DOI: 10.2478/s11686-012-0050-5

Acta Parasitologica, 2012, 57(4), 378–384; ISSN 1230-2821

The bird ectoparasite *Dermanyssus hirundinis* (Acari, Mesostigmata) in the High Arctic; a new parasitic mite to Spitsbergen, Svalbard

Dariusz J. Gwiazdowicz[1]*, Stephen J. Coulson[2], John-Arvid Grytnes[3] and Hanne Eik Pilskog[2,3]

[1]Poznań University of Life Sciences, Department of Forest Protection, Wojska Polskiego 71c, 60-625 Poznań, Poland;
[2]University Centre in Svalbard, Department of Arctic Biology, P.O. Box 156, 9171 Longyearbyen, Norway;
[3]University of Bergen, Department of Biology, Box 7803, 5020 Bergen, Norway

Abstract

Ectoparasites are common on birds and in their nests. Amongst these parasites are diverse gamasid mite species that can lead to irritation, disease transmission and blood loss. Few studies of the ectoparasites of birds breeding in the High Arctic exist. The parasitic mite, *Dermanyssus hirundinis*, was found in nests of snow buntings *Plectrophenax nivalis nivalis*, both natural nests and within nesting boxes, on Spitsbergen. Densities per nest varied from sporadic to greater than 26,000 individuals. This is the northernmost observation of this parasite. The mite was present in new nests, nests constructed the previous year and nests not utilized the previous summer. The parasite survives at least 18 months without access to a blood meal and can tolerate the Arctic winter, surviving temperatures below –20°C. *D. hirundinis* is hence well adapted to arctic conditions. Only females were observed suggesting that this population is facultatively parthenogenetic.

Keywords

Gamasid, nest, snow bunting, passerine

Introduction

The issue of ectoparasites on birds is relatively well known (Philips 2000). Even more studies have investigated the nests of birds where parasites often occur (Dobroscky 1925). For instance, the acarofauna of both annual, unstable nests (Tryjanowski *et al*. 2001) and perennial nests (Błoszyk *et al*. 2005, 2006, Gwiazdowicz *et al*. 2005, 2006) have been surveyed. Insects and spiders are also common in nests (Hicks 1971, Turienzo and Di Iorio 2008). Occasionally the density of ectoparasites is sufficiently great to have negative impacts on the chicks and the breeding birds (Coutant 1915, Møller 1993, Bush *et al*. 2001, Lesna *et al*. 2009, Clayton *et al*. 2010). This may especially be true in periods when birds are under stress, for example during periods of low food availability. Very few studies have considered the ectoparasite fauna of birds in Arctic regions.

Svalbard lies in the Norwegian Arctic between latitudes 74°N and 81°N and longitudes 10°E and 35°E, some 700 km north of mainland Norway. The archipelago has a land area of some 63,000 km^2, of which 60% is under permanent ice and snow. The climate is relatively mild for the latitude due to the northern branch of the north Atlantic drift transporting considerable heat northwards. Nonetheless, the annual mean temperature is –6.7°C with only four summer months, June to September, recording positive monthly averages, July being the warmest month at +5.5°C (Norwegian Meteorological Institute 2012). Monthly mean winter air temperature is often below –15°C but daily minimum temperatures may decline to –40°C on occasion. In the soil under snow, however, temperatures are often far less extreme and may be around –5°C to –10°C for the majority of the winter (Coulson *et al*. 1995). In summer, the temperature of the upper soil layers may exceed air temperature considerably and reach over +20°C on warm days (Coulson *et al*. 1993).

There has been extensive research and monitoring of birds in Svalbard, for example regarding seasonal distribution (Frederiksen *et al*. 2012), effects of pollution (Leat *et al*. 2011), foraging (Hoset *et al*. 2009; Hahn *et al*. 2011) and migration (Hübner *et al*. 2010) but there is relatively little information available concerning their ectoparasites. Indeed, relatively few ectoparasites of birds from the archipelago are recorded; consisting of two species of flea *Mioctenopsylla arctica arctica* and *Ceratophyllus vagabundus vagabundus*

*Corresponding author: dagwiazd@up.poznan.pl

(Insecta: Siphonaptera) (Kaisila 1973, Mehl 1992), the tick *Ixodes uriae* (Coulson *et al*. 2009a) and several species of lice (Insecta: Mallophaga) (Mehl *et al*. 1982). In addition, a few studies of bird nests have been conducted in Svalbard (Lebedeva *et al*. 2006, Coulson *et al*. 2009b). Six studies report invertebrates from bird nests in Svalbard (Elton 1925, Cyprich and Krumpal 1991, Mehl 1992, Lebedeva *et al*. 2006, Coulson *et al*. 2009b, Pilskog 2011). But, most of these are limited studies and only three focus on other invertebrates than fleas (Coulson *et al*. 2009b, Lebedeva *et al*. 2006, Pilskog 2011).

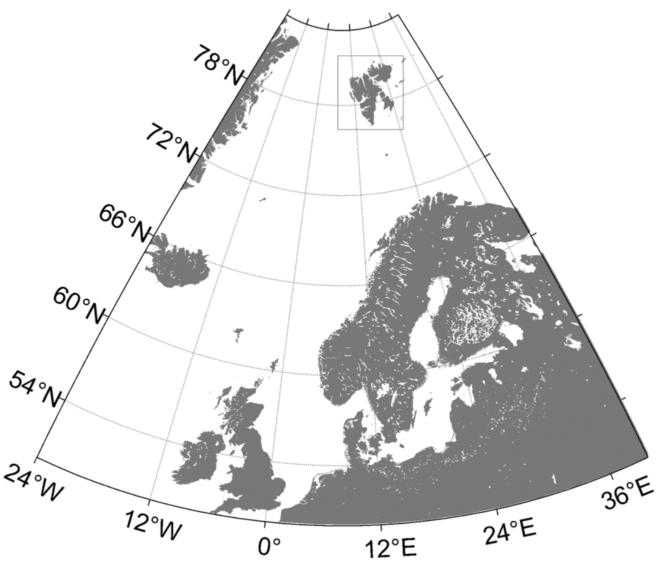
Several species of bird migrate to Svalbard in the summer to breed (Strøm and Bangjord 2004). Of these, the snow bunting *Plectrophenax nivalis nivalis* is the only passerine species. The Svalbard population is believed to spend the winter in the steppes of Kazakhstan, near the Caspian Sea (Cramp and Perrins 1994, Bakken *et al*. 2006). In March or early April the birds return north to the nesting sites. Males arrive first and occupy their territories. Nests are built well out of sight in rock crevices, screes and also in residential buildings (Hoset *et al*. 2009). They can also nest in nest boxes. Snow buntings normally lay five to six eggs in June that are incubated 12–14 days. The chicks leave the nest after 12–14 days, often before they are fully fledged. In good years snow buntings in Svalbard may successfully raise two broods (Hoset *et al*. 2009).

Materials and methods

Snow bunting nests were taken from nest boxes in Adventdalen close to the settlements of Longyearbyen (78°11´N, 15°50´E), one natural nest was taken in Longyearbyen (78°13´N, 15°38´E) and one from a nest box in Ny-Ålesund (78°55´N, 11°55´E) (Fig. 1).

In total, 14 nests were collected. In Adventdalen the nest boxes were placed on old ropeway trestles, approximately 1–2 m above the ground. Snow buntings make new nests each year, and several nest boxes were therefore filled with old and new nest material, mainly plant material, mostly graminoids, lined with feathers and reindeer hairs. The nest boxes in Adventdalen are monitored and we could therefore determine when the snow buntings last had occupied the boxes. To investigate overwintering strategies of invertebrates, nests occupied the previous summer were collected on 1 May 2010 (9 months old nests), before snow melt, and the same nest boxes were emptied in August after the chicks had fledged (1 month old nests). In addition nests that had not been occupied for two consecutive summers were collected (see Table I for sampling information).

After collection, the nests were stored briefly at outdoors (air temperature of approximately +5°C) or in a +5°C room at the University Centre in Svalbard (UNIS) before extraction in Tullgren funnels. The nests were placed upside down in the funnels to allow invertebrates to exit through already existing openings. The samples were extracted until no mites were visible in the material (approximately 9–20 days). Many *D. hirundinis* walked up the funnels in the direction of the heat and collected around the upper margin. These were removed by soft paintbrush and transferred to the collecting pot. Individuals were preserved in 96% ethanol. Due to the large number of mites in the snow bunting nests, a counting grid sub-sampling method similar to Southwood and Henderson (2000) was used by which 10% or 30% of the mites were sub-



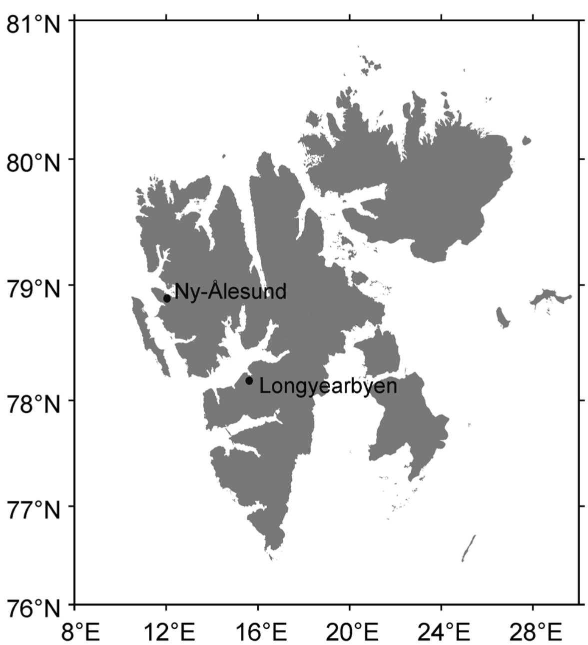


Fig. 1. Location of the archipelago of Svalbard in relation to mainland Norway and the sampling sites on Spitsbergen (the main island of the group), Longyearbyen and Ny-Ålesund

Table I. Nest information and age of different snow bunting nests collected in Svalbard during spring and summer 2010. Explanation: placement – placement of the nests, in Adventdalen nests were collected from nest boxes placed on numbered trestles; date – date of sampling; m – approximate height above ground of the nest box or nest; weight – weight of the nest in grams before extraction, occupied; the years of occupation of the nest; nest age – the age of the nest when sampled; N and E – north and east coordinates; symbol refers to symbols in Figure 3; *unnumbered between trestle 12 and 13; **natural nest in derelict mining vehicle; N/A data not available

Nest	Location	Placement of nest	Date sampled (2010)	Height above ground (m)	Weight (g)	Date nest last occupied	Nest age	Position N	E	Symbol
1	Ny-Ålesund	Nest box	15 July	1.5	69	2010	1 month	78°55´457	011°54´928	◆
2	Adventdalen	trestle 6	1 May	2	54	2009	9 months	78°10´670	015°54´042	▽
3			20 August		147	2010	1 month			
4	Adventdalen	trestle 9	1 May	2.5	N/A	2009	9 months	78°10´761	015 °53´527	●
5			20 August		175	2010	1 month			
6	Adventdalen	trestle 26	1 May	2	182	2009	9 months	78°11´349	015°50´229	□
7			20 August		106	2010	1 month			
8	Adventdalen	trestle 46	1 May	1	96	2008, 2009	9 months	78°11´840	015°47´404	◇
9			18 August		81	2010	1 month			
10	Adventdalen	trestle 12–13*	20 August	1.5	180	2008	2 years	78°10´902	015°52´724	■
11	Adventdalen	trestle 21	20 August	1.5	113	2008	2 years	78°11´190	015°51´134	■
12	Adventdalen	trestle 34	18 August	1.5	58	2008	2 years	78°12´234	015°44´834	■
13	Adventdalen	trestle 37	20 August	1	127	2008	2 years	78°11´691	015°48´259	■
14	Longyearbyen	vehicle**	24 August	1	232	2010	1 month	78°13´065	015°37´084	⬢

sampled from samples with large numbers of individuals. The total number of mites in the sample was then estimated by applying the appropriate multiplication factor to the count. For smaller samples all individuals were counted.

For identification, specimens were mounted on permanent slides (using Hoyer's medium). The material is deposited at the University Centre in Svalbard (UNIS), the University of Bergen, Department of Biology, Norway and the Poznań University of Life Sciences, Department of Forest Protection, Poznań, Poland.

Air temperature

Maximum and minimum monthly air temperatures were obtained for the Svalbard airport meteorological station (Norwegian Meteorological Institute 2012). The meteorological station is located between 9 and 13 km from the nest boxes fixed to the cableway trestles. Air temperatures were recorded at a height of 1.5 m, a similar level to the nest boxes. Minimum monthly winter air temperatures were constantly below –20°C and attained a minimum, below –30°C, in February 2009 (Fig. 2). Summer temperatures climbed to above 10°C in the warmest summer months.

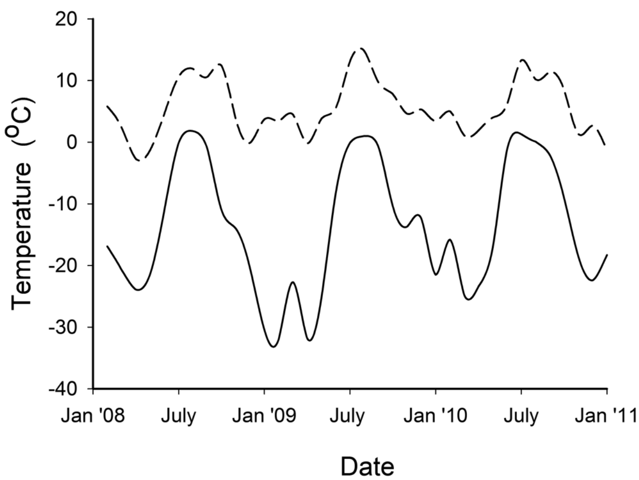


Fig. 2. Maximum and minimum monthly air temperatures recorded at Svalbard Airport, Longyearbyen, 2008–2011 (source Norwegian Meteorological Institute)

Results

Dermanyssus hirundinis (Hermann, 1804) (Acari: Mesostigmata: Dermanyssidae) was the dominating invertebrate species in the nests and present in all samples. This is the first recording of *D. hirundinis* in Svalbard and other invertebrate species present in the nests will be treated in a separate study.

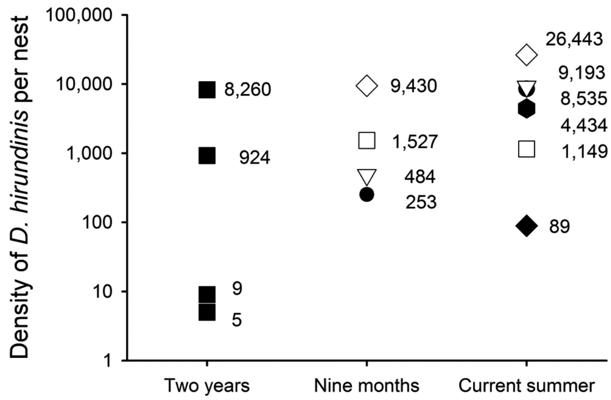


Fig. 3. Number of *Dermanyssus hirundinis* in two year old, 9 months old and recently abandoned nests of snow buntings in Svalbard. Explanation: two years; nests not occupied for two years, collected in the summer, 9 months: nests occupied in the summer 2009 and collected in May 2010 (9 months old) and new; nests from same nest boxes as the 2009 nests plus a natural nest from Longyearbyen and one from Ny-Ålesund, collected after the chicks had fledged in July and August 2010. Note that the y-axis is exponential and the precise number of individuals is given next to the symbols. Symbols indicate nest location. Note that nine month old nests removed in May 2010 were rebuilt during the summer and were sampled again at the end of summer (current summer). For symbol key refer to Table I

D. hirundinis was present in nests from all years examined, and for most nests in high densities (>1000 individuals) (Fig. 3). Highest density was found in the nests from Adventdalen where greater than 26,000 individuals were present in one of the recently abandoned nest. For all except the nest box on trestle 26, the density in Adventdalen was higher in the nest boxes after the chicks had fledged in August than in the spring (winter population). Lowest densities of 5 and 9 individuals were found in two of the two year old nests, but for all years examined there was a large variation in density in the nests. Only females were present in the nests.

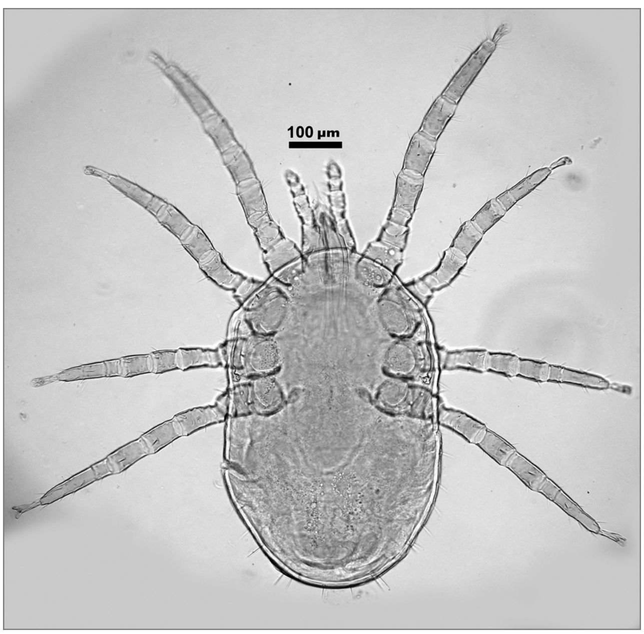


Fig. 4. Female of *Dermanyssus hirundinis*

Description of female

Idiosoma 680–1500 μm long and 300–650 μm wide (Fig. 4). Dorsal shield with 11 pairs of setae, j1 and J5 off the shield, seta J2 absent; surface of shield reticulated; dorsal shield posteriorly rounded. The base of tritosternum (60 μm) significantly shorter than laciniae (80–85 μm). Sternal shield (40 x 130 μm) weakly reticulated, with two pairs of setae and two pairs of pores; st3 and metasternals free on unsclerotized integument. Genital shield (180 x 110 μm) weakly reticulated, with genital setae only. Anal shield (130 x 105–130 μm) with paranal setae (30 μm) and postanal seta (20 μm). Peritreme extends to posterior third of coxa II.

The Svalbard population is therefore consistent with the description of the species (Moss 1968).

Discussion

The presence of *D. hirundinis* in all investigated nests, in all the locations and in both old and new nests indicates that this species is well established in Svalbard and probably common in snow bunting nests having been introduced to Svalbard with the migrating snow buntings. *D. hirundinis* is a nidicolous species and an obligatory ectoparasite of birds that spends most of its life in the nest of its hosts where it also reproduces. It is Holarctic in occurrence, occurring in the nests of a range of birds of the order Passeriformes, Anseriformes, Apodiformes, Columbiformes, Piciformes, Coraciiformes and Sturniformes for example *Sturnus vulgaris*, *Passer montanus*, *Hirundo rustica* (Bregetova 1956, Evans and Till 1966, Roy and Chauve 2007). To our knowledge this is the first record from snow buntings.

In spite of *D. hirundinis* being able to utilise a range of different bird species as hosts (Roy and Chauve 2007), there is no information covering the life history of *D. hirundinis*. However, the closely related species, *D. gallinae*, a severe pest in the poultry industry, is better known and we may infer the likely life history from this *Dermanyssus* species. This species is an obligatory blood feeding parasite with a wide range of host bird species and may bite humans. It is responsible for disease transmission amongst fowl (Chauve 1998). In *D. gallinae*, it is the nymphs and females that feed on blood. Males feed only occasionally and larvae do not feed. The mite only climbs on the bird during darkness and remains there for less than two hours in order to feed before returning to cracks and crevices. Like other Gamasida, *D. gallinae* has a larvae stage and two nymphal stages before moulting into the adult. Females lay up to 30 eggs which hatch after one to two days. In optimal conditions the whole life cycle can be completed in seven days and hence densities can increase rapidly. The mite can tolerate being away from the host for up to seven months and although tolerant to desiccation is susceptible to high humidity.

In Svalbard, many snow buntings produce two egg clutches, but they normally make a new nest, often next to the old one, for the second brood (A. Moksnes pers. comm.). As constructing nests is energy and time consuming there must be a benefit in a new nest, and it is possible that the snow buntings make a new nest to reduce the parasite load for the second clutch. There is little information on whether this is a common behaviour for snow buntings or if this behaviour mainly is associated with areas where the birds have high parasite loads, as in Adventdalen. Many bird species have behavioural adaptations to avoid or reduce the number of parasites in their nest (Clayton *et al*. 2010), and a similar behaviour of building new nests for the second clutch is also known from catbirds *Dumatella carolinensis* that have the northern fowl mite, *Ornithonyssus sylviarum*, in their nest (Garvin *et al*. 2004). As most of the nest boxes were filled up with nest material from old and new nests it is probably easier for the *D. hirundinis* population to reach high densities in these boxes as mites from older nests easily can access the birds and chicks in the new nests. Low densities in the nests from Ny-Ålesund compared to Adventdalen can be coincidental due to low sample size, but it is also possible that sampling approximately one month earlier than in Adventdalen can have affected the result. Garvin *et al*. (2004) found populations of the northern fowl mite in gray catbird nests to increase towards the end of the summer, although they also found large variations in population size.

Little is known about the effect on snow bunting parents and chicks in Svalbard and only one nest was found with a dead chick. However, *D. gallinae* causes large economic losses each year due to decreased egg production, degraded eggs, anaemia and can also serve as a vector for diseases (Chauve 1998, Roy and Chauve 2007). High parasite loads in nests do not always influence chick survival or have health implications (Powlesland 1977), and according to Tripet and Richner (1997) increased feeding rate by the parents can in some cases compensate for the blood loss experienced by the chicks. However, ectoparasites can have severe effects on host fitness (Clayton *et al*. 2010) and cause reduced body weight of chicks (Merino and Potti 1995) and if this is the case with snow buntings, it can possibly have negative consequences for the chicks also after they have left the nest as sufficient body stores for most birds are needed to survive the autumn migration to the wintering grounds.

Depending on the bioclimatic sub-zone, only one to three months in Svalbard have average air temperatures above zero degrees Celsius (Jónsdóttir 2005), which means that *D. hirundinis* must spend most of the year in sub-zero environments and manage to grow and reproduce during the short summer months. Thus far, this is the northernmost occurrence of this parasite discovered which is important information from the standpoint both of zoogeography of invertebrates and the spread of parasites. Only females of *D. hirundinis* were found in these nests, which may suggest that this is the only stage of development that can survive winter in such difficult weather conditions. The observation of large numbers of mites in the spring nests show that *D. hirundinis* is able to overwinter in large populations in the nests. Since nest boxes were placed approximately 1–2 m above the ground and not covered by snow, temperatures during the winter are likely to be close to air temperatures that can go down to below –30°C (Fig. 2). Summer temperatures recorded by the ventilated Stevenson Screen at the Svalbard airport meteorological station cannot be considered representative of the temperatures experienced in the closed bird boxes where solar heating, and the presence of the birds, will raise the internal temperatures above air temperature. However, the polar night at Longyearbyen lasts from 11 November until 30 January and it is not until the middle of March that the insolation reaches the nesting boxes in Adventdalen. During this winter period the internal nesting box temperature is likely to be generally similar to air temperature and the overwintering mites are thus clearly exposed to long periods at sub-zero temperatures. Moreover, that considerable numbers of mites were found in nests that had been abandoned for two summers also indicates that *D. hirundinis* can survive without access to a blood meal for extended periods. This may not be surprising when *D. gallinae* can survive seven months away from the host in the warm conditions of a poultry farm. For some eight to nine months of the year, *D. hirundinis* is at sub-zero temperatures, presumably resting in a dormant form. High humidities are known to be lethal to *D. gallinae* (Chauve 1998). However, the climate of Svalbard ranges from polar desert to middle-Arctic tundra (Jónsdóttir 2005) and hence has long cold winters with mean monthly temperatures often below –15°C and short cool dry summers. The consequent low humidities may promote the extended survival periods observed for *D. hirundinis* here.

In conclusion, this is the northernmost record of *D. hirundinis*. The mite is probably a common ectoparasite of snow buntings in Svalbard and is highly tolerant of Arctic conditions. *D. hirundinis* is able to overwinter in large populations in nests and presence of only females indicates that the Svalbard population may be parthenogenetic. The effect on the breeding birds and chicks, including fledging success, is not known.

Acknowledgements. The authors extend their thanks to Dr. Peter Mašán (Slovak Academy of Sciences) for friendly help and consultation, Dr. Arne Moksnes and Dr. Claus Bech for kindly letting us access snow bunting nests, and to Kristen Marie Peck and Hanna-Kaisa Lakka for assistance in the field. The fieldwork was funded by L. Meltzers Høyskolefond and the Arctic Field Grant.

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(Accepted August 23, 2012)