

# Contribution to the Icelandic fauna of Auchenorrhyncha (Hemiptera, Fulgoromorpha & Cicadomorpha)

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This paper reviews the Icelandic fauna of Auchenorrhyncha and reports on an investigation from 2009 where a total number of 567 individuals of Auchenorrhyncha were collected in the southwestern part of Iceland. Specimens were collected from 22 different localities and the material consisted of five species, with one being new to the Icelandic fauna, namely *Edwardsiana rosae* (Linnaeus, 1958). All the 10 Auchenorrhyncha species reported from Iceland are commented on; *Toya propinqua* (Fieber, 1866), *Javesella pellucida* (Fabricius, 1794), *Philaenus spumarius* (Linnaeus, 1758), *Evacanthus interruptus* (Linnaeus, 1758), *Edwardsiana rosae* (Linnaeus, 1958), *Ribautiana ulmi* (Linnaeus, 1958), *Cicadula quadrinotata* (Fabricius, 1794), *Macrosteles laevis* (Ribaut, 1927), *Macrosteles sexnotatus* (Fallen, 1826), *Jassargus pseudocellaris* (Flor, 1861), all except *T. propinqua* and *M. sexnotatus* being regarded as established. Some aspects of the apparently poor Icelandic fauna of Auchenorrhyncha are discussed.

Key words: Iceland, Hemiptera, Auchenorrhyncha, *Edwardsiana rosae*, species introductions.

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## Introduction

The first records of Auchenorrhyncha (hoppers) from Iceland was probably made by Staudinger (1857) and later e.g. Manson (1890), but the Icelandic fauna of arthropods in general was poorly known until Carl H. Lindroth started his pioneer studies there in the 1920s (Lindroth 1931, Bengtson 2007). He also collected Auchenorrhynchas among other groups, and his material was later re-examined by Frej Ossiannilsson (1947). In Lindroth's material only four species of hoppers were found, namely *Jassargus pseudocellaris* (Flor, 1861), *Cicadula quadrinotata* (Fabricius, 1794), *Macrosteles laevis* (Ribaut, 1927) and *Javesella pellucida* (Fabricius, 1794). Again, in 1948, Ossiannilsson re-examined Icelandic specimen from the collection at the Natural History Museum of Denmark (NHMD), which consisted of the same four species as in Lindroth's material

(Ossiannilsson 1947, 1948). Since Ossiannilssons re-examination of the material at NHMD, little new material of Icelandic Auchenorrhynchas has entered their collection. An exception is a material of the three species *Javesella pellucida*, *Cicadula quadrinotata* and *Jassargus pseudocellaris* collected by Jens Böcher at Skaftafell in July–August 1961 (N.P. Kristensen pers. comm.).

Lindroth *et al.* (1973) investigated the fauna of the Surtsey island between 1963 and 1970, an island appearing south of Iceland in 1963 due to a volcanic eruption. Lindroth *et al.* (1973) also lists records of invertebrates found on the mainland, including the four species of Auchenorrhyncha mentioned above, but none of these were reported from Surtsey. Ólafsson (1978, 1982) followed up investigations on Surtsey, still with no records of Auchenorrhyncha from the island. Interestingly, investigations conducted on Surtsey between 2002 and 2006, concluded e.g. that both *Macrosteles*

*laevis* and *Javesella pellucida* were settled on the island (Ólafsson & Ingimarsdóttir 2009).

In the Palaearctic checklist compiled by Nast (1972), five species is given for Iceland: *Javesella pellucida*, *Macrosteles laevis*, *Macrosteles sexnotatus* (Fallen, 1826), *Cicadula quadrinotata* and *Jassargus pseudocellaris*. Ossiannilsson (1981) notes the presence of *Ribautiana ulmi* (Linnaeus, 1758) from Iceland in his “The Auchenorrhyncha (Homoptera) of Fennoscandia and Denmark”. In the European checklist, Nast (1987) repeats the five species given in Nast (1972). In 1991, Ólafsson publish his checklist on the Icelandic insects (Ólafsson 1991). He repeats previously listed species, but adds *Philaenus spumarius* (Linnaeus, 1758) and omits *Macrosteles sexnotatus*, giving six Auchenorrhyncha species for Iceland.

Remane (2005) reviewed over 17000 specimens of Auchenorrhyncha collected in 2001 by Dr. M. v. Tschirnhaus from 21 different localities in the northern, western and southwestern parts of Iceland. In this material, Remane (2005) found no more than five species in total, with one being reported from Northern Europe for the first time, namely *Toya propinqua* (Fieber, 1866).

The latest checklist from Northern Europe thus includes the following eight species from Iceland: *Toya propinqua*, *Javesella pellucida*, *Philaenus spumarius*, *Ribautiana ulmi*, *Cicadula quadrinotata*, *Macrosteles laevis*, *Macrosteles sexnotatus*, *Jassargus pseudocellaris* (Söderman *et al.* 2009).

## Material and methods

All the species of Auchenorrhyncha reported from Iceland are commented on and details on new material from an investigation conducted by the author in 2009 are given. 567 specimens were collected with a sweep net from 22 localities in Southwest Iceland between 31 July and 3 August 2009. Several species of shrubs and trees were investigated, including e.g. *Betula*, *Salix*, *Populus*, *Rosa* and *Picea*, along with herbs and grasses. All these records are given below under the species presentations. If nothing else is stated the specimens are collected and determined by

the author, and kept in the author’s collection. The distribution maps (Figures 1, 3, 4, 6, 7, 9, 11, 12, 14) and the catalogue (Table 1) are based on published records presented by Lindroth (1931) (see Ossiannilsson 1947), Ossiannilsson (1948), Lindroth *et al.* (1973), Guðleifsson & Bjarnadóttir (2002), Remane (2005), Gratton *et al.* (2008), Ólafsson & Ingimarsdóttir (2009) and Ólafsson (2011). Included are also records presented in this paper, material collected by Jens Böcher (coll. NHMD) and photo-documented specimen by Johannes Skaftason. Material from museums or from the Icelandic Institute of Natural History (IINH) is not included.

Systematics follows Söderman *et al.* (2009).

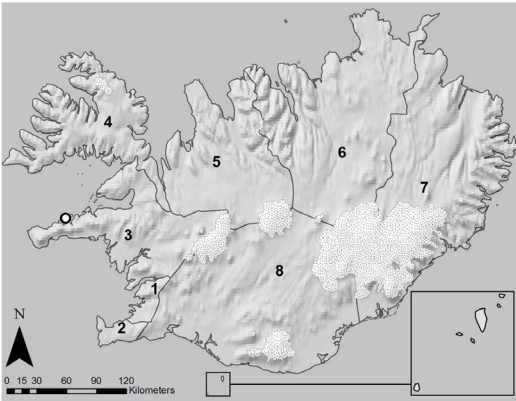
## The species

### FULGOROMORPHA

#### Delphacidae

#### *Toya propinqua* (Fieber, 1866)

Remane (2005) reported this species from Iceland. Only one single male of *Toya propinqua* was found after revising a material of 17000 specimens. It was found on a locality close to the domestic airstrip “Stykkisholmur” (Figure 1). Remane (2005) expected this specimen to be introduced by men, but did not rule out the possibility that it could be transported with jet streams (as mentioned by Söderman *et al.* 2009). *T. propinqua* can disperse far by wind. It is previously reported from different atolls in the Indian Ocean (Webb 1975) and from Micronesia (Fennah 1971). *T. propinqua* was the third most abundant delphacid caught in suction traps during 1994 within the Euraphid Network in France (della Giustina & Balasse 1999). della Giustina & Balasse (1999) did however show that all delphacids caught (4264 especimens) in suction traps were macropters, and they concluded that long distance hopper-migration (in France) would be an exception and that it is mainly short distance or non-existing. The Icelandic specimen represented the first record from Northern Europe, and the fact that the nearest continental population is 2000 km away, and that the individual found on



**FIGURE 1.** The distribution of *Toya propinqua* (Fieber, 1866) on Iceland. Only one individual from one locality is ever found (Remane 2005). Numbers 1–8 represents Iceland’s eight regions. Map source: Natural Earth.

Iceland was a brachypter, support the introduction-hypothesis.

*T. propinqua* is mainly found on Bermuda grass *Cynodon dactylon*, though it may live on different grasses (Nickel 2003). This grass origin is disputed, but it is clearly a tropical grass (Langdon 1954) and thus very unlikely to be found on Iceland. This grass is only found once in southern Norway introduced with transport of timber (Lid & Lid 2005). It is very unlikely that *T. propinqua* is established on Iceland, and it should therefore be regarded as a non-native and non-established species on Iceland until else is confirmed.

***Javesella pellucida* (Fabricius, 1794)**

When Ossiannilsson (1948) re-examined the Icelandic species found in NHDM (including Lindroth’s material) he reported on only one specimen of *J. pellucida*, with no further locality information (“Island Juli 1929 Sv. G. Larsson”). Still, several localities for this species are mentioned in Lindroth (1931).

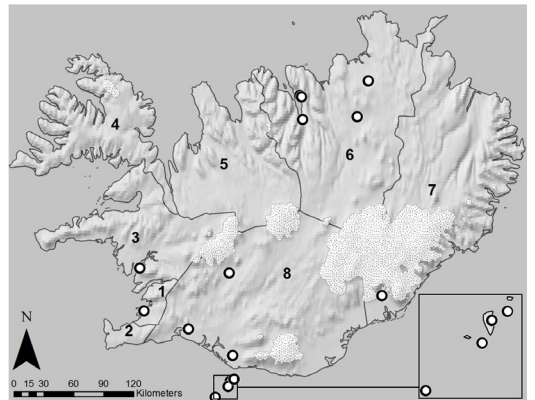
*J. pellucida* seems to be the only delphacid being established on Iceland. It is apparently found in low numbers even though it has localities both in the south and in the north of the island. It was found on only one locality in the southwest out of the 22 localities from the investigation reported here, and with only eight specimens in

total. This number, compared to the total number of specimens collected, is relatively in the same proportion that Remane (2005) reports, even though Remane (2005) reports this species from six localities in the north. Lindroth *et al.* (1973) reports the species also from the Islands Vestmannaeyjar, Bjarnarey and Suðurey. Finally, it is one of two species of Auchenorrhyncha that have colonized Surtsey, probably between 1993 and 2002 (Ólafsson & Ingimarsdóttir 2009) (Figure 2–3).

*Javesella pellucida* is a generalist species that



**FIGURE 2.** *Javesella pellucida* (Fabricius, 1794) from Selfoss, Iceland, 30 June 2003. Photo: Johannes Skaftason ©.



**FIGURE 3.** The distribution of *Javesella pellucida* (Fabricius, 1794) on Iceland. The distribution is based on 15 published localities. Numbers 1–8 represents Iceland’s eight regions. Map source: Natural Earth.

feeds on different grasses (Poaceae) in different environments (Nickel 2003). It can also withstand habitat disturbances well and it has good dispersal abilities, and can be characterized as a pioneer species (Nickel & Achtziger 2005). It is also one of the more common hopper species in Europe, even though it has some geographical limits (Nast 1987, della Giustina & Balasse 1999, Nickel 2003). In Norway, it is found also in the far north (Ossiannilsson 1978, Raatikainen & Ylönen 1988).

## CICADOMORPHA

### Aphrophoridae

#### *Philaenus spumarius* (Linnaeus, 1758)

To the author's knowledge, Ólafsson (1991) is the first to report *P. spumarius* from Iceland. This publication does not give any information on the record(s). Neither Ossiannilsson (1947, 1948), Nast (1972, 1987) nor Remane (2005) report this species from Iceland.

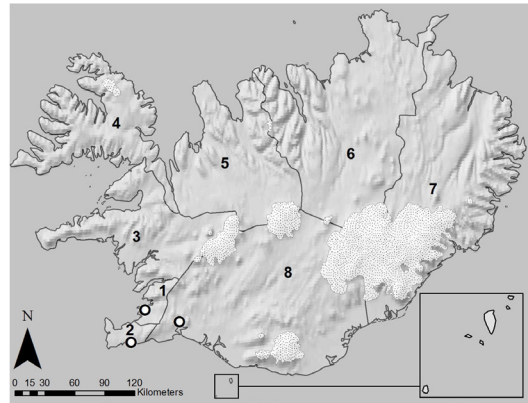
According to Mifsud *et al.* (2010), it is likely that *P. spumarius* was introduced to Iceland in the late 1970s, but this statement is not well documented. It is noteworthy that this species was not in either the author's material or the vast material investigated by Remane (2005). It is therefore likely that it has a restrict distribution on southern Iceland, even though it according to E. Ólafsson (pers. comm.) is spreading in the south-west of Iceland. According to J. Skaftason (pers. comm.), *P. spumarius* can be found in Hveragerði, Reykjavik (e.g. Korpúlfsstaðir) and on at least one locality in Reykjanes (Krisuvik) (Figure 4–5).

*P. spumarius* is, as the previous species, very well distributed in Europe and found in a great variety of habitats. It is also very polyphagous, and can be found on herbs, grasses and shrubs (Ossiannilsson 1981, Nickel 2003). *P. spumarius* is a very common species on the Norwegian mainland, also in the far north up to 70°N.

### Cicadellidae

#### *Evacanthus interruptus* (Linnaeus, 1758)

*E. interruptus* was first collected on Iceland on garden angelica, *Angelica archangelica*, at



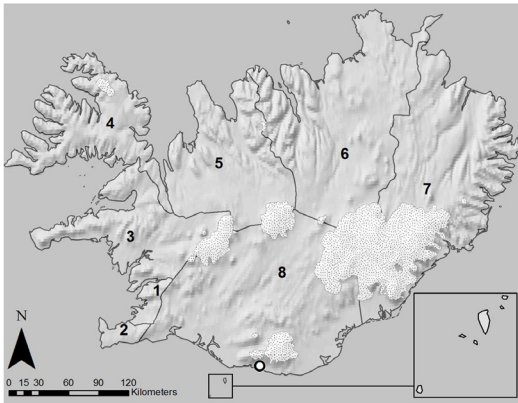
**FIGURE 4.** The distribution of *Philaenus spumarius* (Linnaeus, 1758) on Iceland. The distribution is based on three localities. Numbers 1–8 represents Iceland's eight regions. Map source: Natural Earth.



**FIGURE 5.** *Philaenus spumarius* (Linnaeus, 1758) (nymph) from Reykjanes near Krisuvik, Iceland 3 July 2006. Photo: Johannes Skaftason ©.

the farm Drangshlíð south of Eyjafjallajökull in August 2008 (leg. Sigurþóri Ástþórssyni, coll. IINH) (Figure 6). This area was severely affected by the 2010 eruptions of Eyjafjallajökull, but both the hostplant and *E. interruptus* survived the event and was found again in 2011 (Ólafsson 2011). It is difficult to speculate on when this species colonized the island, but this area of Suðurland has been investigated on several occasions by Lindroth *et al.* (1973) and others without any





**FIGURE 6.** The distribution of *Evacanthus interruptus* (Linnaeus, 1758) on Iceland. The distribution is based on one locality. Numbers 1–8 represents Iceland’s eight regions. Map source: Natural Earth.

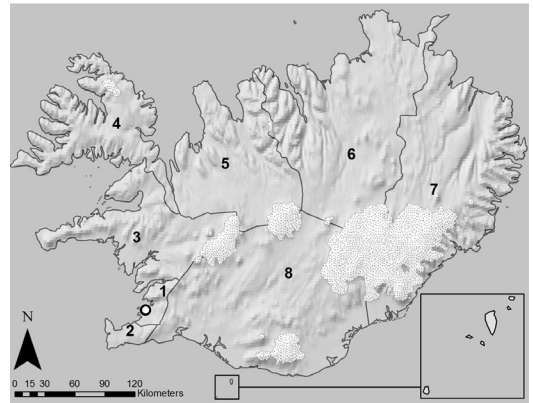
reports on this species. Dr. M. v. Tschirnhaus collected Auchenorrhynchas from *Angelica archangelica* in the north of Iceland (Myvatn), but Remane (2005) did not report this species at all.

*E. interruptus* is found in various habitats and on various host plants (Nickel 2003). In Europe, it has been found up to 2200 m a.s.l. and in Norway up to about 63°N. *Angelica archangelica* was one of the first species to colonize Iceland after the Weichsel 10000 years ago, and it has been used for human consumption and been important as a medicinal herb.

#### ***Edwardsiana rosae* (Linnaeus, 1958)**

*E. rosae* is here reported new to the Icelandic fauna. It was found in the central park area in Reykjavik, close to the botanical garden (Grasagarður) on at least two different rosebushes (*Rosa* spp.). It is likely that this species is well established, at least in the Reykjavik area, which is also confirmed by E. Ólafsson (pers. comm.). It has most likely been imported with plant material. Rosebushes were also investigated by the author in other parts of Iceland (commonly used as ornamental plants on roadsides, gardens and in cities etc.) without any additional records.

As its name implies, this species lives on roses, and can locally be extremely abundant on ornamental roses in gardens and parks (Nickel 2003). *E. rosae* has a restricted distribution in Norway, only found in Akershus County. It is



**FIGURE 7.** The distribution of *Edwardsiana rosae* (Linnaeus, 1958) on Iceland. The distribution is based on one locality. Numbers 1–8 represents Iceland’s eight regions. Map source: Natural Earth.

likely that this species have a very restricted distribution around Reykjavik on Iceland (Figure 7).

**Records. Höfuðborgarsvæði,** Reykjavíkurborg: Laugardalur (N64.13909 W21.86877), 3 August 2009, 10♂3♀.

#### ***Ribautiana ulmi* (Linnaeus, 1758)**

To the author’s knowledge, Ossiannilsson (1981) was the first to report *R. ulmi* from Iceland. He states that *R. ulmi* is “widespread in Europe, recently found even in Iceland”. This statement is not documented and no details are given on the record(s). On Iceland *Ulmus* is used in gardens and parks as an ornamental tree. *R. ulmi* is therefore suspected to have a very restricted distribution on Iceland, even though it can be locally common according to E. Ólafsson (pers. comm.). Known localities are in Reykjavik (J. Skaftason pers. comm.) (Figure 8–9). It is noteworthy that this species was not in the the material reported here or the vast material investigated by Remane (2005), even though several *Ulmus* specimens in Reykjavik were examined.

This species lives on elms (*Ulmus*). In Europe *R. ulmi* can occur above 1000m.a.s.l., even though *Ulmus* have a restricted distribution towards the north with its northern boundary around the Arctic Circle at 66°N. The northernmost record of *R. ulmi* in Norway is at 66.5° (Træna municipality, Endrestøl 2013).

***Cicadula quadrinotata* (Fabricius, 1794)**

*C. quadrinotata* was first reported from Iceland by Lindroth (1931) and is apparently one of the most common hoppers on Iceland, and could be termed pan-Icelandic (Lindroth 1931, Lindroth *et al.* 1973). It is found in all the Icelandic regions (Figure 10–11). *C. quadrinotata* is also reported from Vestmannaeyjar (Lindroth *et al.* 1973).

*C. quadrinotata* is widely distributed in Europe, and it can be found in a broad variety of

habitats. It probably prefers moist localities as it lives on different species of *Carex* (Nickel 2003).

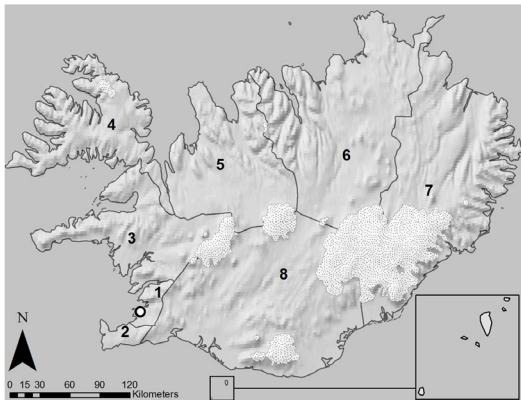
**Records.** Höfuðborgarsvæði, Reykjavíkurborg: Elliðaá (N64.12190 W21.84587), 31 July 2009, 14♂4♀; Kollafjörður (N64.20915 W21.71652), 3 August 2009, 1♂; Suðurnes, Reykjanesbær: Seltjörn (N63.94692 W22.43308), 31 July 2009, 3♂3♀; Vesturland, Borgarbyggð: Borgarnes (N64.51756 W21.89597), 2 August 2009, 3♂7♀ (Figur 15); Laxfoss (N64.72439 W21.59791), 2 August 2009, 18♂11♀; Dalabyggð: Búðardalur (N65.10976 W21.76538), 2 August 2009, 1♀; Gunnarsstaðir (N65.01264 W21.96139), 1 August 2009, 1♀; Snæfellsbær: Staðastaður (N64.80873 W23.11248), 1 August 2009, 1♀; Stykkishólmsbær: Arnarstaðir (N65.03168 W22.75267), 1 August 2009,



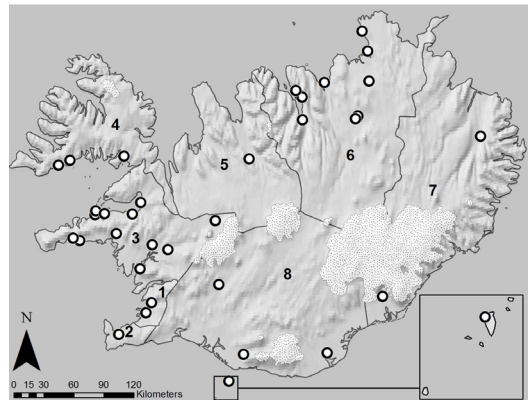
**FIGURE 8.** *Ribautiana ulmi* (Linnaeus, 1758) from Reykjavik, Iceland, 31 July 2004. Photo: Johannes Skaftason ©.



**FIGURE 10.** *Cicadula quadrinotata* (Fabricius, 1794) from Selfoss, Iceland, 14 September 2004. Photo: Johannes Skaftason ©.



**FIGURE 9.** The distribution of *Ribautiana ulmi* (Linnaeus, 1758) on Iceland. The distribution is based on one locality. Numbers 1–8 represents Iceland’s eight regions. Map source: Natural Earth.



**FIGURE 11.** The distribution of *Cicadula quadrinotata* (Fabricius, 1794) on Iceland. The distribution is based on 37 localities. Numbers 1–8 represents Iceland’s eight regions. Map source: Natural Earth.

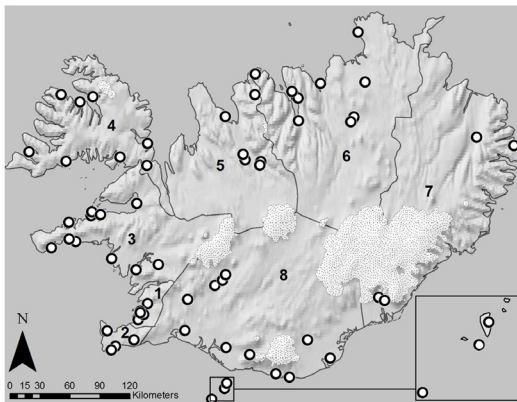
4♂; **Vestfirðir**, Reykhólahreppur: Klukkufell (N65.53508 W22.04239), 2 August 2009, 6♂2♀; **Suðurland**, Bláskógabyggð: Geysir (N64.31268 W20.30032), 1 August 2009, 5♂2♀.

### *Macrosteles laevis* (Ribaut, 1927)

Ossiannilsson (1947, 1948) identified *M. laevis* from Icelandic material at NHMD (see *M. sexnotatus* below). It is apparently the most common hopper on Iceland, found in all the Icelandic regions (pan-Icelandic) (Lindroth 1931, Ossiannilsson 1947). From the 17000 individuals identified by Remane (2005), more than 14400 individuals were identified as *M. laevis*. It is also collected in pitfall traps from Northern Iceland (Guðleifsson & Bjarnadóttir 2002) and found on Vestmannaeyjar and Suðurey (Lindroth *et al.* 1973) (Figure 12).

*M. laevis* is a polyphagous pioneer species that can be found in many different habitats (Morris 1990, Nickel 2003, Nickel & Achtziger 2005). Found also in the far north of Norway (Ossiannilsson 1981).

**Records.** **Höfuðborgarsvæði**, Hafnarfjörður: Hamraberg (N64.07160 W21.93207), 31 July 2009, 15♂4♀; Reykjavíkurborg: Elliðaá (N64.12190 W21.84587), 31 July 2009, 9♀; Kollafjörður (N64.20915 W21.71652), 3 August 2009, 1♀; **Suðurnes**, Reykjanesbær: Keflavík (N63.99291 W22.58360), 31 July 2009, 23♂30♀; **Vesturland**: Borgarbyggð: Borgarnes



**FIGURE 12.** The distribution of *Macrosteles laevis* (Ribaut, 1927) on Iceland. The distribution is based on 72 localities. Numbers 1–8 represents Iceland’s eight regions. Map source: Natural Earth.

(N64.51756 W21.89597), 02.08.2009, 9♂6♀ (Figure 15); Lundur (N64.54733 W21.42016), 1 August 2009, 6♂6♀; Snæfellsbær: Staðarstaður (N64.80873 W23.11248), 1 August 2009, 1♀; Stykkishólmsbær: Arnarstaðir (N65.03168 W22.75267), 1 August 2009, 1♂; Dalabyggð: Búðardalur (N65.10976 W21.76538), 2 August 2009, 11♂11♀; **Vestfirðir**, Reykhólahreppur: Klukkufell (N65.53508 W22.04239), 2 August 2009, 3♂; Strandabyggð: Gálmaströnd (N65.63577 W21.42632), 2 August 2009, 7♂11♀; Snartartunga (N65.44075 W21.48122), 2 August 2009, 5♂4♀; **Suðurland**, Bláskógabyggð: Geysir (N64.31268 W20.30032), 1 August 2009, 8♂2♀; Háalda (N64.35151 W20.12718), 1 August 2009, 16♂28♀; Laugarvatnsvellir (N64.21408 W20.88749), 1 August 2009, 1♂; Sveitarfélagið Ölfus: Sog (N63.99469 W20.98158), 31 July 2009, 1♂.

### *Macrosteles sexnotatus* (Fallen, 1826)

*M. sexnotatus* was first reported from Iceland (“Reykjavik and Reykir”) by Manson (1890). Several authors including Lindroth (1931) later documented it. Nast (1972, 1987) and Söderman *et al.* (2009) also listed this species from Iceland, but the uncertainty of this species is mentioned in the latter. Ossiannilsson (1947, 1948) commented on the “*Cicadula sexnotata*”-complex, and found specimens in Lindroth’s material identified to “*Cicadula sexnotata*” which he re-identified to both *Cicadula quadrinotata* and *Macrosteles laevis*. In his paper (Ossiannilsson 1947) he commented that since all the specimens from the *Macrosteles sexnotatus*-group were identified to *Macrosteles laevis*, that could probably also be the case with other specimen identified as *Macrosteles sexnotatus*. In 1948, he also re-examined the Icelandic material from the collection at NHMD without discovering any new species. Since *M. sexnotatus* is not reported from Iceland after Lindroth (1931), it is likely that previous authors have misidentified this species, and that it should not be included on the Icelandic checklist as correctly reflected in Ólafsson (1991).

### *Jassargus pseudocellaris* (Flor, 1861)

This might be the first published Auchenorr-



hyncha from Iceland. It is reported from Iceland by Staudinger (1857) who wrote: „[...] *Jassus pallens*, im juli an mit niedern Pflanzen bewachsenen Stellen sehr häufig, [...]“. Lindroth (1931) also documented the species: “Auf Island eine sehr typische Wiesenart.” Citing Staudinger (1857), Metcalf (1963) list this species from Iceland as “*Jassargus distinguendus*”. However, “*pseudocellaris*” should be given priority (Nickel 2003). It is also collected in pitfall traps from Northern Iceland (Guðleifsson & Bjarnadóttir 2002), and is relatively common around the

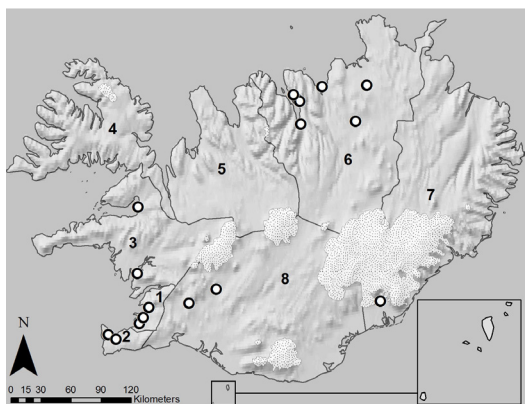
island. The species seems to have a south-western and north-eastern distribution, but it is likely to be more broadly distributed than it appears (Figure 13–14).

*J. pseudocellaris* is mainly found on low-productivity meadows and pastures, heaths and abandoned fields (Nickel 2003). It is reported as having high colonizing ability (Morris 1990). Host plants are grasses (*Agrostis capillaris* and *Festuca rubra*) (Nickel 2003). In Norway only found in the southern parts (Ossiannilsson 1981).

**Records. Höfuðborgarsvæði, Hafnarfjörður:** Hamraberg (N64.07160 W21.93207), 31 July 2009, 25♂27♀; Reykjavíkurborg: Elliðaá (N64.12190 W21.84587), 31 July 2009, 8♂1♀; Kollafjörður (N64.20915 W21.71652), 3 August 2009, 8♂7♀; **Suðurnes, Reykjanesbær:** Keflavík (N63.99291 W22.58360), 31 July 2009, 43♂11♀; Seltjörn (N63.94692 W22.43308), 31 July 2009, 5♂3♀; **Vesturland, Borgarbyggð:** Borgarnes (N64.51756 W21.89597), 2 August 2009, 45♂22♀ (Figure 15); Dalabyggð: Búðardalur (N65.10976 W21.76538), 2 August 2009, 1♂; **Suðurland, Bláskógabyggð:** Geysir (N64.31268 W20.30032), 1 August 2009, 11♂6♀; Laugarvatnsvellir (N64.21408 W20.88749), 1 August 2009, 1♂4♀; Sveitarfélagið Ölfus: Sog (N63.99469 W20.98158), 31 July 2009, 6♂2♀.



**FIGURE 13.** *Jassargus pseudocellaris* (Flor, 1861) from Reykjavík, Iceland, August 2004. Photo: Johannes Skaftason ©.



**FIGURE 14.** The distribution of *Jassargus pseudocellaris* (Flor, 1861) on Iceland. The distribution is based on 18 localities. Numbers 1–8 represents Iceland’s eight regions. Map source: Natural Earth.

## Discussion

Iceland is the most isolated landmass in Europe being 285km east of Greenland and 990km west of Norway (Rundgren 2007). Being situated between 63°N and 67°N, Iceland also has a harsh climate. Overall, Iceland has low summer temperatures comparable to northern Norway; even though the southern parts of Iceland has mild winters with temperatures comparable to southern, coastal Norway (Lindroth 1931). About two thirds of the island have sparsely or very sparsely vegetation and soil erosion being a serious problem to the remaining one-third (ME/IINH 2001).

The covering of ice during Weichsel (115 000 yr.–10 000 yr.) has led to different hypothesis regarding the origin of the Icelandic fauna, which are still disputed. These are e.g. the “*tabula rasa*





**FIGURE 15.** The author collecting at the locality Borgarnes (Vesturland) with Hafnarfjall as the backdrop (2 August 2009). This was the only out of the 22 investigated localities where *Javesella pellucida* (Fabricius, 1794) was found, in addition to *Cicadula quadrinotata* (Fabricius, 1794), *Macrosteles laevis* (Ribaut, 1927) and *Jassargus pseudocellaris* (Flor, 1861). Photo: Ragnhild E. Waagaard.

*hypothesis*” arguing a post-glacial re-migration of species to Iceland, “*the nunatak hypothesis*” stating a possible glacial survival of some species in refuges or “*the ice-rafting hypothesis*” arguing that a major part of the modern fauna on Iceland were passively dispersed across the North Atlantic to Iceland on ice floes (Rundgren 2007). Downes (1988) characterized the Icelandic fauna as being incomplete (disharmonic), meaning that many taxa living in the corresponding life zone in neighbouring countries are lacking. This is also the impression regarding the Auchenorrhyncha. The hopper-fauna on Iceland is the poorest in Europe compared to any other country, with only eight established species.

If one compares the southernmost Icelandic latitude with the Norwegian mainland, as many as 93 species of Auchenorrhyncha are found further north in Norway. Many of these species are very common and widely distributed in Norway, also to the far north, and have host plants that can be found on Iceland (e.g. *Arthaleus pascuellus*

(Fallén, 1826), *Deltocephalus pulicaris* (Fallén, 1806), *Neophilaenus lineatus* (Linnaeus, 1758), *Oncopsis* ssp. etc.). Remane (2005) gives several other species apparently “lacking” from the Icelandic fauna. It is surprising not to find any Auchenorrhyncha associated with e.g. *Betula* and *Salix* (also noted by Remane 2005) on Iceland, even though the author and others have investigated these plant species thoroughly. Koponen (1980) investigated the herbivorous insects on *Betula* from several localities on Iceland and did not report any Auchenorrhyncha species, except some unidentified nymphs at Heiðmörk (Reykjavik). These nymphs could represent species previously not reported from Iceland, but they could also very well be nymphs of both *Javesella pellucida*, *Philaenus spumarius* and *Macrosteles laevis* as they all have been reported from birch stands (Kula 2002). Koponen (1980) also noted the total absence of psyllids. One should also take into account that even though birch is relatively spares on Iceland today, it has been much wider

**TABLE 1.** The distribution of settled Auchenorrhyncha species from Iceland. The distribution is based on material presented by Lindroth (1931) (see Ossiannilsson 1947), Ossiannilsson (1948), Lindroth *et al.* (1973), Guðleifsson & Bjarnadóttir (2002), Remane (2005), Gratton *et al.* (2008), Ólafsson & Ingimarsdóttir (2009) and Ólafsson (2011). Included are records presented in this paper, material collected by Jens Böcher (coll. NHMD) and photo-documented specimen by Johannes Skaftason.

Family	Species	1. Höfuðborgar- svæði	2. Suðurnes	3. Vesturland	4. Vestfirðir	5. Norðurland vestra	6. Norðurland eystra	7. Austurland	8. Suðurland
FULGOROMORPHA									
Delphacidae	<i>Javesella pellucida</i> (Fabricius, 1794)			x			x	x	x
CICADOMORPHA									
Aphrophoridae	<i>Philaenus spumarius</i> (Linnaeus, 1758)	x	x						x
Cicadellidae	<i>Evacanthus interruptus</i> (Linnaeus, 1758)								x
Cicadellidae	<i>Edwardsiana rosae</i> (Linnaeus, 1958)	x							
Cicadellidae	<i>Ribautiana ulmi</i> (Linnaeus, 1758)	x							
Cicadellidae	<i>Cicadula quadrinotata</i> (Fabricius, 1794)	x	x	x	x	x	x	x	x
Cicadellidae	<i>Macrosteles laevis</i> (Ribaut, 1927)	x	x	x	x	x	x	x	x
Cicadellidae	<i>Jassargus pseudocellaris</i> (Flor, 1861)	x	x	x			x	x	x

distributed in the past. Iceland has lost 95% of its original birch (*Betula*) woodlands due to early clearing of woodlands for pastures (ME/IINH 2001). This all adds to the impression of an *incomplete* fauna as stated by Downes (1988), with an exception being the soil fauna that might be underestimated (Fjellberg 2007).

However, several factors might change this situation. Since Iceland is an isolated landmass, an anemochore expansion (active flight or spread by wind) into Iceland from surrounding landmasses are less likely within a short time perspective (decades) and thus less important than the ongoing anthropochore expansion, which is a range expansion with the help of man. This process also has historical dimensions (Downes 1988). As stated by Sadler (1991) “*There can be little doubt that the Norse have had a major impact on the biota of the North Atlantic islands. Almost half the Coleopteran fauna of Greenland and Iceland are anthropochorous and many of these species probably represent Norse introductions.*”

Travel and increased globalizations is one of the major reasons for introduction of new species to new territories on the globe

today, including Iceland. E.g., Heie (1964) has previously documented hemipterans introduced to Iceland with imported plant material. Regarding Auchenorrhyncha, at least *Toya propinqua*, *Philaenus spumarius*, *Evacanthus interruptus*, *Edwardsiana rosae* and *Ribautiana ulmi* are likely to have been introduced to Iceland by men during the last decades, likely on imported plant material. Much of this ongoing introduction of “hitchhikers” around the world is not detected because there are few means of control and that many of the individuals introduced belong to species that already exists on the actual territory, and thus can “hide in the masses”. On an isolated landmass like Iceland with a very poor fauna, “hitchhikers” would have a high probability of being species new to the territory. At the same time, due to the poor fauna, there is high niche availability and a low amount of controlling factors (like predators and parasites) that could facilitate establishment of new species. Considering that tourism is the second largest industry in Iceland, after agriculture, with both industries being known for potentially enhancing insect-introductions, the rate of introductions of new

species into Iceland would be high and could be of both Palearctic and Nearctic origin. One example is that several insect species found on Iceland the past years have a Nearctic origin that could be due to the past presence of US military forces at the Naval Air Station Keflavik (G. Söderman pers. comm.). Other examples could be the Holarctic spider *Micaria pulicaria* (Sundevall, 1831), the European spider *Theonoe minutissima* (O. P.-Cambridge, 1879) and the European millipede *Unciger foetidus* (C.L.Koch, 1838) that according to Bengtson & Hauge (2007) could be suspected being introduced to Iceland with camping equipment (and at least the two latter species could be characterized as synantropic). As found in Norway (e.g. Ødegaard & Endrestøl 2007, Endrestøl 2008, Hagen *et al.* 2012), it is likely that the insect fauna on Iceland will increase with increased import of plant material and increasing tourism.

It is surprising that so few species of Auchenorrhyncha have been established on Iceland so far, taking into account the increased rate of travel and plant import the last decades. On Iceland, the harsh climate could account for some of this resilience, even though a great number of species can be found under the same climatic conditions in other countries (e.g. Norway). The climate on Iceland is though changing towards a warmer climate. From 1975 to 2008 Iceland has warmed by about 1.2°C (Björnsson & Gíslason 2010). The effect of climate change seen on Iceland have large impacts on the landscape, being a combination of glacier retreat, forest growth at higher altitude, increased productivity of plants and increased production of grains (Björnsson & Gíslason 2010). That would also facilitate arthropod establishment both because of warmer climate, but also because of more available habitats and niches.

It can be concluded that the Icelandic fauna of Auchenorrhyncha is still incomplete, with eight established species. Four can be considered common or well distributed (from most to least common: *Macrosteles laevis*, *Jassargus pseudocellaris*, *Cicadula quadrinotata*, *Javesella pellucida*) and four can still be considered rare with few localities or distributed only in the south

(*Philaenus spumarius*, *Evacanthus interruptus*, *Edwardsiana rosae*, *Ribautiana ulmi*), possibly due to an anthropochore introduction during the last decades. Iceland is likely to experience an increasing rate of hopper-hitchhikers due to increased travel and plant-import, and the probability that these new species will establish population on Iceland is increasing due to climate change.

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## References

- Bengtson, S.-A. 2007. On Icelandic terrestrial arthropods and soil fauna. Introduction. *Insect Systematics & Evolution Supplement* 64, 3–4.
- Bengtson, S.-A. & Hauge, E. 2007. Spiders in Iceland: distributions, species richness, and faunal changes. *Insect Systematics & Evolution Supplement* 64, 97–120
- Björnsson, H. & Gíslason, S. 2010. *Climate change in Iceland*. Icelandic Communities Adapting to Climate Change? Clim-ATIC workshop Copenhagen 17 Feb 2010. <http://www.clim-atic.org/>
- della Giustina, W. & Balasse, H. 1999. Gone with the wind: Homoptera Auchenorrhyncha collected by the French network of suction traps in 1994. *Marburger entomologische Publikationen* 3(1), 7–42.
- Downes, J.A. 1988. The Post-Glacial Colonization of the North Atlantic Islands. *Memoirs of the Entomological Society of Canada* 144, 55–92.
- Endrestøl, A. 2008. Hoppers on Black Poplars – The Auchenorrhyncha fauna on *Populus nigra* in Norway. *Norwegian Journal of Entomology* 55, 137–148.
- Endrestøl, A. 2013. Et bidrag til Trænas insektfauna. *Insekt-Nytt* (submitted).
- Fennah, R.G. 1971. Insects of Micronesia. Homoptera: Fulgoroidea. Supplement. *Insects of Micronesia* 6(8), 563–609.
- Fjellberg, A. 2007. Icelandic Collembola – revised checklist and general comments. *Insect Systematics*



- & *Evolution Supplement* 64, 45–60.
- Gratton, C., Donaldson, J. & Vander Zanden, M.J. 2008. Ecosystem Linkages Between Lakes and the Surrounding Terrestrial Landscape in Northeast Iceland. *Ecosystems* 11, 764–774.
- Guðleifsson, B.E. & Bjarnadóttir, B. 2002. List of invertebrates collected in pitfall traps in hayfields and pastures in Northern-Iceland. *Icelandic Agricultural Sciences* 15, 27–30.
- Hagen, D., Endrestøl, A., Hanssen, O., Often, A., Skarpaas, O., Staverløkk, A. & Ødegaard, F. 2012. Alien species. Mapping and monitoring of “horticultural import” as a vector for invasion. *NINA Report* 915. 73 pp. In Norwegian.
- Heie, O. 1964. Aphids collected in Iceland in August, 1961. (Homopt., Aphididae). *Entomologiske meddelelser* 32, 220–235.
- Koponen, S. 1980. Herbivorous insects of the birch in Iceland. *Annales Universitatis Turkuensis Series A II Biologica-Geographica-Geologica* 63, 7–12.
- Kula, E. 2002. The leafhopper fauna in birch (*Betula pendula* Roth) stands. *Journal of Forest Science* 48 (8), 351–360.
- Langdon, R.F.N. 1954. The Origin and Distribution of *Cynodon dactylon* (L.) Pers. The University of Queensland Papers, Department of Botany 4, 41–44.
- Lid, J. & Lid, D.T. 2005. *Norsk flora*. 7. utgåva. Red. Reidar Elven. Det Norske Samlaget, Oslo.
- Lindroth, C.H., Andersson, H., Bödvardsson, N.H. & Richter, S.H. 1973. Surtsey, Iceland. The development of a new fauna, 1963–1970. Terrestrial invertebrates. *Entomologica Scandinavica Supplement* 5. 280 pp
- Lindroth, C.H. 1931. *Die Insektenfauna Islands und ihre problem*. Inaugural-Dissertation. Almqvist & Wiksellens boktryckeri AB, Uppsala. 599 pp.
- Manson, P.B. 1890. Insects and Arachnida captured in Iceland in 1889. *Entomologist's Monthly Magazine* XXVI, 198–200.
- ME/IINH (Ministry for the Environment/ The Icelandic Institute of Natural History) 2001. Biological Diversity in Iceland. National Report of the Convention on Biological Diversity. Reykjavik.
- Metcalf, Z.P. 1968. *General Catalogue of the Homoptera. Fascicle VI. Cicadelloidea. Part 10. Euscelidae*. U.S. Department of Agriculture, Agriculture Research Service, Washington, D.C. 2074 pp.
- Mifsud D., Cocquemot 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. et al. (eds) 2010. Alien terrestrial arthropods of Europe. *BioRisk* 4(1), 511–552.
- Morris, M.G. 1990. The Hemiptera of two sown calcareous grasslands. 1. Colonization and early succession. *Journal of Applied Ecology* 27, 367–378.
- Nast, J. 1972. *Palaeartic Auchenorrhyncha (Homoptera). An annotated check list*. Polish Scientific Publications, Warszawa. 550 pp.
- Nast, J. 1987. The Auchenorrhyncha (Homoptera) of Europe. *Annales Zoologici Polska Akademia Nauk* 40, 535–662.
- Nickel, H. & Ahtziger, R. 2005. Do they ever come back? Responses of leafhopper communities to extensification of land use. *Journal of Insect Conservation* 9, 319–333.
- Nickel, H. 2003. *The Leafhoppers and Planthoppers of Germany (Hemiptera, Auchenorrhyncha): Patterns and strategies in a highly diverse group of phytophagous insects*. 460 pp. Pensoft Publishers, Sofia-Moscow & Goecke & Evers, Keltern.
- Ødegaard, F. & Endrestøl, A. 2007. Establishment and range expansion of some new Heteroptera (Hemiptera) in Norway. *Norwegian Journal of Entomology* 54, 117–124.
- Ólafsson, E. & Ingimarsdóttir, M. 2009. The land-invertebrate fauna on Surtsey during 2002–2006. *Surtsey Research* 12, 113–128.
- Ólafsson, E. 1978. The development of the land-arthropod fauna on Surtsey, Iceland, during 1971–1976 with notes on terrestrial Oligochaeta. *Surtsey Research Progress Report VIII*, 41–46.
- Ólafsson, E. 1982. The status of the land-arthropod fauna on Surtsey, Iceland, in summer 1981. *Surtsey Research Progress Report* 9, 68–72.
- Ólafsson, E. 1991. Íslenskt skordýratil. *Fjölrit Náttúrufræðistofnunar* 17. 69 pp.
- Ólafsson, E. 2011. Hvanntifa - *Evacanthus interruptus* (Linnaeus, 1758). Náttúrufræðistofnun Íslands. Published online: <http://www.ni.is/poddur/nattura/poddur/nr/13670> [accessed: December 2012]
- Ossiannilsson, F. 1978. The Auchenorrhyncha (Homoptera) of Fennoscandia and Denmark. *Fauna Entomologica Scandinavica* 7: 1, 1–222.
- Ossiannilsson, F. 1981. The Auchenorrhyncha (Homoptera) of Fennoscandia and Denmark. *Fauna Entomologica Scandinavica* 7: 2, 223–593.
- Ossiannilsson, F. 1947. Om C.H. Lindroths isländska stritar. *Entomologisk Tidskrift* 68, 127–128
- Ossiannilsson, F. 1948. Ett bidrag till kännedomen om Islands stritfauna (Hemiptera Homoptera Auchenorrhyncha). *Entomologiske meddelelser*

XXV 1948, 249–251.

- Raatikainen, M. & Ylönen, H. 1988. Zikadenfauna verschiedener Biotope Nordfinlands und Nordnorwegens. *Annales Entomologici Fennici* 54, 73–88.
- Remane, R. 2005. Zur Zikadenfauna Islands, einer nur geologisch „alten“ Vulkaninsel: Analyse eines 2001 von Dr. M. v. Tschirnhaus gesammelten Materials (Insecta Rhyncota Auchenorrhyncha). *Marburger entomologische Publikationen* 3(3), 111–123.
- Rundgren, S. 2007. Glacial survival, post-glacial immigration, and a millennium of human impact: On search for a biogeography of Iceland. *Insect Systematics & Evolution Supplement* 64, 5–44.
- Sadler, J.P. 1991. Beetles, boats and biogeography. Insect invaders of the North Atlantic. *Acta Archaeologica* 61, 199–211.
- Söderman, G., Gillerfors, G. & Endrestöl, A. 2009. An annotated catalogue of the Auchenorrhyncha of Northern Europe (Insecta, Hemiptera: Fulgoro-morpha et Cicadomorpha). *Cicadina* 10, 33–69.
- Staudinger, O. 1857. Reise nach Island zu entomologischen Zwecken unternommen. *Entomologische Zeitung* 18, 209–289.
- Webb, M.D. 1975. Fulgoroidea from Aldabra, Astove, and Cosmoledo Atolls, collected by the Royal Society Expedition 1967–68 (Hemiptera-Homoptera). *Atoll Research Bulletin* 177, 1–10.

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