

SHORT REPORT

Open Access



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

Noureddine Mechouk<sup>1,2</sup>, Georgiana Deak<sup>2</sup>, Angela Monica Ionică<sup>2,3</sup>, Dan Traian Ionescu<sup>4\*</sup>, Gabriel Bogdan Chișamera<sup>5</sup>, Călin Mircea Gherman<sup>2</sup> and Andrei Daniel Mihalca<sup>2</sup>

## Abstract

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

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

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

**Conclusion:** To our knowledge, this is the first report of a subcutaneous tick in a golden jackal. This finding broadens the host spectrum of subcutaneous ticks, and reinforces the idea that, among carnivores, this phenomenon only occurs in canids.

**Keywords:** Golden jackals, Subcutaneous, Ticks, Romania

## Background

Ticks represent a large group of blood-sucking arthropods and are parasitic in a wide range of mammals, birds, reptiles, and occasionally amphibians. Ticks are also important vectors for various pathogens [1]. In ticks, 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 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 have been suggested to explain the presence of ticks in 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 host preference or to the number of studies performed on this wild carnivore species. Hence, elucidating the full host spectrum of subcutaneous ticks is important to fill in the knowledge gaps for this phenomenon. It is also unclear why most of the reports on subcutaneous ticks 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. During the last 20

\*Correspondence: dionescu@unitbv.ro

<sup>4</sup> Department of Game and Wildlife, Faculty of Silviculture and Forestry Engineering, Transilvania University, Șirul Beethoven 1, 500123 Brașov, Romania

Full list of author information is available at the end of the article



© The Author(s) 2021. This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>. The Creative Commons Public Domain Dedication waiver (<http://creativecommons.org/publicdomain/zero/1.0/>) applies to the data made available in this article, unless otherwise stated in a credit line to the data.

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., and are also 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, we necropsied 198 carcasses of 12 species of wild carnivores (57 golden jackals, six gray wolves, 19 wild cats, two Eurasian lynxes, 76 Eurasian badgers, 20 beech martens, eight European polecats, four European pine martens, three Eurasian otters, one stoat, one European mink, one least weasel) (Additional file 1) and examined them for parasites. The carcasses originated from roadkills or legally hunted animals. The carcasses were stored at  $-20^{\circ}\text{C}$  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 species level under an Olympus binocular magnifier and was based on 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 level of tick degradation, the gnathosoma and a large 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, although several factors such as the species or the sex of the tick have been incriminated as favoring factors. A more common presence under the

**Table 1** Review of reports of ticks in the 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>	Czech Republic	[7]
	<i>Ixodes hexagonus</i>		
	<i>Ixodes crenulatus</i>		
	<i>Dermacentor reticulatus</i>		
	<i>Ixodes ricinus</i>	Romania	[7]
	<i>Ixodes ricinus</i>	Slovakia	[18]
	<i>Ixodes ricinus</i>	Sweden	[19]
<i>Ixodes ricinus</i>	Poland	[20]	
	<i>Dermacentor reticulatus</i>		
	<i>Ixodes ricinus</i>	Germany	[8]
	<i>Ixodes hexagonus</i>		
	<i>Ixodes canisuga</i>		
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

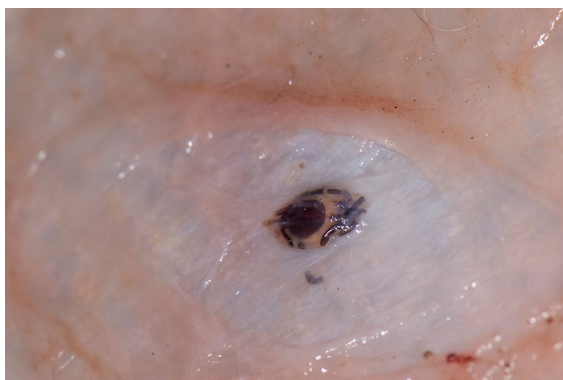
skin was noted for ticks with a long rostrum (i.e. *Ixodes* spp.) or that feed for longer periods (adults in general and females in particular), which seem to be predisposing factors [7, 8]. Although the vast majority of reports of subcutaneous ticks concern red foxes (Table 1), it is not clear if host-related factors are involved. The lack of reports of subcutaneous ticks in other hosts could be related to their absence in them or to the lack of studies on other hosts of ticks. To determine the full host spectrum of subcutaneous ticks, negative reports are also useful. However, with the exception of one study in roe deer [9], we know of no other negative reports.

To our knowledge, this is the first report of a subcutaneous tick in a golden jackal (frequency 1/57; 95 % confidence interval 0.04–9.39 %); subcutaneous ticks were absent from the other 11 species of carnivores examined. However, with the exception of a few host species such as Eurasian badger, beech marten and wild cat, the number of carcasses examined was too low for us to draw a firm conclusion from our results.

So far, with the exception of one human case, all reports of subcutaneous ticks are from studies on 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 be related to the more common occurrence of these ticks in red foxes [10, 11].

## Conclusion

We report a new host for subcutaneous ticks, and confirm that, to date, canids are the only group of carnivores to show this phenomenon. The results indicate a possible role of the host as a risk factor for subcutaneous ticks. We highlight the importance of carrying out further studies on other hosts of ticks, which should also be undertaken in other geographical regions.



**Fig. 1** *Ixodes ricinus* in the subcutaneous tissue of a golden jackal *Canis aureus*, from Romania

## Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s13071-020-04510-7>.

**Additional file 1.** Database with all examined carnivores.

## Acknowledgements

We are indebted to all the people who collected the carnivore carcasses.

## Authors' contributions

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

## Funding

The research was carried out within the framework of the UEFISCDI project PCCDI 57/2018. One of the authors was financially supported by a grant from Altius SRL Romania to support and promote research in Romania.

## Availability of data and materials

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

## Ethics approval and consent to participate

Not applicable.

## Consent for publication

Not applicable.

## Competing interests

The authors declare that they have no competing interests.

## Author details

<sup>1</sup> Ecology of Terrestrial and Aquatics Systems Laboratory (EcoStaQ), Department of Biology, Faculty of Science, Badji Mokhtar University—Annaba, Annaba, BP 12, 23200, Algeria. <sup>2</sup> Department of Parasitology and Parasitic Diseases, Faculty of Veterinary Medicine, University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca, Calea Mănăştur 3-5, Cluj-Napoca 400372, Romania. <sup>3</sup> Molecular Biology and Veterinary Parasitology Unit (CDS 9), Regele Mihai I al României Life Science Institute, University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca, Calea Mănăştur 3-5, 400372 Cluj-Napoca, Romania. <sup>4</sup> Department of Game and Wildlife, Faculty of Silviculture and Forestry Engineering, Transilvania University, Șirul Beethoven 1, 500123 Brașov, Romania. <sup>5</sup> Grigore Antipa National Museum of Natural History, Sos. Kiseleff no. 1, 011341 Bucharest 1, Romania.

Received: 29 July 2020 Accepted: 1 December 2020

Published online: 05 January 2021

## References

- Estrada-Peña A, Mihalca AD, Petney TN (editors). Ticks of Europe and north Africa: a guide to species identification. Springer, 2018;1—195.
- Oliver JH. Biology and systematics of ticks (Acari: Ixodida). *Annu Rev Ecol Syst.* 1989;20:397–430.
- Papp CR, Banea OC, Szekely-Sitea AL. Applied ecology and management aspects related to the golden jackal specific ecological system in Romania. *Act Mus Maram.* 2013;9:275–92.
- Gherman CM, Mihalca AD. A synoptic overview of golden jackal parasites reveals high diversity of species. *Parasites Vectors.* 2017;10:419.
- Lombaard LJ. Age determination and growth curves in the black-backed jackal, *Canis mesomelas* Schreber, 1775 (Carnivora: Canidae). *Ann Transv Mus.* 1971;27(7):135–69.
- Klevezal G, Kleinenberg S. Age determination of mammals by layered structure in teeth and bone (in Russian). Moscow Nauka; 1967.

7. D'Amico G, Juránková J, Tăbăran FA, Frgelecová L, Forejtek P, Matei IA, et al. Occurrence of ticks in the subcutaneous tissue of red foxes (*Vulpes vulpes*) in Czech Republic and Romania. *Ticks Tick Borne Dis.* 2017;8(2):309–12.
8. Haut M, Król N, Obiegala A, Seeger J, Pfeffer M. Under the skin: *Ixodes* ticks in the subcutaneous tissue of red foxes (*Vulpes vulpes*) from Germany. *Parasites Vectors.* 2020;13:189.
9. Król N, Chitimia-Dobler L, Dobler G, Karliuk Y, Birka S, Obiegala A, et al. Tick burden on European roe deer (*Capreolus capreolus*) from Saxony, Germany, and detection of tick-borne encephalitis virus in attached ticks. *Parasitol Res.* 2020;119:1387–92.
10. Dumitrache MO, D'Amico G, Matei IA, Ionică A, Gherman CM, Barabási SS, et al. Ixodid ticks in red foxes (*Vulpes vulpes*) from Romania. *Parasites Vectors.* 2014;7:P1.
11. Karbowiak G, Stanko M, Miterpaková M, Hurníková Z, Víchová B. Ticks (Acari: Ixodidae) parasitizing red foxes (*Vulpes vulpes*) in Slovakia and new data about subgenus *Pholeoixodes* occurrence. *Acta Parasitol.* 2020; <https://doi.org/10.2478/s11686-020-00184> —4 (online ahead of print).
12. Nuttall GHF. Penetration of *Ixodes* beneath the skin. *Parasitology.* 1914;7(3):258–9.
13. Drozd J. Penetration of *Ixodes ricinus* under the skin of the host. *Acta Parasitol Polon.* 1958;6:383–5.
14. Hinaidy HK. Ein weiterer Beitrag zur Parasitenfauna des Rotfuchses *Vulpes* (L.), in Österreich. *Zentralbl Veterinarmed B.* 1976;23:66–73.
15. Lebeda M. Findings of *Ixodes ricinus* in the deep layers of the skin and in the lymphatic ganglion (lymph node) of foxes (*Vulpes vulpes*). *Vet Cas Bratislava.* 1962;11:193–205.
16. Tovornik D. Penetracija klopov (Ixodidae) v globoke plasti kože gostitelja. *Biol Vestnik.* 1984;32:117–20.
17. Smith DD, Frenkel JK, Smith EI. Intradermal infestation of a red fox (*Vulpes vulpes*) by the lone star tick (*Amblyomma americanum*). *J Wildl Dis.* 1986;22(1):122–4.
18. Pet'ko B, Stanko M. Finding of the tick *Ixodes ricinus* under the skin of a fox in Slovakia. *Folia Vet.* 1991;21:159–162.
19. Zakrisson G. Ticks, *Ixodes ricinus* in the subcutaneous tissues of a dog and foxes (in Swedish). *Svensk Veterinartidning.* 2010;62:25–7.
20. Dwuznik D. Ectoparasites of red fox (*Vulpes Vulpes*) with particular focus on ticks in the subcutaneous tissues. *Ann Parasitol.* 2019;65(Supplement1):s250.
21. Matysiak A, Wasielewski O, Włodarek J, Ondrejková A, Tryjanowski P. First report of ticks in the subcutaneous tissue of the raccoon dog *Nyctereutes procyonoides*. *Vet Med-Czech.* 2018;63(12):571–4.

### Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Ready to submit your research? Choose BMC and benefit from:

- fast, convenient online submission
- thorough peer review by experienced researchers in your field
- rapid publication on acceptance
- support for research data, including large and complex data types
- gold Open Access which fosters wider collaboration and increased citations
- maximum visibility for your research: over 100M website views per year

At BMC, research is always in progress.

Learn more [biomedcentral.com/submissions](https://biomedcentral.com/submissions)

