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A comparison between decomposition rates of buried and surface remains in a temperate region of South Africa

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Abstract Several studies have been conducted on decomposition patterns and rates of surface remains; however, much less are known about this process for buried remains. Understanding the process of decomposition in buried remains is extremely important and aids in criminal investigations, especially when attempting to estimate the post mortem interval (PMI). The aim of this study was to compare the rates of decomposition between buried and surface remains. For this purpose, 25 pigs (*Sus scrofa*; 45–80 kg) were buried and excavated at different post mortem intervals (7, 14, 33, 92, and 183 days). The observed total body scores were then compared to those of surface remains decomposing at the same location. Stages of decomposition were scored according to separate categories for different anatomical regions based on standardised methods. Variation in the degree of decomposition was considerable especially with the buried 7-day interval pigs that displayed different degrees of discolouration in the lower abdomen and trunk. At 14 and 33 days, buried pigs displayed features commonly associated with the early stages of decomposition, but with less variation. A state of advanced decomposition was reached where little change was observed in the next ±90–183 days after interment. Although the patterns of decomposition for buried and surface remains were very similar, the rates differed considerably. Based on the observations made in this study, guidelines for the estimation of PMI are proposed. This pertains to buried remains found at a depth of approximately 0.75 m in the Central Highveld of South Africa.

Keywords Accumulated degree days · Forensic anthropology · Post mortem interval · Decomposition · Total body score · Buried remains · Decomposition rates

Introduction

With the rising incidences of violent crime and death in South Africa (5% average increase over a period of 10 years [2004–2014]) [1], the need for knowledge of decomposition in different settings is becoming increasingly important. Decomposition studies within a forensic context are often aimed at estimating the post mortem interval (PMI).[2] The PMI estimation remains a very complicated assessment due to the vast number of variables influencing the patterns and rate of decomposition [3]. While bodies decomposing on the soil surface may reach skeletonisation within weeks, buried remains may take months or even years under favourable conditions to reach the same stage [4, 5]. To further complicate an accurate PMI estimation, decomposition rates of buried bodies decrease with burial depth due to lower in-soil temperatures, less insect activity and grave soil moisture content [6]. For this reason, developmental and succession data taking into consideration a great number of geographical regions and death scene scenarios are essential [7].

According to Fiedler and Graw [8], the rate of decomposition in both buried and surface remains depends mainly on three factors, namely (1) scavenger activity, (2) insect

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colonisation and (3) temperature. Remains are usually protected from scavenger activity when buried at a depth of about a meter and/or deeper. Buried remains also reduce oviposition of insects as it can only be colonised by a minority of insects [8]. Remains on the surface are vulnerable to scavengers, which normally leads to the destruction of soft tissue, gnawing on the bones and acceleration of the decomposition process [4]. Even though stages of decomposition are very similar in some respects [9–11], it is important to note that decomposition stages will not always accurately describe the decomposition process, as decomposition occurs under varying conditions and many factors play a role in the patterns and tempo of decomposition. However, fewer variables are associated with in-soil decomposition than surface decomposition, as there is no access by scavengers, limited insect activity and reduced temperature fluctuations. Therefore, one should potentially be able to get a narrower estimate than what is the case for surface remains.

Researchers have been trying to establish standardised decomposition stages for decades. When decomposition stages are standardised by making use of quantifiable methods, for example total body scores (TBS) and accumulated degree days (ADD), data can be compared with similar studies, replicated and validated. A clear description of decomposition rates within specific geographical areas may assist investigators to estimate a more reliable PMI. In 2005, Megyesi et al. [10] proposed a sequential ranking model in order for the decomposition scores to reflect the smaller sequential changes that took place, focusing specifically on the accumulative effect of temperature the remains were exposed to. Megyesi et al. [10] concluded that over 80% of the variation in decomposition could be accounted for by the combination of ADD and elapsed time [10, 12]. One can therefore assume that ADD can also predict stages of decomposition [13]. ADD would allow for the construction of taphonomic models for scoring decomposition rates which will enhance future studies on decomposition processes.

The aim of this study was to compare the rates of decomposition between buried and surface remains, using a pig model, in a temperate region of South Africa. Burial, in this case, refers to shallow burials as would be the case in clandestine graves found in forensic contexts.

Materials and methods

The study site for this research project is situated at the Forensic Anthropology Body Farm (FABF) on the Miertjie le Roux Experimental Farm belonging to the Faculty of Natural and Agricultural Sciences of the University of Pretoria, South Africa. The farm is located at Kaalfontein 513 JR, in the Cullinan District, Gauteng Province (25°47′20.2″S; 28°32′34.3″E), approximately 45 km east of Pretoria, Gauteng Province. This farm has a total size of 560 ha and is situated on the central Highveld plateau of South Africa. This is a temperate region of the country with warm summer days and temperatures rarely below 0 °C even in winter. Rainfall mainly occurs during the spring and summer months of September to April (with an average 650 mm of rainfall per annum) and vegetation mostly consists of sour veldt grasslands.

For purposes of this study, *Sus scrofa*, or domestic pig carcasses were used, as pigs are considered acceptable proxies for humans. Although differences in the decomposition pattern of *Sus scrofa* carcasses versus human cadavers have been noted [14], pigs have been accepted as proxies for human bodies because they share many biological characteristics, such as comparable skin thickness, body size and the amount of body hair [15, 16].

Pig carcasses ($N = 25$) were donated from two local farmers and buried within 24 h after natural death. According to these farmers, death is usually caused by *E. coli* (*Escherichia coli*) and Salmonellosis (*Salmonella choleraesuis*) infection. All pigs in this study had a weight range of between 45 and 80 kg. As it has been shown that smaller pigs decompose at a much faster rate than large pigs [17], no pigs smaller than 45 kg were included. This weight range was also chosen as it resembles the average weight of an adult human. Five pigs were excavated for each predetermined time category from the date of burial. Each pig was allocated a number, and the date of placement (same as date of death), sex and weight were measured and recorded prior to placement in graves (Table 1).

Shallow burial pits were dug by means of a back actor to an average dimension of 2.25 m × 1.22 m with a depth of 0.75 m to simulate clandestine graves of buried victims (neither shallower than 0.4 m nor deeper than 0.9 m) [18]. The remains were placed in direct contact with soil. The pigs were not covered with additional objects (i.e., plastic) or clothed. Pigs were numbered and placed in sequence of arrival at the farm and observed in situ.

The decomposition rates for buried remains were observed at different time intervals (1 week, 2 weeks, 1 month, 3 months and 6 months) over a period of 10 months (September 2014 to June 2015). TBS was used to assess the rate of decomposition, and the qualitative descriptions of the stages of decomposition were converted into quantitative scores. The allotted point values of each region were then added to determine the TBS which represents the overall stage of decomposition of each pig (from a minimum of three to a maximum of 35 points). An improved equation for ADD and a redefined scale range (from a minimum of zero to a maximum of 32 points) was suggested by Moffatt et al. [19]; however, in order to compare results found in the Myburgh [20] study on surface remains, the Megyesi et al. [10] TBS scales were also used in this study.

ADD was calculated by adding together the daily average temperature for the duration of the data collection

Table 1 Summary of the date of death and excavation, sex, weight and metric dimensions of the pigs

Pig	Date of placement	Date of excavation	Sex	Weight (kg)
1	30/09/2014	31/03/2015	Male	80
3	30/09/2014	31/03/2015	Male	45
4	30/09/2014	31/03/2015	Male	45
6	30/09/2014	31/03/2015	Male	70
7	30/09/2014	31/03/2015	Male	73
15	09/10/2014	10/11/2014	Male	70
16	09/10/2014	10/11/2014	Male	80
17	09/10/2014	10/11/2014	Male	80
19	09/10/2014	10/11/2014	Male	65
20	09/10/2014	10/11/2014	Male	50
21	24/11/2014	08/12/2014	Male	80
22	24/11/2014	08/12/2014	Male	66
24	24/11/2014	08/12/2014	Male	60
25	24/11/2014	08/12/2014	Male	60
26	24/11/2014	08/12/2014	Male	58
28	19/03/2015	18/06/2015	Male	45
29	19/03/2015	18/06/2015	Male	60
30	19/03/2015	18/06/2015	Male	55
31	23/03/2015	22/06/2015	Female	70
32	23/03/2015	22/06/2015	Female	48
33	13/04/2015	20/04/2015	Male	80
34	13/04/2015	20/04/2015	Female	75
35	13/04/2015	20/04/2015	Female	76
36	13/04/2015	20/04/2015	Male	45
40	13/04/2015	20/04/2015	Female	64

phase. This information was obtained from the closest South African National Weather Service Station, approximately 23 km south-east of the burial site, based in Bronkhorstspruit. The results from this study for buried remains were then compared to the results found in the study done by Myburgh [20] on surface remains with respect to TBS relative to ADD. Both studies were conducted at the same research facility.

In order to assess the rate of decomposition of the raw data, the PMI and TBS, and TBS and ADD were compared using linear regression. As longitudinal data were used, random-effects maximum likelihood regression was applied to model ADD and PMI. Also, as both PMI and ADD results produced skewed distributions on the original scale, PMI and ADD was log-transformed so as to be linearly related with TBS. All relationships were compared using their coefficients of determination (r-squared value). In order to explain the percentage of the variation in logPMI and logADD that can be explained by the variation in TBS, the coefficients of determination was multiplied by 100.

Results

As was expected, buried remains reached much lower TBS values compared to surface remains within similar periods (Table 2). Initially, the TBS of all pigs followed a logarithmic curve during decomposition. During the early decomposition stages (a PMI of 7 days), decomposition followed a linear pattern for both groups. Buried remains reached an average TBS of 9.6 after 7 days of burial (Table 2) compared to surface remains that decomposed much faster reaching an average TBS of 13.8 in the same period. TBS and decomposition rates began to vary drastically between buried and surface remains between 8 and 15 days as surface remains decomposed more rapidly. After a PMI of 14 days, buried remains had an average TBS of 13.4 (±3.8) compared to surface remains with a score of 22.6 (±8.8).

After rapid decomposition during the early phase, decomposition rates slowed considerably where little change was noted after 32 days PMI. Buried remains reached an average TBS of 17.4 and surface remains averaged 25.2 after approximately 1 month of burial. During advanced decomposition, the TBS did not increase much for either buried or surface remains, with TBS values of 20.4 and 22.2 observed after 92 and 183 days, respectively, for the buried remains. A similar plateau phase was observed with surface remains which reached an average TBS of 28.2 after 92–93 days and 29.8 after 162–175 days.

A comparison of TBS vs. PMI or ADD for both buried and surface remains shows a non-linear relationship (Figs. 1 and 2). In both groups, decomposition rates followed a curvilinear pattern indicating rapid decomposition during early decomposition where after the rate of decomposition slowed down during the later stages.

The averaged TBS values for surface remains are higher than buried remains within the complete timeframe and are also much more spread out (wider ranges), emphasising the higher degree of variation seen in surface remains. After 2 weeks (313.1 ADD), there was a noticeable difference between the groups (an averaged 9.8 score difference) after which decomposition slowed down to reach the plateau phase (between 665 and 3860.6 ADD). TBS differences remain, on average, 7.7 between buried and surface remains during the plateau phase. Throughout the study period, TBS remained higher for surface remains. The greater rate of decomposition for surface remains may be due to exposure to insects and higher temperatures where in contrast, buried remains were protected from these elements by their burial depth and the moist soil surrounding the remains.

Table 3 indicates how the PMI can be estimated from the TBS or ADD of burials based on the observations made in this study. It also shows the corresponding values for surface remains [12]. The estimation would, however, pertain to adult remains with a weight range between 45 and 80 kgs (Table 1).

Table 2 Summary of PMI and TBS scores of buried and surface remains

Buried Remains					Surface Remains				
Pig number	Sex	Kg	PMI/TBS	Avg TBS	Pig number[a]	Sex	Kg	PMI/TBS	Avg TBS
33	M	80	7/10	9.6	7	M	38	7/9	13.8
34	F	75	7/11		8	M	68	7/8	
35	F	76	7/8		9	M	80	7/21	
36	M	45	7/9		12	M	85	7/17	
40	F	64	7/10		28	M	91	6/14	
21	M	80	14/13	13.4	20	M	65[b]	15/23	22.6
22	M	66	14/14		23	F	75[b]	15/21	
24	M	60	14/13		24	F	75[b]	15/23	
25	M	60	14/13		25	M	85[b]	15/21	
26	M	58	14/14		26	M	68	15/25	
15	M	70	33/16	17.4	10	M	80[b]	32/25	25.2
16	M	80	33/20		11	F	59	33/23	
17	M	80	33/16		14	M	74	32/21	
19	M	65	33/16		21	M	65[b]	32/26	
20	M	50	33/20		22	M	70[b]	32/31	
28	M	45	92/20	20.4	13	F	80[b]	92/24	28.2
29	M	60	92/22		15	M	80[b]	93/29	
30	M	55	92/21		16	M	65[b]	93/31	
31	F	70	92/20		17	M	75[b]	92/29	
32	F	48	92/19		18	F	65[b]	92/28	
1	M	80	183/21	22.2	1	M	82	175/31	29.8
3	M	45	183/21		2	F	75	169/32	
4	M	45	183/23		4	F	55	168/30	
6	M	70	183/25		5	F	63	163/25	
7	M	73	183/21		6	F	83	162/31	

[a] From the [20] study

[b] Estimates

Also, the estimations will only be applicable for remains found at approximately the same depth (0.75 m) in the Central Highveld region of South Africa with similar environmental factors as it is not yet known if the process of decomposition would be different in other regions within South Africa. Although pigs share many biological characteristics with humans, it should be kept in mind that differences in decomposition patterns could arise when applying these PMI estimates to cadavers.

When insects or insect activity is visible on buried remains, it is suggested that the estimated PMI be shortened as insects might accelerate the rate of decomposition due to the

Fig. 1 TBS vs. PMI for buried (N = 25) and surface (N = 25) remains with similar PMIs (Table 2 contains details as some points overlap due to similar values for buried and surface remains)
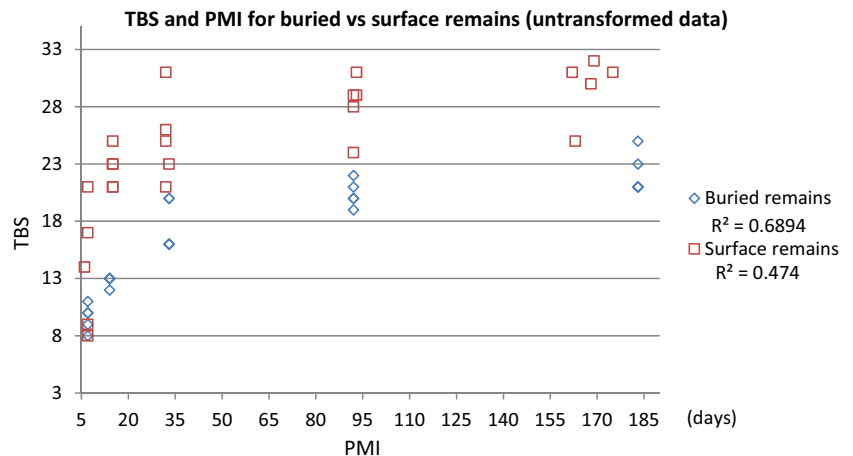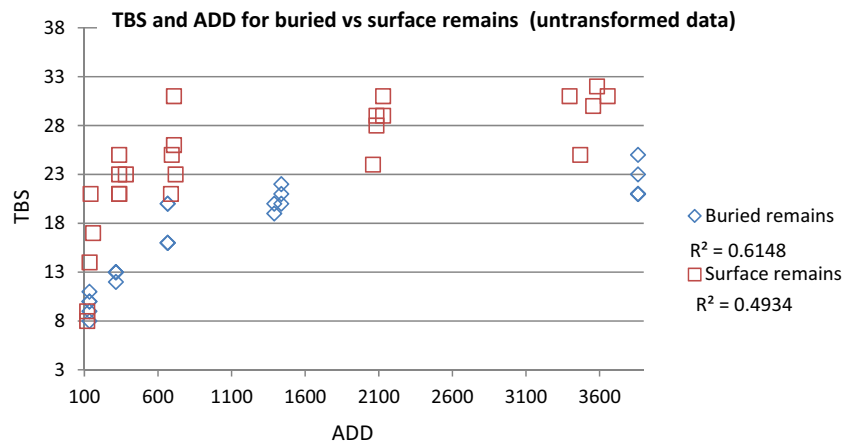

TBS and PMI for buried vs surface remains (untransformed data)

◇ Buried remains
R² = 0.6894
□ Surface remains
R² = 0.474

Fig. 2 TBS vs. ADD for buried (*N* = 25) and surface (*N* = 25) remains with similar PMIs (Table 2 contains details as some points overlap due to similar values for buried and surface remains)

consumption of soft tissue. On the other hand, adipocere formation on remains should suggest a longer PMI estimation as adipocere can delay the rate of decomposition on remains.
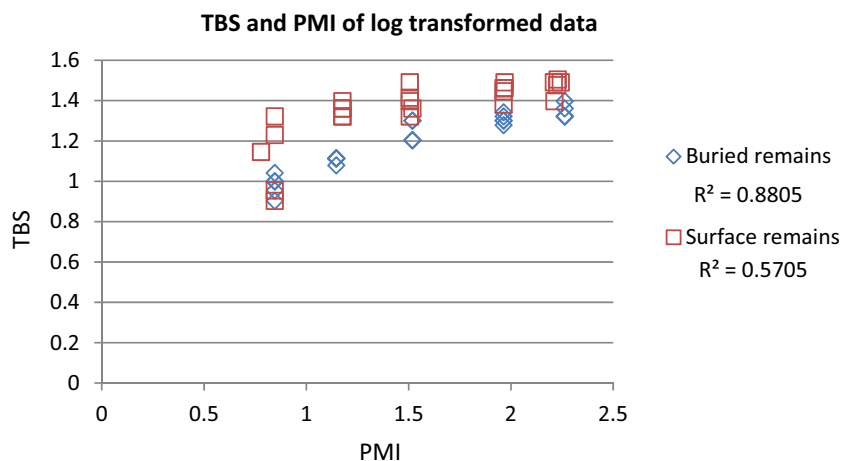
In the untransformed data for TBS of buried remains, PMI accounted for 68% of the variability in decomposition, while PMI accounted for 47% of the variability for surface remains (Fig. 1). TBS and PMI are thus much better correlated for buried than surface remains. When plotting TBS vs. ADD, the *r* value increases somewhat for surface remains to 49% and declines for buried remains to 61% (Fig. 2); although PMI is of course always the constant factor and the value that we attempt to determine either by means of TBS or by means of ADD. In this instance, ADD reflects the amount of temperature (degree days), whereas PMI reflects the passage of time.

Therefore, in this case, it was attempted to assess what contributes most to the observed decomposition changes; temperature or simply elapsed time. As the correlation between TBS vs. PMI and TBS vs. ADD was not too different for buried remains, data was log-transformed to determine the relationship between TBS vs. PMI and ADD, respectively. By log transformation, a more linear curve was produced which provided for easier interpretation of the data and a better indication of the relationship between TBS and PMI. This allowed for the use of random-effects maximum likelihood regression. Log transformations produced improvements in the *r*-squared value for TBS (Figs. 3 and 4). The *r*-squared value increased from 0.6894 (Fig. 1) to 0.8805 (Fig. 3) for buried remains and from 0.474 (Fig. 1) to 0.5705 (Fig. 3) for

Table 3 PMI estimation for buried vs. surface remains in the Central Highveld region of South Africa

Buried remains				Surface remains			
Estimated PMI	Estimated ADD (daily avg. 23 °C)	Estimated TBS (days)	Description of remains	Estimated PMI	Estimated ADD (daily avg. 23 °C)	Estimated TBS (days)	Description of remains
4–9 days	90–200	8–11	Bloating Purging of fluids Skin slippage	4–9 days	90–200	11–17	Insect activity Bloating Discolouration Drying of extremities
10–18 days	250–450	9–15	Sagging of trunk Discolouration	10–18 days	250–450	18–24	Purging of fluids Bone exposure Insect activity
24–40 days	550–900	14–19	Bloating Adipocere Insect infestation	24–40 days	500–1000	23–26	Bone exposure Insect activity
56–100 days	1300–2300	17–22	Dark discolouration Strong putrid smell Adipocere Partial skeletonisation Collapsed trunk	56–100 days	1800–2600	25–29	Desiccated tissue Grease on bone Mummification
152 days +	3500 +	20–35	Black skin interface Adipocere Skeletonisation of the head	152 days +	3300 +	28–35	Dry bone Mummification

Fig. 3 LogTBS vs. PMI for all pigs indicating the regression relationship (Table 2 contains details as some points overlap due to similar values for buried and surface remains)

surface remains. Therefore, the log-transformed data for TBS against PMI for buried remains has a strong correlation of 88% indicating that the variability in decomposition are higher in surface remains (57%).

TBS was also plotted against ADD (Fig. 4) and log-transformed. When ADD and TBS data were logged (Figs. 2 and 4), the r-squared value increased from 0.6148 (Fig. 2) to 0.8717 (Fig. 4) for buried remains and from 0.4934 (Fig. 2) to 0.6218 (Fig. 4) for surface remains. The greater increase in the r-squared values in buried remains is due to the log transformation; however, the difference in degree of improvement between PMI and ADD after transformation is important as it reflects the effect of temperature in the two groups. In this study, the log-transformed r-squared values remained very similar for buried remains (88% for PMI and 87% for ADD), irrespective of the use of PMI and/or ADD (1% difference). The log-transformed r-squared value increases from 57% (PMI) to 62% (ADD) for surface remains, indicating a 5% stronger correlation. ADD is therefore a better descriptor of decomposition for surface remains, whereas for buried remains, PMI (lapsed time) is more closely correlated with TBS.

Table 4 summarises the average TBS at the different PMI intervals for the different anatomical regions scored for the

buried remains. The most prominent change in decay was observed during the early stages of decomposition (7–14 days), which slows down considerably after 33 days of burial. From Table 4, it can be seen that decomposition progressed more rapidly in the head and neck regions than the rest of the body. Following rigour mortis and the predictable pattern known as Nystens' Law, rigour first appears in the small muscles of the face and then spreads to the neck, trunk, upper limbs and lower limbs [21]. This same general pattern can be seen in the progression of the TBS scores. As is expected, decay is slowest in the limbs.

Figure 5 indicates that the variability in decomposition for buried remains is less than that of surface remains. The more linear pattern for buried remains suggests a more predictable decomposition process.

Discussion

In this study, the rates of decomposition between buried and surface remains were compared, using a pig model. This study took a quantitative approach to observe decomposition of buried remains, an area in the realm of forensic anthropology with

Fig. 4 LogTBS vs. ADD for all pigs indicating the regression relationship (Table 2 contains details as some points overlap due to similar values for buried and surface remains)
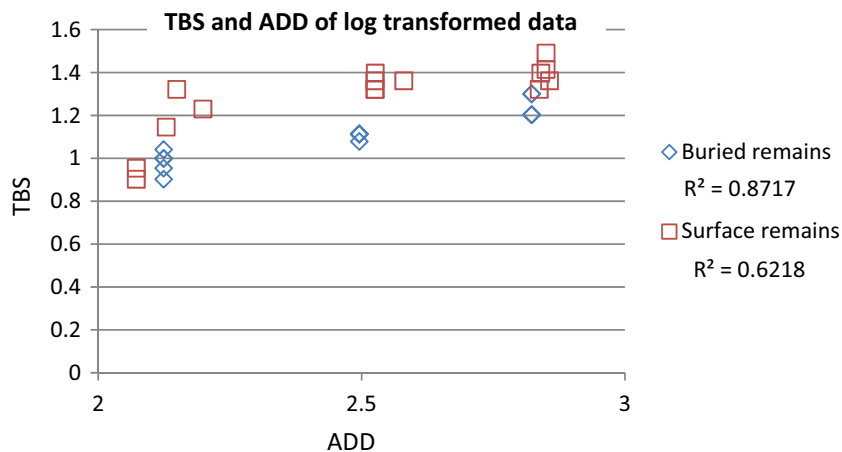
Table 4 Summary of average TBS scores of all anatomical regions of buried remains

	PMI 7	PMI 14	PMI 33	PMI 92	PMI 183
Head and neck	4	5	6.8	8.4	9
Trunk	3.2	5.8	6	6.4	7.2
Limbs	2.4	2.6	4.6	4.6	6
TBS	9.6	13.4	17.4	20.4	22.2

few experimentally supported findings within a South African setting. Taphonomic studies are generally difficult as the processes of decomposition are complex, influenced by many variables and may vary in different settings. It must be kept in mind that decomposition is a continuous process which makes it difficult to characterise all regions of a body into the same decompositional state. In this study, the stages of decomposition for both surface and buried remains were found to be very similar; however, there was a vast difference as far as the rate of decomposition was concerned with decomposition of buried remains taking place at a much slower rate. This finding agrees with the general observations reported from other studies [4, 8, 10]. This slower rate is ascribed to variables associated with decomposition, particularly insect activity and temperature. Insects are considered the most significant environmental decomposer [22], with temperature being the most important overall contributor [4]. Lower in-soil temperatures will have a significant effect on the decomposition process [23], as will the absence of insects.

There was a notable difference between the surface and buried remains during the early phases of decomposition as the process for buried remains slowed down gradually, mostly resulting from the fact that buried remains displayed moist decomposition compared to surface remains which already showed signs of desiccated tissue. After fairly rapid decomposition during the early phase in the buried carcasses, decomposition rates slowed considerably as remains reached what

Fig. 5 TBS for buried (N = 25) and surface remains (N = 25) with similar PMIs

seemed to be a plateau phase where little change was noted after 32–33 days PMI (Table 2). A plateau phase, indicating little change (slow decomposition) during advanced decomposition, was also observed and described in the study by Sutherland et al. [17]. This plateau phase therefore seems to present itself regardless of size of the body and whether remains were decomposing in soil or on the surface.

No cases reached advanced decay up to the point of skeletonisation (TBS scores of 27+) within the 6 months (183 days) interval of this study. The most advanced decomposition observed within this time frame (TBS of 25) for buried remains was limited to moist decomposition with bone exposure in less than one-half of the area being scored. According to Troutman et al. [24], the delay in decay of buried remains is mostly ascribed to the lower in-soil temperature and accessibility by insects on the remains. They state that buried remains can take up to eight times longer to decompose than surface remains [24]. The results from this research suggest that buried remains, at an average depth of 0.75 m, can have a decay rate of between 55.2 and 82.9% less than surface remains with similar PMIs. The average TBS score difference for buried remains were therefore 7.4 times less than that of surface remains.

The literature reports on a distinct foul smell, observable maggot masses, skeletonised head, expulsion of liquids from the mouth, collapse of the abdomen and spilling of intestines after 13 days of burial [3, 15, 25, 26]. However, the flesh on the head was still relatively fresh after 14 days of burial in our study. During active decay, the remains displayed a great loss of mass as a result of purging of decompositional fluids, and the odour remained very distinct.

In contrast to what was reported by Gennard [5], buried remains in the current study entered the stage of advanced decomposition [10] anywhere between 14 and 183 days (caving in of the abdominal cavity, some bone exposure and adipocere development). Gennard [5] reported an average time of 2.8 years for advanced decay to manifest on buried remains. This shows that the rate of decay is highly variable and that advanced decay can be reached after unexpectedly short time periods.

Previous studies [4, 11, 27, 28] suggested that a better estimate of the PMI may be obtained through the use of ADD. This may be true for remains decomposing on the surface, where temperature plays a major role. Our study suggests that this is not the case for buried remains and that elapsed time is the most important contributor to the degree of decomposition observed (as reflected by TBS). Although temperature fluctuations occur in the soil, the temperature changes are not as large as those on the surface. Overall the variation in the decomposition process is much less for buried remains than compared to surface remains, suggesting that it may be possible to obtain tighter PMI estimates for buried remain.
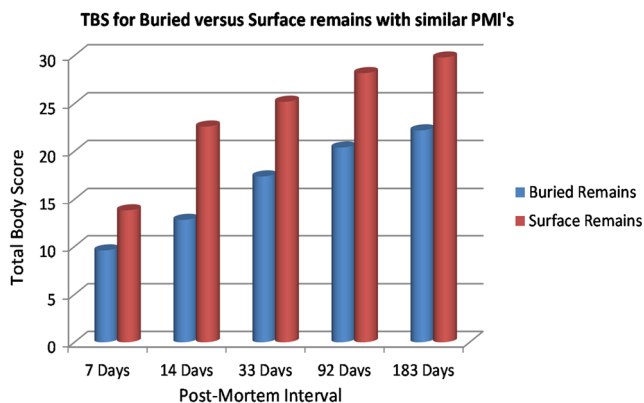
In future, it would be valuable to observe the rate of decomposition when remains are buried and excavated with similar PMIs in different seasons to compare seasonal fluctuations if applicable. With this study, no difference in the rate of decay which could be ascribed to (in soil) season fluctuations was observed. In the study done by Myburgh [20] however, it was suggested that seasonality have a great influence on the rate of decomposition for surface remains.

The substitution of pigs for human cadavers is not ideal, but continues to be a viable alternative for decomposition studies due to the complications of conducting actualistic research on donated bodies. Pig carcasses are more readily available, and therefore, sample sizes can be increased with future studies. It should be kept in mind that pig carcasses are considered appropriate proxies due to the fact that their internal anatomy, fat distribution, skin and general lack of hair is comparable to that of humans [25, 29]. Moreover, pigs and humans are omnivorous and it is suggested they share a similar gut flora [29]. However, differences in the pattern of decomposition which influences how decomposition is scored have been observed. Keough et al. [14] noted decomposition differed considerably between humans and pigs, especially during the early stages of decomposition, with bloating occurring more rapidly in pigs. Therefore, it is not advisable to use pig models to produce formulae for human PMI estimations but rather to study the effects of various environmental factors on the decomposition process.

Furthermore, it is important to note that PMI estimations based on decomposition rates (as reflected by the TBS) only are not advisable. As various taphonomic factors contribute to decomposition of remains, factors such as burial depth, soil type, body weight, should be taken into account when attempting to estimate a PMI. The standard uses of quantitative variables such as ADD and TBS facilitated the comparison of data regardless of environmental factors as this approach incorporates variability associated with temperatures and seasons. This allows for the development of prediction models for a specific geographical region.

Conclusion

In this study, the rates of decomposition between burials in shallow graves and surface remains were quantitatively assessed in an experimental study using a large sample of pigs. Considerable variation in the degree of decomposition was found in the buried 7-day interval pigs. The variation decreased by 14 and 33 days, where the buried pigs displayed features commonly associated with the early stages of decomposition. Thereafter, changes were slow to take place, and none of the carcasses reached complete skeletonisation in the time period observed. The results from this study suggest that buried remains can have a decay rate of between 55.2 and 82.9% less than surface remains with similar PMIs. Following on these results, a model (Table 3) was developed that can be used to estimate the PMI of buried remains in a South African setting. Overall, buried and surface remains decompose with similar patterns, but buried pigs decompose at a much slower rate. Previously, it was found that ADD was a good descriptor of decomposition for surface remains as ADD is useful for standardising the effect of temperature. On the other hand, TBS was found to be a better descriptor of observations for buried remains. It is important to note that environmental exposure can alter expected assumptions on decomposition rates and patterns at times. This highlights the importance of taking context into consideration for each forensic case.

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