PROMETHEUS PRESS/PALAEONTOLOGICAL NETWORK FOUNDATION (TERUEL)

Journal of Taphonomy

2013 *Available online at www.journaltaphonomy.com*

VOLUME 11 (ISSUE 1)

Shape and Distribution of Griffon Vulture (*Gyps fulvus*) Scavenging Marks on a Bovine Skull

Rafał A. Fetner, Arkadiusz Sołtysiak*

Department of Bioarchaeology, Institute of Archaeology, University of Warsaw
ul. Krakowskie Przedmieście 26/28, 00-927 Warszawa, Poland

Journal of Taphonomy 11 (1) (2013), 41-47.
Manuscript received 5 April 2013, revised manuscript accepted 5 May 2013.

During a three week long experiment, a male bovine head was scavenged by an adult Griffon vulture. Twenty five linear scavenging marks were identified on the defleshed cranium and mandible, ranging in length from 2 to 31 mm with an average of 9.02 mm. Based on the experimental observations, the following criteria may be used for diagnosis of vulture scavenging marks: a _/ cross-sectional shape, tapered width, a tendency toward clustering into parallel sets of 2-4 lines, and the presence of V- or L-shaped double lines. Although reliable identification of a single line as a vulture scavenging mark is impossible, a number of features meeting these criteria may allow for a more confident diagnosis. Scavenging lines appear significantly longer on more exposed areas of the cranium, such as the frontal bone in this experiment, and shorter on less accessible areas, such as the mandible.

Keywords: GRIFFON VULTURES, TAPHONOMY, AVIAN SCAVENGERS, DIFFERENTIAL DIAGNOSIS

Introduction

Over the past several decades there has been a growing interest in taphonomic agents that can modify animal and human bones retrieved from archaeological and forensic contexts. Many papers have been published examining mammal tooth marks (e.g. Haglund *et al*., 1988; Haynes, 1983; Willey & Snyder, 1989) and scavenging patterns (e.g. Haglund *et al*., 1989; Kjorlien *et al*., 2009), as well as cut marks (e.g. Domínguez-Rodrigo & Yravedra, 2009; Lewis, 2008) and other features related to human activity (e.g. d'Errico & Blackwell, 2009). However, for many years very few studies examined avian fauna as a taphonomic agent (cf. Binford, 1981; Marin-Arroyo & Margalida, 2012). Only three years ago Nicole Reeves (2009) found that the American Black vulture (*Coragyps atratus*) and the Turkey vulture (*Cathartes aura*) may leave linear scratches up to 40 mm long on the periosteum and bone surface.

The first experiments with vulture scavenging focused on the time required for skeletonization and the pattern of

*E-mail: a.soltysiak@uw.edu.pl

disarticulation in animal and human bodies scavenged by New World vulture species (Reeves, 2009; Spradley *et al*., 2011), and it was still unclear whether avian scavenging marks would be preserved and recognized in completely skeletonized remains. Moreover, the literature regarding Old World avian scavengers was even more scarce and superficial (e.g. Molleson, 2009; Sołtysiak, 2010) prior to the publication of a paper by Domínguez-Solera & Domínguez-Rodrigo (2011) who reported on the scavenging of a deer carcass by wild Griffon vultures (*Gyps fulvus*) at the Reserve of El Hosquillo in Cuenca (Spain). Taking into account the paucity of literature, we designed a simple experiment, exposing a bull head for scavenging by a Griffon vulture to examine the resulting marks preserved on the cranium and mandible after complete skeletonization, particularly their distribution, length and morphology.

The first aim of the present report is to compare the patterns of scavenging marks between long-term scavenging with low competition (our study) and short-term scavenging with high competition among Griffon vultures (the experiment by Domínguez-Solera & Domínguez-Rodrigo, 2011). The second aim is to check differences in scavenging pattern between various areas of the skull, which may be attributed to variable accessibility.

The Griffon vulture is a common, large opportunistic scavenger living in the Mediterranean, Near East, Central Asia, and occasionally observed in adjacent regions of the Old World. Adult individuals may weigh up to 7 kg with a 280 cm wingspan. Their diet is based on carrion, primarily large and medium-sized ungulates such as sheep, goat, cattle, gazelles and antelopes, but they may also feed on dogs, birds or fish (Becker *et al*., 2009; Xirouchakis, 2005; Zuberogoitia *et al*., 2010). In its geographic range, the Griffon vulture is the most likely avian scavenger which will feed on animal or human remains retrieved from archaeological or forensic contexts.

Material and methods

The experiment was performed in the Garden of Polish Fauna in Bydgoszcz, Poland. A complete fleshed, male subadult bovine (*Bos taurus*) head was retrieved from a local butcher. The animal was killed using a pneumatic piston which left a hole measuring 14 mm in diameter on the frontal bone. The head was cut off at the level of the second cervical vertebra. For three weeks in February 2009 the head was placed in an aviary occupied by a single adult female Griffon vulture.

The normal fodder provided to the vulture was reduced to about 1/3 of the regular ration. While constant observation of the vulture's behavior was not performed, it was occasionally observed when feeding on the head. The aviary was constructed in such a way that small mammals, such as rodents, could not gain entry and insect activity on the carrion was very limited during the winter season (the temperature during the days of experiment ranged from -12 to +5°C).

When large portions of the skull were exposed, the head was moved to the Department of Pathology and Veterinary Diagnostics at the University of Life Sciences in Warsaw to be defleshed. The protocol involved boiling the head for three hours with use of neutral soap and then removal of the remaining soft tissues by scraping with a metal tool in a controlled manner to avoid damaging the skull. The tool was handled with minimal pressure to minimize the contact with bone surface.

Table 1. Basic statistics for length of scavenging marks (in mm) from three skull regions.

Skull region	n	min	max	mean	sd	median
Frontal + nasal bone	11	7.0	31.0	12.7	6.6	12.0
Maxilla + zygomatic bone	6	5.0	12.0	7.8	3.0	7.0
Mandible	8	2.0	8.0	4.8	2.3	5.0

All marks on external bone surfaces were scored with 10× magnifying glass using a protocol including precise positioning, length and width measurements. The lengths of linear features were measured using sliding caliper with 0.5 mm accuracy. The scavenging marks were distinguished from vascular grooves following these criteria: (1) occurrence on bone surfaces where vascular grooves are not expected; (2) presence of microstrations and; (3) well defined margins with some microfractures. One cut mark was made using the metal scraping tool for differential diagnosis. It was much deeper and produced a clear polished V-shaped cross-section, easy to distinguish from scavenging marks.

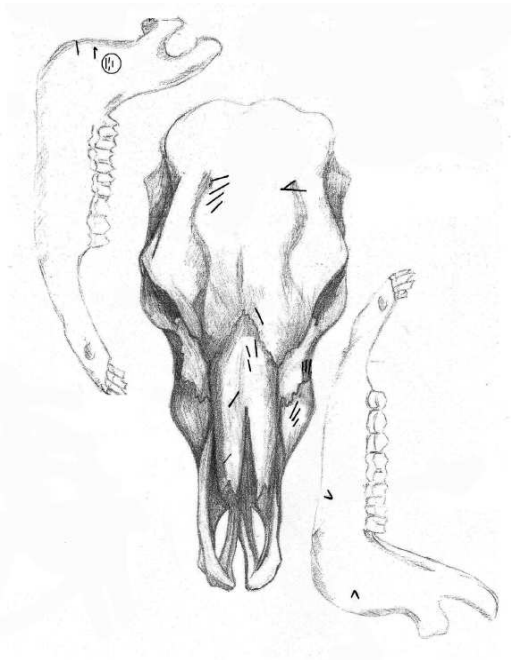

Figure 1. Distribution of vulture scavenging marks on a bovine cranium and mandible (drawing by Dagmara Morozowicz and Barbara Mydlak).

Macrophotographs of all features were taken in the Photography Lab at the Institute of Archaeology, University of Warsaw. Polyurethane resin molds of three randomly selected marks were photographed using a Scanning Electron Microscope LEO 1430 VP with magnification 50× and 100× provided by the Biology Faculty at the University of Warsaw.

The mean differences between scavenging mark length on three parts of the skull (the top of the cranium, maxilla and zygomatic bones, and mandible) were tested for statistical significance using the Kruskal-Wallis non-parametric one-way analysis of variance.

Results

In total, 25 features were recognized as scavenging marks and their distribution on the cranium and mandible is shown in Figure 1. Typically, the marks occurred as single

lines, sometimes clustered in roughly parallel groups of two, three or four, or were coupled to form a V- or L-shape. The scavenging mark lengths differed in expression over three regions of the skull. They were relatively long on the anterior portions of the cranium (frontal and nasal bones) and relatively short on the mandible (see Table 1). The mean differences observed are statistically significant in spite of the small sample size, Kruskal-Wallis H=13.35, p=0.0013. Scavenging mark breadth was always less than 1 mm, and variable in most cases, with one of the mark ends usually wider than the other (Fig. 2). All features are rather shallow (maximum depth 0.3 mm) and _/-shaped in cross-section, with straight but irregular walls (Fig. 3).

Discussion

Our experiment was more limited in scope than the study by Domínguez-Solera & Domínguez-Rodrigo (2011), but the different research design produced some results which were not noted previously. Especially, the analysis of scavenging mark length may be potentially useful in the analysis of scavenged bones from archaeological contexts.

Domínguez-Solera & Domínguez-Rodrigo (2011) reported 10 marks on a deer skull and mandible including punctures, shallow scores and striae. In most cases they were linear and occurred singly but occasionally they appeared as parallel sets of linear, curved or winding marks. One mark was described as "tick-shaped". Except punctures, the same types of marks with microstrations were observed in the present experiment, including "tick-shaped" marks (designated here as L-shaped) and lines combined in parallel clusters. Linear features observed in the current experiment are also more or less comparable to marks described by Revees (2009). The lack of punctures may be possibly explained by the lack of competition in the zoological garden. The carcass in the Domínguez-Solera & Domínguez-Rodrigo (2011) experiment was scavenged by more than 50 wild birds and high level of competition between them might have led to the punctuation of bone surface.

It may be difficult to distinguish scavenging marks from trampling-related features which are also linear, _/-shaped in cross-section, and may be clustered in parallel sets (Domínguez-Rodrigo *et al*., 2009). The most specific characteristic is tapered width, and commonly a V- or L-shape, probably related to the increasing pressure of the beak and the pull-and-tear movement of the scavenger. Tapered width of linear features was not reported by Domínguez-Solera & Domínguez-Rodrigo (2011).

A clear difference in the length of scavenging marks on various regions of the skull may be related to the accessibility of the bone. Frontal and nasal bones were most exposed on the experimental head, which lay on its base, and the mandible was more difficult to access resulting in shorter L- or V-shaped linear features. This observation may be potentially useful in determining the original position of a body/carcass prior to burial.

Observed features are usually shallow and may be quite easily removed by various diagenetic agents. However, the process of diagenesis strongly depends on local environment and any uniform model cannot be proposed for the obliteration of scavenging marks, at least at the present stage of research. As frequently in the investigation of taphonomic features, the absence of damage attributed to vultures cannot be considered as an evidence that bone was not scavenged.

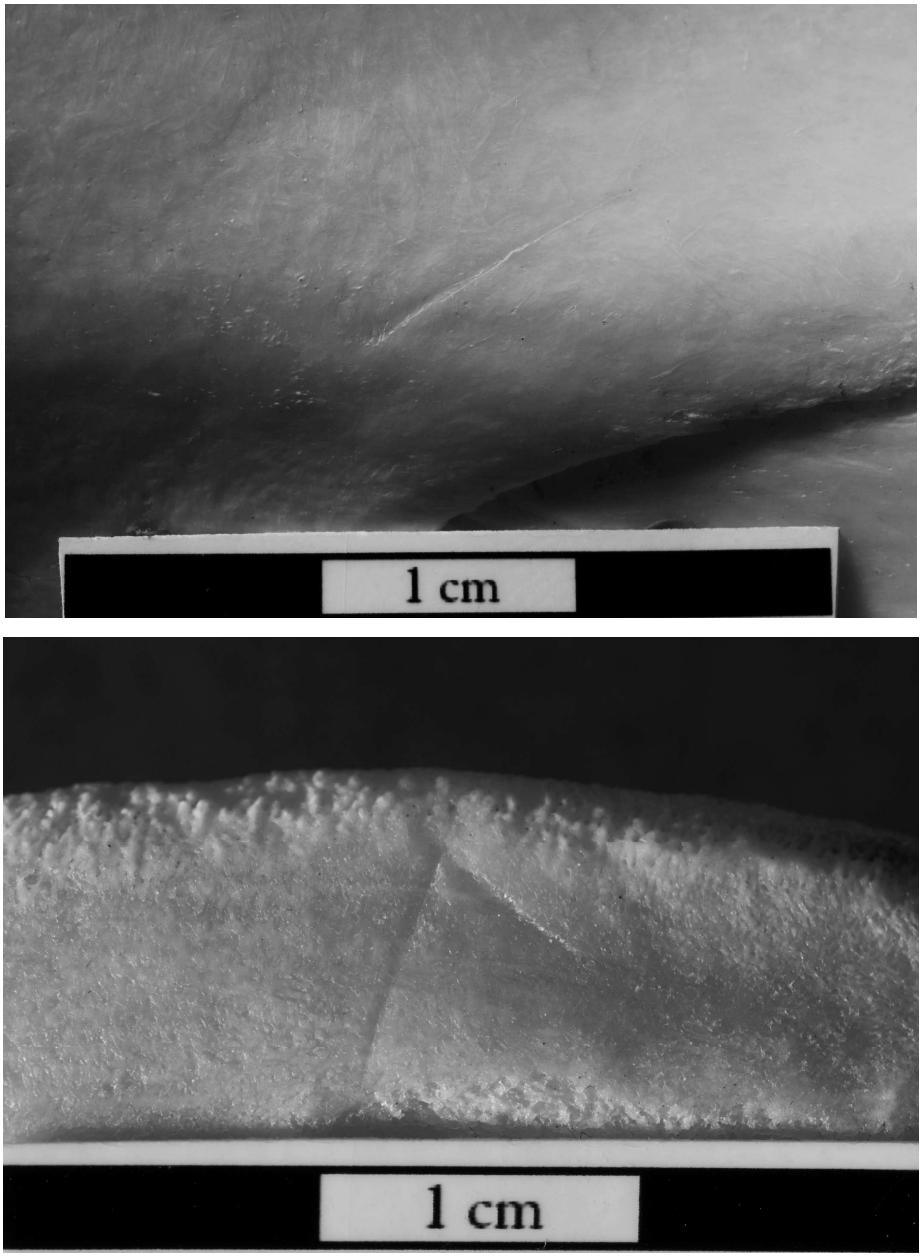

Figure 2. Picture of vulture scavenging marks: (upper) single line with increasing width, (lower) V-shaped double line (photographs by Dagmara Morozowicz and Justyna Sasanka).

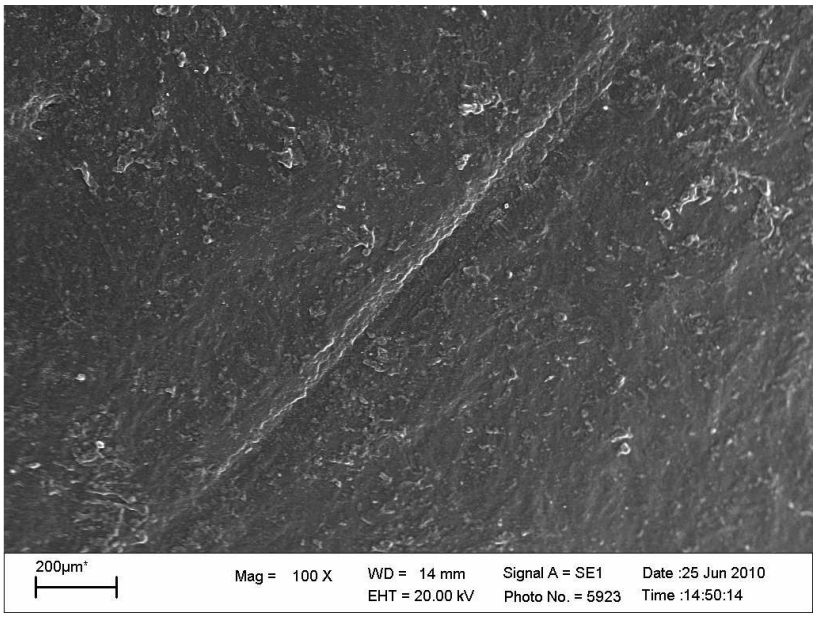

Figure 3. SE micrograph of a vulture scavenging mark, 100× magnification.

Conclusion

The scope of the present research is narrow, but its results may enhance the potential of research on Griffon scavenging marks in archaeological and forensic contexts. Although it was found that use of a single feature to identify vulture scavenging marks is impossible (cf. also Domínguez-Solera & Domínguez-Rodrigo, 2011), a series of linear features with increasing width and _/ cross-sectional shape, which tend to cluster together in parallel sets and frequently appear as V- or L-shaped double lines, may be attributed to the Griffon vulture as a taphonomic agent. In crania scavenged by vultures, the analysis of linear mark average length may be helpful in reconstruction of the original body/carcass position, since marks tended to be longer on bones that were easier to access.

Acknowledgements

The vulture experiment was completed with the assistance of several B.A. archaeology students at the University of Warsaw, namely Dagmara Morozowicz, Barbara Mydlak and Justyna Sasanka. Many thanks to the staff of the Garden of Polish Fauna in Bydgoszcz, to Maria Jaromirska for logistical support during the experiment, and to Jessica Walker for language correction.

References

Becker, N., Choresh, Y., Bahat, O. & Inbar, M. (2009). Economic analysis of feeding as a means to preserve an endangered species: The case of griffon vulture (*Gyps fulvus*) in Israel. *Journal for Nature Conservation*, 17: 199-211.

Binford L.R. (1981). *Bones: ancient men, modern myths*. Academic Press, New York.

d'Errico, F. & Backwell, L. (2009). Assessing the function of early hominin bone tools. *Journal of Archaeological Science*, 36: 1764-1773.

Domínguez-Rodrigo, M., de Juana, S., Galan, A.B. & Rodriguez, M. (2009). A new protocol to differentiate trampling marks from butchery cut marks. *Journal of Archaeological Science*, 36: 2643-2654.

Domínguez-Rodrigo, M. & Yravedra, J. (2009). Why are cut mark frequencies in archeofaunal assemblages so variable? A multivariate analysis. *Journal of Archaeological Science*, 36: 884-894.

Domínguez-Solera, S. & Domínguez-Rodrigo, M. (2011). A taphonomic study of a carcass consumed by Griffon vultures (*Gyps fulvus*) and its relevance for the interpretation of bone surface modifications. *Archaeological and Anthropological Sciences*, 3: 385-392.

Haglund, W.D., Reay, D.T. & Swindler, D.R. (1988). Tooth mark artifacts and survival of bones in animal scavanged human skeletons. *Journal of Forensic Sciences*, 33: 985-997.

Haglund, W.D., Reay, D.T. & Swindler, D.R. (1989). Canid scavenging/disarticulation sequence of human remains in the Pacific Northwest. *Journal of Forensic Sciences*, 34: 587-606.

Haynes, G. (1983). A guide for differentiating mammalian carnivore taxa responsible for gnaw damage to herbivore limb bones. *Paleobiology*, 9: 164-72.

Kjorlien, Y.P., Beattie, O.B. & Peterson, A.E. (2009). Scavenging activity can produce predictable patterns in surface skeletal remains scattering: Observations and comments from two experiments. *Forensic Science International*, 188: 103-106.

Lewis, J.E. (2008). Identifying sword marks on bone: criteria for distinguishing between cut marks made by different classes of bladed weapons. *Journal of Archaeological Science*, 35: 2001-2008.

Marin-Arroyo, A.B. & Margalida, A. (2012). Distinguishing bearded vulture activities within archaeological context: Identification guidelines. *International Journal of Osteoarchaeology*, 22: 563-576.

Molleson, T. (2009). Two Sasanian ossuaries from Bushehr, Iran. Evidence for exposure of the dead. *Bioarchaeology of Near East*, 3: 1-16.

Reeves, N. (2009). Taphonomic effects of vulture scavenging. *Journal of Forensic Sciences*, 54: 523-528.

Sołtysiak, A. (2010). *Death and decay at the dawn of the city. Interpretation of human bone deposits at Tell Majnuna. Areas MTW, EM and EMS*. Institute of Archaeology, Warsaw.

Spradley, M.K., Hamilton, M.D. & Giordano, A. (2012). Spatial pattering of vulture scavenged human remains. *Forensic Science International*, 219: 57-63.

Willey, P. & Snyder, L. M. (1989). Canid modification on human remains: implications for time-since-death estimations. *Journal of Forensic Sciences*, 34: 894-901.

Xirouchakis, S.M. (2005). The diet of Eurasian griffons (*Gyps fulvus*) in Crete. *Journal of Raptor Research*, 39: 179-183.

Zuberogoitia, I., Martínez, J.E., Margalida, A., Gómez, I., Azkona, A. & Martínez, J.A. (2010). Reduced food availability induces behavioural changes in griffon vulture *Gyps fulvus*. *Ornis Fennica*, 87: 52-60.