Tick species (Ixodida) identified in Iceland

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ABSTRACT
Eight species of ticks of the family Ixodidae have been identified in Iceland; *Ixodes uriae*, *I. caledonicus, I. ricinus, I. hexagonus, I.* cf *scapularis, Rhipicephalus sanguineus, Dermacentor variabilis* and *Hyalomma aegyptium*. Ticks of the family Argasidae have not been found. *I. uriae* is indigenous and common in seabird colonies in Iceland. *I. caledonicus* has been found on stationary birds and therefore also considered to be indigenous. *I. ricinus* has been found all over the country on humans, other mammals and birds and is carried by migratory birds to the country in the spring but it is uncertain if it is indigenous. *I. hexagonus* has been reported once. The remaining four species were all found under circumstances that suggest incidental findings.

Keywords: Ixodidae, ticks occurrence, Iceland

YFIRLIT
Átta tegundir stórmítla (ticks) hafa verið greindar á Íslandi; *Ixodes uriae* (lundamítillinn, lundalúsin), *I. caledonicus* (norræni fuglamítillinn), *I. ricinus* (skógarmítillinn), *I.* cf *scapularis* (dádýramítillinn), *Ixodes hexagonus* (broddgaltamítillinn), *Rhipicephalus sanguineus* (brúni hundamítillinn), *Dermacentor variabilis* (ameríski hundamítillinn) og *Hyalomma aegyptium* (skjaldbökumítillinn). *I. uriae* er landlægur og algengur í sjófuglabyggðum á Íslandi. *I. caledonicus* hefur fundist á staðfuglum og því einnig talinn landlægur. *I. ricinus* hefur fundist víða um land á mönnum, öðrum spendýrum og fuglum og berst með farfuglum til landsins en óvíst er hvort hann er landlægur. Greint hefur verið frá *I. hexagonus* einu sinni. Hinar fjórar tegundirnar hafa fundist við aðstæður sem benda til þess að þar hafi slæðingar verið á ferðinni.

INTRODUCTION
Ticks (suborder Ixodida) are blood-feeding ectoparasites found worldwide and are of two main families; Ixodidae (hard ticks) and Argasidae (soft ticks). All feed on the blood of land vertebrates. Eight species have been identified in Iceland. All are members of Ixodidae.

According to Hillyard (1996) the life cycle of the Ixodidae consists of four developmental stages; an egg, and three blood feeding stages - larvae, nymphs and adults, with great variation in size between the stages. Each blood feeding stage seeks a host, feeds, drops off to the ground and digests its meal. The larva and nymph then moult to the next stage while the mated female lays 1,000-10,000 eggs and then dies. The three hosts may or may not be different vertebrate species. Some tick species can have a wide variety of hosts, while others are more specialised. Once on the host, a tick may wander around for several hours before attaching and starting to feed. Blood ingestion

may take several days. The adult females are capable of increasing their weight as much as 80-120 times during feeding. If adult males feed, it is only briefly. Larvae, nymphs and males are not as easily noticed on a host in contrast to the engorged females, because of the marked difference in size. The life cycle may take 1-6 years, depending on tick species and local conditions. Worldwide, ticks are known to transmit a variety of pathogenic infectious organisms, such as various viruses, bacteria, rickettsiae, protozoa, filariae and fungi, causing a number of diseases of medical and veterinary importance known as tick-borne diseases and they may also cause tick paralysis.

In Iceland several studies on parasites of domestic and wild animals, involving ectoparasites, have been carried out, e.g. on sheep (Richter et al. 1997), arctic fox (Hersteinsson 2004), wood mouse (Lupton & Wykes 1938, Bengtson et al. 1986), feral house mouse (Magnúsdóttir 1998), and rock ptarmigan (Skírnisson et al. 2012). These studies did not reveal tick infestations. Other studies have revealed ticks on seabirds or in seabird colonies (Lindroth et al. 1973, Moss et al. 1986). Furthermore, for several decades ticks from various sources have been brought or sent in for identification to the Institute for Experimental Pathology at Keldur and to the Icelandic Institute of Natural History.

In the present article tick species that have been identified in Iceland are reported and their occurrence and indigenous status discussed.

MATERIALS AND METHODS

In the past, mainly since 1976, many ticks found in Iceland have been brought or sent to the Institute for Experimental Pathology at Keldur or to the Icelandic Institute of Natural History, for identification. The specimens have been sent in by veterinarians, medical doctors or the public, and if known, data on host, collection date, sampling site, etc. have been registered. Recently, this collection was re-examined and species-identified according to Gregson (1956), Arthur (1963), Anonymous (1978) and Hillyard (1996). The nomenclature follows that of Barker & Murrel (2004).

Specimens of the following species have been deposited in the Icelandic Institute of Natural History, Reykjavík, Iceland: *Ixodes uriae* (catalogue number: IMNH26505), *I. caledonicus* (IMNH26506), *I. ricinus* (IMNH26507), *I.* cf *scapularis* (IMNH26508), *Rhipicephalus sanguineus* (IMNH26509), *Dermacentor variablis* (IMNH26510) and *Hyalomma aegyptium* (IMNH26511).

TICK SPECIES IDENTIFIED IN ICELAND

Seven tick species; *Ixodes uriae*, *I. caledonicus, I. ricinus, I.* cf *scapularis, Rhipicephalus sanguineus, Dermacentor variabilis* and *Hyalomma aegyptium* were identified from the re-examined material. The eighth species, *Ixodes hexagonus*, had been reported earlier. Below, each species is discussed separately.

Ixodes uriae White, 1852 (seabird tick)

A globally distributed parasite species associated with cliff nesting seabirds (Hillyard 1996). This tick species has been found in Iceland on puffin, black guillemot and fulmar and free in or near seabird colonies (Sellnick 1940, Lindroth et al. 1973, Moss et al. 1986, Frandsen et al. 1999) and is very common. Usually its presence is well known to people that live nearby or visit nesting areas of sea-birds and therefore these ticks are only occasionally sent in for identification. Consequently relatively few specimens of *I. uriae* are present in our collections.

During the period 1976-2011 a total of 15 *I. uriae* specimens were identified from other hosts than sea-birds (Table 1). All these specimens originated from humans and in all cases the ticks were regarded to have attached to these individuals within Iceland. Adult female ticks were involved in twelve of the cases, and nymphs in three. One reason for this proportion is probably that engorged females are more easily observed than nymphs and larvae. Males do not attach to hosts (Hillyard 1996). In

Table 1. *Ixodes uriae* and *I. ricinus* specimen numbers recorded in Iceland during 1976-2011 (*I. uriae* from birds excluded). Only cases presumably contracted within Iceland are listed.

	I. uriae		*I. ricinus*	Host
Year	**Humans**	**Humans**	**Animals**	**unknown**
1976	1	1		
1977			1	
-				
1980			1	
1981			1	
-				
1986			1	
-				
1989	1		1	
-				
1991	1			
-				
1994	1	1		
1995		2	2	
1996		1	1	
1997	2	1	1	
1998		2	1	
-				
2000	1		1	
2001			1	
2002	1		4	1
2003	1	1	2	
2004		2	2	
2005		3	8	1
2006			7	
2007		1	5	1
2008		2	3	
2009	4	2	10	
2010	1	1	18	
2011		1	14	1
Unknown	1			
Total	**15**	**21**	**85**	**4**

14 of these cases the date of tick removal was known; 2 in June, 8 in July and 4 in August (Table 2).

Ixodes caledonicus Nuttall, 1910 (northern bird tick)

A parasite found in northern Europe, occurring on various bird species, mainly those that nest on cliffs and buildings (Hillyard 1996).

In a recent survey on the ectoparasites of the gyrfalcon (*Falco rusticolus*) larvae and nymphs of *I. caledonicus* were found on two birds in 2008 and 2009. A re-examination of an adult female tick collected from a kittiwake (*Rissa tridactyla*) in 1967 also revealed the presence of *I. caledonicus*. Since this species has been found on sedentary bird species it is regarded to be indigenous to Iceland.

Ixodes ricinus (Linnaeus, 1758) (common sheep tick, castor bean tick, wood tick)

A parasite of many bird and mammalian species, including humans. It is distributed throughout much of the western Palaearctic, from Europe to central Asia and North Africa and is the most common tick species in NW Europe (Hillyard 1996).

Apart from a questionable report of Hlíðar (1936) the first confirmed report of *I. ricinus* in Iceland dates back to 1967 when *I. ricinus* was found on a migrating passerine bird (Lindroth et al. 1973), and later Richter (1981) reported two further incidences from sheep and one from a dog.

The number of *I. ricinus* specimens from humans, other mammals and birds sent in for identification remained low from 1976 until the beginning of this century. Since 2005 the annual number of cases has increased (Table 2). The total number of reported cases during 1976 to 2011 was 128. In almost all cases a single tick was involved and 123 ticks were available for re-examination.

The cases were divided into two groups, “native” and “foreign”, based on the circumstances where they had been found. Human cases numbered 30 (21 native/9 foreign), dogs

64 (60/4), cats 21 (21/0), sheep 3 (3/0), reindeer 1 (1/0), wild bird 1 (1/0), and in 8 cases the involved host was not known (4/4). Thus, in total 110 (86%) cases have been regarded as native. Since 1976 the number of human cases has remained fairly stable but in the last decade the number of animal cases has increased (Table 1). This increase is mainly explained by increased publicity, an increase in the number of pet dogs and our request to veterinarians to send in ticks for identification.

Table 2. Seasonal occurrence (when known) of *Ixodes uriae* and *I. ricinus* specimens recorded in Iceland during 1976-2011 (*I. uriae* from birds excluded). Only cases presumably contracted within Iceland are listed. No larvae were found.

	I. uriae		*I. ricinus*	
Months	**Nymphs**	**Adults**	**Nymphs**	**Adults**
May				5
June	1	1	1	2
July	2	6	6	11
August		4	2	35
September			2	26
October				8
November				2
Total	**3**	**11**	**11**	**89**

Ticks have been sent in for identification from all parts of Iceland but most of the material originates from Reykjavík and the nearby communities where approximately 2/3 of the 320 thousand human population of Iceland lives. Cats and dogs are common pets and it is fairly easy to bring or send in ticks from there for identification. Yet, some of the cases brought in from the Reykjavík area could have originated from the countryside where humans and dogs have contracted the ticks during summer vacation of their owners. This could possibly explain why significantly fewer ticks are found on cats than dogs.

In the 106 cases that were designated as native, 93 were adult females, 13 were nymphs, but no larvae or adult males were present in this material. The reason for this proportion could in part be that engorged females are more easily observed than nymphs and larvae, especially on furry animals. In Germany and Great Britain nymphs are most commonly found attached to humans, then adult females and to a much lesser extent larvae, but males are only occasionally found (Liebisch & Liebisch 1996, Maiwald et al. 1998, Robertson et al. 2000). Out of 20 "native" *I. ricinus* ticks found on humans in Iceland, 10 were nymphs and 10 adult females.

In the cases of *I. ricinus* designated to the group native, the collection date of 100 ticks (11 nymphs and 89 females) was known. The nymphs were collected during the period June to September but the females during May to November (Table 2). Thus, the seasonal peak for the nymphs was in July but for the females not until August and September. Findings from Germany showed that most (40.2%) *I. ricinus* bites found on humans occurred in June (Liebisch & Liebisch 1996), probably due to the earlier arrival of spring in Germany.

Ixodes hexagonus Leach, 1815
(hedgehog tick, European dog tick)

Parasitic, mainly on smaller mammals which live in burrows or nests, but can also attach to other mammals, including humans, and occasionally birds. It is widespread and common in western Europe and ranges also from North Africa through eastern Europe to southern Asia (Hillyard 1996).

A single nymph was reported in a survey of terrestrial invertebrates in 1967 in South Iceland (Lindroth et al. 1973) but there was no mention of a host. It is unlikely that this tick is indigenous since only this single specimen has been reported from Iceland.

Ixodes cf *scapularis* Say, 1821
(black legged tick, deer tick)

A parasite of birds and mammals, including humans, in the eastern half of the United States of North America (Anonymous 1978).

Adult females presumably of this species have been found three times in Iceland; from a cat (1997) and a dog (2008), both in quarantine after being imported from the USA, and from a human (2008) immediately after arriving in Iceland from the USA. The species identification in these cases is based upon the locality from where these ticks are believed to have originated. *I. scapularis is* closely related to and morphologically difficult to distinguish from *I. ricinus* and these specimens would probably have been identified as *I. ricinus* if their origin had not been known. In this context it is worth mentioning that a great majority of migratory bird species in Iceland overwinter in the Palaearctic where *I. ricinus* occurs. Birds arriving in Iceland from the Nearctic where *I. scapularis* is common are rare in this comparison (Petersen 1998).

Rhipicephalus sanguineus (Latreille, 1806) (brown dog tick, kennel tick)

Found mainly on dogs but is also reported from other mammals, including man. This species originates from Africa and the Mediterranean region but has spread to many other parts of the world. In central and northern Europe the cold climate prevents the tick from breeding in the wild but local tick colonies may survive in kennels and other sheltered places with dogs (Hillyard 1996).

The tick has been identified on five occasions in Iceland; 2006, 2008 (Skírnisson & Eydal 2008), 1978, 1983 and 2010, where the ticks have been found on dogs and/or humans. The ticks examined were adult females, adult males and a nymph, and in one case a population of ticks had developed in a home where a dog was living. In most of the cases the ticks were clearly imported by means of human activities. Furthermore a nymph and two adult females have been found on three occasions on dogs in quarantine. This species is not considered permanently present in Iceland although it is known to have survived and reproduced indoors.

Dermacentor variabilis (Say, 1821) (American dog tick, common wood tick)

A North American parasite found mainly on dogs but feeds readily on many large mammals, including man (Anonymous 1978).

The tick has been identified on five occasions in Iceland; 2004 (Skírnisson & Eydal 2008), 1998, 1999, 2003 and 2006. The ticks were either adult females or males. In three of the cases the specimens were found on humans that had been travelling in the USA, but in two cases the origin was unknown.

Hyalomma aegyptium (Linnaeus, 1758) (tortoise tick)

Occurs in southern Europe, southern Asia and Africa and usually parasitizes reptiles but also occurs on mammals and birds (Hillyard 1996).

An adult female tick was found in 2007, attached to a human a few days after arrival in Iceland from Spain.

GENERAL DISCUSSION

The tick species *I. uriae* and *I. caledonicus*, which complete their life cycles on birds and have been found on resident birds in Iceland, are considered indigenous to Iceland. Larvae and nymphs of *I. ricinus* often parasitize birds. This species is probably carried to Iceland by migratory birds every spring, but it is not certain if the species is permanently present. *I. hexagonus* has never been found in surveys involving ectoparasites in Iceland, and it is unclear how the single specimen reported might have been brought to the country. The species is presumably not permanently present in Iceland. The four remaining tick species (*I.* cf *scapularis*, *R. sanguineus*, *D. variabilis* and *H. aegyptium*) apparently represent sporadic cases that have probably all been imported by means of human activities. None of these species are considered as indigenous to Iceland.

Only a few tick species are indigenous or have been sporadically found in Iceland compared to the number of species in other count-

ries in North-West Europe (Hillyard 1996) even though many of the European species could be transported to the country with migratory birds. Studies on ticks carried by migratory birds to neighbouring countries have shown that *I. ricinus* ticks are by far the most common. In Norway more than 4,000 individuals of 65 bird species were examined for ticks during spring migration in the period 1964 to 1976. The study was performed on islands in outer Oslo Fjord in southern Norway. *I. ricinus* made up 93% of the 602 specimens found (Mehl et al. 1984). In a second survey on migratory birds in Sweden and Denmark during their spring and autumn migrations, 967 ticks were detected on the heads of 465 out of 22,998 birds of 37 species (predominantly passerine birds). Of the birds 3% had ticks in the spring and 1.3% in the autumn. *I. ricinus* constituted 98.2% of all the tick specimens. A total of 283 larvae, 663 nymphs, 3 adult females and one adult male of *I. ricinus* were identified (Olsén et al. 1995). Furthermore, during the spring migrations of 2003 to 2005, a total of 9,768 passerine birds were caught along the southern coastline of Norway and their heads examined for ticks. Altogether 713 birds (7.3%) carried a total of 517 larvae and 1,440 nymphs and more than 99% of the ticks were *I. ricinus* (Hasle et al. 2009). Some of the ticks found in these studies might of course have infested the birds after they came to these countries. It is likely that migratory birds arriving in Iceland in the spring carry similar tick infestations, even though the bird species are not all the same.

Since late 19th century a number of legislations have been in force in Iceland which have banned or restricted import of live mammals and birds in order to protect animals in Iceland, in particular farm animals and pets, against contagious diseases (Anonymous 1947, Runólfsson 2004). A ban on importing dogs and cats was lifted in 1989, but with certain conditions that enforce a stay in quarantine and various medical tests and treatments, including treatments against ectoparasites. The main routes for ticks to enter Iceland therefore seem to be by attaching to migratory birds or humans.

Factors limiting the number of indigenous tick species and their abundance in Iceland may include the isolation of the country, relatively few suitable mammalian host species with in many cases low densities of individuals, the highly variable cold-temperate climate and limited favourable vegetation cover. Available hosts in Iceland, in addition to humans, are domestic mammals (e.g. dogs, cats, sheep, goats, cattle, horses), wild mammals (reindeer, arctic fox, mink, brown rat, wood mouse and house mouse), and numerous bird species. During the last decade the climate has been markedly warmer in Iceland than during the previous three or four decades (Anonymous 2013), which could possibly increase the likelihood of survival of some tick species. The relatively mild climate since the 1990s in Sweden is probably one of the primary reasons for the observed increase in density and geographic range of *I. ricinus* ticks (Lindgren et al. 2000, Jaenson et al. 2012). Preservation of forested areas and forestry began in Iceland during the last century and the increase in woodlands could possibly also favour the survival of tick species. In Britain and Sweden higher abundances of *I. ricinus* have been observed in forested areas than in open areas (Walker et al. 2001, Lindström & Jaenson 2003).

The tick species identified in the present study were mainly found on humans, dogs and cats, but rarely on other animals, apart from *I. uriae* found on birds. This simply reflects the fact that people discover ticks more readily on themselves and their pets. The proportion of *I. ricinus/I. uriae* recorded from humans in Iceland was 30/15. If only cases which probably were contracted within Iceland are considered the number is 21/15, but as mentioned earlier the number of *I. uriae* is probably underestimated. In a Swedish study approximately 98% of 274 ticks found on humans, 99% of 1,362 ticks found on dogs and 97%

of 403 ticks found on cats were *I. ricinus* (Jaenson et al. 1994).

The number of ticks sent in for identification has increased notably during the last few years, the majority being *I. ricinus* (Tables 1 and 2). A reason could be that this species might have become resident in Iceland because of recent climate and vegetation changes. On the other hand the reason for this increase could be an increased coverage in the media resulting in more public awareness regarding ticks and their potential role as vectors of human pathogens. It should also be mentioned that for decades it was prohibited to keep dogs in Reykjavík and some of the neighbouring communities, where approximately two thirds of the human population in Iceland lives. The ban was lifted in the 1980s. As a consequence the number of dogs has since then consistently been increasing. In addition, veterinarians in Iceland have been encouraged, during recent years, to send in ticks found on pets. The observed increase in *I. ricinus* ticks identified in recent years has indeed originated mainly from pets, dogs in particular.

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