Short Note

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Who is the killer? Barking up the wrong tree

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Abstract: In recent years, several cases of predation on hunting dogs have been reported in Italy. These cases caused uproar among owners and the wolf was singled out as the culprit. The remains of a dog allegedly killed by wolves were submitted for forensic analysis. Wolf predation was ruled out based on gross findings and wild boar aggression was suspected instead. Genetic analysis of salivary swab samples confirmed that wild boars fed on the dog. As poaching is one of the main threats to wolf conservation, it is essential to identify correctly the predator in cases of attacks on domestic animals.

Keywords: hunting dog; predation; salivary samples; wild boar attack.

In the winter of 2015–2016, several cases of predation and consumption on domestic dogs (*Canis lupus familiaris*) were reported in Tuscany (Central Italy) by local press and social media. A vast majority of dogs were used for wild boar (*Sus scrofa*) hunting. Owners reported that hounds, unleashed in the woods to track the boars, were found dead within hours and carcasses appeared largely consumed. These cases caused uproar among hunters and dog owners, and the wolf (*Canis lupus*) was singled out as being responsible for the killings, despite the lack of official necroscopic examinations or other scientifically

collected evidence on the deceased dogs. In January 2016, a hound got lost whilst boar hunting in the woods in the Province of Siena (Tuscany). A couple of hours after disappearance, the dog was found dead thanks to a global positioning system (GPS) tracker; the carcass appeared to be extensively but incompletely consumed. The dog was submitted for post-mortem examination. The aim of this short report was to outline a forensic approach to predation cases with media coverage, in which pointing out the wrong culprit may have negative consequences on the conservation of endangered species.

The examined dog (Figure 1) was an adult female Maremma hound. The carcass was devoid of the skin and superficial muscles. The skin was only preserved at the head and left rear limb. Skin margins had a scalloped appearance and did not show bruising or bleeding, suggesting that defleshing had occurred post-mortem. Lesions consistent with intra-vitam or post-mortem carnivore bite marks, such as paired incised or punctured wounds (Pavlov and Hone 1982, Bury et al. 2012), were not identified. Large chunks of intercostal muscles were missing, amongst multiple rib fractures. Signs of deep furrowing on the distal bone end were observed on the left femur, on both compact and cancellous bone (Figure 2). No punctures or pits were identified on bones, while these lesions are usually produced by carnivore scavenging (Colard et al. 2014, Young et al. 2015). Viscera were not affected by consumption. The cause of death could not be determined due to the incompleteness of the remains. From necroscopic findings, the signs of consumption on the carcass were not consistent with the action of a carnivore.

Eight salivary swab samples were collected with cotton swabs from the margins of scavenging lesions on muscles and long bones (one sample per lesion). The swabs were individually put in sterile plastic tubes and frozen at –20°C until processing. The DNA was extracted following published methods (Lorenzini et al. 2014). One mock tube with reagents and no DNA was included. Two panels of 18 and 12 nuclear loci specific to *Canis lupus* and *Sus scrofa*, respectively, were amplified following published protocols (Lorenzini 2005, Lorenzini et al. 2014). Negative controls were added to each polymerase

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Figure 1: Extensive consumption on the carcass of an adult female Maremma hound, found in the woods after being lost during boar hunting.

Figure 2: Left femur. Collection of salivary swab from a consumption mark (furrowing on the distal bone end).

chain reaction (PCR) session to check for contamination. PCR products were loaded onto an 3130 Genetic Analyzer (Applied Biosystems, Foster City, CA, USA). Allele sizing was performed using the GeneMapper Software Version 3.1 (Applied Biosystems, Foster City, CA, USA). Genetic profiles obtained from the eight samples at the 18 loci specific to *C. lupus* were all identical and coincided with the profile of the dog. No alleles attributable only to wolves were found from any swab. The amplification of the short tandem repeat (STR) panels specific to *S. scrofa* was positive for four salivary samples. One sample yielded a single complete genotype while the remaining three swabs showed more than two alleles at three different loci. Statistical analyses assigned the genotypes to the wild boar population (c.f. Lorenzini 2005, Lorenzini et al. 2014). Furthermore, the presence of three or four

alleles per locus revealed that at least two boar individuals fed on the dog.

Boar hunting in Tuscany is traditionally practiced with a pack of hounds: the dogs are unleashed in the woods to track the boars and to push them towards the hunters. When the hounds meet a pack of wild boars or if they succeed to isolate an adult boar, a fight can happen in which the dogs can be severely injured. For this reason, nowadays hunters commonly employ GPS trackers on the dog collars, to retrieve injured or deceased dogs. Lesions produced by wild boar aggression on dogs typically show a so-called “iceberg effect”, i.e. despite a small skin wound an extensive damage of underlying tissues is present, involving large vessels, nerves and viscera. Often the deeper injury is far from the entrance at the skin level and 25% of wounds penetrates into the thoracic or abdominal cavity, according to Barsotti et al. (2001). This wound pattern is due to the typical pointed and curved shape of canine teeth (the so-called tusks) in the wild boar. The lower canines are particularly prominent and sharp in adult male boars (Kose et al. 2011), whilst the lesions produced by young boars and females, who do not grow analogous tusks, predominantly consist of shallow bites.

In an experimental study on bone modifications induced by suids (Domínguez-Solera and Domínguez-Rodrigo 2009), it was observed that a prominent use of the incisor teeth provides distinctive features to suids’ tooth-marking. In contrast to carnivores feeding on bones with premolars and molars, suids indeed rather remove flesh with their incisors, producing a characteristic furrowing with flat removal of cancellous bone.

Cases of fatal aggression by wild boars have been described in humans, where death is usually attributed to exsanguination from vascular injuries or evisceration from penetrating wounds to the abdomen (Langley 1994, Manipady et al. 2006, Bury et al. 2012, Mayer 2013). Wild boars and feral pigs have also been reported to actively predate on livestock (Pavlov and Hone 1982, Fico et al. 1993, Barrett and Birmingham 1994), but in the case of a boar hunt it is more likely that the aggression was started as a defensive action. In a review on wild pig attacks against humans (Mayer 2013), it appeared that attacks from boars under hunting circumstances were mostly inflicted by wounded animals. Dogs too were frequently involved in these attacks, and could get injured or killed (Mayer 2013).

In the present case, it can be hypothesized that the dog has been attacked by one or more boars during the hunt. Death may have been caused by injuries undetectable after the extensive consumption of the carcass, such as lacerations of major vessels, or penetrating wounds at the chest with development of pneumothorax but lack of lesions on

cavitary organs. The aggression eventually evolved into carcass consumption by at least two different individuals. The species is a known opportunistic omnivore (DeVault and Rhodes 2002, Selva et al. 2005) and also in some fatal attacks on humans, wild boars have been reported consuming the remains of the victims (Domínguez-Solera and Domínguez-Rodrigo 2009, Mayer 2013).

The Italian wolf population has increased in recent years, especially in Central Italy. In the years 2009–2013, the Apennines sub-population consistency was estimated to be 1212–1711 wolves (Galaverni et al. 2016). Official reports in 2015 counted about 109 reproductive wolf packs in the Tuscany region alone (Regione Toscana 2017). The increase in the wolf population caused a resurgence of conflicts with human activities, especially in areas of recent recolonization (Lovari et al. 2007). Illegal killings (poaching with firearms, traps or poison) still represent one of the main threats to the conservation of the species (Dondina et al. 2014, Galaverni et al. 2016). For this reason it is essential not only to implement conflict management practices, but also to establish with certainty the identity of the predator in cases of aggression whether on livestock and pet animals (Fico et al. 2005, Caniglia et al. 2013, Peltola and Heikkilä 2015) or on humans (Caniglia et al. 2016). Furthermore, reliable predator identification would be a necessary condition to consider compensation measures for dog losses due to wolf attacks.

The prejudicial attribution to the wolf in episodes of predation on dogs in Italy, probably stems from documented cases in northern Europe or USA (Kojola and Kuitinen 2002, Backeryd 2007, Olson et al. 2014). Most dogs in these countries are killed by wolves while employed in hunting activities, and wolf attacks have been shown to increase during periods of low ungulate prey densities. Nevertheless, in Italy, wild boar represents the main prey of the wolf (Mori et al. 2017) and wild boar census in Tuscany reports a pre-reproductive consistency of 150,000 individuals (Regione Toscana 2018). These data can lead to ruling out the scarcity of wild prey as a trigger for possible predatory behavior of wolves on dogs at least in this region. Overall in the Mediterranean area, caution should be taken in cases of dog killings to exclude other scenarios that are probably more common, such as aggression by wild boars to hunting dogs, especially where boars are locally abundant.

Hounds during the hunting season are at risk of suffering defensive attacks, injuries or being killed by wild animals who have been disturbed during the hunt. Defensive behavior and consequent injuries or killings have been described in Italy by the wild boar (Barsotti et al. 2001) and the crested porcupine *Hystrix cristata* (Mori et al. 2014). However, only the wild boar shows a feeding behavior on dog remains after the attack. There are no unique patterns of consumption described

Table 1: Summary of reported cases of wild boar aggressions on domestic animals.

	Pavlov and Hone 1982	Barsotti et al. 2001	Mayer 2013	This paper
Domestic animal species	Lamb (<i>Ovis aries</i>)	Dog	Dog (71%), camel (<i>Camelus dromedarius</i>), domestic pig (<i>Sus scrofa</i>), horse (<i>Equus caballus</i>), ox (<i>Bos taurus</i>)	Dog
Location	New South Wales (Australia)	Tuscany (Italy)	Worldwide scale study	Tuscany (Italy)
Season	Fall and spring	n.a.	Seasonal increase in attacks during fall and winter	Winter
Ongoing hunting activities	No	Yes (boar hunt)	Both hunting and non-hunting activities	Yes (boar hunt)
N° of domestic animals involved	22	118	70	1
Aggression outcome	Death	– 57% deep injuries to thigh or shoulder – 25% penetrating wounds to chest or abdomen – 18% superficial wounds	– 79% uninjured or escaped – 12% injured – 10% killed (all dogs)	Death
Consumption following aggression	Yes	–	n.a.	Yes
Necroscopic findings	Almost complete consumption of lamb carcass in 45 min (see original paper for detailed sequence)	–	n.a.	– Extensive consumption of the carcass – Deep furrowing on distal femur, on compact and cancellous bone

on animals killed by wild boars (Table 1), but particular attention should be paid to bone modifications and features of bite marks; eventually, necroscopic findings should be corroborated by molecular analysis. This is the first report of the combined use of forensic pathology and genetics to allow identification of wild boar as being responsible for a case of aggression and consumption on a hunting dog.

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