Rapid Communication

The invasion of two species of social wasps (Hymenoptera, Vespidae) to the Faroe Islands

Sjúrður Hammer[1,*] and Jens-Kjeld Jensen[2]

[1]*Environment Agency, FO-165, Argir, Faroe Islands*
[2]*Í Geilini 37, FO-270 Nólsoy, Faroe Islands*

Author e-mails: *sjurdur@hammer.fo (SH), nolsoy@gmail.com (JKJ)*

**Corresponding author*

Citation: Hammer S and Jensen J-K (2019) The invasion of two species of social wasps (Hymenoptera, Vespidae) to the Faroe Islands. *BioInvasions Records* 8(3): 558–567, https://doi.org/10.3391/bir.2019.8.3.11

Received: 9 January 2019
Accepted: 10 June 2019
Published: 12 August 2019

Handling editor: Tim Adriaens
Thematic editor: Stelios Katsanevakis

Abstract

Two species of social wasps have established in the Faroe Islands in 1999 – common wasp *Vespula vulgaris* and German wasp *Vespula germanica*. The population growth, and dispersal in the Faroes has been followed in detail through correspondence and contact with local residents and authorities throughout the Faroes. Collected wasps have been identified, and nest eradication data from the local municipalities is also presented. In total there have been 1.222 nests located and destroyed, mostly in Tórshavn, where they were first introduced, but nests have also been found on neighbouring islands. Both the introduction and the spread within the Faroes suggest a strong relationship with human settlements and travel. Social wasps have established on four out of 18 islands – all of which are connected by land, suggesting that their spread within the islands is also human aided. With no active biosecurity measures to prevent the introduction of invasive alien species to the Faroes, we predict that the introduction of more species of social wasps to be very likely, and wasps already present will likely invade new islands. Although social wasps represent a public nuisance in the Faroes, the potential ecosystem impacts are grossly underappreciated and understudied.

Key words: social wasp, *Vespula*, nesting habitat, island spread, *Vespula germanica*, *Vespula vulgaris*

Introduction

Social wasps (Hymenoptera) are globally recognised as Invasive Alien Species (IAS) (Beggs et al. 2011). However records and case studies of invasive social wasps in the Northern hemisphere are rather scarce (Ward and Edney-Browne 2015). In the Northeast Atlantic, social wasps have been introduced relatively recently to different archipelagos: In Iceland (1973), Orkney (1983), and Shetland (1989) (Table 1).

The first wasp nests of *Vespula germanica* (Fabricius) was found in 1973 in Reykjavík, Iceland (Ólafsson 1979). The population grew, and they became a common species in 1990–2000. However, there are sometimes lengthy periods when they are not observed, for example, one *V. germanica* queen was seen in 2011, 2015 and 2016, but not since (E. Ólafsson, *pers. comm.*

Table 1. Social wasp species confirmed in Iceland, Shetland, Orkney and the Faroe Islands. The years in brackets are only individuals observed and not nests.

Region	Taxa	Year of first nest observed	Reference
Iceland	*Vespula germanica* (Fabricius, 1793)	1973	E. Ólafsson 1979
Iceland	*Vespula vulgaris* (Linnaeus, 1758)	1978	E. Ólafsson 1979
Iceland	*Dolichovespula norwegica* (Fabricius, 1793)	1982	E. Ólafsson, *pers. comm.* 2017
Iceland	*Vespula rufa* (Linnaeus, 1758)	1997	E. Ólafsson, *pers. comm.* 2017
Shetland	*Vespula vulgaris* (Linnaeus, 1758)	1989	M. Pennington, *pers. comm.* 2018
Orkney	*Dolichovespula norwegica* (Fabricius, 1793)	1983	J. Crossley, *pers. comm.* 2018
Orkney	*Dolichovespula sylvestris* (Scopoli, 1763)	(1996)	J. Crossley, *pers. comm.* 2018
Orkney	*Vespula rufa* (Linnaeus, 1758)	(2003)	J. Crossley, *pers. comm.* 2018
Faroe Islands	*Vespula vulgaris* (Linnaeus, 1758)	1999	This study
Faroe Islands	*Vespula germanica* (Fabricius, 1793)	1999	This study

2018). The first nest of *Vespula vulgaris* (Linnaeus) in Iceland was found in 1978 and it is now found commonly throughout Iceland (E. Ólafsson, *pers. comm*. 2018). A *Dolichovespula norwegica* (Fabricius) nest was observed in 1982 simultaneously in west and east Iceland and they are now commonly found throughout Iceland (Ólafsson 2008). The first nest of *Vespula rufa* (Linnaeus) was found in 1997, but individual observations have been noted since 1986, and only rarely observed since – once in 2010 and once in 2016 (Ólafsson 2018; E. Ólafsson, *pers. comm*. 2018).

In Shetland the first social wasp nest (*V. vulgaris*) was discovered in the outskirts of Lerwick in 1989. This was destroyed, but in 1993 a *V. vulgaris* nest was found in Lerwick and removed, but the following year, 18 wasp nests were found in Lerwick, as well as one 8 km away in Scalloway. In 1995, 40 nests were found in Lerwick. Despite the best effort by Environmental Services Department of the Shetland Island Council removing all reported nests, they appear to persist in Shetland (Pennington et al. 2004). They are now found in Lerwick, Brae, and possibly other locations (M. Pennington, *pers. comm*. 2018).

On Orkney *D. norwegica* was first observed in 1983, and is now common on the island of Mainland, while continuing to spread to other islands. *V. vulgaris* was first observed in 1984 with several nests found in 1985–86, and it is now common on all of Mainland. Other species such as *Dolichovespula sylvestris* (Scopoli) was first observed on Hoy and is now common on Mainland also. *Vespula rufa* was seen in 2003 and is now common on Mainland. Two *Vespula austriaca* (Panzer) specimens were seen in 2006 yet have not been seen since. It is however noteworthy that *V. germanica* has not been found on the Orkney islands yet (John Crossley, *pers. comm*. 2018).

The Faroe Islands (Faroes hereafter) are an isolated archipelago in the North Atlantic consisting of 18 small islands, 300 km to northwest of Shetland, and 450 km east of Iceland (Figure 1). It's an autonomous part of the Danish kingdom, and the majority of goods from mainland Europe are imported via Denmark. The Faroese population of 50,000 people inhabit 17 out of the 18 islands, and approximately 13,000 live in the capital Tórshavn.

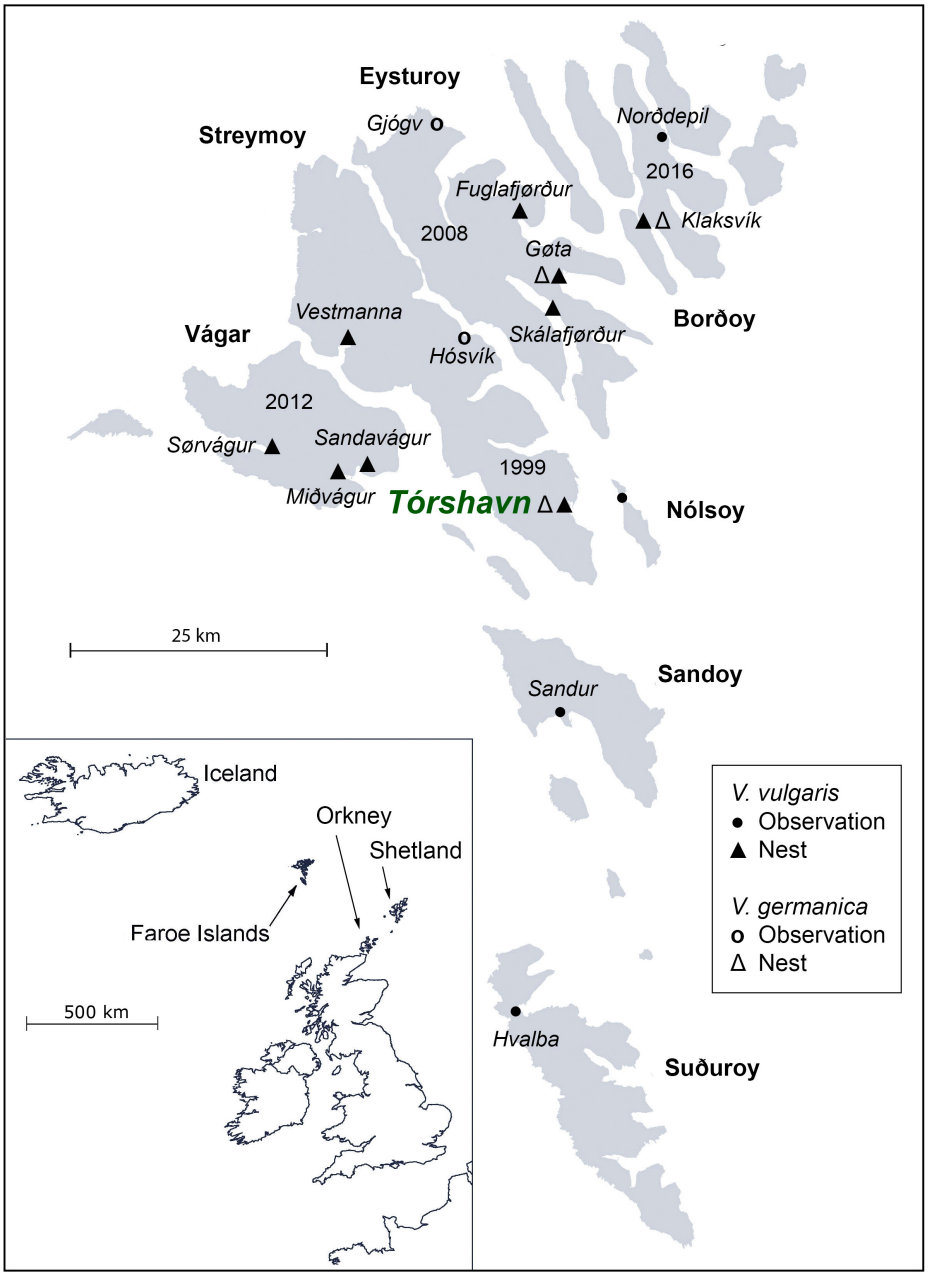

Figure 1. Map of Faroe Islands showing where individuals and nests of *V. vulgaris* and *V. germanica* nests have been found, and year of first nest confirmed of particular islands (for details see Supplementary material Table S1). The island names are featured in bold, while village and town names are in italics.

Nearly 88% of the population is on islands which are already connected by sub-sea tunnels, causeways, and a bridge (Statistics Faroe Islands 2018). There is also a proposal to connect Sandoy and potentially Suðuroy to the mainland via sub-sea tunnels, which will result in 99% of the human population being connected (Landsverk 2017).

The past decade has seen the arrival of several non-native insects to the Faroes such as, grasshoppers Orthoptera, Acrididae (Jensen and Nielsen 2005), true bugs (Heteroptera) (Tolsgaard and Jensen 2010) and bumble bees (*Bombus pratorum* (Linnaeus) and *B. lucorum* (Linnaeus)) (Jensen and Madsen 2013). For many of these recent observations, it is unclear if they

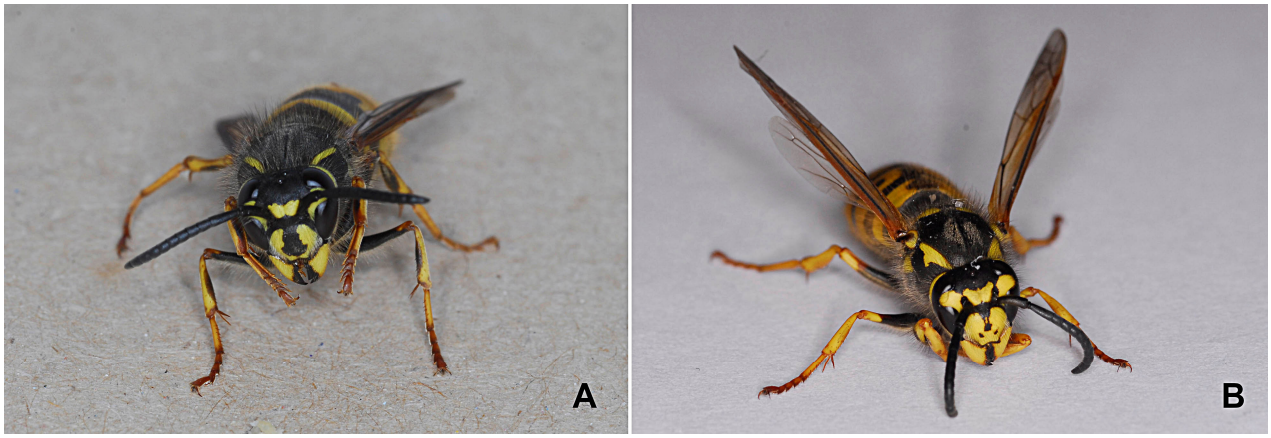

Figure 2. Photograph of A. *Vespula vulgaris* and B. *Vespula germanica*. Notable morphological differences in frontal patch, with *V. vespula* having a bold black line, and *V. germanica* only a thin line and small spots. Photographs by Jens-Kjeld Jensen.

reached the Faroes via natural or human-mediated dispersal, however some species such as the bumble bees are quite unlikely to have reached the Faroes naturally (Jensen and Madsen 2013).

Methods and results

In 1999 in connection with the new national football stadium construction in Tórshavn, grass turf was imported from Denmark. This same year and over the following years many wasp nests began appearing in close proximity of the stadium (< 1 km). Although individual wasps have been seen in the Faroes before 1999, they were not identified, and no wasp nests have been discovered before 1999. Following the introduction in 1999 (Jensen and Bloch 2001), information regarding social wasps in the Faroes have been collected by JKJ and specimens and photographs have been gathered from 1999 to 2017. Edwards (1980) was used for taxonomic identification and collected specimens deposited at the Natural History Museum in Tórshavn and in the private collection of JKJ. The species of social wasps identified so far are *V. vulgaris* and *V. germanica*. There have been multiple public engagement efforts both via radio and the Faroese science magazine Frøði (Jensen and Bloch 2001), with an appeal to submit photographs and information to JKJ. Numbers and type of wasp nests eradicated were obtained from municipal authorities around the Faroes.

The wasp species identified in the Faroes are: *V. vulgaris* and *V. germanica*, and the main distinguishing feature is – *V. vulgaris* has a bold black line down its frontal patch, while on *V. germanica* it is nearly absent (see Figure 2).

Vespula vulgaris

On 15 January 1999 a *V. vulgaris* was killed inside a house near the stadium area in Tórshavn, Streymoy, and while many others were observed, none were caught. On 28 December 1999 JKJ received a *V. vulgaris* queen from a grocery shop in Tórshavn. In the central part of Tórshavn four *V. vulgaris*

nests were found in proximity of the stadium area from 11 August–1 September 2000, and from 9 August–13 December 2000, 12 *V. vulgaris* individuals were caught in the same area. In 2002, specimens were recorded at 22 different addresses in the same area.

There have been single observations of individual wasps around the Faroes, without any confirmed nests: Nólsoy (15 November 1998), Sandur, Sandoy (1 December 2000), Hvalba, Suðuroy (12 April 2005), and Norðdepil, Borðoy (14 March 2017). Outside Tórshavn, *V. vulgaris* nests have been found in Skálafjørður (2008), Miðvágur (2012), Fuglafjørður (2012), Gøta (2013), Vestmanna (2015), Klaksvik (2016), and Sandavágur (2016). For most of these locations, there were prior notes of observations of individual wasps, yet no located nests.

Vespula germanica

On 8 October 1999 many individuals of the species *V. germanica* were seen in and around the Nordic House, approximately 500 m from the football stadium area in Tórshavn, Streymoy. Four *V. germanica* were caught and sent to JKJ. Since then no *V. germanica* have been recorded in Tórshavn, even though several hundred individuals have been investigated so far. In the summer of 2009, many *V. germanica* were found in Gøta, Eysturoy and one nest was located (Karl A. Thomsen, *pers. comm.*), however it has not been recorded since. On 23 June 2011 a *V. germanica* queen was caught in the village of Gjógv, Eysturoy, but no other wasps have been observed. On 19 December 2012 a *V. germanica* queen was caught in Klaksvík, Borðoy, and more were observed in 2014 and 2015, but none were caught until 7 October 2016. In 2017 *V. germanica* were observed in various locations in Klaksvík, and at least one nest was destroyed. On 31 December 2016 a *V. germanica* was caught in a house in Hósvík.

In 2002 Tórshavn municipality began eradication of located nests, and this has continued ever since, however eradications were not documented between 2003 and 2007 (Figure 3). The nest eradication data is not species specific but are assumingly predominantly of *V. vulgaris*. In total 1.145 nests have been removed in Tórshavn and 77 outside Tórshavn (15 in Klaksvík, Borðoy, 12 in Fuglafjørður, Eysturoy and 11 in Sørvágur, Vágar, and 13 in three other towns). In 2008–2017 over 100 nests have been removed per year in Tórshavn, but 2009 and 2016 were unusually high numbers with 230 and 170 nests respectively. It has been reported that the population size of *V. germanica* and *V. vulgaris* can fluctuate markedly between years in their native range and where they have become invasive (Lester and Beggs 2019). Nest sites of *V. vulgaris* and *V. germanica* in Tórshavn, Fuglafjørður and Vestmanna can be categorized into three groups (Table 2): in the root systems of trees or shrubs ("ground"), in built rock walls along gardens or roads, and in buildings such as outhouses, in between the exterior of adjacent houses or in house walls themselves.

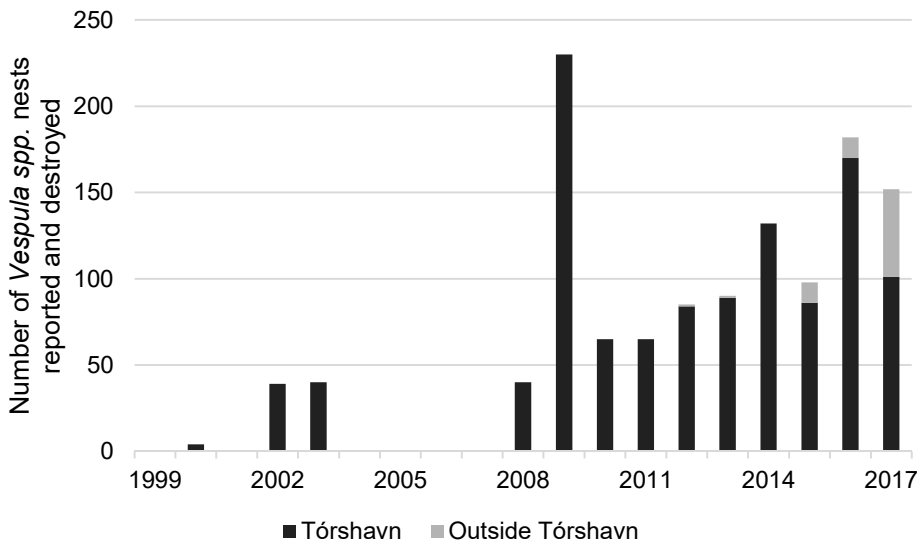

Figure 3. Number of eradicated *Vespula* spp. nests in the Faroes 1999–2017.

Table 2. Percentage of nest types at three locations in the Faroe Islands.

	Tórshavn (n=38)	Vestmanna (n=4)	Fuglafjørður (n=12)
Ground	42	25	0
Rock wall	11	0	75
Attic or house cover	47	75	25

Discussion

When social wasps established in the Faroe Islands in 1999, this was the last human-populated archipelago in the sub-Arctic Northeast Atlantic to be invaded by social wasps. Considering the arrival of social wasps in neighbouring island groups, up to three decades prior (Table 1) this last invasion was perhaps to be expected. The fact that two species reached the Faroes at the same time and area would strongly suggest that this particular invasion was human-mediated, and most likely associated with the import of grass-turf to Tórshavn. However it is important to recognise that individual wasps have been observed prior to 1999 in the Faroes, but these have not been noted or recorded, and no nests have been found prior to 1999. Since then both species have been found to spread within the Faroes. Both *V. vulgaris* and *V. germanica* are globally recognised as effective colonisers, and have in some cases been found to be highly invasive (Beggs et al. 2011). Their versatility and resourcefulness is also demonstrated in the Faroes, where they show a clear difference in nesting types between three towns in the Faroes (Table 2). Although this location difference may be confounded by a species difference or general awareness bias which we can't account for in current data, so no specific conclusion should be drawn from this difference in nesting types.

Although systematic surveys and monitoring of IAS lacks throughout this region, our investigation has shown that several different species of social wasps have arrived and established in the region over the past three decades. However, both in the Faroes and Iceland there seem to be

puzzling cases of social wasps appearing and disappearing, or at least with no recorded observations for a number of years. For example since *V. germanica* was observed in Tórshavn, Streymoy in 1999 it was not observed again until 2009 in Gøta, Eysturoy. Such lag phases could suggest that there is perhaps significant underreporting, or environmental or ecological factors may influence how species establish and thrive. Potentially environmental variables are unfavourable and for example *V. germanica* depends on some favorable climatic tipping point in order for them to emerge in detectable numbers. In Iceland, *V. germanica* was first introduced in 1973 in Reykjavík, it only became common around Reykjavík 1990–2000, and disappeared shortly after for a number of years, only to re-emerge in 2015 and 2016, but was again not found in 2017 (E. Ólafsson, *pers. comm.*). Such climatic barriers may have been the saving grace for many similar sub-polar archipelagos in the past, but a recent study has suggested that such barriers are weakening and we may expect to see an increase in IAS as a consequence (Duffy et al. 2017).

Regardless of the mechanisms behind it, it would appear that *V. germanica* has so far not had such a solid establishment in the Faroes as *V. vulgaris*, and there may for example be a competitive or antagonistic relationship between the two species, as was shown in a study in New Zealand (Harris et al. 1994). It was shown in New Zealand where *V. vulgaris* outcompeted and largely displaced *V. germanica*, which had arrived earlier (Harris et al. 1994).

In the Faroes, social wasps have not been observed away from human settlements, and it is unlikely that they arrived to the Faroes on their own. Individuals have frequently been found indoors in shops and businesses that receive imported goods, also before the 1999 introduction. *V. germanica* queens are not known to spread more than a few kilometers (Masciocchi et al. 2018), so their spread from Tórshavn to Klaksvík (27 km NE) has most likely been facilitated by human traffic.

There are no effective restrictions of biological material to the Faroes, so great quantities of plants and trees with soil are imported to the Faroes every year, both by the retail sector and privately. This can be assumed to be the leading pathway of a variety of insects to the Faroes over the past decades (Tolsgaard and Jensen 2010; Jensen and Madsen 2013). *Vespula* spp. have frequently been observed by the authors on public busses between the towns in the Faroes, and hibernating queens in transported goods may well have been the cause of spread within the Faroes as well as allowing them to reach the Faroes initially, as this is a recognized pathway in other invasions (Moller 1996).

The initial introduction to Tórshavn and spread to other islands and towns, suggest a strong relationship with human activites and transport, and herein may lie some potential to prevent wasps to establish on more islands in the Faroes. There are currently 14 islands in the Faroes where no

social wasp nest has been recorded. Nests have been found only on land-locked islands, so this could suggest that the distance between islands may be a natural barrier, halting their spread between islands. However if there continues to be no control or regulation of imported biological goods such as plants, turf and soils, the Faroes will inevitably see additional social wasp species being introduced, and also expectedly find them spreading between islands and towns. If import regulation from Denmark could be implemented, where the vast majority of imports to the Faroes are shipped from, this would likely have a significant preventative effect. In their review Beggs et al. (2011) found three out of nine introduction cases of *V. germanica* were known or suspected to be invasive,i.e. to have a significant negative effect on the environment. One out of six *V. vulgaris* were known or suspected to be invasive. One important predictor of invasiveness in social wasps is eusociality, and both *V. germanica* and *V. vulgaris* are highly eusocial. Faroese native fauna has no eusocial insects, which would be likely to compete with the invading wasps.

While there are unknown economic and public health costs to the recent introduction of social wasps, the potentially greatest implications are ecosystem changes. Experience from other areas have shown *V. vulgaris* to be very aggressive predators, and they are also highly competitive species, so there are multiple potential ecosystem changes which they can inflict to a relatively naïve ecosystem. The majority of the Faroese terrestrial environment is low-intensity sheep grazing habitat with virtually no native woodlands. Assessing some of these impacts should in our view be studied with the most urgency. The control or eradication of social wasps is with current technology not viable (Beggs et al. 2011), so focus should be on the prevention of introduction in the first place, and prevention of spread within the Faroes. A note of encouragement from the limited spread of social wasps in the Faroes, would be that if the Faroes were to implement some biosecurity measures such as restricting imports of turf and other materials from the European mainland, it would likely be an effective prevention of the spread of IAS to and within the Faroes.

There is currently no scientific evaluation of the ecological impacts of the wasp introduction to the Faroes. One factor which is frequently missed in invasion biology, is to which degree can generalizations be made across areas or hemispheres (Ward and Edney-Browne 2015). By collating and presenting some of the initial notes on social wasp spread in the Faroe Islands and noting some of the unpublished knowledge in the region, the authors hope that this may contribute towards increased focus and research, and in the long term perhaps establish biosecurity measures in the region. Our concern is that since no particular industry sector is directly influenced by terrestrial IAS, there is very limited drive for change, and many invasions over the past few decades have gone largely unnoticed

by the government and scientists alike. This is not a unique challenge (Lester et al. 2013), and since environmental and ecological monitoring has not been carried out systematically, it is not possible to reliably estimate the ecological impact of introduced predators such as social wasps to the Faroes. But more generally we can establish that the number of introduced organisms has increased markedly over the past two decades, and that there currently is no local or national impetus to study potential effects or to prevent the introduction of alien organisms. Several countries and island communities have over the past few years formulated strategies and resources to establish island biosecurity, so there is globally a great degree of know-how and scientific expertise, which can be drawn upon if or when there is a public understanding in the Faroes that preventing the spread of invasive alien species is a conservation priority.

Acknowledgements

Many thanks to all who have submitted specimens or photographs for identification. Their contribution has been very valuable to this article. A special thanks to: Annette Spange Davidsen, Danial Jespersen, Eskild Hansen, Hanna Dalsenni, Jákup Durhuus, Jóan Petur Berg, Karl A. Thomsen, Maria Chun Nielsdóttir, Rodmund á Kelduni, Sigrid Dalsgaard, Tóta Árnadóttir. We thank Erling Ólafsson (Reykjavík, Island) for information about the Icelandic social wasp fauna and Lee Johnson, John Crossley for updates on the social wasp fauna on Orkney. We also thank Alex Bond for comments and guidance on an early draft, and Marita Gulklett for graphical design of the map, and many thanks to the reviewers.

References

Beggs JR, Brockerhoff EG, Corley JC, Kenis M, Masciocchi M, Muller F, Rome Q, Villemant C (2011) Ecological effects and management of invasive alien Vespidae. *BioControl* 111: 505–526, https://doi.org/10.1007/s10526-011-9389-z

Duffy GA, Coetzee BWT, Latombe G, Akerman AH, McGeoch MA, Chown SL (2017) Barriers to globally invasive species are weakening across the Antarctic. *Diversity and Distributions* 23: 982–996, https://doi.org/10.1111/ddi.12593

Edwards R (1980) Social Wasps: Their Biology and Control. The Rentokil Library, 398 pp

Harris RJ, Moller H, Winterbourn MJ (1994) Competition for honeydew between two social wasps in South Island beech forests, New Zealand. *Insectes Sociaux* 41: 379–394, https://doi.org/10.1007/BF01240641

Jensen, J-K, Bloch D (2001) Vespur. *Frøði* 4–7

Jensen, J-K, Madsen HB (2013) To arter af humlebier yngler på Færøerne (Hymenoptera, Apidae). *Entomologiske Meddelelser* 81: 1–10

Jensen, J-K, Nielsen OF (2005) Første fund af græshoppe på Færøerne. The first grasshopper in the Faroe Islands. *Norwegian Journal of Entomology* 73: 51–53

Landsverk (2017) Suðuroyartunnilin. http://www.landsverk.fo/Admin/Public/Download.aspx?file=Files%2FFiles%2FTidindi%2FUndirsjovartunlar%2FSuduroyartunnil_framloga_Landsverk_4_sept_2017.pdf

Lester PJ, Beggs JR (2019) Invasion Success and Management Strategies for Social *Vespula* Wasps. *Annual Review of Entomology* 64: 51–71, https://doi.org/10.1146/annurev-ento-011118-111812

Lester PJ, Beggs J, Brown RL (2013) The outlook for control of New Zealand's most abundant, widespread and damaging invertebrate pests: social wasps. *New Zealand Science Review* 70: 56–62

Masciocchi M, Martinez AS, Pereira AJ, Villacide JM, Corley JC (2018) Dispersal behavior of yellowjacket (*Vespula germanica*) queens. *Insect Science* 25: 109–116, https://doi.org/10.1111/1744-7917.12374

Moller H (1996) Lessons for invasion theory from social insects. *Biological Conservation* 78: 125–142, https://doi.org/10.1016/0006-3207(96)00022-5

Ólafsson E (1979) Um geitunga (Hymenoptera, Vespidae) og skyldar gaddvespur á Íslandi. *Náttúrufræðingurinn* 49: 27–40

Ólafsson E (2008) Geitungar á Íslandi. Reykjavík, 24 pp

Ólafsson E (2018) Roðageitungur (*Vespula rufa*). The Icelandic Institute of Natural History. http://old2.ni.is/taxon/vespula-rufa

Pennington M, Osborn K, Okill D (2004) The Common Wasp Colonisation of Shetland. Shetland Entomological Group. http://www.nature-shetland.co.uk/entomology/wasps.htm (accessed 3 June 2018)

Statistics Faroe Islands (2018) Available at: http://www.hagstova.fo/en (accessed 2 June 2018)

Tolsgaard S, Jensen J-K (2010) Nye fund af tæger (Heteroptera) på Færøerne. *Entomologiske Meddelelser* 78: 21–28

Ward D, Edney-Browne E (2015) Poles Apart: Comparing Trends of Alien Hymenoptera in New Zealand with Europe (DAISIE). *PLoS ONE* 10: e0132264, https://doi.org/10.1371/journal.pone.0132264

Supplementary material

The following supplementary material is available for this article:

Table S1. Georeferenced locations in the Faroe Islands where *Vespula* spp. have been confirmed, either as nest (N) or individuals (I).

This material is available as part of online article from:
http://www.reabic.net/journals/bir/2019/Supplements/BIR_2019_Hammer_Jensen_Table_S1.xlsx