

Two introduced species of Typhlocybinae (Hemiptera, Cicadellidae) new to Norway

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This paper present two species of Typhlocybinae (Hemiptera, Cicadellidae) new to Norway, *Zonocyba bifasciata* (Boheman, 1852) and *Zyginella pulchra* Löw, 1885. Both species are reported from plant importers and from established populations in Norway. We argue that both species have been introduced into Norway as hitchhikers on garden plants, but that we cannot rule out the possibility of a simultaneously range expansion into Norway from Sweden.

Key words: Hemiptera, Cicadellidae, *Zonocyba bifasciata*, *Zyginella pulchra*, Norway, alien species, introduction, new records, range expansion.

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Introduction

Introduced species are, amongst other things, major threats to biodiversity worldwide. Introduction is also an increasing phenomenon worldwide, due to an increased rate of trade and travel in recent decades. Imported plants and plant parts are regarded as a major vector for introduced invertebrates, including hoppers (Hemiptera, Auchenorrhyncha) both in Norway (Gederaas *et al.* 2012) and globally (Mifsud *et al.* 2010). According to Mifsud *et al.* (2010), about 0.5–0.6 new alien hoppers have been recorded per year in Europe since 2000 (mainly from North America). Several of these have dispersed throughout Europe (Gjonov & Shishiniova 2014, della Giustina 2002, Sergel 1987). In addition, several Mediterranean hopper species have expanded their range

northwards in Europe (Nickel & Holzinger 2006, Mifsud *et al.* 2010), and many of them can be characterized as “intra-European” aliens (Roques *et al.* 2009).

The knowledge of the Norwegian fauna of hoppers is increasing. According to Söderman *et al.* (2009) 291 hopper species have been recorded from Norway. Adding some recent publications and some unpublished records, the actual number is now exceeding 315 (Ødegaard & Endrestøl 2015). The subfamily Typhlocybinae comprises about 6000 described species worldwide, and is currently the second largest leafhopper subfamily (after Deltocephalinae) (Dietrich 2013). These species are mostly small (< 5,5 mm) and delicate leafhoppers that feed preferentially on the contents of leaf parenchyma cells of their host plants (Dietrich 2013). So far, 83 species of this

subfamily occur in Norway, including the two published in this paper (Söderman *et al.* 2009, Endrestøl 2011).

Some of the hopper species reported from Norway the recent years have host plants that are not native to Norway (introduced after the year 1800 AD) and they are thus regarded as alien species (Gederaas *et al.* 2012). In some cases, however, insects being monophagous on alien plants may not necessarily be regarded as alien species themselves, as some sort of human aid in its range expansion have to be applied to give them that category. In this context, natural range expansion of a certain species due to habitat alternations (e.g. human dispersal of host plants) or global warming, does not qualify it as alien (Roques *et al.* 2009, Gederaas *et al.* 2012), but insects species being introduced to Norway as hitchhikers on garden plants will qualify them as alien. In many cases, the underlying causes of range expansion can be hard to document.

A total of 31 species of Hemiptera are considered alien in Norway, with more than half of them associated with constructed sites due to addition of soil and garden plants (Gederaas *et al.* 2012). Endrestøl (2008) investigated the hopper fauna associated with *Populus nigra*, an alien tree species in Norway, and documented several new species to Norway and a possible range expansion of some of them. He found hoppers monophagous on *Populus nigra* in young and newly established parks, and concluded that some of the species probably were established and spread both anthropochore (indirectly by humans) and anemochore (actively or passively through air). Anthropochore dispersal of hoppers on plant material is also documented on Iceland (Endrestøl 2013a) and a range expansion of several species is seen in both Sweden (Gillerfors 2008) and Denmark (Endrestøl 2013b). Establishment could also possibly be facilitated by a warmer climate (Ødegaard & Endrestøl 2007, Endrestøl 2008, 2013a, Gillerfors 2008).

This paper documents two species of Typhlocybinæ (Hemiptera, Cicadellidae) new to Norway, *Zonocyba bifasciata* (Boheman, 1852) and *Zyginella pulchra* Löw, 1885 and discuss their range expansion and introduction to Norway.

Material and methods

The current paper is based on material collected in two ongoing research programs, one run by BioFokus and the other by the Norwegian Institute for Nature Research (NINA), with some additional records collected by the third author and the Natural History Museum in Oslo (NHMO).

One of the projects (BioFokus) is an attempt to restore an old hayfield (and/or pasture), partly on calcareous ground at Gaustad in Oslo municipality. In this project, many trees and shrubs have been removed, and the grasses and herbs have been cut down and removed in late summer for three consecutive years. Malaise traps were used in the area every year, and some 1x1 m squares was established to monitor the development of the flora. There are still some larger trees present within the field, i.e. *Acer platanoides*, *Ulmus glabra* and *Picea abies*.

The other project (NINA) is investigating the dispersal of alien species through plant import to Norway. This project is funded by the Norwegian Environment Agency and has a three year project period (2013–2016). The project conducts mapping and monitoring of the alien species vector «import of plant products» to obtain the best possible knowledge about this indirect import of alien species (see Westergaard *et al.* (2015) and Endrestøl *et al.* (2016) for further details). Several methods have been applied to investigate both the actual arrival of alien species and whether they are established in the wild in Norway. The methods used relevant for this paper was sweeping/beating of established or potted plant collections outdoors at plant importers, and light traps run indoors at plant importers facilities.

The species

Zonocyba bifasciata (Boheman, 1852)

Ø, Moss: Jeløya, Alby, N59.42307 E10.60780, 10.VIII.2013, 1x, on light; 8.VIII.2014, 1x, on light. Photos J.R. Gustad. **AK**, Oslo: Gaustad «Jubileumsenga», N59.94863 E10.71190, 11.VIII–27.IX.2013, 1♀, malaise trap. Leg./coll. K.M. Olsen; Etterstad, Svartdalsparken,



FIGURE 1. *Zonocyba bifasciata* (Boheman, 1852). Photo: Hallvard Elven (NHMO).

N59.90467 E10.79977, 14.VIII–7.XI.2015, 1♀, malaise trap along river Alna. Leg. H. Elven & L.O. Hansen. Coll. NHMO. **RY**, Sandnes: Folkvord, N58.84373 E5.69882, 23.IX.2015, 1♀, beaten from imported *Carpinus betulus*. Leg./coll. A. Endrestøl (NINA). This last locality were investigated on several occasions during the spring 2016 by beating *Carpinus betulus* as single trees in pots and established hedges, without finding any specimen. As adults emerge in June, these investigations might have been too early in the season, but nymphs should potentially have been found.

Comments. Key and illustrations to the nymph of *Z. bifasciata* are given in Vilbaste (1982). Key and illustrations of adults are found in Ossiannilsson (1981). The most conspicuous character of imagines of this species is the two broad, black-brown, transverse bands across the light yellow, shining fore wings (Ossiannilsson 1981: 508) (Figure 1).

Z. bifasciata is an arboreal leafhopper of the European deciduous forests (Nickel 2008).

According to Vidano & Arzone (1981) it is oligophagous or polyphagous on broad-leaved trees. It is reported from *Carpinus betulus*, *Ulmus minor* and *U. glabra* (Nickel 2003). Boheman (1851, 1852) reports the species to prefer *Corylus avellana*. Günthart (1971) reports the species from *Beta*, but later Günthart (1974) reports the hostplant to be *Carpinus*. Claridge & Wilson (1976) reared specimen from both *Carpinus* and *Ulmus*, and in addition collected adults from “Sycamore”, *Acer*, *Corylus*, *Fagus*, *Sorbus*, *Alnus* and *Quercus*. According to Söderman (2007), this species lives on *Ulmus glabra* and *Ulmus x hollandica* in Finland. Recent findings in Sweden are from *Ulmus* (Gillerfors 2002, 2008). Vidano & Arzone (1981) reports the species from *Alnus glutinosa*, but states that the main host plant is *Carpinus* in Italy. In Germany, it seems to be found in high frequencies on *Carpinus*, but less frequent on *Ulmus* (Nickel 2003). It can be found both in closed forest stands, semi-open tree stands and along hedges (Nickel 2003).

Z. bifasciata is mentioned from Carlbergs-



FIGURE 2. *Zygynella pulchra* Löw, 1885. Photo: Arnstein Staverløkk (NINA).

parken, Stockholm, Sweden already in 1851 (Boheman 1851) and finally described as *Typhlocyba bifasciata* in Boheman (1852). Most standard works of reference, including Nast (1972) and Ossiannilsson (1981), cite 1851 as the year of original description, which is, however, erroneous. According to Nast (1987), *Z. bifasciata* is found throughout Europe. In northern Europe, exceptions are Iceland and Northwestern Russia (Söderman *et al.* 2009). It is reported from Belarus and Caucasus (Gnezdilov 1999, Borodin 2004), and Nast (1972) also list the species from northern and central Russia and Tajikistan. It is now present in all southern counties (län) in Sweden (Ossiannilsson 1981, Gillerfors 2008). The species was reported new to Finland in 1976 (Albrecht 1977). Later, Albrecht *et al.* (2003) reported several new records from Finland, many from *Ulmus glabra*. In Denmark, it is reported from the southeastern parts (Endrestøl 2013b). The species seems to be nocturnal, as it may be caught by light (this paper, Söderman 2004).

Zygynella pulchra Löw, 1885

AK, Skedsmo: Hvam, N59.97983 E10.99188, 30.IV–5.V.2015, 1♂, light trap indoors at plant importer. Leg./coll. A. Endrestøl (NINA); Oslo: Gaustad «Jubileumsenga», N59.94863 E10.71190, 23.V–23.VI.2015, 1♂, malaise trap. Leg./coll. K.M. Olsen; Gaustad «Jubileumsenga», N59.94863 E10.71190, 13.IV.–26.V.2016, 5♂♂, malaise trap. Leg. K.M. Olsen, coll. NHMO; Gaustad, N59.95047 E10.71713, 11.IV.2016, 1♂3♀♀, beaten from *Thuja*. Leg./coll. A. Endrestøl (NINA); Gaustad, N59.95051 E10.71391, 11.IV.2016, 2♀♀, beaten from *Thuja*. Leg./coll. A. Endrestøl (NINA); Gaustad, N59.94874 E10.71885, 11.IV.2016, 1♀, beaten from *Chamaecyparis*. Leg./coll. A. Endrestøl (NINA); Gaustadalléen, N59.94197 E10.71741, 1♀, beaten from *Thuja*. Leg./coll. A. Endrestøl (NINA); Rosenhoff, N59.92985 E10.77460, 11.IV.2016, 2♂♂6♀♀, beaten from *Thuja*. Leg./coll. A. Endrestøl (NINA); 20.IV.2016, 1♂1♀, beaten from *Thuja*. Leg./coll. A. Endrestøl (NINA); 28.X.2016, 1♂1♀, beaten

from *Thuja*. Leg./coll. A. Endrestøl (NINA); Bislett, N59.92518 E10.73103, 12.IV.2016, 1♂4♀♀, beaten from *Thuja*. Leg./coll. A. Endrestøl (NINA); Tullinløkka, N59.91682 E10.73650, 12.IV.2016, 4♂♂3♀♀, beaten from *Chamaecyparis*. Leg./coll. A. Endrestøl (NINA); Torshov, N59.93398 E10.76902, 28.X.2016, 1♀, beaten from *Thuja*. Leg./coll. A. Endrestøl (NINA); Torshov, N59.93434 E10.76898, 28.X.2016, 1♂2♀♀, beaten from *Taxus*. Leg./coll. A. Endrestøl (NINA); Sagene, N59.93898 E10.75430, 28.X.2016, 4♂♂4♀♀, beaten from *Thuja*. Leg./coll. A. Endrestøl (NINA).

Comments. Several illustrations of different characters of *Z. pulchra* are given in Dworakowska (1969) and Biedermann & Niedringhaus (2009). The 5th instar nymph is described by Wilson & Mühlethaler (2010). The most conspicuous character of imagines of this species is the often reddish-colored scutellum and clavus (♂♂), and characteristic dark coloring on apical third of fore wings with distinctive black spots on 3rd apical vein (♂♀) (Biedermann & Niedringhaus 2009) (Figure 2).

Löw (1885) reported *Z. pulchra* from *Quercus petraea*. It is, according to Remane & Fröhlich (1994), found mainly on *Acer pseudoplatanus* and *Acer campestre*, but they also reports it in numbers on *Acer monspessulanum* and less frequently on other tree species (e.g. *Quercus*, *Crataegus*). Malenovsky & Lauterer (2010) collected the species from *Acer pseudoplatanus*, but also from *Acer platanoides*, *Quercus petraea* and *Q. robur*, *Carpinus betulus*, and both apricot and apple orchards. It has been reported as a harmful pest on deciduous fruit trees in Iran (Rajabi & Mirzayans 1989). Stewart *et al.* (2009) reported specimen mainly from *Acer pseudoplatanus* from Britain, but states that overwintering individuals had been recorded from a wide range of evergreen plants, e.g. *Taxus baccata*. Remane & Fröhlich (1994) reports specimen mainly from urban areas, but also from unhabituated areas surrounding cities. Nickel (2003) states that most of the German records are from forest margins, but also from parks and roadside trees in urban areas.

Metcalf (1968) lists *Z. pulchra* from 11 Central European countries; Austria, Germany, Croatia,

Hungary, Italy, Serbia, France, the Netherlands, Cyprus, Greece and Slovakia. Nast (1987) list the species from Germany, Poland, Czechoslovakia, France, Switzerland, Austria, Ukraine, Italy, Yugoslavia, Bulgaria and Greece. It was reported new to Great Britain from an experimental apple orchard (Wiseman's field) at East Malling, Kent in 2001 (Bleicher *et al.* 2007), and has since then expanded its range rapidly from there (Stewart *et al.* 2009). Including the records herein, the species is only found in Scandinavia in the northern part of Europe (Söderman *et al.* 2009). It was reported new to Denmark in 2007 (Endrestøl 2013b), and Sweden in 2008 (Gillerfors 2009).

Discussion

This paper deals with two species of Typhlocybinae new to Norway, with records being from both plant importers and from established populations outdoors in Norway. Both species are very conspicuous, and can not have been overlooked in Norway. It is therefore reason to believe that they have been established here during the last decades. Evidence is clear that both species have been introduced to Norway with garden plants. One can still not rule out that there also have been a northward and natural dispersal of these species to Norway from Sweden.

A natural range expansion into Norway is more plausible for *Z. bifasciata*, as this species have been reported from Sweden the last one and a half century. It can, according to Gillerfors (2008), be found north to the province of Hälsingland, and was published from Halland in 2002 (Gillerfors 2002). In Finland, it seems to have expanded from urban areas and parks into natural elm-grove (Albrecht 1977, Albrecht *et al.* 2003, Söderman 2007). The records of this species from Østfold County, relatively close to the Swedish boarder, could also indicate a natural expansion from Sweden. The habitat at Jeløya is mature temperate broadleaf and mixed forest with a broad range of the Norwegian tree species present, and relatively similar to the type locality (400km away). Still, the record from Rogaland County, on *Carpinus betulus*, clearly indicate anthropochore dispersal

of this species from the European continent into Norway. To use the description of Boheman (1851), such an “utmärkt vacker” [especially beautiful]” species, cannot have been overlooked in Norway.

Niedringhaus & Olthoff (1986) already proposed a northward expansion of *Z. pulchra*. They argued that large urban areas and cities were first colonized due to anthropochore dispersal, i.e. by planting of ornamental trees and plants, and from where the species expanded further. Remane & Fröhlich (1994) also reported a northern range expansion in Germany. Nickel (2003) discusses a northeastward range expansion of *Z. pulchra* along anthropogenic habitats, but finds the evidence not to be convincing. Even so, all Northern European records of this species are from the last decade (Söderman *et al.* 2009), and Endrestøl (2013b) argue that recent findings in Denmark could support such an expansion theory for this species. Endrestøl (2013b) reports the species from North East Zealand and Funen in Denmark, but according to recent internet reports (Danmarks Fugle og Natur 2016) it has now also been reported from South Zealand, Lolland and East Jutland, further supporting this argument. This is also supported by the findings of Gillerfors (2009), who collected *Z. pulchra* from *Acer pseudoplatanus* close to a parking lot in Skåne as new to Sweden in 2008. Recent data for the Netherlands also suggest that this species has had a range expansion there, and that it is found mainly in urban areas (den Bieman & van Klink 2015). Stewart *et al.* (2009) describe a rapid range expansion in Britain, where the first specimen was found in 2001 and again was found after 2007 from a range of widely spaced sites across Britain. The same pattern is seen in the Czech Republic, where the first specimen was found in 2000, with a rapid range expansion in recent years (Malenovský & Lauterer 2010). It is now widespread and common at least throughout Moravia and northern Bohemia in the Czech Republic, mainly at forest margins and in forest clearings, but also in fruit orchards and city parks (Malenovský & Lauterer 2010). They argue that “it is improbable that such a conspicuous species would have been overlooked”. To use the description of Löw (1885), “Diese prächtige

Art [this magnificent species]”, cannot have been overlooked in Norway, either. Still, very few entomologist pay noticed to evergreens (e.g. *Thuja*) in central urban areas, at least during early spring and late autumn, so it might have been established here for a relatively long period without being detected. It is evident that it is now well established and common in central parts of Oslo, and has been documented as overwintering on *Thuja*, *Taxus* and *Chamaecyparis* in the area. Other evergreens, like *Pinus*, *Picea*, *Juniperus*, *Hedera helix* and *Buxus*, have been investigated in Oslo without finding *Z. pulchra* on them. In addition, other urban areas have been investigated briefly, like Drammen, Hønefoss and Sandvika (westwards from Oslo), Fredrikstad and Moss (eastward from Oslo), and even cities further north like Kristiansund and Molde, without finding the species in any of them. Still, one might expect this species to colonize most urban areas along the Norwegian coastline from Østfold County and to the northwest of Norway, depending on its climatic tolerance.

As others, Stewart *et al.* (2009) found the species mainly from urban areas. They suspect that this could reflect collecting biases, but also that it could be related to the abundance of cultivated *Acer pseudoplatanus* with surrounding evergreens. They are reasonably confident that the species has spread rapidly several hundred kilometers both northwards and westwards, and argue that the range expansion probably involved active flight, as most records were from mature trees and not newly planted ones, that might have had eggs on them when planted.

Stewart *et al.* (2009) do not mention the possibility of an anthropochore dispersion of *Z. pulchra* on evergreens as adults. The records presented here support the fact that it might actually be hitchhiking on evergreen plants as adult, as one specimen was collected indoors at a plant importers facility, and most were collected in urban areas on exotic evergreens. Since the species overwinters as adults, they can be found on many different plant species during early spring or late autumn. According to den Bieman & van Klink (2015), the species has been found on evergreens like *Hedera helix*, *Picea*, *Thuja*

and *Chamaecyparis* in the Netherlands from October to early spring. The same phenomenon is reported by Stewart *et al.* (2009) from Britain, who added *Iris pseudacorus*, *Cytisus scoparius*, *Taxus baccata*, *Betula* and *Pinus* to the list. Günthart (1974) reported the species from *Picea* in April from Switzerland. Some of the most recent records of this species in Denmark are from *Thuja* sp. (Danmarks Fugle og Natur 2016). Most of these plant species are commonly imported as garden plants into Norway (Westergaard *et al.* 2015, Endrestøl *et al.* 2016).

The establishment of *Zonocyba bifasciata* and *Zyginella pulchra* in Norway is clear examples of increased intra-European introductions of species into new territories due to trade with garden plants. The ecological effects of the establishment of these two species in Norway are not evaluated here, but would probably be minor. Scientists and management are urged to follow up on the increasing phenomenon of introduced species into Norway and to evaluate ecological effects of already established alien species.

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