

# Vulture Scavenging of Pig Remains at Varying Grave Depths

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*Abstract:* From November 2012 to January 2013, four pig carcasses (*Sus scrofa*) were buried at varying shallow grave depths at the Forensic Anthropology Research Facility at Texas State University–San Marcos. A fifth pig served as a control on the surface. Modification of the graves and surface deposit was recorded through the use of five motion-sensing cameras and daily on-site observation. The research intended to examine how vultures (*Coragyps atratus* and *Cathartes aura*) respond to and modify shallow graves of varying depths. Questions that were to be answered included how and when vultures detect graves; disturb the area; remove, disarticulate, and skeletonize remains; and finally abandon the different graves in comparison to a surface deposition. Vultures in this study did not locate or unearth the pig carcasses in the shallow burials and this may be explained by vulture seasonality and migration, feeding behavior regarding digging, and most importantly, the presence of human disturbance.

**Keywords:** Forensic science, forensic anthropology, physical anthropology, taphonomy, postmortem scavenging, vultures, burials, time since death, decomposition, postmortem interval

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## Introduction

Forensic anthropologists occasionally encounter human remains in burial scenarios such as shallow graves (i.e., one meter deep or less) that show signs of vultures having disturbed the scene (Enwere 2008; Morton and Lord 2006; Rodriguez and Bass 1985; Smith et al. 2002). The purpose of this study was to examine how vultures detect graves; disturb the area; remove, disarticulate, and skeletonize remains; and finally abandon the different graves in comparison to a surface deposition. Accumulated degree days (ADD), humidity, and wind speed were used to assess different environmental and climatic factors that may have affected the timing of vulture activity.

### *Postmortem interval (PMI)*

The postmortem interval (PMI) or time since death is a crucial measurement that allows forensic anthropologists to estimate the time elapsed

since an individual has died. It can also refer to the stage in decomposition (Rodriguez and Bass 1985). Information about PMI may enable law enforcement personnel to compile an applicable list of missing persons or to corroborate the findings with a suspect's accounts and order of events (Spradley et al. 2011). Estimating PMI has already proven to be a difficult measurement to acquire due to the many contributing factors such as seasonality and temperature, presence of trauma, and location of the deposition, and it is made even more difficult to estimate PMI when animal scavengers have disturbed the remains (Anderson 2011; Dent et al. 2004; Rodriguez and Bass 1985; Spradley et al. 2011). Estimating PMI has already proven to be a difficult measurement to acquire due to the many contributing factors such as seasonality and temperature, presence of trauma, and location of the deposition, and it is made even more difficult to estimate PMI when animal scavengers have disturbed the remains (Anderson 2011; Dent et al. 2004; Rodriguez and Bass 1985; Spradley et al. 2011).

### *Vulture scavenging*

Primary avian scavengers in Central Texas include American Black Vultures (*Coragyps atratus*) and Turkey Vultures (*Cathartes aura*) (Reeves 2009; Spradley et al. 2011). These vultures tend to wait 24 hours before feeding on non-human carrion (Reeves 2009). Vultures are ubiquitous taphonomic agents in many areas, but very little is known about these birds and their interaction with decomposing human remains (Buckley 1996; Reeves 2009; Spradley et al. 2011).

Turkey Vultures have an acute sense of smell and are almost always the first species to arrive at carcasses (Kirk and Mossman 1998). Turkey Vultures have the ability to smell ethyl-mercaptan and other decomposition odors (Kirk and Mossman 1998; Smith et al. 2002). Natural gas companies have introduced this odorant into pipelines and have discovered leaks where Turkey Vultures were found circling or on the ground (Smith et al. 2002; Stager 1964).

Unlike Turkey Vultures, Black Vultures lack a highly developed sense of smell and cannot find carrion by scent alone; they exploit the superior food-finding skills of Turkey Vultures (Buckley 1999). Once a carcass is located, Black Vultures often congregate rapidly and displace Turkey Vultures (Buckley 1999). Turkey Vultures prefer relatively fresh carrion but cannot open thick skin and must wait until a large carcass is putrid or is opened by mammals or larger vultures, such as Black Vultures (Kirk and Mossman 1998). When feeding, Turkey Vultures typically pick tissue from the carcass while holding it down with one or both feet (Kirk and Mossman 1998). Black Vultures also depend on decomposition or larger scavengers; once a sufficiently large opening has been made, viscera can be extracted (Buckley

1999). Unlike Turkey Vultures, Black Vultures typically do not use their feet when feeding (Buckley 1999). It has been noted that Turkey Vultures have the ability to scratch away soil until carrion is exposed (Smith et al. 2002).

*Vulture studies at Forensic Anthropology Research Facility (FARF)*

The Forensic Anthropology Research Facility (FARF) at Texas State University–San Marcos is an outdoor decomposition research facility composed of 26 acres of wooded and open land (Forensic Anthropology Center–Texas State 2013). FARF examines decompositional effects on both human and non-human remains that are placed in separate gated areas to avoid overlap of any taphonomic processes and commingling.

*Enwere 2008 study*

Enwere (2008) investigated the taphonomic processes involved in the decomposition of child-sized remains found in shallow graves or surface deposit environments. Child-sized pig carcasses were buried in the summer at FARF to examine the taphonomic processes. The depth of the burials was 0.30 meters. Signs of vulture scavenging activity were present on the surface carcass as well as on the burials. Evidence of vulture scavenging included presence of vulture droppings and feathers.

*Reeves 2007 study*

From July through September 2007, three pig carcasses (weighing between 27 and 63 kilograms) and a goat carcass were placed outside at FARF. A surrounding fence excluded mammalian scavengers while avian scavengers were allowed access. A fourth pig carcass served as a control for the rate of decomposition and was placed in a cage that prevented terrestrial and avian animal access. Modification of the carcasses was recorded through the use of two motion-sensing cameras used for tracking game and daily on-site observations. Black Vultures and Turkey Vultures waited approximately 24 hours before beginning to scavenge and had completely skeletonized the carcasses in 3 to 27 hours of feeding, leaving light scratches on the bones. Conditions for this study were rigorously maintained to avoid any confounding variables through the use of the neutral area where the pigs were placed and the fencing placed around the carcasses.

*Spradley et al. 2011 study*

This research acted as a pilot study to examine the effects of vulture scavenging on human remains. A donated human body was placed at FARF and the effects of vulture scavenging, as well as the rate of skeletonization and the amount of disarticulation and scattering of the bony elements were observed using GPS (Global Positioning System) and motion-sensing camera

equipment. Results showed that initial scavenging took place 37 days after placement at FARF (Spradley et al. 2011). This delay in scavenging differed from previous vulture research done at FARF, including Reeves's 2007 study. However, after the onset of scavenging, the body was skeletonized within only five hours.

This study will use Enwere's (2008) analysis as a springboard to determine if burying carcasses at different depths will have 1) an effect on time needed for a vulture to find a burial and begin scavenging, as well as 2) have an effect on the time needed for vultures to completely skeletonize the remains when they are no longer interested in the carcasses. Knowing this information may aid law enforcement personnel in the future with the determination of whether a shallow grave has been disturbed by vultures, and an estimate of a tentative postmortem interval for shallow grave burial cases that show signs of vulture scavenging.

## **Materials and methods**

In November 2012, four shallow graves one meter long and half a meter wide were dug at a minimum distance of nine meters apart. This was to reduce the amount of overlap from any taphonomic processes that might occur between each of the graves and to avoid commingling of the remains. These graves varied in depth: Grave 1, depth of 0.15 meters; Grave 2, depth of 0.30 meters; Grave 3, depth of 0.46 meters; Grave 4, depth of 0.61 meters. A surface carcass acted as a control.

In forensic anthropology studies, domestic pig carcasses (*Sus scrofa*) are frequently used as comparative decomposition and taphonomy models due to their physiology, skin structure, and musculature being analogous with that of humans (Anderson 2011; Dent et al. 2004; Enwere 2008; Morton and Lord 2006; Reeves 2009; Rodriguez and Bass 1985). For this study, five commercial farm-euthanized juvenile pigs, weighing between 16 and 20 kilograms, were acquired. Whole pigs were used in this study; cut and/or exposed tissue could act as a catalyst to speed up decomposition and thus might act as a confounding variable. The pig carcasses were placed on ice to prevent early decomposition and, less than twelve hours after death on November 16, 2012, were placed in a gated section of FARF isolated from the main part of the facility where human donations were located. Four of the five pigs were buried; one in each of the shallow graves, and fill from each grave was then replaced. The fifth carcass acted as a control specimen and was placed on the surface at least nine meters away from the shallow graves (Figure 1).

During the experiment, five motion-sensing game cameras (Bushnell

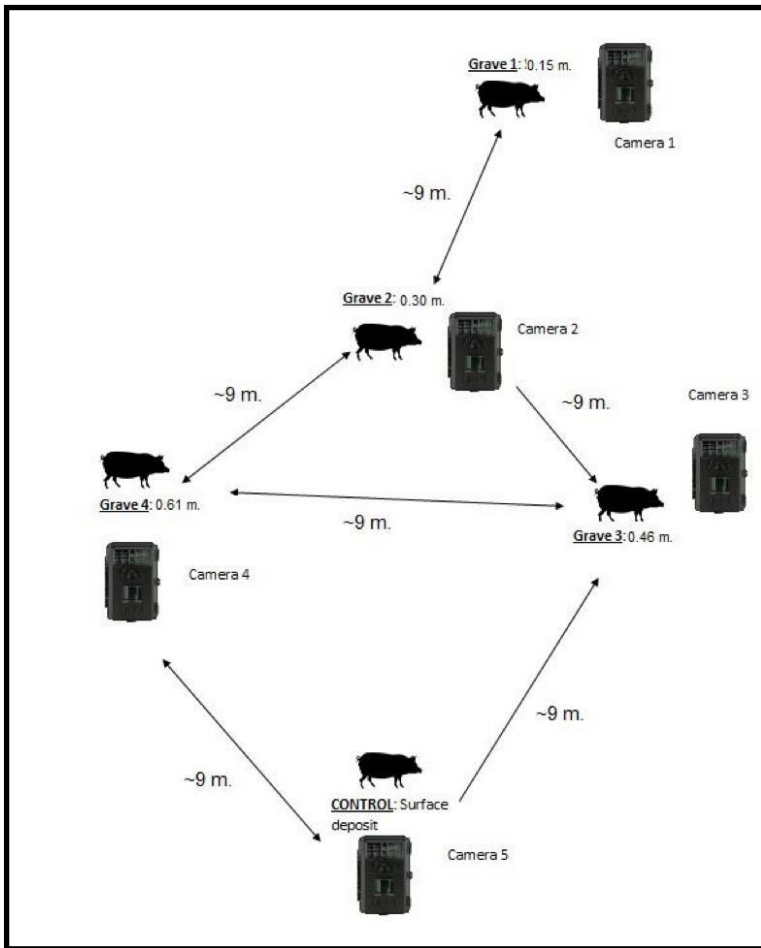


Figure 1: Layout of grave placement.

8MP Trophy Cam Night Vision Trail Camera) were used. A camera was placed in front of each grave and the surface control carcass. All cameras were programmed to take three still pictures (no flash) every time the infrared sensor was triggered. The cameras were secured to telephone poles or chain-link fences to ensure inconspicuousness. Additional photos were taken via digital camera (Canon PowerShot SD1000) to document initial set-up and individual once-daily observations of the graves for the duration of the study. It is important to note that in a previous unpublished study, vultures were observed returning to scavenge a short time (~10–20 minutes) after being disturbed by researchers working at FARF (personal communication, Sophia Mavroudas, 2012). Disturbing the vultures therefore should only minimally

affect the time frame and efficiency of the vulture scavenging. Additional photos were taken via digital camera (Canon Powershot SD1000) to document initial set-up and individual, once-daily observations of the graves for the duration of the study.

Decomposition and scavenging activity may be affected by and dependent upon weather conditions. Consequently, average daily humidity, wind speed, and temperature of the site, ADD, standardized time and temperature was measured and recorded. The site was also physically observed once daily in the evening for the duration of the study. A digital camera recorded any evidence of scavenging activity.

Elements of analysis included: evidence of bird presence (feathers, droppings, birds seen on camera or in person), ground disturbance and evidence of digging (disturbed soil, partially or fully exhumed carcasses or birds seen on camera digging at the graves), and removal of the carcass from the graves.

Additionally, the following specific questions regarding the vultures' scavenging behavior were addressed by visiting the site daily and examining photographic data from the game cameras:

- Which vulture species arrives first;
- Do both species scavenge equally, or does one scavenge more than the other;
- Maximum number of vultures recorded at each grave;
- Average number of vultures recorded at each grave at any given time;
- Which vulture species is seen more often;
- How do the vultures exhume the remains;
- How does the ratio of the two vulture species change over the course of the study?

## **Results**

### *Control carcass results*

For the control carcass, several Black Vultures were observed in flight in the area on the date of initial deposit (November 16, 2012), but it was not until approximately 24 hours later that two Black Vultures landed to investigate the surface carcass. Within the hour, at least four more Black Vultures were seen, with a maximum of five vultures continuing to scavenge the control carcass throughout the day. Within 12 hours of total feeding the control carcass was reduced to skin, bones, and connective tissue. After this time, Black Vultures were captured on camera infrequently visiting the skeletonized remains during the early evening hours until the end of the

study on January 29, 2013. It is of note that vultures only returned to the deposition approximately 20 minutes to half an hour after the researcher and other members of the department had left the immediate area. While no Turkey Vultures were observed in the area during this study, scavenging behavior of the Black Vultures was as observed in previous studies (Reeves 2009; Spradley et al. 2011). As described in the literature, the surface deposit was scattered by Black Vultures early on in the study (within a day of placement) (Spradley et al. 2011). Bony elements were moved outside of the camera frame and, at the end of the study, only the axial skeleton (without the skull) was still present.

### *Graves results*

For the duration of the study (approximately two and a half months), from the day of initial placement on November 16, 2012, until January 29, 2013, no vultures investigated the graves. No vultures landed at or showed any interest in any of the burials. During daily visits, all buried carcasses showed signs of decomposition, including bloating as evidenced by a localized, raised surface, evidence of flies and maggots, and moderate odor emanating from the graves. The results, contrary to those expected, showed that during this project, vultures in Central Texas were unable or unwilling to locate and unearth pig carcasses in shallow burials. The vultures did not land at any of the burials for the duration of the study; this may be explained by a number of potential causes.

## **Discussion**

As previously described, Turkey Vultures possess an acute olfactory sense, with the ability to locate decomposition by sense of smell alone (Bang and Cobb 1968; Buckley 1996; Kirk and Mossman 1998; Smith et al. 2002; Stager 1964). Once carrion has been located, Turkey Vultures have been known to scratch away soil with their feet to expose the carcass (Smith et al. 2002). Black Vultures lack a heightened sense of smell and rely on visual cues to locate scavenging opportunities (Buckley 1999). Using the presence of Turkey Vultures gathered around a carcass, Black Vultures are able to locate carrion (Bang and Cobb 1968).

### *Vulture seasonality and Turkey Vulture presence*

One reason vultures did not visit the burials could be attributed to seasonality and home range of Turkey Vultures. The location of FARF is at the very edge of the range for summer versus year round Turkey Vulture activity (Figure 2). Higher densities of Turkey Vultures are seen in Central

Texas during the summer months as opposed to when this study took place (Kirk and Mossman 1998). Moreover, Turkey Vultures have a more advanced olfactory sense than that of Black Vultures (Bang and Cobb 1968). Black Vultures cue on the presence of Turkey Vultures to lead them to feeding opportunities. If Turkey Vultures were not present to detect the decomposition odors coming from the burials, Black Vultures may therefore not be signaled to land and scavenge (Buckley 1999; Lemon 1991). It is explained in the literature that Black Vultures do not use their feet while scavenging (Buckley 1999; Houston 1988). The presence of Turkey Vultures may be required to initiate the exhumation of the burials to instigate scavenging (Smith et al. 2002).

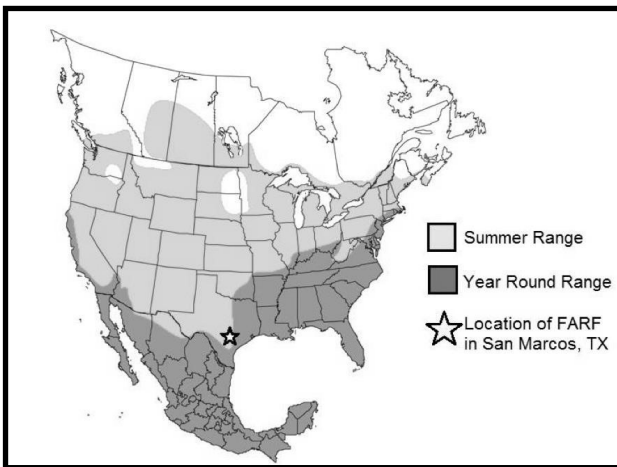


Figure 2: Turkey Vulture range with location of FARF. Used with permission: Arizona Board of Regents/ASU Ask a Biologist. Modified from: [http://askabiologist.asu.edu/aab\\_tools/\\_media/maps/](http://askabiologist.asu.edu/aab_tools/_media/maps/)

### *Vulture versus human interaction*

Another factor that would potentially affect the scavenging behavior of the vultures could be the human presence and intervention at FARF based on 1) deceased humans present (both visually and olfactorally) but inaccessible under

bird-proof chain-link cages, and 2) constant live human presence at FARF for multiple hours. In natural settings, vultures typically show shy behavior if approached by humans (Zuberogoitia et al. 2010). Studies have demonstrated that in natural conditions, to ensure the absence of threats, it may take vultures more than a day to land near a carcass deposited on the surface (Reeves 2009; Spradley et al. 2011; Zuberogoitia et al. 2009). A carcass in a burial scenario, already more difficult to detect, compounded with the constant risk of human intrusion, may introduce an unknown delay to the time it takes for vultures to detect and land at a carcass.

Previous studies have shown that behavioral change can occur depending on the food availability and vulture state of hunger (Deygout et al. 2009; Zuberogoitia et al. 2009). The vultures have learned that there is always

food available at FARF and are perhaps only willing to scavenge from carrion opportunities that are quick and easy to access. Because of this, they do not utilize time or energy to access a burial if there is a surface deposit offered with the added complication of the constant threat of human intrusion. In a scenario where feeding stations or “vulture restaurants” (Donázar et al. 2010:613) were abundant, vultures were likely to find food quickly and stop before all resources were found. Scavenging efficiency is reduced when the number of stations containing resources was high (Degout et al. 2009). Moreover, vultures are drawn to areas where the availability of resources is predictable (Donázar et al. 2010). Vultures that scavenge at FARF have found that most of the food is relatively inaccessible under cages, but surface deposits, when present, appear to be the easiest means of obtaining food. Perhaps the daily presence of researchers has so modified vulture behavior that it is now altering vulture studies at FARF, indicating that there may be a “shelf life” for decompositional facilities when used for vulture scavenging research.

#### *Human activity at FARF*

Approximately three to four students and researchers visit the facility per day. The main activity being performed is photographing and documenting the decompositional phases of more than the average of 20 human donations at a time that are placed under cages, making them inaccessible to vulture scavenging. Researchers visit the facility in small groups at any time from 9:00 am to 5:00 pm and spend approximately two hours per visit. Human donation placements occur, on average, about twice a week. These placements take place from approximately 2:00 pm to 6:00 pm and are comprised of about four individuals that drive into the facility and stay for half an hour to an hour at a time. Vultures seen at the facility are shy and remain at a safe distance (about 10 yards) from humans; if approached, the birds will fly away (personal communication, Dr. Michelle Hamilton, 2013). Since the opening of FARF in 2008, anecdotal evidence indicates the vultures have become more timid and less tolerant of human presence (personal communication, Dr. Michelle Hamilton, 2013). It can be inferred that the increase of human incursion at FARF has affected the behavior of vultures attempting to scavenge in the area. Small groups of human foot traffic have likely deterred vultures from frequently visiting FARF. These disturbances are a constant threat to peak times in vulture activity, although past research shows that human activity and interaction is not a deterrent when access to food is safe and unobstructed (Reeves 2009; Spradley et al. 2011).

## Conclusion

The results of this study likely have implications for scenarios in which humans are buried in shallow graves. Vultures are more likely to scavenge when carrion is within sight or when Turkey Vultures are spotted feeding and/or have exposed enough of the carcass for Black Vultures to gain access (Bang and Cobb 1968; Buckley 1996; Coleman and Fraser 1987; Degout et al. 2009; Houston 1988; Lemon 1991; Smith et al. 2002; Stager 1964; Zuberogoitia et al. 2010). Remains that are placed in high-traffic areas or areas in which there is a possibility of human contact or scent intrusion can affect vulture activity and scavenging behavior (Bang and Cobb 1968; Buckley 1996; Coleman and Fraser 1987; Degout et al. 2009; Houston 1988; Lemon 1991; Smith et al. 2002; Stager 1964; Zuberogoitia et al. 2010). In settings with high occurrences of human interference and intrusion, vultures are more likely to avoid scavenging. Carrion will be more likely to attract vultures when they are deposited in secluded areas during times of the year that have the highest frequency of both species of vultures.

The purpose of this study was to examine the scavenging responses of Black and Turkey Vultures to pig carcasses placed on the surface and in shallow graves of varying depths. It was expected that vultures would be able to detect the graves and begin to unearth the carcasses, as they had been known to do both anecdotally and in the literature (Enwere 2008; Reeves 2007; Spradley et al. 2011). Vultures in this study did not locate or unearth the pig carcasses in the shallow burials and this may be explained by vulture seasonality and migration, feeding behavior regarding digging and the specific vulture species, and most importantly, the presence of human disturbance. Season may have an effect on the migration patterns of Turkey Vultures, especially because the study was conducted in the early winter in a location at the edge of the summer Turkey Vulture range. The lack of Turkey Vulture involvement may have created an intervening variable in which Black Vultures would not and/or could not access the carcasses. Although vultures usually return to scavenging opportunities shortly after being displaced by humans (~20 minutes), consistent human presence at FARF may have influenced vulture behavior and is likely another limitation to the study. Vultures may have moved on to more consistent and secluded sources of food (known and reliable locations of carrion with minimal disturbance, human or otherwise).

This paper highlights the first attempt at understanding vulture response to buried remains in an outdoor decompositional facility. It is suggested that future research should be done in a location that is not frequented by humans and/or during a season when Turkey Vultures are more

prevalent. More information is needed regarding vulture seasonality, feeding habits, and the digging abilities of Turkey Vultures. Finally, it is suggested that any future vulture research at FARF should be conducted in a location that is secluded and as close as possible to conditions found in nature.

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