

Graphocephala fennahi Young, 1977 (Hemiptera, Cicadellidae) and *Seifertia azaleae* (Peck) Partr. & Morgan-Jones (Ascomycota, Dothideomycetes) in Norway

ANDERS ENDRESTØL

Endrestøl, A. 2017. *Graphocephala fennahi* Young, 1977 (Hemiptera, Cicadellidae) and *Seifertia azaleae* (Peck) Partr. & Morgan-Jones (Ascomycota, Dothideomycetes) in Norway. *Norwegian Journal of Entomology* 64, 112–129.

The *Rhododendron* leafhopper *Graphocephala fennahi* Young, 1977 (Hemiptera, Cicadellidae) is presented new to Norway. Additional Norwegian records on the fungus *Seifertia azaleae* (Peck) Partr. & Morgan-Jones (Ascomycota, Dothideomycetes) causing the fungal disease known as bud blast that kills flower buds on *Rhododendron* L. spp. are given. Their biology and recent range expansion, and the ability of *G. fennahi* to vector *S. azaleae* is reviewed.

Key words: Hemiptera, Cicadellidae, *Graphocephala fennahi*, Dothideomycetes, *Seifertia azaleae*, *Rhododendron*, Norway, alien species, introduction, range expansion.

Anders Endrestøl, Norwegian Institute for Nature Research, Gaustadalléen 21, NO-0349 Oslo, Norway. E-mail: anders.endrestol@nina.no

Introduction

Introduced species represent major threats to biodiversity worldwide, and there has been an exponential increase of established alien species in Europe the recent years (Desprez-Loustau 2009, Roques *et al.* 2009). In 2009, there were 1300 alien terrestrial invertebrates characterized as introduced into Europe and an additional 1000 intra-European alien terrestrial invertebrate species (Roques *et al.* 2009). There is pt. (2017) 2740 alien terrestrial invertebrates and 796 alien terrestrial fungi in Europe (DAISE 2017). These could potentially pose direct threats on native biodiversity through processes as parasitism, predation, phytophagy, competition etc.

According to Mifsud *et al.* (2010), about 0.5–0.6 new alien hoppers (Hemiptera, Auchenorrhyncha) have been recorded per year in Europe since the year 2000 (mainly from North America) (e.g. Hamilton 1983). Several of these and other southern European species have dispersed northward in Europe (Arzone *et al.* 1987, Sergel 1987b, della Giustina 2002, Gjonov & Shishiniova

2014), and reached the Nordic countries (Endrestøl 2008, Gillerfors 2008, Söderman *et al.* 2009, Endrestøl 2013ab, Endrestøl *et al.* 2016ab).

The major pathway for alien species in Europe is horticulture and ornamental trade (Desprez-Loustau 2009, Roques *et al.* 2009, Mifsud *et al.* 2010, DAISE 2017). Investigations conducted during 2014–2016 in Norway revealed more than 150 terrestrial invertebrates alien to Norway hitchhiking with newly imported garden plants (Bruteig *et al.* 2017). From 1997, the amount of plants imported to Norway in tons has increased almost fourfold (Endrestøl *et al.* 2016a). One of the plants with an increased use in Norwegian gardens is *Rhododendron* L. (Ericaceae), especially on the west coast where mild winters and wet summers makes it the most suitable area for *Rhododendron* in Scandinavia (Larsen 2016). This have, or could potentially, result in the introduction and establishment of several alien species using *Rhododendron* as hostplants into Norway, e.g. hemipterans as *Massilieurodes chittendeni* (Laing, 1928) (Aleyrodidae), *Illinoia lambersi* (MacGillivray, 1960) (Aphididae),

Stephanitis rhododendri Horváth, 1905 (Tingidae) and *Tupiocoris rhododendri* (Dolling, 1972) (Miridae).

Imported plants could vector virus, fungi and other pathogens that also could harm native species. In 2002, *Phytophthora ramorum* Werres *et al.*, 2001 (Oomycetes, Pythiaceae) was documented on *Rhododendron* in Norway for the first time. Following subsequent finds on *Quercus* L. and *Vaccinium myrtillus* L., *P. ramorum* has been regulated as a quarantine pest and strict regulations are now imposed on import of *Rhododendron* to Norway (Sundheim *et al.* 2009).

Finally, many of the invasive invertebrate species imported with plants could also act as a vector for pathogens, posing a more indirect threat to native biodiversity. A well-known example globally is the bacterium *Xylella fastidiosa* Wells *et al.*, 1987 (Xanthomonadaceae) that can cause different diseases in commercial important species such as *Prunus persica* (L.) Batsch, *Vitis vinifera* L., *Nerium oleander* L., *Prunus amygdalus* Stokes, *Coffea arabica* L., *Olea europaea* L., and *Citrus* L., and which has been spread from America to large parts of the world. This bacterium is vectored by different species of Cicadellidae, e.g. *Graphocephala atropunctata* (Signoret, 1854) and *Homalodisca vitripennis* (Germar, 1821) (Almeida & Nunney 2016).

This paper documents the known distribution of two alien species on *Rhododendron* in Norway. The *Rhododendron* leafhopper *Graphocephala fennahi* Young, 1977 (Hemiptera, Cicadellidae) is presented new to Norway, and additional records of *Seifertia azaleae* (Peck) Partr. & Morgan-Jones (Ascomycota, Dothideomycetes) that causes the fungal disease known as bud blast that kills flower buds of *Rhododendron* spp. are given. Their biology and recent range expansion, and the ability of *G. fennahi* to vector *S. azaleae* is reviewed.

Material and methods

During August 2017, several observations of *G. fennahi* were reported on the internet from Norway (Artsobservasjoner 2017). Because of that, several

localities were investigated by the author along the Norwegian coast from Østfold to Vestfold counties to evaluate the species distribution and to what extent it was well established. At the same time, the *Rhododendron* specimen were also investigated for the presence of bud blast caused by *S. azaleae*. An information note on these two species was distributed directly to all the members of the Norwegian *Rhododendron* Society, with an appeal to report any observations to the author, positive and negative. The same note was also presented on the website of the Norwegian Entomological Society and distributed directly to selected members.

The faunistic divisions within Norway follow Økland (1981), and are given in **bold**. The “European Invertebrate System” (EIS) follows Endrestøl (2005).

The species

Graphocephala fennahi Young, 1977

(Hemiptera, Cicadellidae)

AK, Frog: Drøbak (EIS 28, N59.66561 E10.63195) 20.VIII.2017, 1 ex, indoors gazebo, Photo: Ragne Borge Lysaker (Artsobservasjoner 2017); Oslo: Arnstein Arnebergs vei (EIS 28, N59.92666 E10.69497) 27.VIII.2017, 1♀, on *Rhododendron*, Photo: Trine Brevig (Artsobservasjoner 2017); 18–19.IX.2017, 6 ex., on *Rhododendron*, Photo: Trine Brevig; 27.IX.2017, 12 ex., on *Rhododendron*, Photo: Trine Brevig; Oslo: Blindern T-banestasjon (EIS 28, N59.93970 E10.71739) 30.VIII.2017, 1♀2♂♂, on *Rhododendron*, Leg./coll.: A. Endrestøl (NINA); 14.IX.2017, 1♂, Leg./coll.: A. Endrestøl (NINA); Oslo: Nisseberget (EIS 28, N59.91590 E10.73305) 04.IX.2017, 1♀2♂♂, on *Rhododendron*, Leg./coll.: A. Endrestøl (NINA); Oslo: Nordre gravlund (EIS 28, N59.93748 E10.74748) 08.IX.2017, 1♀, on *Rhododendron*, Leg./coll.: A. Endrestøl (NINA); Bærum: Fornebu (EIS 28, N59.90541 E10.62609) 30.VIII.2017, 2♂♂, on *Rhododendron*, Leg./coll. A.: Endrestøl (NINA). **BØ**, Drammen: Bragernes kirkegård (EIS 28, N59.74833 E10.20170) 30.VIII.2017, 14♀♀10♂♂, on *Rhododendron*, Leg./coll.: A.

Endrestøl (NINA); 09.IX.2019, several, Photo: Marit Endrestøl; 21.IX.2017, 4♀♀3♂♂ (+eggs), on *Rhododendron*, Leg./coll.: A. Endrestøl (NINA); 06.X.2017, 14♀♀7♂♂ on *Rhododendron* (+eggs) and *Calystegia sepium*, Leg./coll.: A. Endrestøl (NINA); 01.XI.2017, 1♀1♂ (+eggs), Leg./coll.: A. Endrestøl (NINA). **VE**, Nøtterøy: Teie (EIS 19, N59.25395 E10.41519) 21.IX.2017, 1♂, on *Rhododendron*, Leg./coll.: A. Endrestøl (NINA). **TEY**, Porsgrunn: Kirkebakken (EIS 18, N59.13755 E9.64890) 22.VIII.2017, 3 ex, on *Rhododendron*, Photo: Morten Angard Mjelde (Artsobservasjoner 2017); Porsgrunn: Storgata, (EIS 18, ~N59.13908 E9.65138) 30.VIII.2017, several ex, on *Rhododendron*, Obs.: Morten Angard Mjelde.

Comments. Keys and illustrations to *Graphocephala fennahi* are given in Young (1977) and Hamilton (1985). Nymphs and eggs are described by Vidano *et al.* (1987). Species in the genus *Graphocephala* are the most brightly coloured Cicadellinae of the Holarctic zone (Hamilton 1985), and *G. fennahi* is very conspicuous not confusable with any other species

in Norway, or Europe for that matter (Figure 1). Key features of *G. fennahi* are a yellow crown with a black broad band round the anterior margin between vertex and frons, scutellum dull orange, tegmina green with narrow red bands and length 7.8–9.1 mm (♂ 7.8–8.3 mm, ♀ 8.6–9.1 mm) (Young 1977, Hamilton 1985).

Graphocephala fennahi is a Nearctic hopper native to the mountains of southern Virginia, western Carolinas and northern Georgia, and was apparently introduced to New York, Pennsylvania on ornamental *Rhododendron* in the 1920s (Hamilton 1985). Young (1977) reports the species from Oregon and expect the species to have been introduced there. According to Hamilton (1985), the species was found in Oklahoma in 1962 and in Canada, Victoria, B.C., in 1941. It was introduced from the Nearctic to Europe in the 1920s, probably with ornamental *Rhododendron* species. It was first reported from Europe in the UK on *Rhododendron* in 1933 (China 1935, Wilson 1937). According to Street (1950), the first observation of the species in the UK was from Windlesham, as early as 1928. It was listed



FIGURE 1. The Rhododendron leafhopper *Graphocephala fennahi* Young, 1977. The species is very conspicuous with a yellow crown, dull orange scutellum and tegmina green with narrow red bands. Photo: A. Endrestøl.

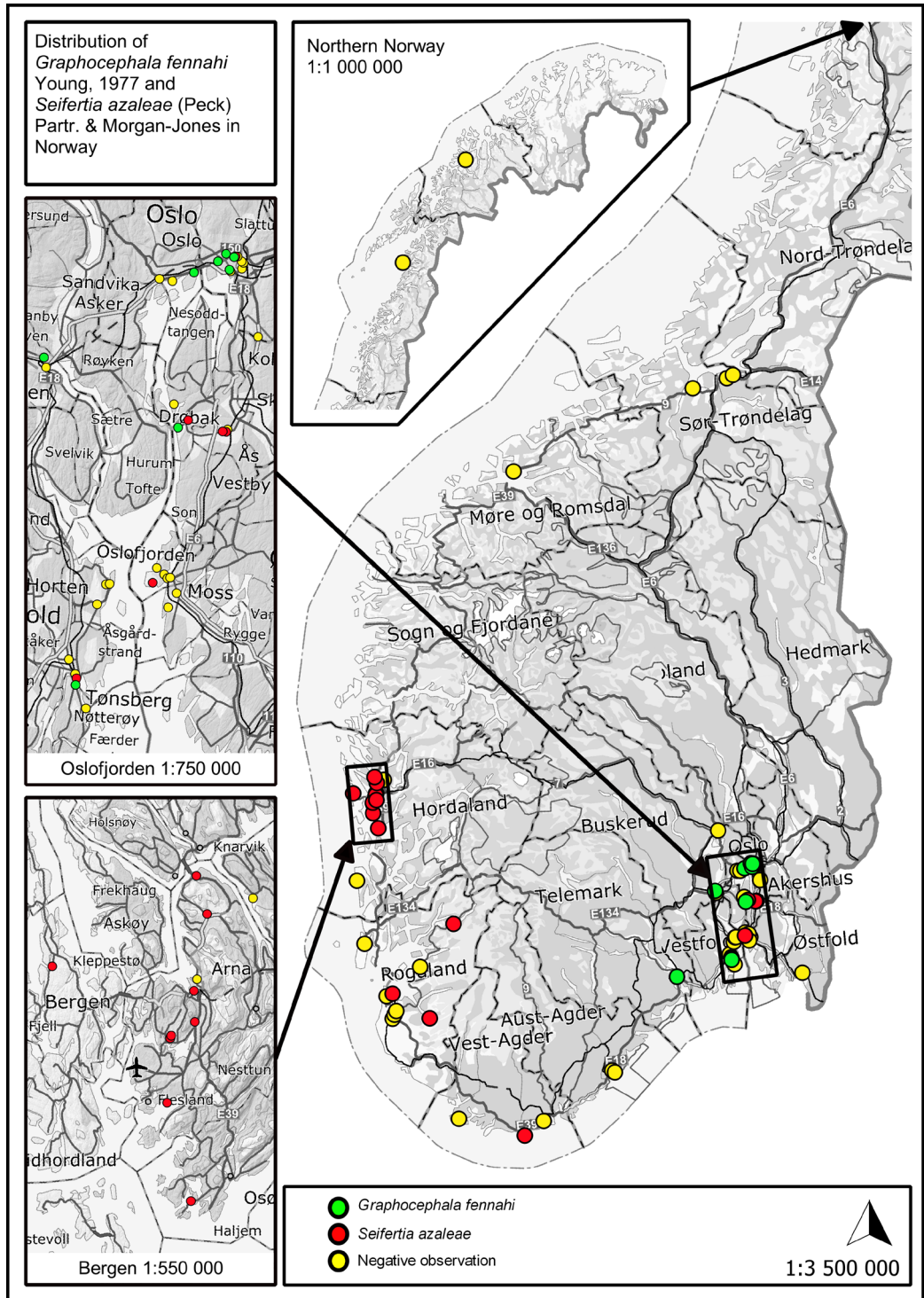


FIGURE 2. Localities investigated for the presence of *Graphocephala fennahi* Young, 1977 and *Seifertia azaleae* (Peck) Partr. & Morgan-Jones in Norway in 2017. A total of 75 localities are included.

from UK and the Netherlands as *Graphocephala coccinea* (Forster, 1771) in Metcalf (1965). The listing from the Netherlands was erroneously based on Reclaire (1944), and this error is repeated in some later publications (e.g. Hamilton 1985, Vidano *et al.* 1987, Papp *et al.* 2012). The species was only listed from the UK in the Palaearctic catalogue compiled by Nast (1972), correctly omitting the Dutch record, but missing Günthart (1971), who published the species new to Switzerland in 1971. It was published from France and Ireland in 1974 (Aguilar & Della Giustina 1974, Cross 1974), from the Netherlands in 1976 (Gravesteyn 1976) and from Belgium in 1977 (Synave 1977). Young (1977) revealed that *G. coccinea* was a complex of species, and described a new species, *Graphocephala fennahi*. The two species differ slightly in color of the forewings and male genitalia as well as in host plant preferences (see Hamilton 1985). All *Graphocephala* specimen found in Europe so far belongs to *G. fennahi*. *G. fennahi* was further found in Italy in 1983 (Vidano *et al.* 1987). It was first mentioned from Germany by Gessner (1984), but according to Nickel (2003), the first observation of the species in Germany is from 1978. In the “The Auchenorrhyncha (Homoptera) of Europe” by Nast (1987), the species is listed from the UK, the Netherlands, France, and Switzerland, missing the Belgian and German records. It was published new to Denmark and Austria 1987 (Sergel 1987b) and from Poland in 1996 (Łabanowski & Soika 1997). In 2001, it was found in Greece (Whitehead 2005). It was reported from the Czech Republic in 2004 by Špryňar (2005) and from Slovenia in 2005 by Seljak (2013). It was published new to Sweden by Gillerfors (2008) and Söderman *et al.* (2009) lists the species only from Sweden and Denmark from Northern Europe. The species was finally published from Latvia and Hungary in 2016 (Piterāns 2016, Papp *et al.* 2016). The Norwegian records presented here are probably the northernmost globally (Figure 2).

G. fennahi is univoltine and the eggs are laid separately under the epidermis of perulae of *Rhododendron* flower buds from the first days of September to the end of October (Morcos 1953, Vidano *et al.* 1987, della Giustina 1989), and the

eggs overwinters (Aguilar & della Giustina 1974, Arzone *et al.* 1987, Vidano *et al.* 1987). The eggs are about 1.8–2.0 mm long, 0.7 mm width, oval/piriform, yellow and often deposited in fan-shaped groups (Baillie & Jepson 1951, Morcos 1953, della Giustina 1989) (Figure 3ab). According to Vidano *et al.* (1987), one female of *G. fennahi* could lay 32 eggs, and they reported egg numbers from buds ranging from 1–42. From one of the localities reported here (Bragernes kirkegård), egg counts were done on 20 flower buds collected randomly. An average number of 25 eggs per bud were found ranging from 7–39. Combining Baillie & Jepson (1951) and Ferracini *et al.* (2003) gives an average number of 55.7 eggs per bud ranging from 1–235. Ferracini *et al.* (2003) report a maximum number of eggs per flower bud as high as 327! The maximum number of eggs on a flower bud reported by Baillie & Jepson (1951) was 60. The first instars emerge in primo May, just before the flowering of the *Rhododendron* (Morcos 1953, Ulenberg & van Frankenhuyzen 1986, della Giustina 1989). The nymphs feed on the young leaves and buds during the spring and summer and there are five instar stadiums, which periods of occurrence are overlapping one another (Ulenberg & van Frankenhuyzen 1986, della Giustina 1989). The adults emerge in mid-July–August (end of June to mid-July according to Vidano *et al.* 1987) and can be found until November–December (Baillie & Jepson 1951, Morcos 1953, Ulenberg & van Frankenhuyzen 1986). Even at latitude 59.75, adults can be found in November, as reported here. The adults prefer to feed on the upper surface of the leaves and often insert the stylets into the middle vein (Arzone *et al.* 1987, Vidano *et al.* 1987, pers. obs.) (Figure 4).

According to Nickel (2003), *G. fennahi* lives in parks, cemeteries and gardens on ornamental species of *Rhododendron*. This is in accordance with several authors (e.g. Ferracini *et al.* 2003, Holzinger 2005). In the Nearctic, this species feeds exclusively on *Rhododendron* spp. (Hamilton 1985), but in Europe it has been observed on a broad spectrum of plants (Sergel 1987b). Sergel (1987a) speculated that the species had extended its host plant range in Europe, perhaps due to the founder effect. This was questioned by della



FIGURE 3. Eggs of *Graphocephala fennahi* are about 1.8–2.0 mm long, 0.7 mm width, oval/piriform, yellow and often deposited in fan-shaped groups under the epidermis of perulae of *Rhododendron* flower buds. Photo: a) A. Endrestøl, b) A. Staverløkk (NINA).



FIGURE 4. About 25 individuals of *Graphocephala fennahi* feeding on *Rhododendron*. The majority are lined up along the middle vein on the upper side of the leaves. Photo: A. Endrestøl.

Giustina (1989) and Nickel (2003) states that the nymphs most likely are monophagous on *Rhododendron* even though adult individuals might be found on other plants (as reported by e.g. Sergel 1987b, Niedringhaus & Olthoff 1986, Vidano *et al.* 1987, Whitehead 2005). Nymphal development on other plants (e.g. *Callistephus chinensis* (L.) Nees, *Castanea sativa* Mill., *Malus* Mill., *Populus* L., *Robinia pseudoacacia* L., *Tilia* L.) have been documented under controlled environments (Morcos 1953, Vidano *et al.* 1987). The evidence for an extended host plant range is so far not convincing, even though adults are found on a broad range of food plants surrounding *Rhododendron* (Vidano *et al.* 1987). To my knowledge, eggs and nymphs are so far only reported from *Rhododendron* under natural conditions.

The most extensive information regarding eggs of *G. fennahi* on different species/subspecies and hybrids/cultivars of *Rhododendron* is given in Baillie & Jepson (1951) and Ferracini *et al.* (2003). Combined they lists about 13 species/subspecies and 43 hybrids/cultivars of

Rhododendron on which eggs of *G. fennahi* are obtained (in different amounts), and the vast majority of these have Asia origin (mainly China and India). These species classify into three sections of the genus *Rhododendron* – *Pentanthera* (2), *Ponticum* (9), *Rhododendron* (2). 32 of the 43 hybrids can be allocated to seven of the 18 “groups” given in Gelderen & Hoey Smith (1992). 28 % (9) of the hybrids can be found in subgroup 2a (*R. catawbiense* Michx. and hybrids) and 28 % (9) hybrids in subgroup 4a (*R. arboreum* Sm. and hybrids) respectively. Another 10 % (3) can be found in subgroup 1a (*R. ponticum* L. and hybrids) and 10 % (3) in subgroup 8a (*R. griffithianum* Wight and hybrids). If looking at the top three average number of eggs per buds in the different groups based on Baillie & Jepson (1951) and Ferracini *et al.* (2003), most eggs per buds (213) are found in subgroup 1b (*R. caucasicum* Pall. and hybrids) based on one hybrid (‘Prince Camille de Rohan’) reported by Ferracini *et al.* (2003), followed by 96 eggs per buds in subgroup 10a (*R. campylocarpum* Hook. f. and hybrids) and 84 eggs per buds in subgroup 2a (*R. catawbiense* and hybrids).

***Seifertia azaleae* (Peck) Partridge & Morgan-Jones (Ascomycota, Dothideomycetes)**

Ø, Moss: Jeløya (EIS 19) 2005, in litt: Talgø & Stensvand (2005); Moss: Jeløya, Alby (EIS 19, N59.42409 E10.61005) 07.IX.2017, Obs.: A. Endrestøl (NINA). **AK**, Ås: NMBU (EIS 28) 2005, in litt: Talgø & Stensvand (2005); Ås: NMBU (EIS 28, N59.66739 E10.76853) 07.IX.2017, Photo: A. Endrestøl (NINA); Ås: Skogveien (EIS 28, N59.66778 E10.77925) 07.IX.2017, Photo: A. Endrestøl (NINA); Oslo: Nordre gravlund (EIS 28, N59.93748 E10.74748) 08.IX.2017, Photo: A. Endrestøl (NINA); Froggn: Drøbak, Kringerudåsen (EIS 28, N59.67871 E10.65993) 01.IX.2017, on *Rhododendron* ‘Ponticum Roseum’, Photo: Per Anker Pedersen. **BØ**, Drammen: Bragernes kirkegård (EIS 28, N59.74833 E10.20170) 30.VIII.2017, 21.IX.2017, 06.X.2017, 01.XI.2017, Photo: A. Endrestøl (NINA). **VE**, Tønsberg: Gunnarsbø (EIS 19, N59.26430 E10.41562) 21.IX.2017, Photo: A. Endrestøl (NINA). **VAY**, Mandal: «Skjærgård»

(EIS 2) 15.V.2014, Photo: Runa (Hagegal 2017). **RY**, Gjesdal: Dirdal (EIS 7, N58.81199 E6.23378) several years, Obs.: Judith Henriksen; Stavanger: Byhaugen (EIS 7, N58.97646 E5.70548) 15.IX.2017, on *Rhododendron* ‘Cunninghams White’, Obs.: Joan Cooke. **RI**, Suldal: Suldalsosen, Fisketjøn (EIS 15, N59.49348 E6.51262) 01.IX.2017, on *Rhododendron* ‘Nova Zembla’ and *R.* ‘Scintillation x Spellbinder’, Obs.: Jakob Roalkvam. **HOY**, Bergen: Hordvik (EIS 39, N60.51636 E5.28940) 17.III.2011, Photo: Harri Kivistø (Artsobservasjoner 2017); Bergen: Stokkedalen (EIS 30, N60.33070 E5.28338) 06.IX.2017, Photo: Matilde Bø; Bergen: Muséhagen (EIS 39, N60.38755 E5.32121) 15.IX.2017, on e.g. *Rhododendron* ‘Cunninghams White’, Photo: Hilde Margrethe Moen; Bergen: Fana, Hausneset (EIS 30, N60.25822 E5.29773) 20.IX.2017, on e.g. *Rhododendron catawbiense* ‘Grandiflorum’, *R.* ‘Cunninghams White’ and *R. campylocarpum* ssp. *campylocarpum*, Photo: Daniel Gaasenbeek; Bergen: Løtveitveien (EIS 30, N60.33383 E5.28486) 19.IX.2017, Photo: Tor Jan Ropeid; Bergen: Åsane gamle kirke (EIS 39, N60.47540 E5.32610) 07.X.2017, Photo: Anita Rude (Artsobservasjoner 2017); Bergen: Grønnestølen (EIS 30, N60.35303 E5.33347) 24.X.2017, Obs.: Steffen Roth; Os: Lepsøy (EIS 30, N60.15226 E5.38257) 06.IX.2017 (and yearly 15–20 years back), on *Rhododendron* ‘Cunninghams White’, *R. catawbiense*, *R. principis*, Photo: Jan Rune Hesjedal; Fjell: Ågotnes (EIS 39, N60.39165 E4.99390) several years, on *Rhododendron degrobianum* ssp. *yakushmanum* ‘Fantastica’, *R. degrobianum* ssp. *degrobianum* and *R. brachycarpum*, Obs.: Harald Kårtveit.

Comments. *Seifertia azaleae* is a necrotic fungus causing bud blast and twig blight on *Rhododendron*. There are several different fungi that can attack buds on *Rhododendron* (see Żoźna *et al.* 2013, Pastirčák *et al.* 2014), but *Seifertia azaleae* can be identified by each synnemata containing a robust, dark brown stipe, up to 0.5–2.5 mm long and nearly 200–500 µm in diameter, terminated by a spherical or ovoid, powdery head (Viennot-Bourgin 1981, Kaneko *et al.* 1988) (Figure 5–6). *S. azaleae* has pale brown



FIGURE 5. *Seifertia azaleae* (Peck) Partr. & Morgan-Jones on a *Rhododendron* flower bud. Photo: A. Endrestøl.



FIGURE 6. *Seifertia azaleae* with each synnemata containing a robust, dark brown stipe, up to 0.5–2.5 mm long and nearly 200–500 μm in diameter, terminated by a spherical or ovoid, powdery head. Photo: A. Endrestøl.

or olive-brown, very rarely septate conidia (Li *et al.* 2016). Li *et al.* (2016) recently described a new species, *Seifertia shangrilaensis* Li *et al.*, 2016, isolated from *Rhododendron decorum* in Yunnan Province, Southwest China. *S. shangrilaensis* can be separated from *S. azaleae* in having hyaline to subhyaline and smaller conidia (Li *et al.* 2016). It is not very likely that this new species appears in Norway and no attempts have been made to separate between these two. All observations of *Seifertia* reported here are treated as *S. azaleae*.

S. azaleae was described in 1873 from New Scotland in New York from *Rhododendron* (*Pentanthera*) *periclymenoides* as *Periconia azaleae* Peck, 1873. In 1914, another species was described from Europe as *Antromycopsis alpina* Höhnelt, 1914 based on material collected on *Rhododendron ferrugineum* from Rax in the Lower Austria (Höhnelt 1914). Later, Moore (1984) argue that *A. alpina* was no *Antromycopsis*, but possibly belonging to *Graphium*. According to Stalpers *et al.* (1991), *Antromycopsis alpina* is a taxonomic synonym of *Seifertia azaleae*, based on their examination of the holotype. *A. alpina* is still referred to in some publications (e.g. Pradhan 2015). Seifert *et al.* (2007) attempts to resolve the taxonomic and nomenclatural confusion surrounding *S. azaleae*, and even though they could not establish the phylogenetic affinities of *S. azaleae* with certainty, they concluded that it seems as *S. azaleae* is allied with the Dothideomycetes and that a “continued recognition of the monotypic genus *Seifertia* seems justified”. One should not rule out the possibility that *S. azaleae* also could be a complex of species that could be distinguished by genealogical concordance (K. Seifert pers. com). Synonyms of *Seifertia azaleae* includes *Periconia azaleae* Peck, 1873, *Sporocybe azaleae* (Peck) Sacc., 1886, *Briosia azaleae* (Peck) Dearn., 1941 and *Pycnostysanus azaleae* (Peck) E.W. Mason, 1941 (Farr & Rossman 2017).

S. azaleae was first observed in Europe in the UK in 1926 (Howell & Wood 1962), disregarding the description of *Antromycopsis alpina* Höhnelt, 1914 (see discussion). It was later reported from e.g. France in 1979 (Viennot-Bourgin 1981), the Netherlands and Switzerland in 1982 (Ulenberg *et al.* 1983, Beenken 2016), Germany in 1983

(Gessner 1984), Italy in 2001 (Garibaldi *et al.* 2001, 2002) and Slovakia in 2014 (Pastirčák *et al.* 2014). It was found in Sweden on at least three occasions in 2015 and later in 2016 (Svensson 2016, Åkesson 2016, Artportalen 2017), which probably represented the first observations of the species in Sweden. It is also found in the United States, Canada, Panama, Russia, Australia, New Zealand, Japan and China (Farr & Rossman 2017). *S. azaleae* was first reported from Norway by Talgø & Stensvand (2005) from Moss and Ås municipalities. The species has been observed in some other localities, e.g. from Jæren, but no exact records exists (Talgø *et al.* 2008, V. Talgø pers. com.). The current known distribution of *S. azaleae* in Norway is given in Figure 2.

Viennot-Bourgin (1981) studied the development of *Seifertia azaleae* and bud blast disease throughout the season. The buds will go through different stages as the fungus develops, resulting in browning and mummification of the buds during the summer. Terminal flower buds are infected mainly in July-August, after which leaf buds and twigs are attacked (Pirone 1978). Pedicels can also be infected (Figure 7). The fructifications of *S. azaleae* appear during the late summer or the following spring. Under controlled experiments, Kaneko *et al.* (1988) observed necrotic lesions on buds and leaves 10 days after inoculation and synnemata bearing conidia on buds 31 days after inoculation. The destroyed flower buds persist on the shoot for several years (up till five years reported by Glawe & Hummel 2006). *S. azaleae* is mainly spread by wind and rain or pollinating insects (e.g. bees (Hymenoptera), Pirone 1978), but could possibly also be vectored by *G. fennahi* (see discussion).

S. azaleae was described from *Rhododendron* (*Pentanthera*) *periclymenoides* (Peck 1873). It is registered from at least 26 (28) species (subspecies) and at least 104 hybrids/cultivars of *Rhododendron* (see Peck 1873, Baillie & Jepson 1951, Viennot-Bourgin 1981, Kaneko *et al.* 1988, Farr *et al.* 1996, Garibaldi *et al.* 2001, Ferracini *et al.* 2003, Glawe & Hummel 2006, Ehsen 2012, Pastirčák *et al.* 2014, Farr & Rossman 2017, this paper). The only deviant taxon is *Leucopogon costatus* reported by Cook & Dubè (1989). The



FIGURE 7. *Seifertia azaleae* on a pedicel of *Rhododendron*. Photo: A. Endrestøl.

majority of the *Rhododendron* species (15) have Asian origin (mainly China, Japan, Burma and India), while nine are of Nearctic origin. Most of the species (15) are found in the Ponticum section. This given section of *Rhododendron* would refer to the Ponticum Series according to the Balfour System or Subsection Pontica according to the Cullen-Chamberlain System (Gelderen & Hoey Smith 1992). 69 of the 104 hybrids can be allocated to 12 of the 18 “groups” given in Gelderen & Hoey Smith (1992). 40 % of those (28) are in subgroup 2a (*R. catawbiense* and hybrids), 16 % (11) are in subgroup 1a (*R. ponticum* and hybrids), and 14 % (10) in subgroup 4a (*R. arboreum* and hybrids). If scoring the sensibility to *S. azaleae* relatively from 1–3 (low – high occurrence) based on the papers cited above, 19 of the hybrids are reported with a high occurrence, eight in subgroup 2a and five in subgroup 4a.

Discussion

The expansion of *Graphocephala fennahi* through

Europe is the result of a combined anemochore and anthropochore dispersal. According to Söderman *et al.* (2009) the expansion route to Northern Europe for *G. fennahi* goes from northwestern Germany over the Danish islands to the eastern coast of Kattegat. Since its appearance in Denmark in 1987, it has spread to several regions there (Sergel 1987b, Endrestøl 2013a). In Sweden, the first observation was done on the southwestern coast in 2007, and in 2009–2010 the species was found in Skåne, close to the Danish border, Göteborg and Stockholm (Gillerfors 2008, Artportalen 2017). The species is p.t. found along the Swedish coast from Göteborg to Stockholm, including the islands Öland and Gotland and a few inland localities (Växjö, Karlstad, Motala and Västerås) (Artportalen 2017). The species can spread several hundred meters by flight (della Giustina 1989), but it is likely that the factor contributing the most to the expansion is the anthropochore dispersal facilitated with *Rhododendron*-trade across countries, e.g. as seen in Switzerland and Ireland (Günthart 1971, Cross 1974). Whitehead (2005) argued for an anemochore dispersal (air-current-assisted stray) from northern Italy to Greece, in favor over anthropochore dispersal.

According to Vidano *et al.* (1987) the species could have been overlooked for some years in Italy due to factors as inconspicuous eggs, nymphs feeding on the dorsal side of the leaves, adults with a certain degree of camouflage, little phytopathological signs on the hostplant, and low attention to the hostplant by entomologists. It is not likely that the species have been overlooked for very many years in Norway. It was expected and has sporadically been searched for on *Rhododendron* in Norway, both on newly imported plants and established specimen in the project “Dispersal of alien species through plant import to Norway” (Westergaard *et al.* 2015, Endrestøl *et al.* 2016a, Bruteig *et al.* 2017). Since the adult stage of this species also has a striking appearance, it would have been documented relatively fast by people on different internet forums, as happened in August 2017. Still, it is likely that this species has been established for some years on a few localities in Norway, but that

it has gone unnoticed so far, possibly due to small populations sizes or that it has been established on localities where there are few entomologists searching, e.g. cemeteries. It is very likely that this species is unintentionally imported to Norway with *Rhododendron*. Most of the plant import to Norway happens in April–Mai (Endrestøl *et al.* 2016a), probably just before the eggs hatch, and it can thus enter unnoticed. One of the localities investigated in Norway, where a few individuals of *G. fennahi* were found, was also recently planted with *Rhododendron* (in 2015–2016) (Figure 8).

Vidano *et al.* (1987) found the populations size of *G. fennahi* to be limited, and explained that by e.g. univoltinism, moderate fertility and the presence of general predators. From the material reported here, only one of the localities seems to have a large population (Bragernes kirkegård), numbering thousands. In many of the other localities in Norway only single, or just a few, individuals were found. The reason for this is not clear. Some of the localities could just recently have been occupied. Another factor that might boost the population with increase egg-laying and longevity is the presence of another food-source close to the *Rhododendron* in the autumn that might have more accessible nutrients at that time. In this study, a food plant shift from *Rhododendron* to *Calystegia sepium* (L.) R.Br. in September and October was observed on the locality with the highest population size (Figure 9). There, the species persisted until November, when all the *Calystegia sepium* was withered. No specimen where observed feeding in November and only two specimens could be found with intensive sweep-netting.

There have been much controversy and confusion regarding the taxon *Seifertia azaleae*, and there still are. Some consider the species to be Nearctic and introduced to Europe (e.g. Laister 2008, Beenken 2016). Drake (2009) lists the species as alien to Europe. Other states that it is of Palearctic origin (van Frankenhuyzen & van Kesteren 1983, Ulenberg & van Frankenhuyzen 1986, Diedrich 2002) and introduced from Europe to America. This could to some extent be traced back to the original descriptions of the taxa *Periconia azaleae* Peck, 1873 from USA and

Antromycopsis alpina Höhnelt, 1914 from Austria. From the 1980s and forward, some authors questioned whether these two taxa were in fact the same one or not (Moore 1984) and Stalpers *et al.* (1991) synonymized them. Seifert *et al.* (2017) later characterized *S. azaleae* as cosmopolitan. The question is why few, if none, have reported *S. azaleae* (or *Antromycopsis alpina*) from the alps between 1914 and the 1980s if they are the same species, i.e. a serious pest on *Rhododendron* in gardens that would have been noticed? Van Frankenhuyzen & van Kesteren (1983) argued that *Antromycopsis alpina* was a saprotrophic fungus until the introduction of the *Rhododendron* leafhopper *G. fennahi*, when it turned necrotrophic causing bud blast, vectored (inoculated) by the hopper. This can though not be the explanation, as bud blast thrive well without the hopper. Interestingly, Beenken (2016) reported a fungus very similar to *S. azaleae* from *Rhododendron ferrugineum* in Switzerland and initially expected this to be *S. azaleae* until barcode sequencing (ITS) revealed that this had to be a separate taxon not further evaluated. One could speculate if this was in fact *A. alpina* Höhnelt, 1914 described from Austria on the same hostplant hundred years earlier, and that *A. alpina* should be treated as a valid species and not a synonym to *S. azaleae*, as proposed by Stalpers *et al.* (1991). This might explain the lack of observation of *A. alpina*, as it is apparently rare and difficult to find (L. Beenken pers. com.).

If *A. alpina* is a valid species confined to the Alps on *R. ferrugineum*, then it could be hypothesized that *S. azaleae* is of Nearctic origin and that it has been introduced into Europe with *Rhododendron*. *S. azaleae* apparently has expanded its range in Europe in the recent decades, somewhat similar to that of *G. fennahi* with the first European observations of both being from the UK in the 1920s and from continental Europe in the 1970s with a subsequent range expansion.

S. azaleae had probably already been established in Norway for a decade or more when its presence was commented on by Talgø & Stensvand (2005). Some of the informants contributing to this paper have stated that they have had the fungus for 15–20 years.



FIGURE 8. A modern habitat of *Graphocephala fennahi* in Bærum municipality. The locality had newly planted (2015–2016) *Rhododendron* and a small population of *G. fennahi*, probably introduced there with the plants. Photo: A. Endrestøl.

Collectors and gardeners of *Rhododendron* might have had it in private gardens for years, unavailable for researchers. The same would probably apply to Sweden, where its presence was first commented as late as 2016 (Svensson 2016), and where it so far only is reported from a few localities around Helsingborg and Göteborg (Artportalen 2017). The species has a large distribution range in Norway along the coast from Østfold to Hordaland counties, but the infected *Rhododendron* specimens are rather scattered. In groups of *Rhododendron*, only one or a few specimens/cultivars might be affected as reported by several authors (e.g. Garibaldi *et al.* 2001) and as seen on the localities Ås and Bragernes kirkegård reported here. The latter is a cemetery of about 4,5 ha with many *Rhododendron* specimens scattered around. A superficial survey revealed that eggs of the hopper were present on most of the *Rhododendron* specimens around the cemetery while bud blast only was found on the one corner of the cemetery, with two single blasted buds on two specimens being the exception. This locality



FIGURE 9. A food plant shift by *Graphocephala fennahi* from *Rhododendron* to *Calystegia sepium* was observed on a locality in Norway during the autumn 2017. On the photo, about 20 individuals can be seen on leaves of *Calystegia sepium* and none on the surrounding *Rhododendron* leaves. Photo: A. Endrestøl.

is also the only one listed in this paper where *G. fennahi* and *S. azaleae* coexists in Norway so far. The appearance of *G. fennahi* does therefore not necessarily result in the occurrence of the fungus, which is in accordance with several authors (e.g. Street 1950, Rose & Zunke 1998).

Street (1950) was probably the first to suggest that *G. fennahi* could be a vector for *S. azaleae*. This issue was studied further by Baillie & Jepson (1951) who claimed to have shown a significant association of bud blast with *G. fennahi*. Howell & Wood (1962) used field experiments to study the infection frequency on enclosed buds, and found that the number of diseased buds increased substantially when the bags enclosing the buds also contained *G. fennahi*. They also investigated tissue around eggs on buds and found *S. azaleae* in the majority of them. Viennot-Bourgin (1981) found a striking correspondence in geographic range of the two species in France, shortly after they were first discovered there. Also, if one compares the year of the first observations of these two species in several European countries (e.g. UK, France, Germany, the Netherlands, Sweden) they tend to appear only about five years apart on average, with the fungus following the hopper. Viennot-Bourgin (1981) demonstrated that nymphs of the hopper could carry spores of *S. azaleae*. Rose and Zunke (1998) found a correlation between number of deposited eggs and the amount of bud blast the year after. Still, Hommes *et al.* (2003) stated that “clear scientific studies [on this association] are however not available”. They investigated the occurrence of *G. fennahi* and *S. azaleae*, but could not show a statistical link between *G. fennahi* infestation and bud blast disease (Hommes *et al.* 2003). One reason for this given by Hommes *et al.* (2003) could be different preferences regarding *Rhododendron*. They found *S. azaleae* mainly on *R. catawbiense* hybrids, with American varieties affected in a more extreme manner than German varieties (Hommes *et al.* 2003). They also found more bud blast on *Rhododendron* specimen on waterlogged soils (Hommes *et al.* 2003). In contrast, *G. fennahi* preferred the Pontica Series rhododendrons and rhododendrons cross bred with *R. catawbiense* hybrids, showing no differences in origin and preferring specimen

locations ‘solitary/sunny’ and ‘compact/half shade’ (Hommes *et al.* 2003). Finally, Ferracini *et al.* 2003 tested the association between *G. fennahi* and *S. azaleae*, including different characteristics of *Rhododendron* spp. They found no difference in number of eggs and budsize, which might contradict Baillie & Jepson (1951) who reported a preference for medium sized buds. Ferracini *et al.* (2003) found a positive correlation between mean number of egg and mean number of *S. azaleae* colonies per flower bud. Ferracini *et al.* (2003) concluded through their work that nymphs and adults (especially males) of *G. fennahi* can transport the spores of *S. azaleae*, and that the females through ovipositioning can inoculate the spores and thus vector *S. azaleae*. Rose & Zunke (1998) pointed out that this association would only be positive for the fungus, as eggs deposited on inoculated buds would die. Little is known of the possible role of other insects in spreading *S. azaleae* (e.g. bees as mentioned by Pirone 1978 or the moth *Earias roseifera* Butler, 1881 mentioned by Kaneko *et al.* 1988).

The presence of *G. fennahi* does not seem to cause any damage or necrosis on the leaves of *Rhododendron* (Aguilar & della Giustina 1974, Arzone *et al.* 1987, Vidano *et al.* 1987), even though some necrosis occurs on the flower buds due to ovipositioning (Vidano *et al.* 1987). Even in high numbers, *G. fennahi* would not affect the buds so much that it would compromise blooming (Ferracini *et al.* 2003). Morcos (1953) reported on some visual damage on a heavily infested *Rhododendron*.

The bud blast disease caused by *S. azalea* can be more severe for blooming and growth. Both flower buds and leaf buds can be affected, and also leaves, twigs and pedicels. Leaf buds are affected to a lesser extent, but in a bad attack they may suffer a severe percentage of loss (Baillie & Jepson 1951). Viennot-Bourgin (1981) found that 7–20 % of the flower buds had mummified, leaving them brown to black, hard, with a dry rot inside. Kaneko *et al.* (1988) reported that as much as 90 % of the flower buds could be damaged on *Rhododendron molle* ssp. *japonicum*. Vidano *et al.* (1987) also reported bud-damage as high as 90 %. Garibaldi *et al.* (2001) tested 48 different

cultivars and found that on four of the cultivars, more than 50 % of the buds were affected. None of the Norwegian localities investigated by the author seems to be more than 10 % affected by bud blast. The impression of Street (1950) was that the older hybrids are affected the most, and possibly those with “a strong *arboreum* blood”. According to Baillie & Jepson (1951) there are notable differences in sensitivity between species, but also between hybrids. This was investigated further by Ehsen (2012), who tested 47 hybrids for their sensitivity to *S. azaleae*. Ehsen (2012) concluded that the most sensitive hybrids had “*catawbiense*-blood” (even though that was true for some of the least affected hybrids too). About 40 % of the 104 *Rhododendron* hybrids from were *S. azaleae* is reported, have “*catawbiense*-blood” to some extent as reviewed here. Some hybrids apparently resistant to *S. azaleae* are given in Westhoff (2007), and of those who are treated in Gelderen & Hoey Smith (1992) will the majority of these be categorized in groups 11–16.

There are several problems in reviewing information on host preference or sensitivity. On the one hand the genus *Rhododendron* is very complex and consist of about 1000 species, with thousands of hybrids. On the other hand, only some researchers have reported the *Rhododendron* species or hybrid when reporting finds of *S. azaleae* and *G. fennahi*. *G. fennahi* is reported from 13 species of *Rhododendron*, while *S. azaleae* is reported from 26. These are relatively low numbers and certainly not exhaustive. It is even more difficult to conclude on host preference or sensitivity of cultivars and hybrids as many of them have uncertain origin (Caser *et al.* 2010). Listing them in hybrid-groups according to Gelderen & Hoey Smith (1992) could still give valuable insight on occurrence relative to parentage. As reviewed here, about 60 % of all the reports of both *G. fennahi* and *S. azaleae* are from either hybrids of *R. catawbiense*, *R. ponticum* or *R. arboreum*. Interestingly, their origin is American, European and Asian respectively (Gelderen & Hoey Smith 1992). Further investigations using molecular markers can provide insight in the genetic variabilities of these cultivars, and results so far confirm that only a few parental species

were employed in the breeding programs in the last centuries (Caser *et al.* 2010). The environmental factors where the *Rhododendron* is growing will probably also affect the sensibility of the species/cultivar in question (e.g. Hommes *et al.* 2003).

Concluding remarks. Both *G. fennahi* and *S. azaleae* are well established in Norway. *S. azaleae* has probably been established for a couple of decades and are now found scattered around the Norwegian coast from Østfold to Hordaland counties. *G. fennahi* has probably been detected early in its establishment and expansion in Norway, but has in one year (2017) already been found in five counties along the coast from Akershus to Telemark counties. Both species will probably continue to spread, and along with a further invasion of *G. fennahi* we can expect to see an increased rate of bud blast on *Rhododendron* spp. as a result of *G. fennahi* vectoring *S. azaleae*.

Acknowledgements. I want to thank the three observant persons who first documented *G. fennahi* from Norway, Ragne Borge Lysaker, Morten Angard Mjelde and Trine Brevig for providing me additional information on their finds. I also want to thank the editor of “Lapprosen” Tor Jan Ropeid for helping me distribute information on the species to the Norwegian Rhododendron Society, the web editor Hallvard Elven for posting my note on the homepage to the Norwegian Entomological Society, and Steffen Roth for distributing the information amongst entomologist and others in the Bergen area. A special thanks to all who responded with information! Thanks to Arnstein Staverløkk for taking photos of the eggs. Many thanks to the following researcher contributing with information to this paper: Keith A. Seifert (Ottawa Research and Development Centre, Ontario, Canada), Ludwig Beenken (Eidg. Forschungsanstalt für Wald, Schnee und Landschaft, Birmensdorf, Switzerland), Martin Pastirčák (Research Institute of Plant Production, Piešťany, Slovakia) and Venche Talgø (Norwegian Institute of Bioeconomy Research, Ås, Norway).

References

- Åkesson, I. 2016. Svamp som sprids med stritar orsakar knoppdöd på rhododendron. *Movium Direkt* 3, 2016, 11–13.
- Almeida, R.P.P. & Nunney, L. 2016. Emerging insect-transmitted plant diseases: the bacterium *Xylella fastidiosa* as a case study. National Academies of Sciences, Engineering, and Medicine. Global Health

- Impacts of Vector-Borne Diseases: Workshop Summary. Washington (DC): National Academies Press (US); 2016 Sep 21. A1, 91–106.
- Artportalen 2017. *Rapportssystem för växter, djur och svampar*. ArtDatabanken, Sveriges lantbruksuniversitet. Available from: www.artportalen.se (21.11.2017).
- Artsobservasjoner 2017. *Artsobservasjoner - Rapportssystem for arter*. Artsdatabanken, Trondheim. Available from: www.artsobservasjoner.no (30.10.2017).
- Aguilar, J. d' & della Giustina W. 1974. Sur la présence en France de *Graphocephala coccinea* (Hom. cicadellidae). *Annales de la Société entomologique de France* (N.S.) 10, 747–749.
- Arzone, A., Vidano, C. & Alma, A. 1987. Auchenorrhyncha introduced into Europe from the Nearctic region: Taxonomic and phytopathological problems. In: Wilson MR, Nault LR, editors. Proceedings of the 2nd International Workshop on Leafhoppers and Planthoppers of Economic Importance; 1986 Jul 28–Aug 1; Provo, UT, USA. London: CIE. Pp. 3–17.
- Baillie, A.F.H. & Jepson, W.F. 1951. Bud blast disease of the rhododendron in its relation to the leaf hopper *Graphocephala coccinea* Forst. *Journal of the Royal Horticultural Society of London* 76, 355–365.
- Bruteig, I.E., Endrestøl, A., Westergaard, K.B., Hanssen, O., Often, A., Åström, J., Fosøy, F., Dahle, S., Staverløkk, A., Stabbetorp, O. & Ødegaard, F. 2017. Fremmede arter ved planteimport – Kartlegging og overvåking 2014–2016. *NINA Rapport* 1329. 221 pp.
- Caser, M., Akkak, A. & Scariot, V. 2010. Are rhododendron hybrids distinguishable on the basis of morphology and microsatellite polymorphism? *Scientia Horticulturae* 125 (3), 469–476.
- China, W.E. 1935. A North American Jassid (Homoptera) in Surrey. *The Entomologist's Monthly Magazine* 71, 277–279.
- Cook, R.P. & Dubé, A.J. 1989. *Host-pathogen index of plant diseases in South Australia*. South Australian Department of Agriculture. 142 pp. In: Farr, D.F. & Rossman, A.Y. 2017. *Fungal Databases, U.S. National Fungus Collections, ARS, USDA*. Available from <https://nt.ars-grin.gov/fungaldatabases/> (26.09.2017).
- Cross, J.R. 1974. *Graphocephala coccinea* (Foster) (Hemiptera, Cicadellidae) a bug new to Ireland. *Irish Naturalists' Journal* 18 (1), 20.
- DAISIE 2017. *European Invasive Alien Species Gateway*. Available from: <http://www.europe-aliens.org/> (12.11.2017).
- della Giustina, W. 1989. Homoptères Cicadellidae. III. Compléments aux ouvrages d'Henri Ribaut. *Faune de France*. Paris: Lechevalier. 73, 350 pp.
- Desprez-Loustau, M.-L. 2009. *Alien Fungi of Europe*. In: Drake, J.A. (Ed.) 2009. DAISIE, Handbook of Alien Species in Europe, Springer. Pp. 15–28.
- Diederich, F. 2002. Neue Untersuchungen zum Knospensterben. *Rhododendron und immergrüne Laubgehölze Jahrbuch* 2002, 43–60.
- Drake, J.A. (Ed.) 2009. *List of Species Alien in Europe and to Europe*. DAISIE, Handbook of Alien Species in Europe, Springer. 139 pp.
- Ehsen, B. 2012. Current evaluation of bud blast resistance in large-flowered rhododendron hybrids. *Rhododendron und Immergrüne* 13, 49–53.
- Endrestøl, A. 2005. Ny versjon av EIS-systemet for Norge. *Fauna, Oslo* 58 (3), 92–97.
- Endrestøl, A. 2008. Hoppers on Black Poplars – The Auchenorrhyncha fauna on *Populus nigra* in Norway. *Norwegian Journal of Entomology* 55, 137–148.
- Endrestøl, A. 2013a. The Auchenorrhyncha of Denmark (Hemiptera: Fulgoromorpha and Cicadomorpha). *Annales de la Société entomologique de France* 49 (2), 181–204.
- Endrestøl, A. 2013b. Contribution to the Icelandic fauna of Auchenorrhyncha (Hemiptera, Fulgoromorpha & Cicadomorpha). *Norwegian Journal of Entomology* 60, 95–107.
- Endrestøl, A., Hanssen, O., Often, A., Stabbetorp, O., Staverløkk, A., Westergaard, K.B., Ødegaard, F. & Gjershaug, J.O. 2016a. Spredning av fremmede arter med planteimport til Norge II – jakten fortsetter. – *NINA Rapport*. 1256. 115 pp.
- Endrestøl, A., Olsen, K.M. & Gustad, J.R. 2016b. Two introduced species of Typhlocybinae (Hemiptera, Cicadellidae) new to Norway. *Norwegian Journal of Entomology* 63, 175–183.
- Farr, D.F., Bartolome Esteban, H. & Palm, M.E. 1996. *Fungi on Rhododendron: A World Reference*. Boone, NC: Parkway Publishers. 192 pp.
- Farr, D.F. & Rossman, A.Y. 2017. *Fungal Databases, U.S. National Fungus Collections, ARS, USDA*. Available from <https://nt.ars-grin.gov/fungaldatabases/> (26.09.2017)
- Ferracini, C., Gilardi, G. & Alma, A. 2003. Role of *Graphocephala fennahi* Young (Homoptera Cicadellidae) in favouring the diffusion of the fungus *Pycnostysanus azaleae* (Peck) Mason on ornamental rhododendron. *Redia* LXXXVI, 53–58.
- Frankenhuyzen, A. van & Kesteren, H.A. van 1984. Knopsterfte bij Rhododendron. *Jaarboek*

- Plantenziektenkundige Dienst 1983, 91–94.
- Garibaldi, A., Gilardi, G., Remotti, D., Bertetti, D. & Gullino, M.L. 2001. *Pycnostysanus azaleae*: presenza in Italia e sensibilità di diverse cultivar di rododendro. *Informatore fitopatologico* 11, 74–76.
- Garibaldi, A., Gilardi, G., Bertetti, D. & Gullino, M.L. 2002. First report of *Pycnostysanus azaleae* on *Rhododendron* in Italy. *The American Phytopathological Society* 86 (5), 560.
- Gelderens, D.M. van & Hoey Smith, J.R.P. van 1992. *Rhododendron portraits*. Timber Press, Inc. Portland, Oregon. 424 pp.
- Gessner, E. 1984. *Pycnostysanus azaleae* (Peck.) Mason (Hyphomycetes), ein Schadpilz an *Rhododendron*. *Nachrichtenblatt des Deutschen Pflanzenschutzdienstes* 36, 119–120.
- Gillerfors, G. 2008. Fjärde bidraget till stritarnas förekomst i Sverige. Sex nya arter för landet, nya landskapsfynd samt fynd av mera ovanliga arter. *Entomologisk Tidskrift* 129 (1), 69–74.
- Glawe, D.A. & Hummel, R.L. 2006. New North American host records for *Seifertia azaleae*. *Pacific Northwest Fungi* 1 (5), 1–6.
- Gravestijn, W.H. 1976. Naamlijst van de in Nederland voorkomende Cicaden (Homoptera, Auchenorrhyncha). *Entomologische Berichten (Amsterdam)* 36, 51–57.
- Günthart, H. 1971. La cicadelle du *Rhododendron* (*Graphocephala coccinea*) pour la première fois en Suisse. *Revue Horticole Suisse* 44 (12), 358–359.
- Hagegal 2017. *Hagegal – Skravleforum for hageGale*. Available from: <http://forum.hagegal.no/index.php> (10.10.2017).
- Hamilton, K.G.A. 1983. Introduced and native leafhoppers common to the Old and new Worlds (Rhynchotha: Homoptera: Cicadellidae). *The Canadian Entomologist* 115 (5), 473–511.
- Hamilton, K.G.A. 1985. The *Graphocephala coccinea* complex in North America (Homoptera, Auchenorrhyncha, Cicadellidae). *Entomologische Abhandlungen Staatliches Museum für Tierkunde Dresden* 49 (6), 105–111.
- Holzinger, W.E. 2005. Erstnachweis der Rhododendronzikade (*Graphocephala fennahi*) aus der Steiermark Hemiptera: Auchenorrhyncha: Cicadomorpha: Cicadellidae). *Beiträge zur Entomofaunistik* 6, 163–164.
- Hommel, M., Diederich, F. & Werres, S. 2003. Investigations on interactions between the rhododendron leafhopper (*Graphocephala fennahi* Young) and the rhododendron bud blast disease (*Pycnostysanus azaleae* (Peck) E. Mason). *Second International Symposium on Plant Health in Urban Horticulture*, Berlin, Germany, August 27–29, 2003, 394, 48–49.
- Howell, P.J. & Wood, R.K.S. 1962. Some factors affecting rhododendron bud blast and its control. *The Annals of Applied Biology* 50, 723–733.
- Höhnelt, F. von. 1914. Fragmente zur Mykologie XVI (XVI. Mitteilung, Nr. 813 bis 875). *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften Math.-naturw. Klasse Abt. I.* 123, 49–155.
- Kaneko, S., Yokozawa, Y. & Kubono, T. 1988. Bud Blight of *Rhododendron* Trees Caused by *Pycnostysanus azaleae*. *Annals of the Phytopathological Society of Japan* 54, 323–326.
- Łabanowski, G. & Soika, G. 1997. Nowe i mniej znane szkodniki występujące na drzewach i krzewach ozdobnych. *Progress in Plant Protection / Postępy w Ochronie Roślin* 37 (1), 218–223.
- Larsen, O.J. 2016. Rhododendron Culture in Norway. *Rhododendrons International* 1 2016 (Part 2), 63–69.
- Laister, G. 2008. Erster Nachweis der Rhododendronzikade (*Graphocephala fennahi*) für Oberösterreich. *ÖKO-L* 30/3, 19–20.
- Li, J., Phookamsak, R., Mapook, A., Boonmee, S., Bhat, J.D., Hyde, K.D. & Lumyong, S. 2016. *Seifertia shangrilaensis* sp. nov. (Melanommataceae), a new species from Southwest China. *Phytotaxa* 273 (1), 34–42.
- Metcalf, Z.P. 1965. *Cicadelloidea, Part 1, Tettigellidae. General Catalogue of the Homoptera*. United States Department of Agriculture, Agricultural Research Service, Washington, D.C. 6(1): [i-ii], 1–730.
- Mifsud, D., Cocquempot, C., Mühlethaler, R., Wilson, M. & Streito, J.-C. 2010. Other Hemiptera Sternorrhyncha (Aleyrodidae, Phylloxeroidea, and Psylloidea) and Hemiptera Auchenorrhyncha. Chapter 9.4. In: Roques, A., Kenis, M., Lees, D., Lopez-Vaamonde, C., Rabitsch, W., Rasplus, J.-Y., Roy, D.B., editors. Alien terrestrial arthropods of Europe. *BioRisk* 4 (1), 511–552.
- Moore, R.T. 1984. Deuteromycetes III. The other species of *Antromycopsis*. *Transactions of the British Mycological Society* 82, 377–380.
- Morcos, G. 1953. The biology of some Hemiptera – Homoptera (Auchenorrhyncha). *Bulletin de la Société Fouad Ier d'Entomologie* 37, 405–439.
- Nast J. 1972. *Palaeartic Auchenorrhyncha (Homoptera). An annotated check list*. Warszawa: Polish Scientific Publications. 550 pp.
- Nast J. 1987. The Auchenorrhyncha (Homoptera) of Europe. *Annales Zoologici* 40, 535–661.

- Nickel, H. 2003. *The leafhoppers and planthoppers of Germany (Hemiptera, Auchenorrhyncha): Patterns and strategies in a highly diverse group of phytophagous insects*. Sofia: Pensoft Publishers, & Keltern: Goecke & Evers. 460 pp.
- Niedringhaus, R., Biedermann, R. & Nickel, H. 2010. Verbreitungsatlas der Zikaden des Großherzogtums Luxemburg - Textband. *Ferrantia* 60, Musée national d'histoire naturelle, Luxembourg, 105 pp.
- Niedringhaus, R. & Olthoff, T. 1986. Zum Auftreten der Zikaden *Graphocephala fennahi* Young 1977, *Fieberiella macchiaae* Linnavuori 1962 und *Zyginella pulchra* Löw 1885 in städtischen Bereichen Nordwestdeutschlands (Homoptera: Auchenorrhyncha). *Drosera* 86, 71–74.
- Økland, K.A. 1981. Inndeling av Norge til bruk ved biogeografiske oppgaver – et revidert Strandsystem. *Fauna, Oslo* 34, 167–178.
- Papp, V., Kondorosy, E., Marácz, L., Haltrich, A. & Véték, G. 2012. A rododendron-kabóca (*Graphocephala fennahi* Young, 1977) (Hemiptera: Cicadellidae) Magyarországon. *Növényvédelem* 48 (11), 523–526.
- Pastirčák, M., Majeská, M., Fergus, P. & Gubiš, J. 2014. Choroby rododendronov spôsobené hubovými patogénmi. In Zborník referátov z vedeckej konferencie: „Dendrologické dni v Arboréte Mlyňany SAV 2014“, 18.09.2014. Vieska nad Žitavou: Arborétum Mlyňany SAV. Pp. 145–149.
- Pirone, P.P. 1978. *Diseases and Pests of Ornamental Plants*. 5th Ed. John Wiley & Sons. New York. 448 pp.
- Piterāns, U. 2016. First record of *Graphocephala fennahi* Young, 1977 (Hemiptera: Cicadellidae) in Latvia. *Latvijas Entomologs* 53, 127–128.
- Pradhan, P. 2015. Preliminary Checklist of Phytopathogenic Fungi in Sikkim, India. *PeerJ PrePrints*. <https://dx.doi.org/10.7287/peerj.preprints.953v1>
- Reclaire, A. 1944. Naamlijst der in Nederland en het aangrenzende gebied waargenomen Cicaden (Hemiptera-homoptera). *Entomologische Berichten* 11, 221–256.
- Robert, V., Stegehuis, G. & Stalpers, J. 2005. *The MycoBank engine and related databases*. Available from <http://www.MycoBank.org> (20.09.2017)
- Roques, A., Rabitsch, W., Rasplus, J.-Y., Lopez-Vaamonde, C., Nentwig, W. & Kenis, M. 2009. *Alien Terrestrial Invertebrates of Europe*. In: Drake, J.A. (Ed.) 2009. DAISIE, Handbook of Alien Species in Europe, Springer. Pp. 63–79.
- Rose, A. & Zunke, U. 1998. Zur Verbreitung und Pathogenität der Rhododendronzikade *Graphocephala fennahi* YOUNG an ausgewählten Rhododendronbeständen im Hamburger Raum unter Berücksichtigung ihrer Rolle als Vektor für die Übertragung des Pilzes *Pycnostysanus azaleae* (PECK) MASON. *Mitteilungen aus der Biologischen Bundesanstalt für Land- und Forstwirtschaft Berlin-Dahlem* 357, 309–310.
- Seifert, K., Morgan-Jones, G., Gams, W. & Kendrick, B. 2011. *The genera of Hyphomycetes*. CBS Biodiversity Series no. 9, 1–997. CBS-KNAW Fungal Biodiversity Centre, Utrecht, Netherlands
- Seifert, K.A., Hughes, S.J., Boulay, H. & Louis-Seize, G. 2007. Taxonomy, nomenclature and phylogeny of three cladospore-like hyphomycetes, *Sorocybe resinae*, *Seifertia azaleae* and the *Hormoconis* anamorph of *Amorphotheca resinae*. *Studies in Mycology* 58, 235–245.
- Seljak, G. 2013. Dinamika vnosa tujerodnih fitofagnih žuželk in pršic v Slovenijo. *Acta Entomologica Slovenica*, 21 (2), 85–122.
- Sergel, R. 1987a. On the occurrence and ecology of the *Rhododendron*-leafhopper, *Graphocephala fennahi* Young, 1977, in the Western Palaearctic region (Homoptera, Cicadellidae). *Anzeiger für Schädlingskunde Pflanzenschutz Umweltschutz* 60, 134–136.
- Sergel, R. 1987b. Area expansion of the imported Nearctic cicadelline leafhopper *Graphocephala fennahi* Young, 1977 in Western Europe (Homoptera: Auchenorrhyncha). *Articulata* 3, 21–22.
- Soika, G. & Łabanowski, G. 2011. Gatunki obce i inwazyjne roztoczy i owadów na roślinach wrzosowatych w polsce. *Progress in Plant Protection / Postępy w Ochronie Roślin* 51 (4), 1582–1589.
- Špryňar, P. 2005. First records of the rhododendron leafhopper (*Graphocephala fennahi*) (Hemiptera: Auchenorrhyncha: Cicadellidae) from the Czech Republic. *Plant Protection Science* 41, 38–41.
- Stalpers, J.A., Seifert, K.A. & Samson, R.A. 1991. A revision of the genera *Antromyopsis*, *Sclerostilbum*, and *Tilachlidiopsis* (Hyphomycetes). *Canadian journal of botany* 69, 6–15.
- Street, F. 1950. Some observations and notes on bud blast on rhododendrons. *Rhododendron Yearbook* 5, 72–77.
- Sundheim, L., Herrero, M.L., Rafoss, T. & Toppe, B. 2009. *Pest risk assessment of Phytophthora ramorum in Norway*. Opinion of the Panel on Plant Health of the Norwegian Scientific Committee for Food Safety, 08/907-3 final, ISBN 978-82-8082-

- 351-9 (Electronic edition). VKM, Oslo, Norway.
- Svensson, J. 2016. "Rododendronknoppdödare" i Ramlösa brunnsparc. *Puggehaten* 29 (1), 6–7.
- Synave, H. 1977. Enquete sur la presence en Belgique de *Graphocephala coccinea* Forst., homoptere originaire d’Amerique du Nord. *Les Naturalistes belges* 58, 29–32.
- Talgø, V. & Stensvand, A. 2005. Knopp- og skotvisning på rododendron. *Gartneryrket* 103 (7), 19.
- Talgø, V., Toppe, B., Stensvand, A., Pundsnes, T., Haugse, S. & Hilmersen, I. 2008. Planteskulehygiene. *Bioforsk TEMA*, 3 (3), 1–29.
- Ulenberg, S.A. & van Frankenhuyzen, A. 1986. The occurrence of the American leafhopper *Graphocephala fennahi* in Europe and its relation to the bud blast disease of *Rhododendron*. *Mededelingen Faculteit Landbouwwetenschappen Rijksuniversiteit Gent* 51/3b, 1245–1248.
- Ulenberg, S.A., Burger, H.C., de Goffau, L.J.W. & van Rossem, G. 1983. Bijzondere aantastingen door insekten in 1982. *Entomologische Berichten* 43 (11), 164–168.
- Vidano, C., Arzone, A. & Meotto, F. 1987. Dati morfologici, biologici e fitopatologici su *Graphocephala fennahi* (Homoptera, Auchenorrhyncha) nuovo fitomizo di *Rhododendron* spp. in Italia. *La difesa delle piante* 10 (1), 101–112.
- Viennot-Bourgin, G. 1981. Observation simultanée en France du bud blast du *Rhododendron* et d’une cicadelle jouant le rôle de vecteur. *Agronomie, EDP Sciences* 1 (2), 87–92.
- Westergaard, K. B., Hanssen, O., Endrestøl, A., Often, A., Stabbetorp, O., Staverløkk, A. & Ødegaard, F. 2015. Spredning av fremmede arter med planteimport til Norge. *NINA Rapport* 1136. 105 pp.
- Westhoff, J. 2007. Knospensterben an *Rhododendron* - Gibt es resistente Sorten? *Deutsche Baumschule* 59 (4), 29–31.
- Whitehead, P.F. 2005. *Graphocephala fennahi* Young (Hem., Cicadellidae) new to Greece. *Entomologist's Monthly Magazine* 141, 92.
- Wilson, G.F. 1937. Contributions from the Wisley Laboratory. 80. A leaf-hopper (Jassid) on *Rhododendron*. *Journal of the Royal Horticultural Society* 62, 210–213.
- Young, D.A. 1977. Taxonomic study on the Cicadellinae (Homoptera: Cicadellidae), pt. 2. New World Cicadellini and the genus *Cicadella*. *Technical Bulletin of the North Carolina agricultural experimental Station* 239, 1135 pp.
- Żoła, M., Kierpiec-Baran, B. & Kowalik, M. 2013. The diversity of fungi colonizing necrotic inflorescence buds of *Rhododendron* (*Rhododendron* L.). *Acta Agrobotanica* 66 (2), 79–84.

Received: 30 October 2017

Accepted: 21 November 2017