

Occurrence of fleas (Siphonaptera) and lice (Phthiraptera) on Brown rats (*Rattus norvegicus*) on the Faroes Islands

JENS-KJELD JENSEN & EYÐFINN MAGNUSSEN

Jensen, J.-K. & Magnussen, E. 2015. Occurrence of fleas (Siphonaptera) and lice (Phthiraptera) on Brown rats (*Rattus norvegicus*) on the Faroes Islands. *Norwegian Journal of Entomology* 62, 154–159.

During the years 2012 and 2013, 61 brown rats (*Rattus norvegicus* Berkenhout, 1769) were collected from 10 locations on the Faroe Islands and investigated for ectoparasites. Two species of fleas, *Nosopsyllus fasciatus* Bosc d'Antic, 1800 and *Ctenophthalmus nobilis* Rothschild, 1898, and one species of louse, *Polyplax spinulosa* Burmeister, 1839, were found. Of these, the fleas were the more frequent, found on 34% of the rats, whereas the occurrence of the single species of louse was only 3%. Of the fleas, *N. fasciatus* was the most common, found on 18 of the 23 the rats infected by fleas (78%), whereas the occurrence of *C. nobilis* was 48%. Both *C. nobilis* and *P. spinulosa* are new species for the fauna of the Faroe Islands; whereas *N. fasciatus* has been reported once before, then on a domestic cat (*Felis catus* Linnaeus, 1758). The finding of *C. nobilis* is both the most westerly and northerly finding of this species in Europe.

Key words: Brown rat, *Rattus norvegicus*, Faroe Islands, fleas, Siphonaptera, *Nosopsyllus fasciatus*, *Ctenophthalmus nobilis*, lice, *Polyplax spinulosa*, occurrence, abundance.

Jens-Kjeld Jensen, Í Geilini 37, FO-270 Nólsoy, Faroe Islands. E-mail: jkjensen@post.olivant.fo

Eyðfinn Magnussen, University of the Faroes, Faculty of Science and Technology. Nóatún 3, FO-100 Tórshavn, Faroe Islands. E-mail: eydfinnm@setur.fo

Introduction

The Faroe Islands are an isolated archipelago located in the middle of the North Atlantic Ocean at 62°N and 7°W (Figure 1). Originally no native land mammals were on the Faroe Islands. However, with time, three species; house mouse (*Mus musculus*), brown rat (*Rattus norvegicus*) and mountain hare (*Lepus timidus*) have occupied the islands, all unintentionally introduced by man.

The house mouse was the first and is supposed to have come during the Viking age, about a thousand years ago (Jones *et al.* 2011). Today it lives on six of the 18 islands, only co-existing with the brown rat in Tórshavn. The mountain hare was introduced for hunting in 1855 from southern Norway (Bloch & Fuglø 1999) and occurs now on

15 of the islands. The black rat (*Rattus rattus*) is also known to have lived and reproduced on the Faroe Islands in the past (Svabo 1976), and still, from time to time, they are unintentionally re-introduced, mainly by Russian fish boats, visiting the Faroe Islands. However, they do not breed on the islands and thus disappear again after a while (Bloch & Fuglø 1999).

The brown rat was first observed on the Faroe Islands in 1768 on the southernmost island, Suðuroy (Figure 1). They were brought on a Norwegian ship which, on its way from Trondheim, Norway, to Dublin, Ireland, stranded on the Scottish island of Lewis. The wreck, which was filled with brown rats, drifted northerly, eventually reaching the village of Hvalba. With this wreck the first brown rats were brought to

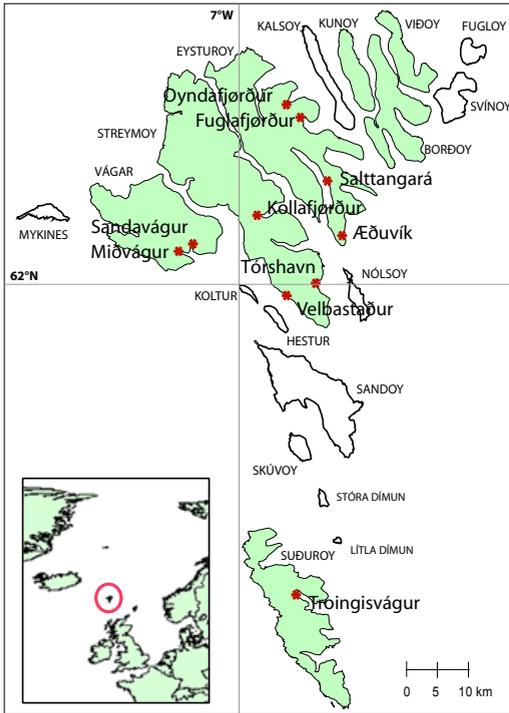


FIGURE 1. Locations (red dot) where brown rats (*Rattus norvegicus* Berkenhout, 1769) were collected for investigations of fleas and lice. The green colour indicates islands where the brown rat occurs. Names written by capital letters are island names. The map in the lower left corner shows the location of the Faroe Islands in the North Atlantic (red circle).

the Faroe Islands (Svabo 1976). Their geographic dispersion seems to have been fast. Already after one year the rats had spread all over the Suðuroy. In 1769, they were observed in Torshavn, which is on the southern part of the largest island, Streymoy. After a decade, they had reached the villages in the northern part of this island. In 1779, they reached Vagar, and during 1776 to 1779 they also occupied Eysturoy (Svabo 1976).

Whether the rats dispersed from the already established population in Suðuroy, or they were brought to the Faroe Islands with other ships, is unknown (Svabo 1976). Today the brown rat is found on seven of the 18 Faroese islands (Figure 1), and is common in and around human habitations as well as in the field. Even though the brown rat is common on all of the largest Faroese islands, only sparse information on the Faroese

brown rat is available in the literature. Jensen and Magnussen (2015) investigated them for the bacterial infection of *Leptospira interrogans*. However, they did not find any infected animals and thus they suggested that the estimated *Leptospira* prevalence rates on the Faroe Islands are among the lowest recorded worldwide. Previously, only some sporadic studies have been conducted, where the brown rat has been one of many species being part of an investigation (Jensen, 2005; Trolle & Jensen, 2002), thus the present investigation is the first targeted scientific study conducted on the Faroese brown rat.

The aim of the present paper is to improve our knowledge and describe the ectoparasites, fleas and lice, on the Faroese rats and quantify the infection rates, occurrence and abundance of the different species and compare if these parameters are varying among seasons and locations.

Material and methods

The ectoparasites were mainly collected from recently dead rats. The rats were collected during the years 2011 and 2013. We contacted private people and municipal employees, responsible for rat prevention. To draw attention to our studies, we used the public media (newspapers, radio and TV) to announce our interest to receive rats, dead as well as alive.

In total, we received 61 rats from 10 locations, collected on 4 of the main islands (Figure 1). Between one to 20 specimens were collected from each location (Table 1). 81% of the rats were collected during the winter (October to March) and 19% from April to September. Most of the rats were newly dead and put directly into a plastic bag and individually frozen. However, a minor part of the rats were frozen at an unknown time after death.

Before examination for ectoparasites, the rats were thawed and then each creature was gently washed with lukewarm soapy water in a plastic bucket and carefully cleaned in running water. To pick up the ectoparasites, the water was then poured through a sieve, having a mesh size of 300 µm. The fleas and lice were then sorted out under

Table 1. Occurrence of fleas and lice species on brown rats (*Rattus norvegicus* Berkenhout, 1769) collected in 10 localities on the Faroe Islands. Names written by capital letters are island names. Infection rates by species are based on total number of rats infected by ectoparasites. Dashes indicate absence of the ectoparasite. Abbreviations: *Nos fas* = *Nosopsyllus fasciatus* Bosc d'Antic, 1800; *Cte nob* = *Ctenophthalmus nobilis* Rothschild, 1898; *Pol spi* = *Polyplax spinulosa* Burmeister, 1839.

Location	Number of rats investigated	Prevalence (% infected)	Infected by (%)			Lice <i>Pol spi</i>
			Fleas			
			<i>Nos fas</i>	<i>Cte nob</i>	Both species	
EYSTUROY						
Oyndafjørður	1	0.0	-	-	-	-
Fuglafjørður	2	100.0	50.0	-	0.0	50.0
Saltangará	2	100.0	50.0	50.0	0.0	-
Æðuvík	11	45.5	80.0	40.0	20.0	-
STREYMOY						
Kollafjørður	20	50.0	90.0	50.0	40.0	10.0
Tórshavn	14	21.4	50.0	50.0	25.0	-
Velbastaður	4	25.0	66.7	66.7	33.3	-
VÁGOY						
Sandavágur	2	0.0	-	-	-	-
Miðvágur	2	0.0	-	-	-	-
SUÐUROY						
Trongisvágur	3	0.0	-	-	-	-
Total	61	37.7	78.3	47.8	30.4	8.7

a dissecting microscope and stored in 70% alcohol for later identification. For more details, see Jensen & Olsen (2003). To avoid contamination between specimens, each rat was treated separately and the bucket was cleaned carefully before investigation of the next rat.

For identification, the fleas and lice were separately slide-mounted, following the technique described in Palma (1978). The fleas were identified using Brinck-Lindroth & Smit (2007) and Smit (1955, 1957). Afterward, all flea specimens identified as *Ctenophthalmus nobilis* (Rothschild, 1898) were controlled and accepted by Paddy Sleema, University College Cork, Ireland. The lice were identified by Ricardo L. Palma, Museum of New Zealand Te Papa Tongarewa, Wellington, New Zealand. Representatives of the fleas and lice are deposited at the Natural History Museum in Tórshavn, Faroe Islands. However, one lice of the species *Polyplax spinulosa* is deposited in the Museum of New Zealand, 55 Cable Street, Wellington, New Zealand. The other specimens are preserved by

the first author of this paper, Jens-Kjeld Jensen, Nólsoy, Faroe Islands.

Results

Of the 61 rats collected, the main bulk came from the two biggest islands, 62% from Streymoy and 30 % from Eysturoy (Table 1). Twenty three of the collected rats were infected by fleas (38%) and two by lice (3%) (Table 1).

Two species of fleas were found on the brown rats in the Faroe Islands, *Nosopsyllus fasciatus* (Bosc d'Antic, 1800) and *Ctenophthalmus nobilis* (Rothschild, 1898). Of these, *N. fasciatus* was the most common, found on 18 of the 23 the rats infected by fleas (78%). The abundance range between 1 and 12 individuals on each rat. In total 41 specimens were found, 7♂♂34♀♀, (Table 2). The other species, *C. nobilis*, was found on 11 rats, corresponding to 48% the rats infected by fleas. The abundance of *C. nobilis* range between 1 and 14 individual on each rats, in total 30 specimens

Table 2. Infection level of fleas on brown rats (*Rattus norvegicus* Berkenhout, 1769) collected on Faroe Islands. N is the total number of *N. fasciatus* or *C. nobilis*, respectively, found on the rats. The range, average and standard deviation in number of specimens of the parasites are also presented. Dashes indicate absence of the ectoparasite. Abbreviations: *Nos fas* = *Nosopsyllus fasciatus* Bosc d' Antic, 1800; *Cte nob* = *Ctenophthalmus nobilis* Rothschild, 1898.

Locality	% of rats infected by fleas	Number of rats infected	<i>Nos fas</i>				<i>Cte nob</i>				
			N	Range	Avg.	S	N	Range	Avg.	S	
EYSTUROY											
Fuglafjørður	50.0	1	1	-	-	-	0	0	-	-	-
Saltangará	100.0	1	5	-	-	-	1	2	-	-	-
Æðuvík	45.5	4	16	1-12	4.0	2.3	2	15	1-14	7.5	3.0
STREYMOY											
Kollafjørður	50.0	9	11	1-2	1.2	0.7	5	8	1-3	1.6	0.9
Tórshavn	21.4	2	4	-	2	0.0	2	3	1-2	1.5	0.8
Velbastaður	25.0	1	4	-	-	-	1	2	-	-	-
Total	41.5	18	41	1-12	2.3	1.60	11	30	1-14	2.7	1.9

(Table 2), 9♂♂21♀♀. Seven rats were infected by both of the respective flea species.

There were no detectible differences in species composition of the parasites or their abundance with regard to geographic location or seasons during the two and half years of sampling collection.

Only one species of louse, *Polyplax spinulosa*, was found on the brown rats in the Faroes Islands, of which a total of two specimens were found: One specimen on a rat collected at the location Kollafjørð on the Island Streymoy, and one from the location Fuglafjørð on the Island Eysturoy.

Discussion

Previously, only some sporadic studies have been conducted on the Faroese brown rats (*Rattus norvegicus*), where the rat has been one of many species investigated. Thus the present investigation is the first targeted scientific study of ectoparasites on the Faroese brown rat. In total, two species of fleas, *Nosopsyllus fasciatus* and *Ctenophthalmus nobilis*, and one species of louse, *Polyplax spinulosa*, were found. Of these, the fleas were the more frequent, found on 38% of the rats investigated whereas the occurrence of the single species of louse was only 3%.

Fleas (Insecta, Siphonaptera) are small,

laterally flattened, wingless, and highly specialized insects. Both adult males and females are obligate hematophagous ectoparasites of mammals and birds. About 2574 species belonging to 16 families and 238 genera have been described (Bitam *et al.* 2010). Even though no literature is available on the brown rat in the Faroes Islands, some investigations have earlier been conducted on fleas and lice living on other animals in the Faroes Islands. The first investigation of fleas in the Faroe Islands was conducted by Henriksen (1929), who described two flea species; human-flea (*Pulex irritans*) and bird-flea (*Ceratophyllus gallinae*). However, this was only a superficial piece of work and in the general remarks the author also mentioned “*The flea-fauna of the Faroes must doubtless include more species than are known till now*”. More than seventy year later this statement was, not unexpectedly, confirmed by Trolle & Jensen (2002). They described nine different species of ectoparasitic fleas, which were collected from nets of 15 bird-species and two rodent’s species; the house mouse (*Mus musculus*) and five specimens of the brown rat (*Rattus norvegicus*). However, no fleas were found on the rats. The best known flea species on Faroese animals is probably the ‘hen flea’ (*Ceratophyllus gallinae gallinae*), which is very common on Faroese birds (Trolle & Jensen, 2001) and has been evident on the Faroe Islands ever since the

first fleas were collected on the islands back in 1929. It is known as “starling-flea” in the Faroese language (Trolle & Jensen 2001).

Of the two flea species reported in the present paper, only one of them, *N. fasciatus*, has been previously reported on the Faroe Islands, when a single specimen was found on a cat in the village of Fuglafjørð in August 1998 (Trolle & Jensen 2001). Our discovery of the other flea species, *C. nobilis*, is thus the first reporting of this species on the Faroe Islands. However, it seems to be quite common on Faroese rats because almost half of the rats in this investigation were infected by this species. Indeed, its rareness in the North Atlantic is confirmed by the absence in Iceland (Erling Ólafsson pers. comm.).

N. fasciatus was the most common of the two flea species found in this investigation, occurring on 78% the rats infected by ectoparasites whereas *C. nobilis* occurred on 48%. *N. fasciatus*, also known as the northern rat flea, is common on commensal rats in the temperate regions, especially *Rattus norvegicus* (Bitam *et al.* 2010), but has also been found on other hosts like the wood-mouse (*Apodemus sylvaticus*), house mouse (*Mus musculus*) and different species of voles (subfamily Microtinae) (Trolle & Jensen, 2001). The other flea species found on the brown rats, *C. nobilis*, has a more narrow dispersal, being concentrated in Western Europe, where it is a common parasite on small mammals in Great Britain, France, Spain and Switzerland (Lopez & Soledad 2013) but are absent in Scandinavian (Brinck-Lindroth & Smit 2007) and is neither found on pets and hedgehogs in Germany (Visser *et al.* 2001). Thus, our finding of *C. nobilis* is remarkable, because this reporting is, to our knowledge, both the most westerly and northerly finding of this species.

Our investigation of rats reveals that the species richness of lice appears to be sparse on the brown rats in the Faroes Islands. Even searching for lice on 61 rats specimen, collected from 10 locations, only one species of louse, *Polyplax spinulosa*, was found on the Faroes rats. Although this species has a cosmopolitan dispersal (Durden & Musser 1994), this is the first finding of this louse species in the Faroe Islands, even though parasitic lice associated to Faroese animals are relatively

well known (Palma & Jensen 2005). Based on collection and findings from 123 bird taxa and six mammal species from the Faroe Islands, including the brown rat, and with previous reported findings, Palma & Jensen (2005) reported 215 species and subspecies of lice. Of these 215 lice species and subspecies, as many as 171 were new records for the Faroe Islands. However, no lice were found on the rats specimen investigated and *P. spinulosa* was not found on any of the other host species investigated.

It is well known that the species richness in an ecosystem depends e.g. on how isolated the ecosystem is (e.g. Smith & Smith 2012). Although remote, about 300 km Northwest of Scotland, 600 km from Norway and 430 km from Iceland, it is in fact unknown how isolated the Faroese brown rat populations really are from the surrounding areas. However, it must be expected that new individuals are regularly introduced by cargo and other human activities. For comparison, a recently study on Faroese mice revealed that mice are regularly unintentionally imported to the islands (Jones *et al.* 2011). This is probably the case also for the brown rat. The migration gives possibilities for other ectoparasites to be introduced to the Faroese rat populations. In addition to the isolation, the time since the rats occupied the islands is also a main factor for the richness of parasites on the rats. Due to the fact that it is only about 250 years since the brown rat was introduced to the islands and also because of the improved travel connections to the islands, we would expect that the number of ectoparasites on Faroese brown rats will increase in the future.

Acknowledgements. We gratefully acknowledge the assistance given to us by a number of local people providing us with rats and to media in the information process. We are particularly grateful to Dr. Paddy Sleeman, University College Cork, Ireland, for verifying our finding of *Ctenophthalmus nobilis*, to Dr. Ricardo L. Palma, Museum of New Zealand, Te Papa Tongarewa, Wellington, New Zealand, for identification of the lice and to Dr. Erling Ólafsson, Icelandic Institute of Natural History for providing us with literature on ectoparasites on Icelandic small mammals.

References

- Bitam, I., Dittmar, K., Parola, P., Whiting, M.F. & Raoult, D. 2010. Fleas and flea-borne diseases. *International Journal of Infectious Diseases* 14, 667–676.
- Bloch, D. & Fuglø, E. 1999. *Villini Súgdjór í Útnorðri*. Føroya Skúlabókagrunnur. Tórshavn. 216 pp.
- Brinck-Lindroth, G. & Smit, G.A.M. 2007. *The fleas (Siphonaptera) of Fennoscandia and Denmark*. Brill. Leiden-Boston. 185 pp.
- Durden, L.A. & Musser, G.G. 1994. The sucking lice (Insecta: Anoplura) of the world: a taxonomic checklist with records of mammalian hosts and geographical distributions. *Bulletin of the American Museum of Natural History* 218. 90 pp.
- Lopez, G. & Soledad, M. 2013. Fauna Europaea: Ctenophthalmidae. Fauna Europaea version 2.6.2, <http://www.faunaeur.org>. version 2.6.2, last update 29 August 2013.
- Henriksen, K.L. 1929. *Siphonaptera*. In: Jensen, A.S., Lundbeck, W., Mortensen, T. & Spärck, R. (Eds.). *The Zoology of the Faroes*, vol. 2(1), 1928–137
- Jensen J-K. & B. Olsen. 2003. A comparison of two methods for collecting feather lice from dead birds. *Atlantic Seabirds* 5, 119–126.
- Jensen, P. & Magnussen, E. *In press*. Is it too cold for *Leptospira interrogans* transmission on the Faroese Islands? *Infectious Diseases*.
- Jones, E.P., Jensen, J.-K., Magnussen, E., Gregersen, N., Hansen, H.S. & Searle, J.B. 2011. A molecular characterization of the charismatic Faroe house mouse. *Biological Journal of the Linnean Society* 102, 471–482.
- Palma, R.L. 1978. Slide-mounting of lice: a detailed description of the Canada balsam technique. *New Zealand Entomologist* 6, 432–436.
- Palma, R.L. & Jensen, J.-K. 2005. Lice (Insecta: Phthiraptera) and their host associations in the Faroe Islands. *Steenstrupia* 29 (1), 49–73.
- Smit, F.G.A.M. 1955. Two new subspecies of fleas (Siphonaptera) from the British Isles. *Transactions of the Royal Entomological Society of London* 107, 341–356.
- Smit, F.G.A.M. 1957. *Handbooks for the identification of British fleas*. Royal Entomological Society of London. London. 94 pp
- Smith, T.M. & Smith, R.L. 2012. *Elements of Ecology*. Benjamin Cummings, Boston. 704 pp.
- Svabo, J.C. 1976. Om firfødde dyr. Indberetninger fra en Reise i Færøe 1781 og 1782. Selskabet til Udgivelse af Færøske Kildeskrifter og Studier, 1959, Copenhagen. 497 pp.
- Trolle, L. & Jensen, J.-K. 2001. The Fleas (Siphonaptera) of the Faroe Islands. *Fróðskaparrit* 48, 135–144.
- Visser, M., Rehbein, S. & Wiedemann, C. 2001. Species of flea (Siphonaptera) infesting pets and hedgehogs in Germany. *Journal of Veterinary Medicine Series B-Infectious Diseases and Veterinary Public Health* 48, 197–202.

Received: 18 May 2015

Accepted: 21 July 2015