Plant galls and gall midges (Diptera: Cecidomyiidae) of the Faroe Islands in the Atlantic Ocean

Plantuvølir og vølamíggj (Diptera: Cecidomyiidae) í Føroyum

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Úrtak

Tíggju vølelvandi og vølatknýttar lívverur, ið komu fyri á sjey vertsplantusløgum, ið hoyrdu til sjey plantuættir, vórðu funnar nærindis Tórshavn í august 2005. Av teimum eru fimm sløg vølamíggj (Cecidomyiidae, Diptera), tvey eru eriophyid-mottur (Eriophyioidea, Acarina) og trý hoyra til ymsar soppaættir. Allir finningar eru nýggjar skrásetingar í Føroyum. Sjey sløg elva til vølir á ymsum vertsplantum, nevniliga Cecidomyiidae, *Oligotrophus juniperinus*, ið elvir til knubbavølir á vanligum baraldi, *Juniperus communis*, og *Contarinia floriperda*, ið elvir til blómuknubbavølir á einum slag av royniviði, *Sorbus aria*; Eriophyoidea, *Aceria pseudoplatani*, á bløð á einum slag av ahorn, *Acer pseudoplatanus*, og *Aculus anthobius* á stelk og blómur á einum slag av steinbrá, *Galium anisophyllum*; og soppurin *Cronartium ribicola*, ið elvir til vølir á bløð á sólberjarunni, *Ribes nigrum*, og *Melampsora caprearum* á bløð á pálmapíli, *Salix phylicifolia*, og *Puccinia violae* á bløð á dimmari blákollu, *Viola riviniana*. Trý vølamíggj, ið ikki elva til vølir, eru knýtt at vølelvandi lívverum, nevniliga *Mycodiplosis melampsorae* og *Clinodiplosis cilicrus*, bæði planturotátin (phytosaprophagous) sløg, ið eru knýtt at rotnum plantutilfari, og *Feltiella acarisuga*, eitt djóraátið (zoophagous) slag, ið gagnnýtir tetranychid-mottur. *Oligotrophus juniperinus*, *Contarinia floriperda* og *Puccinia violae* eru upprunalig í Føroyum í sambandi við upprunan at vertsplantuni; og tey sløg, ið eru eftir, eru fremmand og eru vorðin innslødd til Føroya við fólki. Frá einum lívfrøðilandafrøðiligum sjónarmiði eru *Oligotrophus juniperinus*, *Contarinia floriperda*, *Aceria pseudoplatani og Aculus anthobius* evropisk sløg, *Mycodiplosis melampsorae* og *Clinodiplosis cilicrus* eru evro-sibirisk sløg og *Feltiella acarisuga* er eitt alheimsslag. Finningurin av *C. floriperda* í Føroyum er tann norðasta fyrikomingin í Evropa. Tað lága talið á sløgum av vølelvandi lívverum í Føroyum kemst av landafrøðiligari avbyrging og natúrligum umstøðum í landinum, t.e. heldur lítil gróður og trot á trøum og runnum, sum kundu verið møguligar vertsplantur hjá vølelvandi lívverum.

Abstract

Ten gall-causing and gall-associated organisms occurring on seven host plant species belonging to seven plant families were found near Tórshavn on the island of Streymoy, one of the Faroe Islands, in August 2005. Of these, five species are gall midges (Cecidomyiidae, Diptera), two are eriophyid mites (Eriophyioidea, Acarina) and three belong to various families of fungi. All findings are new records for the Faroe Islands. Seven species cause galls on various host plants, namely the Cecidomyiidae, *Oligotrophus juniperinus* causing bud galls on *Juniperus communis* and *Contarinia floriperda* inducing flower bud galls on *Sorbus aria*; the Eriophyoidea, *Aceria pseudoplatani* on leaves of *Acer pseudoplatanus* and *Aculus anthobius* on stems and

flowers of *Galium anisophyllum*; and the fungi *Cronartium ribicola* galling leaves of *Ribes nigrum*, *Melampsora caprearum* on leaves of *Salix phylicifolia* and *Puccinia violae* on leaves of *Viola riviniana*. Three non-galling gall midges were associated with gall-causing organisms, viz. *Mycodiplosis melampsorae* and *Clinodiplosis cilicrus*, both phytosaprophagous species associated with decaying plant matter, and *Feltiella acarisuga*, a zoophagous species preying on tetranychid mites. *Oligotrophus juniperinus, Contarinia floriperda* and *Puccinia violae* are native to the Faroe Islands with regard to the origin of their host plants; and the remaining species are alien and were introduced to the Faroe Islands by man. From the biogeographical point of view *Oligotrophus juniperinus, Contarinia floriperda, Aceria pseudoplatani* and *Aculus anthobius* are European species, *Mycodiplosis melampsorae* and *Clinodiplosis cilicrus* are Euro-Siberian species and *Feltiella acarisuga* is a cosmopolitan species. The finding of *C. floriperda* in the Faroe Islands is the most northern occurrence in Europe. The low species number of gall-causing organisms in the Faroe Islands is the result of geographical isolation and natural conditions of these islands with relatively poor vegetation and lack of trees and shrubs, which may be potential host plants of gall-causing organisms.

Introduction

A gall (in Latin „cecidium") is defined as any deviation in the normal pattern of plant growth produced by a specific reaction to the presence and activity of a foreign organism (animal or plant) (Bloch, 1965). An interdisciplinary scientific discipline at the border between botany and zoology, directed to the study of plant galls at all levels, is named cecidology. Galls caused by animals are called zoocecidia and animals causing galls are cecidozoa, galls caused by plants are phytocecidia and such plants are called cecidophyta. The ability of organisms to induce galls on plants has evolved independently many times during the evolution of insects as well as of other groups (Roskam, 1992).

At the beginning of the 20th century one thousand and five hundred gall-causing animals were known in Europe, associated with about four thousands host plants (Houard, 1908-1909). Cecidology quickly developed and in the second half of the 20th century about three thousand gall-causing and associated organisms were known to occur in Central and Northern Europe (Buhr,1964-1965). They belong to various groups of organisms: about one third to bacteria and fungi, two thirds to animals. Three groups of animals are the species richest causers of galls on various plants, viz. the gall midges (Cecidomyiidae, Diptera) with about 600 species, eriophyid mites (Eriophyoidea, Acarina) with about 350 species and aphids (Aphidoidea, Hemiptera) with about 370 species. Since that time many new species of gall-causing organisms have been discovered and described and the number of these organisms is at present much higher.

Knowledge of galls has a long history. The famous Italian physician and researcher Marcello Malpighi (1628-1694), the founder of microscope anatomy, is considered to be also the founder of cecidology. In 1679 he published the comprehensive work „Anatomes Plantarum" in which he included the chapter called „De Gallis" (in English: About galls). This chapter is the first scientific approach to the study of galls on plants and, therefore, Malpighi is recognized as the father of cecidology. Redfern *et al.* (2008) translated this fundamental work on galls from Latin to English. The cooperation of these three authors makes it possible to be

acquainted with admirable work of Marcello Malpighi.

The literature on galls is very extensive. Houard (1908-1909) gave a rich bibliography including about 1000 references, Mani (1964) in his comprehensive book „The ecology of plant galls" included 1300 references that refer to the problem of galls, Buhr (1964-1965) in his two-volume book with identification keys to plant galls gave even 2700 references. Useful data on biology and ecology of gall causing organisms may be found in books published by Ananthakrishnan (1984), Shorthouse and Rohfritsch (1992), Redfern *et al.* (2002), Raman *et al*. (2005) and Ozaki *et al.* (2006).

In the period 1955-2008 we investigated gall midges and their galls in many countries of Europe at more that 1800 localities (Skuhravá and Skuhravy, 1998). In August 2005 we had an opportunity to spend one week in Tórshavn, the capital of the Faroe Islands. We did as it we usually do during our field trips and excursions in various countries of Europe, and searched for galls on various host plants.

Study area

Faroe Islands (Føroyar, Faroes, Færøerne) is an interesting country. It is a group of 18 islands of various size situated in the middle of the North Atlantic between latitude 61^0 20' N and 62^0 24' N and longitude 6^0 15' W and 7^0 41' W. They measure from north to south 113 km, from west to east 75 km and the total land area is 1399 square kilometres. They are halfway between Iceland and Norway and the nearest land is Shetland to the south-east, about 300 kilometres away. Faroe Islands were formed in Tertiary times, millions of years ago, from submarine outpourings of basaltic lava, and belong geologically to the North Atlantic Basalt Province. Lava and ashes from volcanic eruptions have formed basalt plateaux. Later the glaciers of the Glacial Age have transformed it into a mountainous group of islands with deep valleys and narrow fiords. The highest point is 882 m, the average elevation 300 m above sea level. A mild and damp oceanic climate prevails owing to the Gulf Stream which meets a cold polar current deflected from Iceland. Average temperature in summer is 11^0 C, in winter 3^0 C. The weather changes very quickly and storms are violet and sudden. Fog, showers and sunshine follows at short intervals (Schlei and Moberg, 2003).

The natural vegetation is dominated by arctic-alpine plant species, viz. wild flowers, grasses, mosses and lichens. Most of the lowland is grassland and some heath. Only about 6% of the total area has been cultivated. The rest is waste land covered with grasses along the seaside and with poor vegetation in higher country. Above 600 metres mosses and lichens predominate. About 340 native wild plant species grow in the Faroe Islands (Fosaa, 2000) and about 60 introduced species. The natural vegetation is characterised by lack of wild trees and shrubs. In the past birch (*Betula* spp.) and juniper (*Juniperus communis*) occurred on islands and their remnants were found in peat bogs. *Salix herbacea*, a native species, is growing in the mountains. Recently various trees and shrubs were introduced and are planted in private gardens around houses. Forest plantation, founded in Tórshavn in 1902, forms now a nice park with relatively high trees and shrubs.

The fauna is characterized by isolation of the islands and has due to its remote location in the North Atlantic Ocean many sea birds and marine animals, as well as various invertebrates and fishes. All terrestrial animals have been introduced by man. Originally there were no wild animals at all, not even toads (Amphibia) or reptiles. This shortage of animals is probably due to the isolation and the lack of natural habitats. Brown rats (*Rattus norvegicus*), mouse (*Mus musculus*) have been introduced to the islands by man fairly recently from wrecked ships and hares (*Lepus timidus*) was introduced deliberately. The wild life is predominated by birds: 227 species occur on Faroe Islands, most of them are migratory birds or stray guests and 68 bird species nest and breed there. Number of insects is relatively low in comparison with numbers in continental Europe but it is increasing in recent years owing to research works of many entomologists.

The Natural History Museum in Tórshavn, founded in 1955, has an important role for development of natural sciences and research in Faroe Islands. Investigations of research workers of the Zoology Department are mainly concerned with the zoology of the sea. For the past ten years the main subjects of investigation have been whales and animals on the sea-floor (marine benthic fauna) in the waters surrounding the Faroe Islands.

Faroe Islands are not too often a destination of field trips or investigations of research workers from foreign countries. As far as we know, nobody collected galls here and we did not find any reference in the literature on this topic.

Material and methods

During our stay we went each day for a walk on the hill-side over Tórshavn at altitudes about 100-200 m a.s.l. and searched for galls on various wild plants growing in grasses and along numerous brooks. We visited also a small park in Tórshavn and a small botanical garden which is a part of the Faroese Museum of Natural History. We observed trees and shrubs grown in private gardens in the town and in the cemetery where we found some very old specimens of trees (maple, yew). Although we took great pains to find some plant galls, the catch was very poor.

Immediately after our arrival in Tórshavn we exposed three small dishes filled with water and with a drop of detergent to catch flying insects. We placed dishes among grasses just outside the window of our hotel room. They were situated at the level of our window and it was possible to control their content easily directly from our room.

Identification of galls is based on Buhr (1964-1965), Houard (1908-1909) and Redfern *et al.* (2002); identification of larvae on Möhn (1955). Nomenclature of gall midge species is based on Skuhravá (1986, 1989) and Gagné (2004), nomenclature of eriophyid mites on Amrine and Stasny (1994), nomenclature of host plants on Tutin *et al.* (1964-1980). The occurrence of organisms causing galls and organisms associated with galls is compared with their occurrence in other parts of Europe where faunal investigations have been carried out at more than 1800 localities (Skuhravá, 1987, 1991, 1994a, 1994b, 1997, Skuhravá and Skuhravy, 1998).

Results

Only ten gall-causing and gall-associated organisms occurring on seven host plant species belonging to seven plant families were found during our seven-days searching for galls in the Faroe Islands (Table 1). Of these seven galls were caused by gall-causing organisms (two species of Cecidomyiidae, two species of Eriophyidae and three species of Fungi) and larvae of three other gall midge species were found during microscope examination of galls and leaves.

Table I. List of host plants and gall-causing and other organisms found in Tórshavn on the island Streymoy in the Faroe Islands in 2005

Host plant species	Gall-causing organism
Acer pseudoplatanus	Aceria pseudoplatani
Galium anisophyllum	Aculus anthobius
Juniperus communis	Oligotrophus juniperinus
Ribes rubrum	Cronartium ribicola
Salix phylicifolia	Melampsora caprearum
	Mycodiplosis melampsorae
Sorbus aria	Contarinia floriperda
	Clinodiplosis cilicrus
	Feltiella acarisuga
Viola riviniana	Puccinia violae

Fig. 1. Swollen flower bud (above on the right), the gall of *Contarinia floriperda* on the flower bud of *Sorbus aria.* Photograph by Václav Skuhravy.

Annotated list of species

Gall midges (Diptera: Cecidomyiidae)

Contarinia floriperda Rübsaamen, 1917

Larvae develop in flower buds of *Sorbus aria* L. (Rosaceae) which become swollen and not develop into flowers (Fig. 1). In July the larvae leave attacked buds and fall to the soil and enter the soil where they hibernate until spring of the following year. At the time of collecting in August 2005, the galls were without larvae. *Sorbus aria* is not native to the Faroe Islands. Locality: Streymoy, Tórshavn, private garden, 6.8.2005. Distribution. *C. floriperda* is a European species that is relatively rare (Skuhravá, 1997). This species was originally described based on adults reared from swollen flower buds of *Sorbus aucuparia* L. in Germany (Rübsaamen, 1917). The galls of this species have been found on this host plant species subsequently in Britain (Bagnall and Harrison, 1921), Russia (Dombrovskaja, 1936), Sweden (Wahlgren, 1944), the Netherlands (Alta, 1946), Latvia (Spungis, 1979), Czech Republic (Baudys, 1923), Bulgaria (Skuhravá *et al*.,1991), Austria (Skuhravá and Skuhravy, 1995), Italy (Skuhravá *et al*., 2002) and Denmark (Skuhravá *et al.,* 2006) (Fig. 2). The galls of *C. floriperda* on the host plant species *Sorbus aria* were found relatively rarely, only in Britain and in the Czech Republic. The finding of *C. floriperda* in the Faroe Islands is the most northern occurrence in Europe.

Vertical occurrence: *C. floriperda* occurs over a large altitudinal span including sites near the sea level in the island of Læsø in Denmark and up to 2200 m a.s.l. in the Alps in northern Italy (Skuhravá *et al.,* 2002; 2006).

Oligotrophus juniperinus (Linné, 1758)

Larvae cause terminal or axillary bud galls on branches of *Juniperus communis* L. (Cupressaceae) (Fig. 3). The

Fig. 2. Distribution area of *Contarinia floriperda* in Europe.

gall is formed of enlarged swollen needles and includes two or three whorls of small needles. One orange coloured larva develops in the central chamber of the gall. It hibernates in the gall and pupates there in the spring of the next year. Only one generation develops per year. The host plant species *Juniperus communis* is a native shrub in the Faroe Islands. At the time of collecting in August 2005, the galls contained full grown larvae.

Locality: Streymoy, Tórshavn, cemetery, 9.8.2005.

Distribution. *O. juniperinus* is a European species. It was described very briefly by Linné (1758) from Sweden, probably from the vicinity of Uppsala, under the name *Tipula juniperina*. Galls of this species were found subsequently at many places in Europe. At present *O. juniperinus* occupies a large distribution area in Europe (Fig. 4). Harstad on the island Hinnoya in northern Norway, far above the Arctic Circle, is the northernmost locality where galls have been found (1995, leg. M. Skuhravá). Karpenisi in central Greece (Skuhravá and Skuhravy, 1997) and Istanbul in western Turkey (Skuhravá *et al*., 2005) are the southernmost situated localities of its known occurrence. In the southern

Fig. 3. *The galls of Oligotrophus juniperinus* on the buds of *Juniperus communis*. Photograph by Václav Skuhravy.

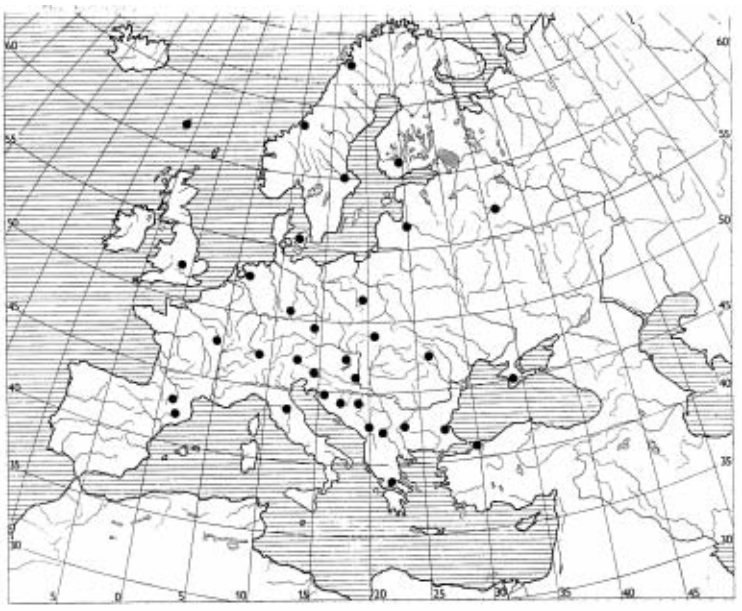

Fig. 4. Distribution area of *Oligotrophus juniperinus* in Europe. *Corrected according to comments of P.H. Enckell, 21.1.2009*

parts of Europe it occurs mainly in the mountains.

The host plant, *Juniperus communis*, is a Holarctic species and occupies a large distribution area in the cool temperate Northern Hemisphere from Arctic south in mountains to around 30°N latitude in North America, Europe and Asia. *Oligotrophus juniperinus* occupies only a small part of the distribution area of its host plant spread in Europe.

Vertical occurrence. *O. juniperinus* occurs over a large altitudinal span including sites in the planare zone up to sites in the Alpine zone. Bisamberg, 190 m a.s.l. in north-eastern Austria was the lowest situated locality where galls were found and the Mount Kanzel, 2348 m a.s.l. in the Alps in northern Italy is the highest point of its known vertical occurrence (Skuhravá, 1987, 1997, Skuhravá and Franz, 1989, Skuhravá *et al*., 2002). *O. juniperinus* has a large ecological tolerance and is able to inhabit places that are distant vertically each other of more than 2000 meters. *O. juniperinus* may be considered to be a sub-boreal and Alpine species.

Clinodiplosis cilicrus (Kieffer, 1889)

Larvae of this species develop in decaying plant matter. They were found in samples among decaying leaves of *Sorbus aria* (Rosaceae) together with swollen flower buds caused by the gall midge *Contarinia floriperda*.

Locality: Streymoy, Tórshavn, private garden, 6.8.2005.

Distribution. *C. cilicrus* is a Euro-Siberian species (Skuhravá, 1997). It was described by Kieffer (1889) as *Diplosis cilicrus* from France. He discovered larvae living gregariously in flower heads of several host plant species of the family Asteraceae, viz. *Centaurea jacea* L., *C. scabiosa* L., *Cirsium vulgare* (Savi) Ten. (= *C. lanceolatum* Scop.) and *Carlina vulgaris* L. Larvae lived between achenes. Skuhravá (1973) demonstated in experiments, that the larvae of *C. cilicrus* are phytosaprophagous and develop in decaying plant matter.

Feltiella acarisuga (Vallot, 1827)

Larvae feed on many tetranychid mites (Acarina: Tetranychidae). Larvae of this species were found among mites in samples of decaying leaves of *Sorbus aria* (Rosaceae) brought for examination.

Locality: Streymoy, Tórshavn, private garden, 6.8.2005.

Distribution. It is probably primarily a European species, at present known to be distributed in several continents and considered therefore to be of cosmopolitan distribution (Gagné, 2004). It was originally described by Vallot (1827) as *Cecidomyia*

acarisuga from Dijon (France). It is one of the most effective and widespread natural enemies of spider mites and is used in biological control.

Mycodiplosis melampsorae (Rübsaamen, 1889)
Larvae feed on uredospores of *Melampsora caprearum* on the leaves of *Salix phylicifolia* L. (Salicaceae). Larvae were found in samples of leaves of this willow brought for examination.
Locality: Streymoy, Tórshavn, town park, 7.8.2005.
Distribution. It is a Euro-Siberian species (Skuhravá, 1997). Rübsaamen (1889) described this species from Germany under the name *Diplosis melampsorae*. He found mycophagous larvae feeding on *Melampsora salicina* on leaves of *Salix* sp.

Eriophyoid mites (Acarina: Eriophyoidea)

Aceria pseudoplatani (Corti, 1905)
Small eriophyid mites cause galls in the form of erineum (a patch of small hairs) on the lower side of the leaves of *Acer pseudoplatanus* L. (Aceraceae). The host plant is not native to Faroe Islands.
Locality: Streymoy, Tórshavn, town park, 6.8.2005.
Distribution. *A. pseudoplatani* is a European species. It was originally described based on material found in Italy by Corti (1905). In central Europe this species occurs abundantly (Vaněčková-Skuhravá, 1996a, 1996b).

Aculus anthobius (Nalepa, 1892)
Small eriophyid mites cause galls on stems of *Galium anisophyllum* Vill. (Rubiaceae). The terminal part of the stem is deformed, shortened and compact, flowers are green and dwarfed. This host plant is not native to Faroe Islands.
Locality: Streymoy, Tórshavn, near the hotel, 6.8.2005.
Distribution. *A. anthobius* is a European species. This species was originally described by Nalepa (1892) based on material collected in Lorraine (France). It may attack various host plant species of the genus *Galium*.

Fungi (Uredinales)

Cronartium ribicola J.C. Fisher
This fungus of the family Cronartiaceae induces galls on the leaves of *Ribes rubrum* L. (Grossulariaceae). Leaves bear yellow raised areas with orange aecia. This host plant is not native to Faroe Islands.
Locality: Streymoy, Tórshavn, private garden, 8.8.2005.

Melampsora caprearum Thuem.
This fungus of the family Melampsoraceae induces galls in the form of irregular thickened spots, bearing orange-yellow uredinia, on leaves and leaf petioles of *Salix phylicifolia* L. (Salicaceae). *Salix phylicifolia* is a native tree to Faroe Islands.
Locality: Streymoy, Tórshavn, city park, 6.8.2005.

Puccinia violae DC
This fungus of the family Pucciniaceae induces galls in the form of swollen areas on the leaves and leaf petioles of *Viola riviniana* (Violaceae). In the swollen areas dark sporangia occur. The host plant is native to Faroe islands.
Locality: Streymoy, Tórshavn, near the hotel, 6.8.2005.

Results of catch of insects in three small dishes filled with water were very poor. During one week we caught only 35 insect specimens. Of them 26 specimens belong to Diptera (3 Cecidomyiidae, 3 Sciaridae, 3 Psychodidae, 5 Tipulidae and 12 specimens of other groups) and 9 specimens of Hymenoptera. On average, only four insect specimens were caught in three dishes during one day. We have not met with such low numbers of specimens caught per day in any country of Europe where we used this method. In some countries it is possible to catch hundreds of various insects in such dishes during one day. However, it may be concluded from this method, that the species richness not only of gall-causing organisms, but also of flying insects in the Faroe Islands is much poorer than in continental Europe.

Discussion

As is to be expected, the species richness of plant galls and gall midges in the Faroe Islands is very poor in comparison with species richness in continental parts of Europe. In the Faroe Islands we found during one week only ten gall-causing and gall-associated organisms occurring on seven host plant species. It is the lowest species number that we found during one-week investigations in any part of Europe. Usually during such a period we have found about 50-60 species of gall midges, as is indicated in the following examples.

In the island Sjælland (Denmark) we found at individual localities from 5 to 43 gall midge species (Skuhravá *et al*., 2006). The richest species composition including 43 species was found during a one-day excursion at Store Dyrehave near Hillerød, 42 species at Tisvilde and 39 species at Farum. The average species number per locality determined from all records of Sjælland is 22. It is relatively high and it approaches the average species number of the Czech Republic situated in Central Europe, which is 26 (Skuhravá, 1994a, 1994b). In the Hautes-Alpes in south-eastern France at altitudes from 850 to 2645 m a.s.l. we found during one week 107 gall midge species and the average species number was 25 (Skuhravá and Skuhravy, 2004). In the surroundings of Trondheim in middle Norway we found 56 gall midge species during one week and in Harstad on the island of Hinnoya in northern Norway, far beyond the Arctic Circle, even 35 species of gall midges (Skuhravá and Skuhravy, in preparation).

During one week in south-eastern Britain we found 60 gall midge species which were associated with 45 different host plant species belonging to 25 plant families (Skuhravá and Skuhravy, 2007). The average species number per locality was 14.

The gall midge fauna of the British Isles includes 620 species of the family Cecidomyiidae and may be considered as very rich (Chandler, 1998). It is the result of extensive investigations of many research workers that studied gall midges and their galls mainly during the 20th century. It is necessary to stress the importance of the founding of the British Plant Gall Society and its journal *Cecidology* in 1985 and the contribution of its members to the development of knowledge about gall insects in Britain. Nevertheless, the British Isles are explored relatively unevenly. Many plant galls and gall-inducing organisms are known mainly from the southern parts, from England and Wales, and relatively little is known about the plant galls of Scotland and of islands situated in the north of Scotland. Investigations directed to plant galls were done only in Orkney Islands and nothing is known about galls of Hebrides and Shetland Islands. From Orkney Islands 28 gall-inducing organisms are known, of them 16 gall-causing animals and 12 gall-causing fungal organisms (Spooner,1986a,b; Redfern, 2002). Orkney, the archipelago of 70 islands, is situated 16 km off northern Scotland. The flora is much more species rich than that of the Faroe Islands and trees and shrubs occur in Orkney, although in low numbers. Most of the islands are farmed for hay and sheep.

The absence of native trees and shrubs in the Faroe Islands is the main reason for the low number of gall inducing organisms. Trees and shrubs in Europe are the most frequent

host plants of gall causing organisms. Of seven plant species that were found to be host plants of ten species of gall-causing and associated organisms in the Faroe Islands, *Juniperus communis*, *Salix phylicifolia* and *Viola riviniana* are native to the Faroe Islands, in contrast to *Acer pseudoplatanus*, *Ribes rubrum*, *Sorbus aria* and *Galium anisophyllum* that are alien species introduced to Faroe Islands intentionally by man in historical times. In accordance with the origin of host plants, we may consider the gall-causing and associated organisms to be of the same origin, at least the gall midge *Oligotrophus juniperinus* as native to Faroe Islands and *Contarinia floriperda* as alien to Faroe Islands. We do not know surely the origin of other gall midges that are not gall-causing, but mycophagous or zoophagous, and their association with host plants is not so narrow. These gall midges could be transferred by wind or with air flows from continental Europe to Faroe Islands.

It is also a question if the species causing galls on flower buds of *Sorbus aria* that has been identified as *Contarinia floriperda* is identical with species developing in flower bud galls of *Sorbus aucuparia.* To solve this problem, it is necessary to examine larvae and adults reared from galls of both host plants, and DNA sequencing may also be necessary.

Conclusions

There are several probable reasons of such low species number of gall-causing and associated organisms in the Faroe Islands. Above all it is the low number of flowering plants – only about 400 species – and the absence of wild trees and shrubs that could be host plants of gall-causing organisms. This is the result of the geological origin of the Faroe Islands which came into being through the activity of submarine volcanoes. The soils are salt, unfertile and include insufficient amount of nutrients for plants. An important reason is the geographical isolation of the Faroe Islands which are situated far from continental Europe – about 600 km from Norway and 300 km from the Shetlands where any investigations of gall-causing organisms have been done. In contrast, the gall midge fauna of Norway is rich including 290 species (Skuhravá and Skuhravy in prep.). Also climatic factors, viz. relatively low temperatures and short growing season may influence species numbers that developed in Faroe Islands. It seems that breeding of sheep and grazing are also important reasons for the low species number of gall-causing organisms. Sheeps are everywhere walking in small groups in the wild and feeding on grasses and wild plants.

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