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Original article

Surveillance for *Ixodes ricinus* ticks (*Acari*, *Ixodidae*) on the Faroe Islands

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ABSTRACT

Ixodes ricinus ticks are expanding their geographic range in Europe, both latitudinally in Scandinavia, and altitudinally in the European Alps. This paper details the findings of both passive and active surveillance on the Faroe Islands. Active field surveillance, using tick dragging, was conducted at 38 sites across the main seven inhabited islands of the Faroes during June-August 2015. Field sampling was conducted at all wooded sites on the islands of Vágar, Streymoy, Eysturoy, Borðoy, Kunoy and Suðuroy as well as in urban parks in the capital Tórshavn, among seabird colonies and at a bird observatory on Nólsoy, at moorland sites on Vágar and Borðoy, and a coastal headland on Suðuroy. In addition, as part of the promotion of a new passive surveillance scheme for the Faroes, new tick records were submitted during summer 2015 and early spring 2016. During tick dragging, only three questing *I. ricinus* ticks (two nymphs, one male) were found at two separate sampling locations in the village of Tvøroyri on the southernmost island of Suðuroy. No questing ticks were found at any other field site. The passive surveillance of ticks identified an additional 33 records of *I. ricinus* collected during the last 10 years on the Faroes, with almost half of these records from 2015. Although this represents the first finding of questing *I. ricinus* and overwintering *I. ricinus* on the Faroe Islands, there appears to be little evidence so far to suggest that *Ixodes ricinus* are established on the Faroe Islands. Additional reports of ticks through the passive surveillance scheme are reported from seven inhabited islands. Reports of ticks on both companion animals and humans suggest that ticks are being acquired locally, and the records of ticks on migratory birds highlight a possible route of importation. This paper details the likely ecological constraints on *I. ricinus* establishment and density on Faroe and makes recommendations for future surveillance and research.

1. Introduction

A recent review of the driving forces for the change in distribution of the tick *Ixodes ricinus* in Europe has highlighted an expansion in its altitudinal and latitudinal range across Europe (Medlock et al., 2015). *Ixodes ricinus* is the principal vector of *Borrelia burgdorferi* sensu lato (agent of Lyme borreliosis) across much of Europe, and one of the main vectors of Tick-borne encephalitis (TBE) virus, as well as a known and potential vector of a number of other pathogens such as *Babesia, Anaplasma, Rickettsia, Borrelia miyamotoi* and louping ill virus (Tijsse-Klasen et al., 2011; Hansford et al., 2015; Medlock and Leach, 2015). The continued movement of tick vectors into new localities is increasingly of greater significance to public and veterinary health, and each incursion requires investigation. Regions previously considered free of ticks and their associated pathogens are facing new public health challenges with regard to ticks (Jaenson et al., 2012; Jore et al., 2014; Hvidsten et al., 2015). This makes surveillance activities and the Europe-wide exchange of knowledge on the distribution of tick vectors crucial for responding effectively to newly emerging threats posed by tick-borne diseases.

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Owing to the fact that *I. ricinus* feeds on a range of animal species, and that it is commonly found on migratory birds, their continental dispersal by birds is widely acknowledged (Olsén et al., 1995; Comstedt et al., 2006; Jameson et al., 2012). For many remote islands in Northern Europe, the regular movement of ticks on birds is the most likely route by which certain tick species can extend their distribution. This paper investigates evidence for latitudinal spread of *Ixodes ricinus* in northern Europe. Other recent work has focussed on their northward spread in Norway (Jore et al., 2014; Hvidsten et al., 2015) and Sweden (Jaenson et al., 2012) but here we consider the evidence for *Ixodes ricinus* on the Faroe Islands.

The Faroe Islands are an archipelago between the Norwegian Sea and the North Atlantic Ocean approximately half way between Norway and Iceland, and 320 kilometres from Great Britain. The islands are an autonomous country within the Danish Kingdom. The land area is approximately 1400 km^2, composed of 18 major islands, with all except one inhabited (Human population ~49,000). The islands are dominated by tholeiitic basalt lava, which was part of the great Thulean plateau during the Paleogene period. The islands are exposed to maritime subarctic climate, with mild winters and cool summers. The daily mean temperature in the coldest month (February) is a mild 3.6 °C, and in the warmest month (August) is a cool 10.6 °C. The weather is generally windy, cloudy and cool with ~260 days of precipitation annually. Extreme cold temperatures are rare despite its northerly latitude (Tórshavn, 62°0′N, 6°47′W).

Faroese sheep dominate the islands, and apart from other livestock, sheep are the only large mammals distributed widely across the Faroes. There are no native wild land mammals however *Lepus timidus* [mountain hare], *Rattus norvegicus* [brown rat], and *Mus musculus/domesticus* [house mouse] (Jones et al., 2011) have all been introduced and are established, with mice commonly found associated with bird colonies. Domesticated cats and dogs are numerous around towns and villages, with dogs also employed in outfield (i.e. upland) areas for sheep herding. Although there are about 110 species of birds on the Faroe Islands (excluding reports of rare vagrants), only 40 species are classed as common breeding species.

Three species of tick have previously been reported on the Faroe Islands (Jaenson and Jensen, 2007): *Ixodes uriae, Ixodes ricinus* and *Ixodes caledonicus*, but only *Ixodes uriae* is considered to be established. The seabird/puffin tick, *Ixodes uriae* is locally known as "puffin louse" and is reported to be a common ectoparasite of puffin where it adopts a nidiculous life history (Nosek and Balat, 1986). *Ixodes uriae* is also a pest species of humans particularly among those who visit puffin colonies. It has been reported on seabirds from all 18 islands, with one engorged nymphal *I. uriae* nymph found on *Rattus norvegicus* in the capital Tórshavn (Jaenson and Jensen, 2007). *Ixodes uriae* has also been found to be infected with *Borrelia garinii* and may therefore play a role in *Borrelia* transmission (Olsén et al., 1993; Gylfe et al., 1999). The possible role of rats as a host for both *I. uriae* and *I. ricinus* has been suggested as a likely route by which the seabird-associated *Borrelia* transmission cycle might transfer to a local cycle amongst *Ixodes ricinus*; assuming the latter were to establish (Jaenson and Jensen, 2007). However, the likelihood of *Borrelia*-infected *I. ricinus* arriving on the islands on migratory birds seems an equally plausible route of introduction of *B. burgdorferi* s.l. A second species, *Ixodes caledonicus*, has only been reported once, in August 2004 from *Fulmaris glacialis* [fulmar] that had been caught at sea, south of the island of Svínoy.

The earliest published record of *I. ricinus* on the islands was from a dog at Vestmanna (Streymoy) in August 1990 (Hallas and Olsen, 1990). A further four records were later published (Jaenson and Jensen, 2007); an engorged nymphal *I. ricinus* from *Oenanthe oenanthe* [wheatear] at Tórshavn (Streymoy) in May 2000; a fully engorged adult *I. ricinus* from a cat in Tvøroyri (SuÐuroy) in April 2004; an engorged larva from a *Phylloscopus collybita* [chiffchaff] from Nólsoy in May 2005, and a partly-fed nymphal *I. ricinus* from a boy in Fuglafjørður (Eysturoy) in July 2005. Although two of these five previously published records are possibly associated by breeding or passage migratory birds, three of the records (from a human, dog and cat) were enough for Jaenson and Jensen (2007) to suggest that *I. ricinus* might be established on the Faroe Islands, particularly given the likely regular introduction of larval and nymphal *I. ricinus*, possibly infected with *B. burgdorferi* s.l., on birds from continental Europe. Indeed they advocated a more detailed investigation on the potential presence of this tick on the islands.

This paper details the results of a new passive surveillance scheme established by the authors to gather additional recent and current records of *I. ricinus* from the Faroe Islands, and also reports on the first field-based survey of likely habitats of *I. ricinus* across the Faroes as part of an active surveillance programme funded by the European Food Safety Authority and the European Centre for Disease Prevention and Control VectorNet project.

2. Methods

Various strategies were employed on the Faroe Islands to detect the presence of questing *I. ricinus,* as well as identifying reports of tick biting, particularly on humans and domestic animals. The aim of the study was not only to conduct a national scale field survey of likely tick habitats, but also to establish a system of passive and active surveillance within the islands to further build capacity locally and raise awareness of tick-biting and the associated risks.

Active field surveillance for *I. ricinus* on the Faroe Islands was conducted during June 2015 with some sites revisited in July and August 2015. Owing to the fact that *I. ricinus* is principally a tick of woodland and ecotonal habitats in the nearby British Isles (Medlock et al., 2008, 2012) and such areas are often used for recreational activities, the primary focus for field sampling was given to visiting the main public woodlands across the islands of Vágar (at Sandavágur, Miðvágur), Streymoy (at Vestmanna, Hvalvík, Havnardalur), Eysturoy (at Gøtugjógv, Leirvík), Borðoy (at Klaksvík), Kunoy (at Kunoy village and Suðuroy (at Tvøroyri (Fig. 1a and b), Trongisvágur, Vágur). Vegetated areas in cattle pasture, moorland and urban areas were also visited on the islands of Vágur (Gásadalur, Bøur, Sørvágur, Sandavágur, near Vaga Floghavn, Miðvágur), moorland on Borðoy (Klaksvík), coastal headland on Suðuroy (near Sumba) and large urban parks and the arboretum were sampled in the capital, Tórshavn (Streymoy). Several vegetated areas among the Suðuroy villages of Tvøroyri and Vágur were also surveyed. On Nólsoy, field sampling was conducted at a Heligoland bird trap, as well as at several private gardens frequented by migrant birds, and at the puffin and storm petrel colonies underneath the cliffs of Eggjarklettur.

In total, 38 separate sites were sampled, constituting all of the main woodland sites and a selection of the other tick habitats (moorland, urban, pasture, coastal headland, and seabird colonies) across the main inhabited islands. At each location field sampling was conducted using the tick flagging technique. A 1 m^2 cotton cloth was dragged over a distance of five metres at a slow walking pace. The habitat was sampled at random with 45 separate five metre drags conducted at each location. Any ticks found were taken back to the laboratory for identification using the keys of Hillyard (1996). A full list of sites visited is detailed in Table 1 (Supplementary file), and maps of their locations are shown in Fig. 1a and b.

In addition to the active surveillance, an effort was made to establish passive surveillance through gathering recent records of tick biting and other unpublished tick records from other likely sources, including the Faroese Museum of Natural History (FMNH).