First record of *Hyalomma marginatum* sensu stricto C.L. Koch, 1844 and distribution of *Dermacentor reticulatus* (Fabricius, 1794) (Acari, Ixodidae) in Luxembourg

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Abstract. This study reports the findings of non-native tick species (*Hyalomma* and *Dermacentor*) in Luxembourg from 2015-2020. The finding of a male *Hyalomma marginatum* sensu stricto C. L. Koch, 1844 tick in the city of Dudelange forms the first record of this species in the country (in 2018). Two more *Hyalomma* ticks were observed in the summer 2020 (male in Beaufort, female in Aspelt). Both males were barcoded and genetically similar to *H. marginatum* sensu stricto individuals originating from Asia and Europe. A passive introduction into Central Europe via migratory birds (mainly from Asia) is suspected. *Hyalomma* ticks are considered the most important vector for the Crimean-Congo Hemorrhagic Fever virus, rendering the records highly relevant for public health. In 2015, six *Dermacentor* ticks were collected in SE-Luxembourg. Previously, these individuals had been identified as *Dermacentor marginatus* Leach, 1815. However, morphological re-investigation as well as DNA barcoding identified the specimens as *Dermacentor reticulatus* (Fabricius, 1794). Thus, and to the best of our knowledge, only *D. reticulatus* is known from Luxembourg, which has implications for the list of neobiota in the country. Current distribution data suggests that *D. reticulatus* actively entered Luxembourg from the South. Goat and sheep pastures as well as horse farms particularly in the Gutland and Minette should be investigated in the upcoming years (and their pathogens screened), thus to obtain a better understanding about the establishment of non-native ticks in the country and the diseases they transmit.

Keywords. Invasive ticks, infectious diseases, neobiota, CCHF virus, first record.

1. Introduction

Ongoing climatic and environmental changes, when coupled with the globalisation trend and the ever increasing transportation rate of goods and people, favour the introduction of non-native and invasive species worldwide (Díaz et al. 2019). As such, national and international administrations have installed monitoring systems, and are producing alert and watch lists to track entries of the newcomers. As an example, in 2019 the European Commission published an updated list of 66 animal and plant species of Union concern (Anonymous 2019), with 26 of them being relevant for Luxembourg (https://neobiota.lu/eu-species/). From a national perspective, a total of 51 non-native invertebrate species are recorded and assessed for Luxembourg (Ries et al. 2017), including a single tick species – *Dermacentor marginatus* (Sulzer, 1776) – which in 2017 was classified as "C1" according to the Invasive Species Environmental Impact Assessment protocol (ISEIA protocol; = isolated populations having a low impact) (Branquart et al. 2009).

Over the last few years, a spread of large ticks with banded-legs has been reported in Central Europe (Chitia-Dobler et al. 2019; Hansford et al. 2019) and brought to the attention of the media, e.g. in Germany, France, the

United Kingdom and Luxembourg. Members of the genus *Hyalomma* are two-host ticks, which are restricted to the Palaearctic, Indo-Malaysian and Afrotropical regions (Estrada-Peña et al. 2018). In contrast to what is stated by the media, species prefer dry subtropical desert conditions than life in the tropics. Nymphs infest hedgehogs, hares and ground-dwelling birds, whereas immatures have ungulate mammals as their secondary hosts, particularly cattle but also horses, sheep, goats, camels, deer, wild boar, and humans (Capek et al. 2014). Given that *Hyalomma* ticks are infesting a limited number of secondary hosts – which can be at very low population densities in desert environments – they are actively and quickly following their hosts after sensing them. Nymphs can stay attached to their bird hosts for up to four weeks (Capek et al. 2014), allowing them to considerably increase their (passive) migration distance and to enter new geographical regions. In Europe, traditional resting sites of migrating birds such as the Camargue (France) are predestined 'entry points' (Vial et al. 2016; De Liberato et al. 2018). Likewise, single findings in Scandinavia originating from the last century can be traced back to the passive introduction by migratory birds (Johnsen 1942; Nuorteva & Hoogstraal 1963; Saikku et al. 1971; Mehl et al. 1984). Upon arrival, favourable climatic conditions and the availability of suitable ungulate hosts are decisive factors for population establishment. Under warmer climates (e.g. in the Mediterranean region), *Hyalomma* ticks act as the most important vector for the Crimean-Congo hemorrhagic fever in Europe (Hoogstraal 1979).

The taxonomy, systematics and evolutionary history of the genus are under current debate (Sands et al. 2017). In particular, the five species of the *Hyalomma marginatum*-complex (*H. isaaci*, *H. marginatum* sensu stricto, *H. rufipes*, *H. turanicum*, and *H. glabrum*) are hard to differentiate, because of frequent hybridisation and a generally high phenotypic variability (Rees et al. 2003; Sands et al. 2017). Consequently, occurrence data often can only be reliably linked to this species complex and not to individual species.

In parallel to the arrivals of *Hyalomma* ticks in Central Europe, two Eurasian tick species of the genus *Dermacentor* are increasingly reported. *Dermacentor marginatus* Leach, 1815 (the ornate sheep tick) is adapted to warmer and drier climates (e.g. steppes, semi-deserts) and well represented in the Mediterranean Basin up to Central Asia. Geographically proximate populations to Luxembourg exist in SW-Germany (Rhine Valley and Saarland) and Central France. Nymphs infest rodents and insectivore mammals, adults feed on ungulates (e.g. sheep, cattle, horses, deer), dogs and hedgehogs. *Dermacentor reticulatus* (Fabricius, 1794) favors somewhat more moist environments (e.g. alluvial forests, deciduous forests, swamps). As such, the species is apparently absent in the Mediterranean Basin but occurs at higher latitudes in Europe (Rubel et al. 2016). Populations can be found in the Netherlands, Belgium, Germany and France. Similar to *D. marginatus*, nymphs infest rodents, however, adults can be preferably found on cattle, deer and dogs. Both tick species are important vectors for diverse species of *Babesia*, *Rickettsia*, *Theileria* and *Borrelia* (Bonnet et al. 2013, Rubel et al. 2016) – amongst others.

The aims of this publication are (1) to compile available records of non-native *Hyalomma* and *Dermacentor* ticks in Luxembourg, (2) to genetically characterise specimens, (3) to access current distribution patterns, as well as (4) to discuss the potential entry routes of the species.

2. Material and methods

2.1. Specimen details

The tick specimens presented here were collected by members of the public and brought to the attention of the National Museum of Natural History Luxembourg (MNHNL). Morphological determination was performed using a Leica binocular lens and a Keyence VHX-6000 digital microscope, consulting the taxonomic keys of Nosek et al. (1972), Walker et al. (2003) and Estrada-Peña et al. (2018). Furthermore, some specimens were subjected to DNA barcoding

because i) of difficulties in morphologically identifying members of the *Hyalomma marginatum*-complex to the species level, and since ii) we were interested in the intraspecific genetic diversity of *Dermacentor* ticks in Luxembourg. Finally, the public nature app iNaturalist (Van Horn et al. 2018) was consulted to retrieve further occurrence records of *Dermacentor* ticks. A geographical distribution map was produced in QGIS (QGIS Development Team 2019).

2.2. DNA Barcoding

A fragment of the Cytochrome C Oxidase subunit 1 (COI) gene was investigated for selected *Hyalomma* and *Dermacentor* specimens (Table 1). The primer ChelF1 (5'-TACTCTACTAATCATAAAGACATTGG-3') was used in combination with ChelR1 (5'-CCTCCTCCTGAAGGGTCAAAAAATGA-3') and ChelR2 (5'-GGATGGCCAAAAAATCAAAATAAATG-3') (Barrett & Hebert 2005). PCR reactions were conducted using the Qiagen Multiplex PCR Plus Kit (5 µL MasterMix, 2.5 µL of each primer at 0,8 µM and 1 µL DNA template of variable concentration) under the following cycling conditions: initial denaturation 120s at 94°C followed by 40 cycles of 40s denaturation at 94°C, 60s annealing at 48°C and 60s elongation at 72°C; completed with a final elongation step of 90s at 72°C. PCR results were visualised on a 1.5% Agarose gel and the product cleaned according to the Agencourt AMPure XP manufactures protocol (Beckman Coulter, Massachusetts, USA). PCR volumes for Sanger sequencing were 0.5 µL BigDye, 2 µL 5x reaction buffer, 3.25 µL water and 0.25 µL of each primer (10 µM) combined with 4 µL of template DNA of variable concentration. The sequencing product was cleaned according to the Agencourt® CleanSEQ protocol (Beckman Coulter, Massachusetts, USA). Bi-directional Sanger sequencing was performed in-house at the National Museum of Natural History Luxembourg on a Applied Biosystems 3730xl DNA Analyzer.

Sequence chromatograms were assembled and edited in Geneious Prime 2019.2.1 (Biomatters Limited, Auckland, New Zealand). The Barcode of Life Data system (BOLD, Ratnasingham & Hebert 2007) was used for molecular taxonomic identification as on 16.08.2019. All available COI data for the *H. marginatum*-complex were downloaded, aligned with the MAFFT plugin (Katoh & Standley 2013) of Geneious PRIME 2019.2.1 and a neighbour-joining tree calculated with MEGA-X for visualisation (Kumar et al. 2018).

3. Results

3.1. First records of *Hyalomma* ticks in Luxembourg

A male *Hyalomma marginatum* sensu stricto C. L. Koch, 1844 was collected on the 31.08.2018 in the city of Dudelange, representing the first record of this species in the country (Fig. 1, Table 1). On 11.12.2018, a first attempt was made to morphologically identify the tick at the MNHNL. The tick turned out to be still alive. Subsequent to this finding and its media attention, two further *Hyalomma* sp. sightings were reported. On 14.06.2020, a male *H. marginatum* sensu stricto was collected in Beaufort while infesting a horse. After release, the tick very quickly tried to escape and turned towards another horse nearby (Fig. 2a). On 06.07.2020, a female *Hyalomma* sp. was found crawling on a horse in Aspelt, which was outside for a maximum of five minutes (Fig. 2b). Both latter ticks were collected from the uppermost interior site of the rear legs of the horse, between the thigh and the belly. It was not possible to identify the female tick further since only images were available.

3.2. Identifications and distribution of *Hyalomma* and *Dermacentor* ticks in Luxembourg

COI fragments were generated for two *Hyalomma* and 17 *Dermacentor* ticks (Table 1). When compared to other COI sequences of the *Hyalomma marginatum*-complex (Fig. 3, corresponding to clade 5.2 of Sands et al. 2017), the two Luxembourgish *Hyalomma* specimens showed an identical / similar sequence with several specimens of *H. marginatum* sensu stricto and clustered in a predominantly European + Eurasian

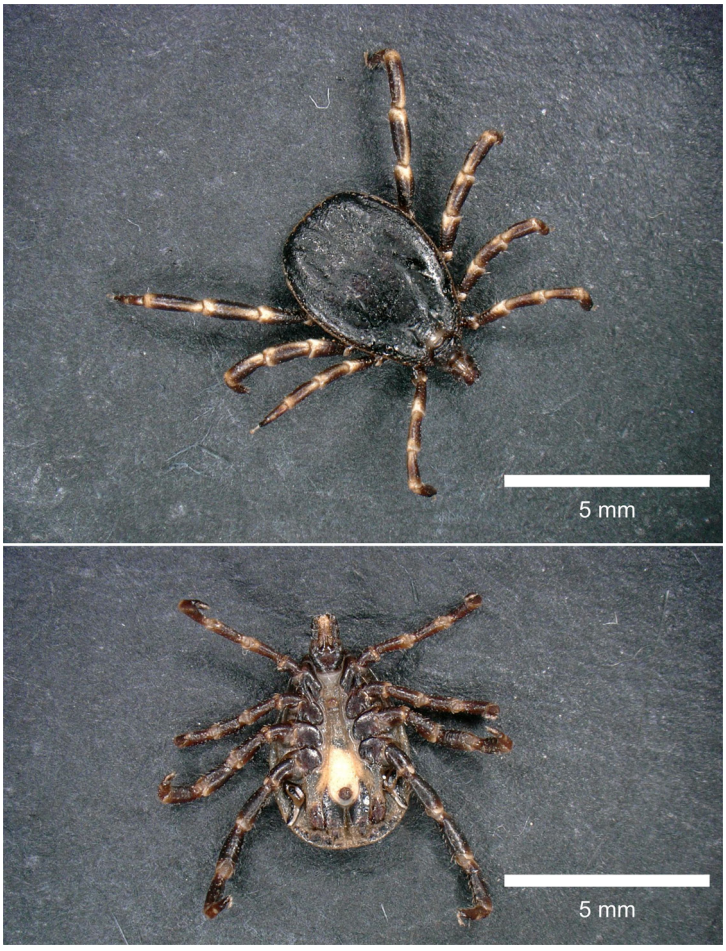


Fig. 1. First record of *Hyalomma marginatum* sensu stricto C. L. Koch, 1844 in Luxembourg. Male specimen (MNHNL67133) found on a human in Dudelange. A) Dorsal view. B) Ventral view.

clade of genetically analysed *H. marginatum* specimens collected in Southern France (n = 13), Georgia (11), Bulgaria (4), Kosovo (3), Russia (1), Ukraine (1), Portugal (1), as well as with a single *H. turanicum* from Pakistan and two sequences of unknown origin (GBCH4212-09 and GBCH4213-09).

All *Dermacentor* ticks collected by members of the public were identified as *Dermacentor reticulatus* (by means of morphology and/or DNA barcoding, Table 1). Available distribution records (iNaturalist, MNHNL database) likewise either refer to *D. reticulatus*, or in case of insufficient image quality on iNaturalist, have not allowed a more precise species-level annotation (i.e. *Dermacentor* sp.) (Table 1). The large majority of records originated from the South of the country (Fig. 4).

4. Discussion

In 2018, *Hyalomma marginatum* sensu stricto was detected in Luxembourg for the first time, also representing the first finding of this species in the Benelux region. Besides the first record, two more animals (*H. marginatum* sensu stricto and *Hyalomma* sp.) were recorded in 2020 after alerting the public. Further records and populations of the *H. marginatum*-complex are known from neighbouring countries. For example, only in 2018, *Hyalomma rufipes* was reported from Lower Saxony, Hesse, Rhineland-Palatinate, Schleswig-Holstein, and *H. marginatum* from Baden-Württemberg, Hesse, Lower Saxony, Rhineland-Palatinate and Schleswig-Holstein (Chitimia-Dobler et al. 2019). Both

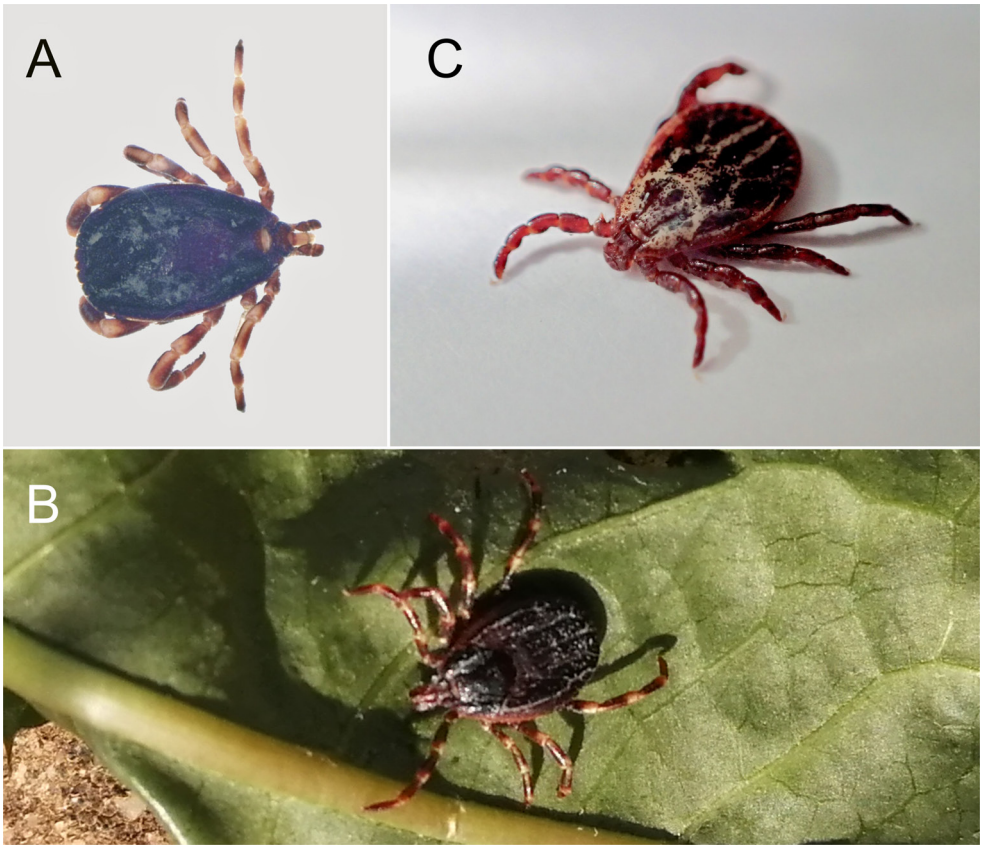


Fig. 2. A: Second finding of *Hyalomma marginatum* sensu stricto C. L. Koch, 1844 tick in Luxembourg. Male specimen (MNHNL77743) infesting a horse in Beaufort. B: Third finding of a *Hyalomma* tick in Luxembourg. Living female detached from a horse, crawling quickly on the ground in Aspelt. Specimen was not collected. C: Male of *Dermacentor reticulatus* photographed 2018 in Dudelange, retrieved from iNaturalist (CC-BY-NN © raedwulf68).

species seem now to be regularly imported to western Germany. Interestingly, there are no records from the eastern part of Germany (Chitimia-Dobler et al. 2019). Probably due to the current climatic conditions, *Hyalomma* ticks might have overwintered in Germany during the 2018/2019 season for the first time. Likewise, *H. marginatum* has established populations in Southern France (e.g. departments of Hérault, Gard, Sud-Ardèche, Pyrénées-Orientales), whereas *H. rufipes* is only sporadically found. Currently, the Massif Central seems to represent an effective environmental / climatic barrier for *H. marginatum*, limiting a more northern natural dispersal (pers. comm. Frédéric Stachurski).

Vial et al. (2016) have hypothesised that *Hyalomma* ticks most likely are introduced to Europe through trans-Mediterranean bird migrations. Indeed, *Hyalomma* ticks are frequently found on migratory birds (Capek et al. 2014) even having reached Scandinavia during the last century (see references in Chitimia-Dobler et al. 2019). However, in our case, and taken the genetic similarities of our specimens to available sequence data from the *Hyalomma marginatum*-complex into account, a more likely scenario refers to the introduction of nymphs via migratory birds coming from Asia. The same might hold true for the *H. marginatum* population established in the Camargue (France, Jourdain et al. 2007; Vial et al. 2014). Once

Table 1. Overview of non-native tick records from Luxembourg. Occurrence records either originate from curated specimens in the collection of the National Museum of Natural History Luxembourg (MNHNL) or come from field observation data. *D* = *Dermacentor*, *H* = *Hyalomma*, f = female, m = male. SC = Svenja Christian, AW = Alexander Weigand. BOLD = Barcode of Life Database. BIN = Barcode Index Number. Asterisks mark the first record of the species in Luxembourg.

Species	N	MNHNL number	BOLD BIN	Coordinates (WGS84)	Site	Leg.	Det.	Date	Comment
Specimen data									
**H. marginatum*	m	67133	AAC1486	49.481N; 6.080E	Dudelange	Germain Hentges	SC AW	31.08.2018	found alive on a human; after visit of a meadow in private garden
H. marginatum	m	77743	AAC1486	49.8337N; 6.28887E	Beaufort	Lucy Leer	AW	14.06.2020	found alive on a horse
D. reticulatus	m	67119	AAL1453	49.5911N; 5.9821E	Dippach, Biohaff Witry	Caroline Massard	AW	28.10.2019	found alive walking in sleeping room. House is home for a cat and dog
D. reticulatus	m	67120	AAL1453	49.518549N; 5.88019E	Differdange	Cyrille Hill	AW	10.09.2019	found alive on a dog (Australian Shepherd); six ticks found, three collected
D. reticulatus	m	88988	AAL1453	id.	id.	id.	id.	id.	id.
D. reticulatus	f	88989	AAL1453	id.	id.	id.	id.	id.	id.
D. reticulatus	f	67121	AAL1453	49.583N; 5.896E	Käerjeng, Forest Um Schack	Thierry Andre-Laribi	AW	15.09.2019	found alive on a dog; after forest walk
D. reticulatus	m	67123	AAL1453	49.545199N; 5.85403E	Pétange	Cabinet Vét. Sanima	AW	30.08.2019	found alive on a dog; transported to veterinary station
D. reticulatus	m	67124	AAL1453	49.523N; 6.162E	Forest between Crauthem, Hellange and N3 (Rue de Schlammestee; Crauthemer Besch)	Mike Dusseldorf	AW	16.09.2019	found alive on a dog
D. reticulatus	m	67128	AAL1453	49.7516N; 6.2708E	Reilander Mühle, Reuland, Heffingen	Marina Bertolini	AW	13.10.2019	found alive on a human; probably from a walk around the Reilander Mühle but collected at home (Mensdorf, Betzdorf)
D. reticulatus	m	67129	AAL1453	49.5897N; 6.0576E	Forest between Bertrange and Schlewenhaff	Georges Faber	AW	08. & 10.11.2019	found alive on a human
D. reticulatus	m	88990	AAL1453	id.	id.	id.	id.	id.	id.
D. reticulatus	m	67130	AAL1453	49.5319N; 5.8794E	Apple orchard, Am Kannerbongert, Niederkorn, Differdange	Lisa Hengen	AW	08.01.2020	found alive on a human; after working in apple tree orchard
D. reticulatus	m	57648		49.53N; 5.99E	Mondercange	Joëlle Lanners	SC	26.08.2019	found alive on a dog
D. reticulatus	m	67131	AAL1453	49.52251N; 6.34177E	Wellenstein, Schengen	Marc Klinker	AW	17.11.2015	several, found alive on horses and producing wounds; initially identified as *D. marginatus*
D. reticulatus	m	88991	AAL1453	id.	id.	id.	id.	id.	id.
D. reticulatus	f	88992	AAL1453	id.	id.	id.	id.	id.	id.
D. reticulatus	m	88993		id.	id.	id.	id.	id.	id.

Table 1. (Continued)

Species	N	MNHNL number	BOLD BIN	Coordinates (WGS84)	Site	Leg.	Det.	Date	Comment
D. reticulatus	f			id.	id.	id.	id.	id.	id.
D. reticulatus	m			id.	id.	id.	id.	id.	id.
D. reticulatus	m	68621	AAL1453	49.686N; 6.449E	Grevenmacher, Wengert um Flohr	Natascha Senal	AW		found alive
D. reticulatus	m	77742	AAL1453	49.48452N; 6.33578E	Burmerange	Dr. Manon Bourg	AW	25.03.2020	found alive on a dead pig
D. reticulatus	m	88986	AAL1453	49.49168N; 6.11971E	Wal, forest east of Dudelange	Guy Marson	AW	11.06.2020	found alive on a human
D. reticulatus	m	88995		49.640N; 6.251E	Zoo Senningen, Niederanven	Ben Louis	AW	09.09.2020	found alive on a dog
D. reticulatus	2m	88996		49.545146N; 6.016791E	Ehlange	Géraldine Thill	AW	13.09.2020	found alive on a dog
D. reticulatus	m	88360		49.60409N; 6.27376E	Oetrange	Marco Schmit	AW	28.09.2020	found alive on human after orchard visit
D. reticulatus	f	88361		49.611N; 6.218E	Sandweiler	Brigitte Welbes	AW	28.09.2020	found alive on a dog
Field observation data									
H. sp.	f			49.522N; 6.225E	Aspelt	Claire Buzogany	AW	06.07.2020	found alive on a horse
D. reticulatus				49.57466N; 6.03384E	Roedgen	François Erasmy		16.10.2019	
D. reticulatus				49.56075N; 5.87191E	Pétange	natur&ëmwelt		10.10.2019	
D. reticulatus	m			49.49739N; 6.095687E	Dudelange	raedwulf68		22.09.2018	retrieved from iNaturalist; found in rough grassland with dock and thistles in alluvial plain
D. sp.	m			49.5381N; 6.3061E	Welfrange	Roland Felten		03.05.2020	
D. sp.	m			49.516N; 6.188E	Frisingen	Michèle Biwer-Erpelding		14.09.2020	found alive on a horse
D. sp.	f			49.707N; 6.424E	Manternach	Michèle Mangen		March 2020	collected from house wall
D. sp.	m			49.52925N; 5.84790E	Differdingen, Roudenhaff	Carine Blasen		19.09.2020	found alive on a horse
D. sp.	m, f			49.90N; 5.857185E	Esch-sur-Sûre	S. Hermes		22.03.2018	retrieved from iNaturalist
D. sp.	2m 2f			49.50635N; 6.16424E	Frisange	Serge Raus		25.10.2019	retrieved from iNaturalist; found alive on wild boar and angus cows
D. sp.	m			49.561943N; 5.878529E	Bascharage	kiischti		03.12.2019	retrieved from iNaturalist
D. sp.	f			49.830722N; 6.099367E	Schieren, Diekirch	tdesousa		22.12.2019	retrieved from iNaturalist
D. sp.	f			49.510558N; 5.894481E	Differdingen	tmpo		08.03.2020	retrieved from iNaturalist
D. sp.	m			49.52N; 6.21E	Aspelt, Frisange	mkayser		15.03.2020	retrieved from iNaturalist
D. sp.	m			49.544N; 6.288E	Welfringen, Dalheim, Grevenmacher	jhermann		11.05.2020	retrieved from iNaturalist
D. sp.	f			49.507692N; 6.332863E	Schengen	janvi0985ec2		21.05.2020	retrieved from iNaturalist

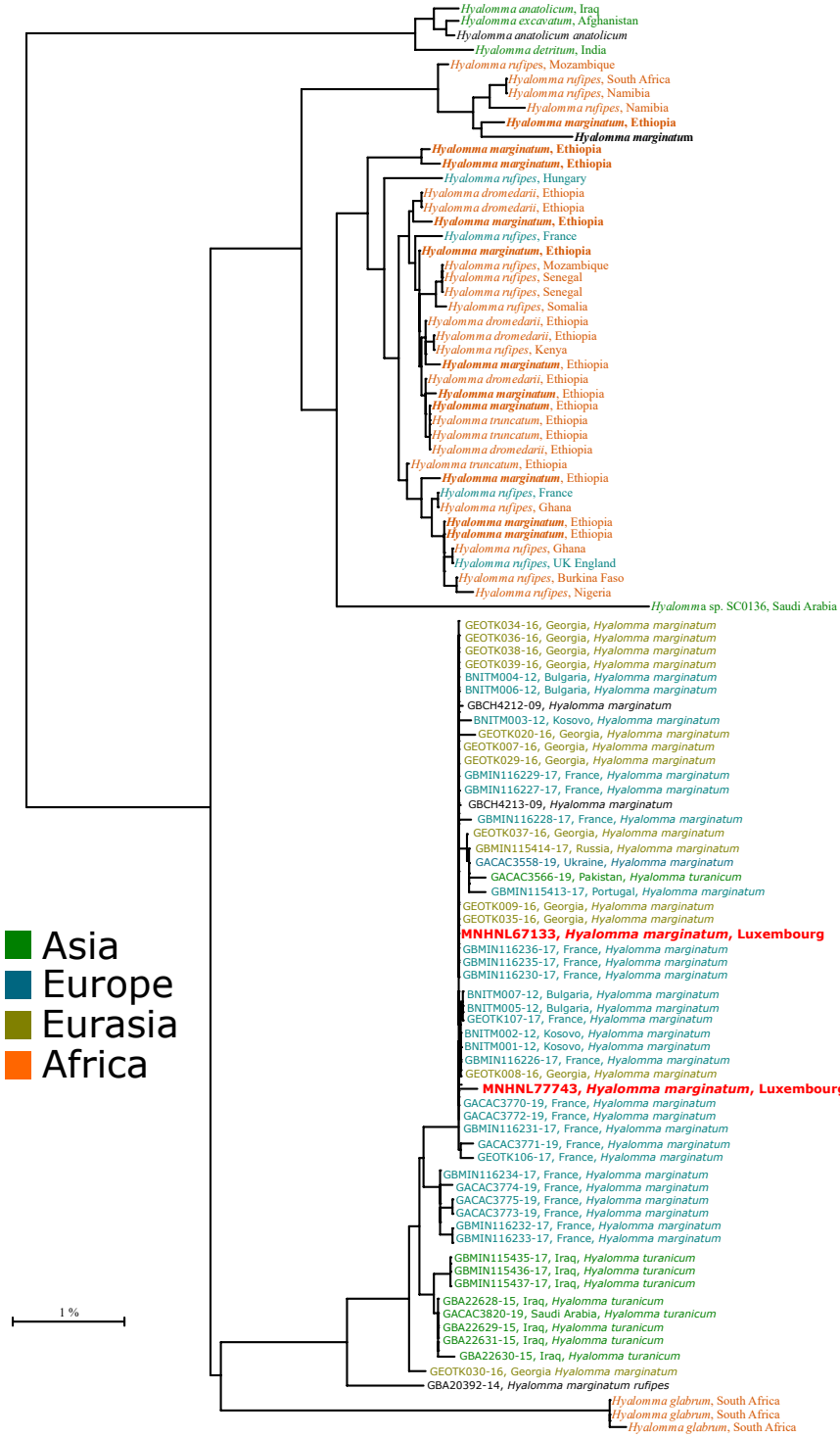


Fig. 3. Overview tree of COI sequences of the *Hyalomma marginatum*-complex. Data retrieved from BOLD as on 16.08.2019. The two Luxembourgish specimens are highlighted in red.

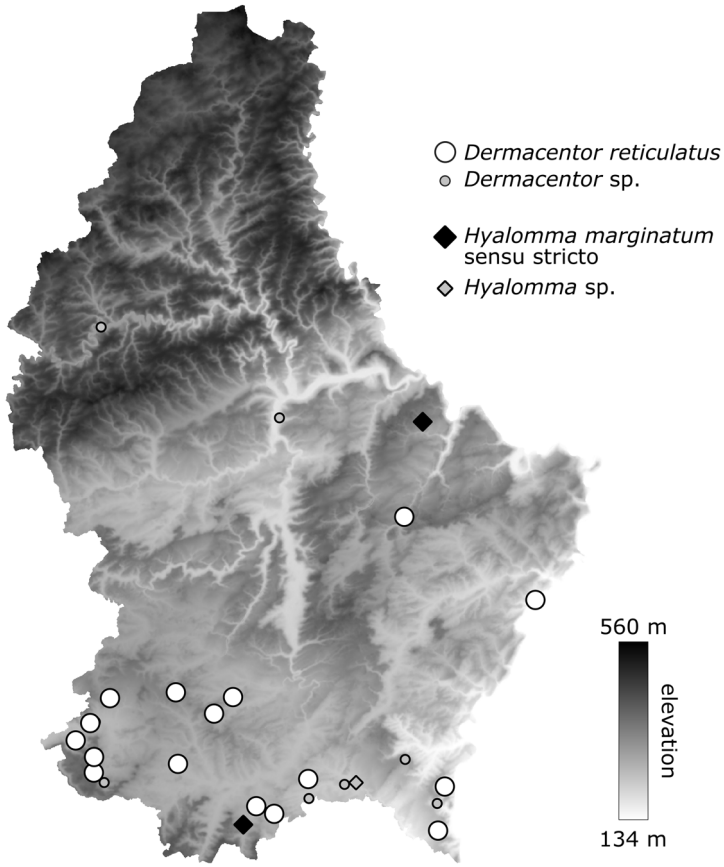


Fig. 4. Distribution of *Dermacentor* and *Hyalomma* ticks in Luxembourg.

arrived in Europe, nymphs of the *H. marginatum*-complex have been frequently observed e.g. on several species of *Acrocephalus*, *Locustella luscinioides*, *Luscinia megarhynchos*, *Erithacus rubecula*, *Prunella modularis* and adults on horses, humans, sheep and goats (Capek et al. 2014; Vial et al. 2016; Chitimia-Dobler et al. 2019; BOLD data). This can be corroborated by our findings, as the three Luxembourgish *Hyalomma* specimens were found on two horses and on a human.

The appearance of ticks of the *Hyalomma marginatum*-complex in Central Europe is of general importance for public health, as the species can transmit *Rickettsia aeschlimannii* and is the most important vector for the Crimean-Congo Hemorrhagic fever (CCHF) in Europe. In the 2018 samples collected in Germany, *R. aeschlimannii* has been detected in *Hyalomma* ticks during nine collection events in Hesse, Lower Saxony and Rhineland-Palatinate (Chitimia-Dobler et al. 2019), but none were positive for the CCHF virus.

In the context of the revision of available *Dermacentor* ticks at the MNHNL, the taxonomic annotation of the specimens collected in 2015 at Wellenstein (Schengen, Luxembourg) had to be corrected. Those specimens were initially identified by one of the authors as *D. marginatus*, but now have to be referred to as *D. reticulatus* instead. This means that, to the best of our knowledge, only *D. reticulatus* findings have been reported from Luxembourg until today. This is in line with a large national survey performed between 2007-2009, which was coordinated by the Centre de Recherche Public de la Santé (CRP-Santé) of the Laboratoire National de Santé (LNS). The study analysed 8,104 ticks from the vegetation

at 33 sampling sites visited monthly from May to October. Further >1,600 specimens were obtained from members of the public, retrieved from humans and (domestic) animals. Four tick species were detected: *Ixodes ricinus*, *I. hexagonus*, *I. frontalis* and *D. reticulatus*. The latter species had a frequency of 0.01% in the vegetation dataset (i.e. a single female collected in 2009) and of 0.4% in the citizen dataset (i.e. 7 specimens, all collected from dogs) (Reye et al. 2010, Reye 2011). While no *D. marginatus* records are currently known from the country, the species is classified as 'invasive' for Luxembourg (C1; Ries & Pfeiffenschneider 2020). This now should be corrected, and additionally, *H. marginatum* and *D. reticulatus* added to the list of neobiota. In Germany, *D. reticulatus* was first reported in 1973 and since then has largely expanded its northern range (Rubel et al. 2016; Földvári et al. 2016). The majority of the Luxembourgish *D. reticulatus* / *Dermacentor* sp. specimens have been collected from dogs and humans. Additional observations come from a dead pig, Angus cows, wild boar and horses. Given the very low number of sightings stated by Reye (2011) for the years 2007-2009, it can be assumed that this species currently enters the country from the South due to changing climatic conditions. The species in particular prefers warm riverine areas (Rubel et al. 2016, Estrada-Peña et al. 2018). This is in line with the current distribution within the country, which largely covers the South.

During the upcoming collection seasons, a screening for non-native *Hyalomma* and *Dermacentor* ticks, and for the pathogens they transmit, should be conducted in Luxembourg (preferably in the Gutland and Minette regions). Horse farms as well as goat and sheep pastures might be good entry points for such a survey. Likewise, dog owners and livestock farmers should be sensitized. Finally, as it has been demonstrated by the current study, the involvement of the wider public in detecting and collecting "strange-looking" ticks should not be underestimated and can lead to further findings of invasive ticks in Luxembourg, and Central Europe.

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