

Subcutaneous ticks: first report in a golden jackal and their absence in non-canid carnivores

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Short report

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Abstract

Background: Ticks are hematophagous arthropods which normally attach to the surface of the skin of the host. Their aberrant presence in the subcutaneous tissue of a few carnivores, predominantly foxes has been reported. However, there are no reports in other carnivores such as mustelids or golden jackals. Our aim was to investigate and broaden the host spectrum for this aberrant localization of ticks.

Methods: Between 2015 and 2020, 198 carnivore carcasses from 12 species were examined by parasitological necropsy. When subcutaneous ticks were found, the nodules were removed, carefully dissected, and stored in ethanol. The morphological identification of the subcutaneous ticks was carried out to the species level.

Results: A single subcutaneous tick was found in one carcass, a golden jackal. The tick was identified as a female *Ixodes ricinus*. All the other carcasses were negative for the presence of subcutaneous ticks.

Conclusion: The present paper represents the first report of a subcutaneous tick in a golden jackal (*Canis aureus*), extends the host spectrum for this unusual phenomenon and reinforces its presence only in canids among carnivores.

Background

Ticks represent a large group of blood-sucking arthropods parasitic in a wide range of mammals, birds, reptiles, and occasionally in amphibians. Ticks are also important vectors for various pathogens [1]. A blood meal is required for molting, egg laying, and, in some species, preparation for mating [2].

Ticks typically attach to the external surface of the skin. However, there are reports of ticks being found in the subcutaneous tissue (Table 1). Most of the reports of subcutaneous ticks are from red foxes, with occasional findings in other carnivore hosts (a raccoon dog, and a domestic dog) (Table 1). So far, several hypotheses were suggested to explain the presence of ticks in the subcutaneous tissue, but none of them has been confirmed by experimental studies. It is unknown if the number of reports and the relatively common occurrence of subcutaneous ticks in red foxes is related to some host preference or to more studies performed on this species. Hence, understanding the full host spectrum is important to fill in the knowledge gaps for this unusual phenomenon. It is also unclear why most of the reports are from Eastern and Central Europe and if this geographical bias is related to the fact that foxes are the most widespread and studied wild canids in this area. Nevertheless, during the last twenty years, the population of another canid, the golden jackal (*Canis aureus*) has increased significantly [3]. Golden jackals have an important role as reservoir hosts for parasites such as *Leishmania infantum*, *Alaria alata*, *Dipylidium caninum*, *Mesocestoides lineatus*, *Trichinella* spp., and *Dirofilaria* spp., but also as hosts for ticks [4]. Moreover, it is not clear if other wild carnivores such as mustelids can harbor subcutaneous ticks, as the lack of published reports could be a result of the lack of investigations. The aim of the present study was to investigate the occurrence of subcutaneous ticks in various species of wild carnivores in a

geographical area where this aberrant localization is known to be prevalent in red foxes, in order to elucidate the role of the host species.

Materials And Methods

Between 2015 and 2020, 198 wild carnivore carcasses from 12 species (57 golden jackals, 6 gray wolves, 19 wild cats, 2 Eurasian lynxes, 76 Eurasian badgers, 20 beech martens, 8 European polecats, 4 European pine martens, 3 Eurasian otters, 1 stoat, 1 European mink, 1 least weasel) (Suppl. material) have been examined by parasitological necropsy. Carcasses originated from road kills or legally hunted animals. The carcasses were stored at -20 °C until processing. The age of the animals was estimated based on the state of tooth wear [5] and sexual maturity [6]. The carcasses were checked for the presence of ectoparasites, then necropsied using a standard method, starting with the removal of the skin. When subcutaneous ticks were found, the nodules were removed, carefully dissected, and stored in ethanol. The identification of the subcutaneous ticks was carried out to the species level under an Olympus® binocular magnifier and was based on the taxonomic criteria according to dichotomous keys [1].

Results

A single subcutaneous tick was found in one sample, a golden jackal collected from Comana Natural Park, Romania (Fig. 1). The nodule was found under the skin of the left inguinal area. The tick was in an advanced stage of decomposition. However, despite the state of tick degradation, the gnathosoma and a big part of the idiosoma were well preserved, and the tick was identified as a female *Ixodes ricinus*. No subcutaneous ticks were found in the other examined carcasses.

Discussion

The mechanism causing the subcutaneous localization of ticks is still unknown. Several tick-related factors such as the species or the sex were incriminated as favoring factors. A more common presence under the skin was noted for ticks with a long rostrum (i.e. *Ixodes* spp.) or ticks feeding for longer periods (adults in general and females in particular), which seem to be predisposing factors [7, 8]. Although it is evident that the vast majority of reports of subcutaneous ticks are from red foxes (Table 1), it is not clear if host-related factors are involved. The lack of reports from other hosts could be related to the actual absence of subcutaneous ticks or the lack of studies in other hosts. To understand the full host spectrum of this unusual occurrence, negative reports are also useful. However, with the exception of one study in roe deer [9], no other negative reports are known.

We report here for the first time the presence of a subcutaneous tick in a golden jackal (frequency 1/57; 95% CI 0.04–9.39%) and the absence in 11 other carnivore species. However, with the exception of few hosts, such as Eurasian badgers, beech martens and wild cats, the number of carcasses from other species was too low for a stronger conclusion.

So far, with the exception of one human case, all other reports originate from canids, with high local prevalence in red foxes [7, 8]. The vast majority of these reports refer to ticks of the genus *Ixodes* (Table 1) but this may also be related to the more common occurrence of these ticks in red foxes [10, 11].

Conclusion

The present paper reports a new host for the presence of subcutaneous ticks and confirms the canids as the single group of carnivores to show this phenomenon indicating a possible role of the host as a risk factor. We highlight the importance of further studies on other hosts, but also in other geographical regions.

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interest.

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Authors' contributions

NM wrote the manuscript and identified the tick species. GD performed the necropsies and revised the manuscript. CMG and AMI performed necropsies. DTI and GBC collected carnivore samples. ADM and CMG coordinated the study and revised the manuscript. All authors read and approved the final manuscript.

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Table

Table 1. Review of reports of ticks in subcutaneous tissues of various hosts

Host	Species	Country	Reference
Red fox <i>Vulpes vulpes</i>	<i>Ixodes ricinus</i>	UK	[12]
	<i>Ixodes hexagonus</i>		
	<i>Ixodes ricinus</i>	Poland	[13]
	<i>Ixodes ricinus</i>	Austria	[14]
	<i>Ixodes ricinus</i>	Slovakia	[15]
	<i>Ixodes ricinus</i>	Slovakia	[16]
	<i>Amblyomma americanum</i>	USA	[17]
	<i>Ixodes ricinus</i> <i>Ixodes hexagonus</i> <i>Ixodes crenulatus</i> <i>Dermacentor reticulatus</i>	Czech Republic	[7]
	<i>Ixodes ricinus</i>	Romania	[7]
	<i>Ixodes ricinus</i>	Slovakia	[18]
	<i>Ixodes ricinus</i>	Sweden	[19]
	<i>Ixodes ricinus</i> <i>Dermacentor reticulatus</i>	Poland	[20]
	<i>Ixodes ricinus</i> <i>Ixodes hexagonus</i> <i>Ixodes canisuga</i>	Germany	[8]
Raccoon dog <i>Nyctereutes procyonoides</i>	<i>Ixodes ricinus</i>	Poland	[21]
Domestic dog <i>Canis familiaris</i>	<i>Ixodes ricinus</i>	Sweden	[19]
Golden jackal <i>Canis aureus</i>	<i>Ixodes ricinus</i>	Romania	current study

Figures

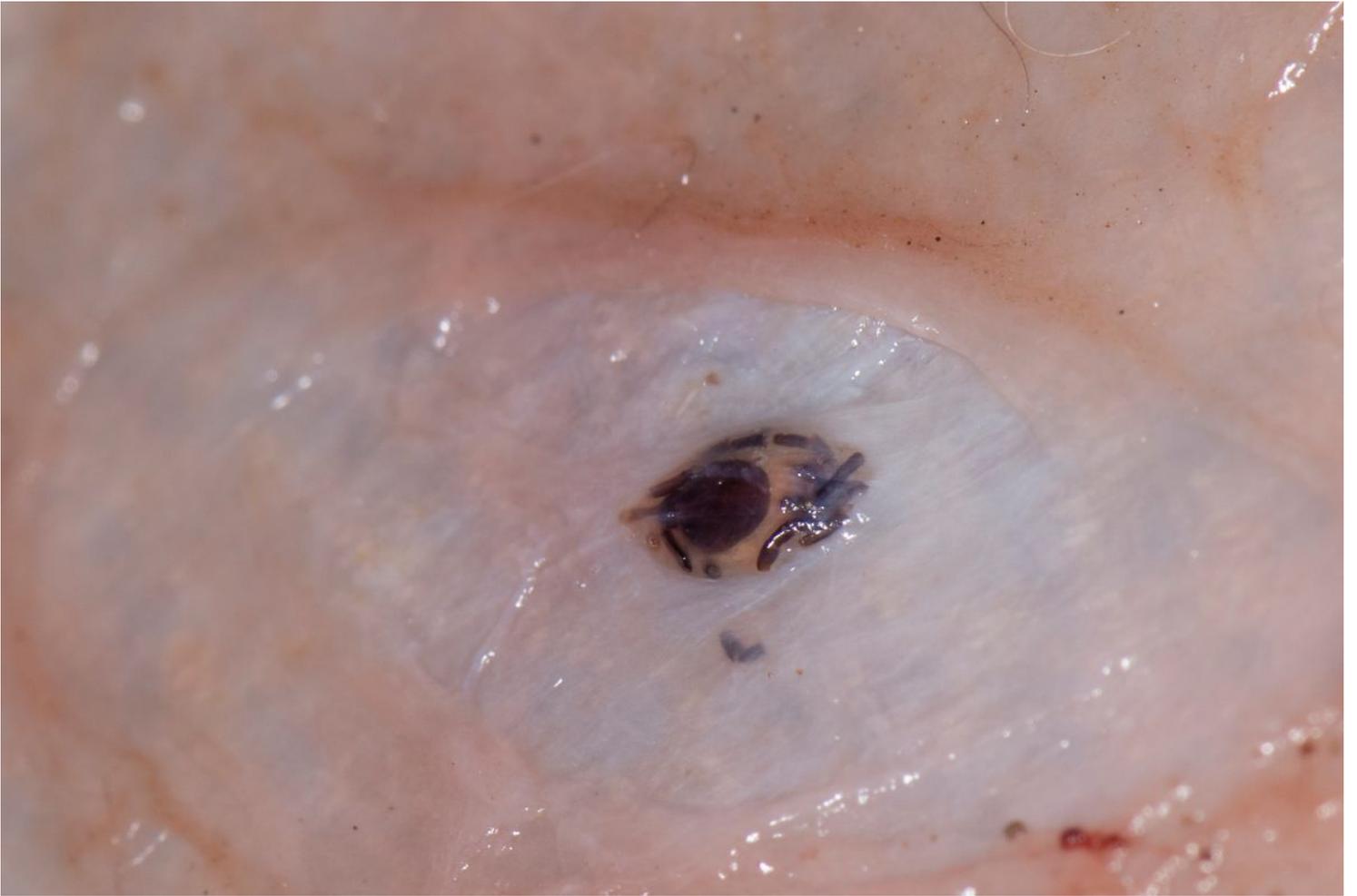


Figure 1

Ixodes ricinus in the subcutaneous tissue of a golden jackal, *Canis aureus*, in Romania

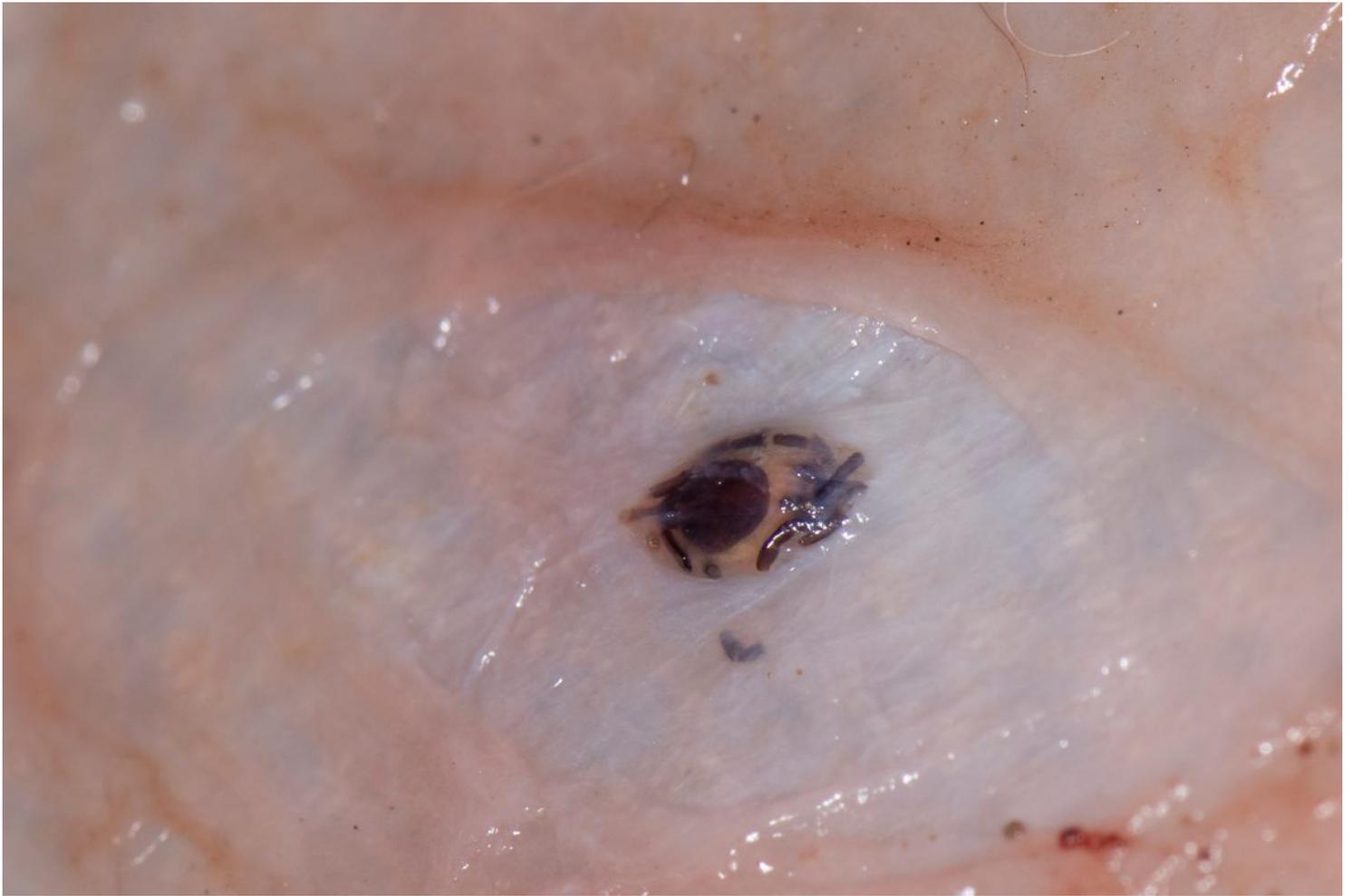


Figure 1

Ixodes ricinus in the subcutaneous tissue of a golden jackal, *Canis aureus*, in Romania

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