined that the compost/manure mixture caused the fastest decomposition rate followed by the topsoil and then the sand.

Keywords: Decomposition, Soil Types, Forensic Taphonomy, Post-mortem Interval

The decomposition rate of soft tissues can vary depending on a number of different environmental factors and is therefore difficult to quantify in a universal sense. The general stages of decomposition and their order is known, as well as a general idea of how long it takes a decomposing corpse to go through each step of the process under certain conditions. Over the years, multiple tests and research has shown that the decomposition rate of tissues is directly related to the ambient temperature and moisture level of the environment in which the body is located and is inversely proportional to the amount of protection the cadaver has from the elements (The Forensics Library). For example, the time necessary for a body to progress from one stage of decomposition to the next while it is located above ground in an open space will be much shorter than the time necessary for a similar body that is located in a lake. Furthermore, the body in the lake would take a much shorter amount of time to progress than a body that is buried six feet underground. Additionally, the depth at which a body is buried has an effect on the rate of decomposition in that the deeper the body is buried, the slower it will decompose (Rodriguez and Bass). However, there are certain properties within different types of soil that create a varying environment for the carcass depending on where it is buried. The ability for soil to retain heat is directly correlated with the amount of moisture the soil contains (M S et al.). The use of manure increases the soil's carbon content which improves the water retention of the soil (J. Arriaga and Lowery). Moreover, sand lacks the ability to support the presence of organic matter such as microorganisms that aid in decomposition (Yakubu), while compost and manure has the potential to add nutrients and microorganisms to its surrounding environment as well as foster the bacteria and fungi that are already present (Zhen et al.). Using this information, one could conclude that it would take longer for a carcass to decompose in sand than it would in manure. However, it is difficult to estimate the degree at which these changes would affect the decomposition rate and process. In order to determine this, chicken carcasses were placed in three different soil types and their rate of decomposition was observed and recorded over four weeks. The results were analyzed and used to determine if there were any major differences in how soft tissue decomposes in various environments.

Material and Methods

Samples of the three soil types were gathered from a local home improvement store along with nine plastic containers with lids. Each of the nine bins were partially filled with their designated soil type (three bins per soil type). A chicken carcass was placed in each partially filled bin and then covered with the designated soil type until the bin was full. The soil types were: A) sand (S) (Oldcastle Kolor Scape 0.5 cu ft Tan/Brown Paver Base), B) topsoil (T) (Garden Pro Multi Purpose Topsoil), and C) manure/compost mixture (M) (Timberline Cow Manure and Compost). A lid was placed over each bin to hamper any scavenger's attempts to eat the chicken carcasses. The bins were then placed in a secluded area where they were not likely to be disturbed.

Chickens were examined by removing the lid from the bin and gently scooping through the soil that covered the carcass until the carcass was exposed enough to observe. The rate of decomposition was based on the visual appearance, smell, and how the carcass flesh felt to the touch. The carcasses were checked once a week for four weeks. Any signs of decomposition were recorded, and the data was catalogued with pictures and notes describing the varying states of decay.

Results

The S1 chicken carcass was eaten by a predator during the first week and was therefore unavailable for observation for the rest of the experiment.

After the first week of burial, S2 and S3 presented with discoloration of the outer layer of the flesh of the carcass with a slight putrid smell present in the bins. The T1 and

T2 carcasses both had flies present around the carcasses, as well as a slight putrid smell emanating from the bins, but no signs of the discoloration that was found in the S2 and S3 carcasses. The T3 carcass had the same signs of decomposition as the T1 and T2 chickens, but it also had multiple large maggots on and around the carcass. The M1, M2, and M3 chicken carcasses all had slight discoloration of the exterior of the chicken's flesh as well as a slimy texture, and an intense putrid smell.

After the second week of burial, S2 and S3 were mostly discolored around the exterior of the carcasses, but no further signs of decomposition were present. The T1, T2, and T3 all had slight discoloration of their carcasses along with the presence of maggots (Figure 1), and an intense putrid smell.

Fig. 1. Presence of maggots in T3

However, T2 also had some small, white, egg shaped structures on the soil covering the carcass (Figure 2).

Fig. 2. Egg shaped structures on T2

M1, M2, and M3 had major discoloration of the carcasses' flesh as well as a slimy texture and an intense putrid smell. Additionally, M2 and M3 both had palpable deterioration of the chicken's muscles, as well as the continued presence of large maggots around the carcass of M3.

After the third week of burial, S2 showed signs of discoloration under the superficial exterior layer of the carcass and had a slight putrid smell. The S3 chicken, however, had small maggots present in the crevices and folds of the carcass (Figure 3),

Fig. 3. Small maggots present in S3

but not around the exterior where the carcass was touching the sand, and had a slight putrid smell. T1 and T3 both had the same white, egg-like structures on top of their soil that the T2 had the previous week, along with major discoloration of the carcass, and large maggots were found on T3. T2 now had mushrooms growing from the soil above the carcass where the white, egg like structures were the previous week (Figure 4)

Fig. 4. Mushrooms growing on T2

along with major discoloration of the carcass and an intense putrid smell. M1, M2, and M3 all had partial skeletonization of the carcass and palpable deterioration of the remaining meat on the chicken (Figure 5 and 6),

Fig. 5. Partial skeletonization of M1

Fig. 6. Deterioration of muscle in M2

and a noticeable putrid smell that was not quite as strong as it had been the previous weeks. Large maggots were found surround the areas of M1 that still had some accessible meat left. M2 and M3 presented a hardening of the skin around areas of the carcass that gave it a rough texture.

After the fourth and final week of being buried in the bins, the S2 had complete discoloration of all layers of the flesh as well as the beginnings of mummification of the carcass (Figure 7).

Fig. 7. Discolored flesh and mummification of the carcass in S2

S3, on the other hand, had no signs of mummification, only more discoloration present in the lower layers of the chicken's flesh as well as some flies around the bin. T1, T2, and T3 all had palpable deterioration of the meat around the carcass's extremities (wings and thighs) without much change in the interior of the carcass other than a slimy texture and some discoloration in T2 (Figure 8).

Fig. 8. Slimy texture and discoloration in T2

There was an increase in the skeletonized area of the M1, M2, and M3 carcasses, as well as the continued presence of a putrid smell. The soil surrounding the M1 chicken had turned white and moldy texture (Figure 9),

Fig. 9. White and moldy soil surrounding the M1 chicken

and the skin of the M2 and M3 carcasses had hardened slightly in some of the deteriorated areas of the remaining flesh (Figure 10).

Fig. 10. Hardened skin on the M3 chicken

Discussion

Throughout the four weeks of observation, the carcasses in the manure/compost mixture decomposed the fastest, reaching almost complete skeletonization over this time period. This is likely due to the conditions that the properties of manure and compost create. The manure and compost mixture is very rich in microorganisms and bacteria that are working to decompose the soil and organic matter around them which produces excess heat (Science of Composting). This combined with its ability to retain moisture, the manure/compost mixture creates the most ideal conditions necessary for the acceleration of the decomposition process in this soil type. However, the rate of decomposition observed in the topsoil samples was never very far behind; normally averaging about a week or two slower than the manure samples to reach certain stages of decomposition. Additionally, the appearance of mushrooms on the T2 soil in week three suggests that with the amount of nutrients that the chicken carcass was releasing into the soil, the microorganisms already present in the topsoil were provided with the nutrients necessary to be able to grow into these small mushrooms along the edges of the area covering the carcass. By feeding on the chicken carcass, these mushrooms also sped up the decomposition process until the amount of nitrogen being released by the carcass became too much and killed them (Rodriguez and Bass). Since fly larvae feed on the soft tissue of decomposing organisms, the presence of maggots on or around the bodies in T1, T2, and T3 for the majority of the experiment is likely another major factor that greatly contributed to the decomposition rate of the chicken in the topsoil (Bertolini). These maggots likely would've had the most time on the topsoil carcasses because their growth is dependent largely on the temperature of their surroundings, which would have been slightly lower in the topsoil than in the manure/compost mixture (Danks).

The sand, as predicted, was the slowest to decompose, not even getting maggots until week 3 with S3. Moreover, by the end of the experiment, S2 was showing signs of mummification. This is likely because the grainy texture of sand is good for absorbing moisture from its surroundings but is not very capable of retaining that moisture for long periods of time. The sand dried out the carcass leading the tissues to become rough and leathery, and mummify in the soil (Lefebvre). Unlike topsoil and manure, sand also lacks the ability to retain much heat, so that would have had a negative effect on the decomposition rate as well.

It was evident during this experiment that depending on the type of soil a body is buried in, there is a major change in the process and rate of decomposition observed. This data could potentially assist forensic investigators in determining a more accurate post-mortem interval (PMI) of bodies found in various environments.

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