

## First records of *Chlamydatus saltitans* (Fallén, 1807) and *Tupiocoris rhododendri* (Dolling, 1972) (Heteroptera, Miridae) and notes on other rare and alien true bugs in Switzerland

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An extensive arthropod survey of 85 urban gardens in the city of Zurich revealed the presence of two new true bug species for Switzerland, the European *Chlamydatus saltitans* (Fallén, 1807) and the North American *Tupiocoris rhododendri* (Dolling, 1972). Furthermore, we confirm a formerly doubted Swiss record of the Mediterranean *Orius laevigatus laevigatus* (Fieber, 1860) and record the Mediterranean *Macrolophus glaucescens* (Fieber, 1858) and *M. melanotoma* (A. Costa, 1853) for the first time north of the Western Alps. We also report new records north of the Alps of the thermophiles *Nezara viridula* (Linnaeus, 1758) and *Liorhyssus hyalinus* (Fabricius, 1794), and give new records of the alien *Halymorpha halys* (Stål, 1855), *Leptoglossus occidentalis* (Heidemann, 1910) and *Stephanitis takeyai* (Drake & Maa, 1955) and the rare native *Ceratocombus coleoptratus* (Zetterstedt, 1819).

Keywords: distribution, first record, garden, Heteroptera, invasive, urban, Switzerland, Zurich

### INTRODUCTION

Rapid floral and faunal turnover is occurring worldwide due to human mediated environmental change (Sala *et al.* 2000). Hence, reporting species occurrences is important for evaluating extinction risks of threatened species and for early detection of potentially invasive organisms (Nichols & Williams 2006; Simberloff *et al.* 2013).

Cities are hotspots of species turnover. On the one hand, anthropogenic habitat disturbance, modification, loss and fragmentation lead to changes in richness and abundance of native species (McKinney 2008; Faeth *et al.* 2011; Turrini & Knop 2015). On the other hand, the increased movement of persons and exchange of goods favour the introduction of non-native species (Rebele 1994; Kowarik 2011).

Gardens are a major component of urban green space and may therefore play an important role in shaping urban biodiversity (Gaston 2005; Goddard *et al.* 2010). Whereas their importance as sources of alien plant species is recognized (Hodkinson & Thompson 1997; Smith *et al.* 2006a), fewer studies have focused on garden arthropods (Owen 1991; Smith *et al.* 2006b, 2006c; Goddard *et al.* 2010; Sattler *et*

*al.* 2010; Germann *et al.* 2015). This contrasts with their key role as both pests and beneficial organisms. There have been particularly few in-depth studies on true bugs (Heteroptera) in gardens and in urban areas in general (McKinney 2008; Raupp *et al.* 2010; but see Smith *et al.* 2006b, 2006c; Turrini & Knop 2015).

The lack of data on the diversity and distribution of Heteroptera in anthropogenic ecosystems is all the more surprising since several true bug species are considered to be agricultural and horticultural pests (Kenis 2005; Rabitsch 2010). Their close association with plants favours their accidental introduction, in particular with the readily available ornamental plants and non-native forest trees (Rabitsch 2010). In consequence, alien true bugs have been increasingly reported across Europe (Rabitsch 2010). In Switzerland, however, data on both native and alien bug species remain incomplete (Kenis 2005).

The aim of this paper is to report first records of species of true bugs in Switzerland and to report first records north of the Western Alps of rare and alien species, as well as true bugs, that had previously only been found in other parts of Switzerland.

#### MATERIAL AND METHODS

An arthropod survey was conducted within the framework of the Sinergia SNF (Swiss National Foundation) project BetterGardens ([www.bettergardens.ch](http://www.bettergardens.ch)) led by the Research Institute of Organic Agriculture (FiBL) in collaboration with the Swiss Federal Research Institute for Forest Snow and Landscape (WSL). The survey was carried out in 43 private gardens, 41 allotment garden lots and one school garden, which were located across the entire city of Zurich, Switzerland. Garden lots were chosen along a) a management intensity and structural complexity gradient, ranging from extensive and structurally rich to intensive and structurally poor; and b) along an urbanization gradient, ranging from the city centre to the urban fringe. Within each garden, surface dwelling arthropods were caught using six 70 mm diameter pitfall traps covered with transparent roofs as rain protection. Traps were placed in two of the most abundant garden habitats, i.e. lawn, flower- or vegetable-beds and berry cultivations. Within each habitat, traps were arranged in an equilateral triangle with a side length of one meter. Alternatively, traps were placed in a single row of one-metre length, where the arrangement in triangles was not possible. In addition, flying arthropods were sampled with three one-litre bowl traps fixed on a triangular wooden pole (Buri *et al.* 2014), which was placed in a central and unshaded position in each garden. Each bowl was sprayed with either UV-bright blue, white or yellow paint (Sparvar Leuchtfarbe, Spray-Color GmbH, Merzenich, Germany, details in Westphal *et al.* 2008) and three quarters filled with 0.2 % Rocima solution (bactericide and fungicide from Acima, Buchs, Switzerland). The traps were continuously open between May 18th and August 19th 2015 and emptied weekly. Arthropods were sorted into specific taxa and sent to specialists for further determination. Heteroptera were identified by Ralf Heckmann. Vouchers of the species new to Switzerland are deposited temporarily in his reference collection.

In the following section, garden type, geographical coordinates, altitude, date of collection, number of individuals, sex, trap type and, for pitfall traps, the trap location are given. Finally, the existing literature is reviewed and the probable native or alien status is discussed.

## RESULTS AND DISCUSSION

## CERATOCOMBIDAE

*Ceratocombus coleopratus* (Zetterstedt, 1819)

1. private garden; N 47°23'09.5", E 8°28'43.6"; 414 m; 1<sup>st</sup> June 2015; 1 ♂; pitfall trap in lawn.
2. private garden; N 47°23'02.6", E 8°29'55.7"; 405 m; 8<sup>th</sup> June 2015; 1 ♂; pitfall trap in lawn.

*Ceratocombus coleopratus* is considered to be relatively rare in Switzerland and has previously been recorded in eight Cantons. Here we present the second and third records of this species in the Canton of Zurich (Hollier *et al.* 2014). *C. coleopratus* lives on the soil surface among mosses and litter and is found at forest margins, in heaths and in swamps (Wachmann *et al.* 2006). Thus, recording it in intensively managed garden lawns situated in residential areas of the city of Zurich is surprising. While this observation shows that the species can disperse into urban areas, it remains unclear whether it is able to naturalize there. Furthermore, this inconspicuous species may be considered to be rare due to observer bias rather than natural rarity (Heckmann & Rieger 2001; Hollier *et al.* 2014).

## TINGIDAE

*Stephanitis takeyai* (Drake & Maa, 1955) (Fig. 1)

1. allotment «Wehrenbach»; N 47°21'19.6", E 8°34'40.4"; 480 m; 9<sup>th</sup> June 2015; 1 ♂; bowl trap.
2. private garden; N 47°22'01.2", E 8°32'03.7"; 409 m; 9<sup>th</sup> June 2015; 1 ♂; bowl trap.

These are, to our knowledge, only the second and third records of *Stephanitis takeyai* in Switzerland, where the species was first found in the Canton of St. Gallen (Megróz 2008). It is native to Japan and feeds on Ericaceae; especially *Pieris japonica*, which is a widespread ornamental plant in Europe (Rabitsch 2008). Thus it is considered to be a horticultural pest and probably disperses with the commercial sale of garden plants. In Europe, *S. takeyai* was first recorded in the Netherlands in 1994 (Aukema 1996) and has subsequently expanded to become established in Austria, Belgium, the Czech Republic, France, Germany, Great Britain, Italy, the Netherlands, Poland and Switzerland (Aukema *et al.* 2013). The occurrence in Hungary was supplemented by Véték *et al.* (2012). Although few records currently exist in Switzerland, it is likely that the species is naturalizing due to the widespread horticultural use of exotic Ericaceae.

## MIRIDAE

*Macrolophus glaucescens* (Fieber, 1858)

1. allotment «Stotzstrasse»; N 47°19'50.7", E 8°30'36.1"; 510 m; 27<sup>th</sup> July 2015; 1 ♀; bowl trap.

This is the first record of *Macrolophus glaucescens* north of the Western Alps. This Mediterranean species reaches the northern edge of its distribution range in southern Switzerland (Canton Ticino), eastern Austria, and Hungary (Göllner-Scheiding & Rezbanyai-Reser 1992). In the Czech Republic, the species is considered to have been introduced, probably together with its host plants (Šefrová & Laštůvka 2005; Kment 2006). *M. glaucescens* differs morphologically from the Mediterranean



Fig. 1. A male *Stephanitis takeyai* (Drake & Maa, 1955) from Zurich sampled during the BetterGardens arthropod survey. The body-length is slightly below 4 mm. The main difference to European species of the genus is the larger and more rounded neck bubble. Photograph by C. Rieger.

*M. melanotoma* and the native *M. pygmaeus* by having a much broader black spot behind the eye and a shorter 2<sup>nd</sup> antennal segment with respect to the width of the pronotum. In its native area, *M. glaucescens* is associated with *Echinops sphaerocephalus* (Asteraceae), a ruderal and thermophilous plant native to Eurasia (Wachmann *et al.* 2004). This plant species has a great ornamental value and is therefore frequently cultivated in gardens (D. Frey, personal observation). In Zurich, it is likely that *M. glaucescens* has been introduced accidentally, with its presence favoured by the frequent cultivation of *Echinops*. Yet it remains unclear whether *M. glaucescens* is currently naturalized north of the Swiss Alps.

***Macrolophus melanotoma* (A. Costa, 1853)**

1. allotment «Stotzstrasse»; N 47°19'50.7", E 8°30'35.9"; 510 m; 20<sup>th</sup> July 2015; 1 ♂ and 1 nymph; pitfall trap in vegetable bed.
2. allotment «Wehrenbach»; N 47°21'23.6", E 8°34'38.0"; 492 m; 21<sup>st</sup> July 2015; 1 ♂; pitfall trap in vegetable bed.
3. allotment «Susenberg»; N 47°23'02.0", E 8°33'44.6"; 623 m; 18<sup>th</sup> August 2015; 2 ♀ ♀; bowl trap.
4. private garden; N 47°21'11.9", E 8°34'41.3"; 494 m; 18<sup>th</sup> August 2015; 1 ♀; bowl trap.
5. allotment «Wydäckerring»; N 47°22'14.9", E 8°29'45.5"; 431 m; 10<sup>th</sup> August 2015; 1 ♀; bowl trap.
6. allotment «Hagenbuchrain»; N 47°22'13.1", E 8°29'02.0"; 478 m; 17<sup>th</sup> August 2015; 1 ♀; bowl trap.
7. allotment «Käferberg»; N 47°24'02.9", E 8°31'25.9"; 520 m; 10<sup>th</sup> August 2015; 1 ♀; bowl trap.
8. allotment «Steinkluppe»; N 47°24'09.0", E 8°32'17.8"; 460 m; 13<sup>th</sup> July 2015; 1 ♀; bowl trap.

These are the first records of the Mediterranean bug *Macrolophus melanotoma* north of the Alps in Switzerland. In our investigation the species was found even more frequently than its native congener *M. pygmaeus*. In Switzerland, *M. melanotoma* has been recurrently recorded in the Southern Alpine Canton Ticino, where it occurs sporadically (Göllner-Scheiding & Rezbanyai-Reser 1992; Otto & Rezbanyai-Reser 1996; Göllner-Scheiding & Rezbanyai-Reser 2000). The distribution records given in DAISIE (Delivering Alien Invasive Species Inventories for Europe, 2016) for North and Central Europe (including the arctic island of Svalbard) are doubtful and may pertain to glasshouse observations or may be due to a confusion with *M. pygmaeus* or to a software-error. No peer reviewed publications reporting *M. melanotoma* from one of these countries exist to our knowledge. *M. melanotoma* differs morphologically from *M. pygmaeus* by having a narrower black spot behind the eye, shorter 2<sup>nd</sup> antennal segments (Wagner 1970-71) and shorter middle-tibiae (R. Heckmann, personal observation). However, *M. melanotoma* remains difficult to distinguish from *M. pygmaeus*, and the two species are often confused (Castañé *et al.* 2013). Both *M. pygmaeus* and *M. melanotoma* are used as biocontrol agents in greenhouse cultures in Europe (Rabitsch 2008). Although, in Switzerland, only the use of the native *M. pygmaeus* is approved (Bundesamt für Landwirtschaft 2016), a mistaken use of *M. melanotoma* in cultures could have led to its introduction. Alternatively, the species could have been accidentally introduced with the international trade of plants or with the intensive movement of people and goods between Switzerland and Italy. The numerous records of *M. melanotoma* across the entire city of Zurich suggest that the species is naturalizing, probably favoured by the warmer climatic conditions of the urban ecosystem. Hence, to our knowledge, this is the first reported established population of *M. melanotoma* north of the Alps.

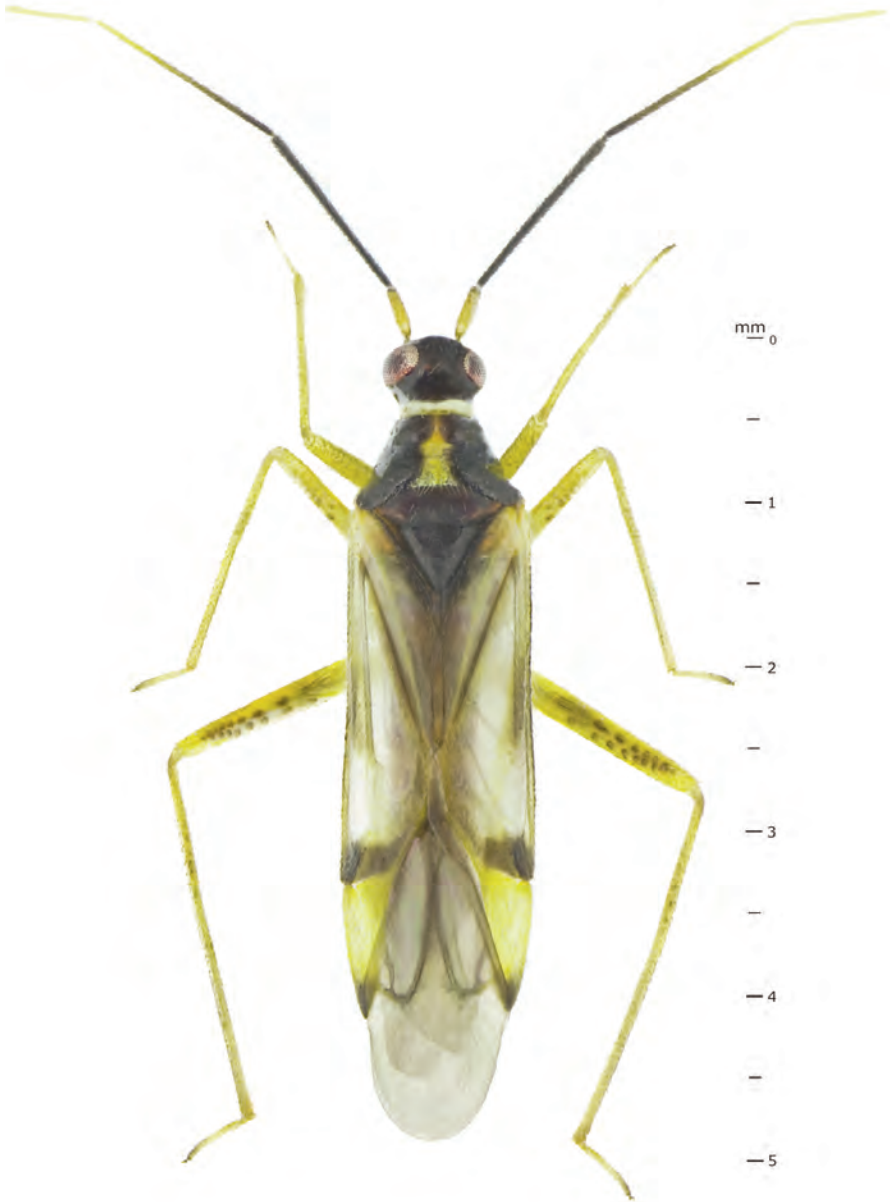


Fig. 2. A female *Tupiocoris rhododendri* (Dolling, 1972) from the Island of Mainau (Baden-Württemberg). Collected by R. Heckmann, photograph by G. Strauß.



***Tupiocoris rhododendri*** (Dolling, 1972) (Fig. 2)

1. private garden; N 47°24'56.6", E 8°31'31.9"; 446 m; 22<sup>nd</sup> June 2015; 1 ♂; bowl trap.

This is the first record of the North American *Tupiocoris rhododendri* in Switzerland. Although native to the eastern coast of North America, the taxon was first described based on animals collected in Great Britain, where it was accidentally introduced (Dolling 1972). The species subsequently appeared in the Netherlands (Aukema *et al.* 2005), Germany (Schrameyer 2004), Belgium (Aukema *et al.* 2007) and Denmark (Aukema *et al.* 2013). The presence of *T. rhododendri* in Switzerland is not surprising because it is already naturalized in southern Germany (Baden-Württemberg) (Aukema *et al.* 2005; R. Heckmann personal observations). As with *Stephanitis takeyai*, it is found on *Rhododendron* cultivars, where it feeds on aphids. Due to the widespread cultivation of *Rhododendron* in gardens, its apparently great dispersal capacity and the frequent occurrence in adjacent Germany, it is likely that *T. rhododendri* is also naturalizing in Switzerland.

***Chlamydatius saltitans*** (Fallén, 1807) (Fig. 3)

1. allotment «Dreiwiesen»; N 47°22'47.5", E 8°34'21.0"; 604 m; 21<sup>st</sup> July 2015; 1 ♂; pitfall trap in lawn.
2. private garden; N 47°24'43.0", E 8°33'00.0"; 430 m; 25<sup>th</sup> May, 8<sup>th</sup> June, 3<sup>rd</sup> August 2015; 10 ♂♂; pitfall trap in lawn.
3. private garden; N 47°24'43.1", E 8°33'00.4"; 430 m; 29<sup>th</sup> June 2015; 1 ♀ and 1 ♂; pitfall trap in flowerbed.

These are the first published records of *Chlamydatius saltitans* in Switzerland. Note that the species was already found in 2003 in the Canton of Basel-Land during another WSL-arthropod survey (WSL, unpublished data). These findings are, however, not unexpected because the species is native to Europe and present in all surrounding countries, with the exception of Liechtenstein (Aukema & Rieger 1999). *C. saltitans* lives in open vegetation on dry, sandy and gravelly soils. Unusually for Miridae, the species is able to cover considerable distances by jumping and thus can be easily spotted (Wachmann *et al.* 2004). In Baden-Württemberg (southern Germany), the species was found among *Achillea* sp. (Asteraceae) plants as well as on green roofs dominated by *Sedum* (Crassulaceae) and *Saxifraga* (Saxifragaceae) (R. Heckmann, personal observations). Urban areas are rich in dry and open habitats so it is likely that *C. saltitans* has been overlooked in the City of Zurich.

## ANTHOCORIDAE

***Orius laevigatus laevigatus*** (Fieber, 1860) (Fig. 4)

1. allotment «Juchhof»; N 47°24'04.5", E 8°28'24.0"; 395 m; 14<sup>th</sup> July; 1 ♂; bowl trap.

This is the first confirmed record of *Orius laevigatus* in Switzerland. Even though females of the species have previously been found in the Canton Basel-Stadt, this record remained doubtful (Wyniger & Burckhardt 2003). A further Swiss record of the species, of which a specimen was deposited in the Zoological Museum of the University of Helsinki, Finland, lacks information about the location (Péricart 1972). It is notable that this record of *O. laevigatus* is one of 4425 *Orius* specimens determined during the BetterGardens arthropod survey. The taxonomic assignment



Fig. 3. A male *Chlamydatus saltitans* (Fallén, 1807) from Zurich sampled during the BetterGardens arthropod survey. The species can easily be distinguished from the other three Central European *Chlamydatus* species with its mat hemelytra, having parts of lighter colour and only a narrow rest of the membrane. Photograph by S. Mangili.



was confirmed by the careful control of the paramere, revealing the unique character of having two long parallel flagellums as shown in Péricart (1972). *Orius laevigatus* has an Atlanto-circummediterranean distribution, extending as far as northern Great Britain. It was not found in Northern Italy, Austria or Germany (Péricart 1972) but has recently been recorded for the first time in the Netherlands (Aukema & Loomans 2005). Since this inconspicuous taxon is difficult to identify, data deficiency currently hinders any assessment of its naturalization status in Switzerland.

## RHOPALIDAE

### *Liorhyssus hyalinus* (Fabricius, 1794)»

1. allotment «Freilager West»; N 47°22'46.5", E 8°29'03.1"; 418 m; 1<sup>st</sup>, 8<sup>th</sup> June 2015; 2 ♀♀, 1 ♂; bowl trap.
2. allotment «Burgwies»; N 47°21'30.9", E 8°34'23.0"; 461 m; 2<sup>nd</sup> June 2015; 1 ♀; bowl trap.
3. private garden; N 47°24'42.6", E 8°31'13.8"; 498 m; 9<sup>th</sup> June 2015; 1 ♀; bowl trap.
4. allotment «Steinkluppe»; N 47°24'09.0", E 8°32'17.8"; 460 m; 15<sup>th</sup>, 22<sup>nd</sup> June 2015; 1 ♀, 1 ♂; bowl trap.
5. allotment «Wydäckerring»; N 47°22'14.9", E 8°29'45.5"; 431 m; 15<sup>th</sup> June 2015; 1 ♂; bowl trap.
6. allotment «Köschenrütistrasse»; N 47°25'35.1", E 8°32'12.4"; 434 m; 23<sup>rd</sup> June, 11<sup>th</sup> & 18<sup>th</sup> August 2015; 1 ♀ & 2 ♂♂; bowl trap.
7. allotment «Käferberg»; N 47°23'59.8", E 8°31'22.6"; 505 m; 6<sup>th</sup> July 2015; 1 ♀; bowl trap.
8. allotment «Herrenbergli»; N 47°23'38.3", E 8°28'06.0"; 525 m; 20<sup>th</sup> July 2015; 1 ♂; bowl trap.
9. allotment «Oberes Paradis»; N 47°19'57.2", E 8°31'28.1"; 485 m; 20<sup>th</sup> July 2015; 1 ♂; bowl trap.
10. allotment «Moos»; N 47°19'45.2", E 8°32'03.9"; 475 m; 20<sup>th</sup> July 2015; 2 ♂♂; bowl trap.
11. allotment «Stotzstrasse»; N 47°19'50.7", E 8°30'36.1"; 510 m; 20<sup>th</sup> July 2015; 1 ♂; bowl trap.
12. private garden; N 47°24'56.6", E 8°31'31.9"; 446 m; 20<sup>th</sup>, 27<sup>th</sup> July, 3<sup>rd</sup> August 2015; 2 ♀♀, 1 ♂; bowl trap.
13. private garden; N 47°20'07.4", E 8°30'58.6"; 454 m; 20<sup>th</sup> July 2015; 1 ♀; bowl trap.
14. allotment «Juchhof»; N 47°24'04.5", E 8°28'24.0"; 395 m; 21<sup>st</sup> July 2015; 1 ♀; bowl trap.
15. allotment «Susenberg»; N 47°23'02.0", E 8°33'44.6"; 623 m; 21<sup>st</sup> July 2015; 1 ♀; bowl trap.
16. allotment «Friedhof Ost»; N 47°22'19.4", E 8°30'32.4"; 418m; 27<sup>th</sup> July 2015; 1 ♂; bowl trap.
17. school garden «Schulhaus Wengi»; N 47°22'31.2", E 8°31'22.1"; 411 m; 28<sup>th</sup> July 2015; 1 ♀; bowl trap.
18. private garden; N 47°24'05.7", E 8°30'14.1"; 473 m; 28<sup>th</sup> July 2015; 1 ♀; bowl trap.
19. allotment «Allmend»; N 47°24'37.4", E 8°29'34.5"; 526 m; 3<sup>rd</sup> August 2015; 1 ♂; bowl trap.
20. allotment «Breitenstein»; N 47°23'38.7", E 8°30'57.4"; 401 m; 4<sup>th</sup> August 2015; 1 ♂; bowl trap.
21. private garden; N 47°24'41.0", E 8°32'54.9"; 433 m; 10<sup>th</sup> August 2015; 1 ♀; bowl trap.
22. allotment «Probstei»; N 47°23'59.9", E 8°34'46.3"; 449 m; 11<sup>th</sup> August 2015; 1 ♀; bowl trap.
23. private garden; N 47°24'24.6", E 8°34'36.3"; 427 m; 11<sup>th</sup> August 2015; 1 ♀; bowl trap.
24. private garden; N 47°21'08.9", E 8°34'55.8"; 511 m; 11<sup>th</sup> August 2015; 1 ♀; bowl trap.
25. allotment «Friesenbergstrasse»; N 47°21'43.4", E 8°29'56.1"; 495 m; 17<sup>th</sup> August 2015; 1 ♀; bowl trap.
26. allotment «Juchhof»; N 47°23'54.0", E 8°28'39.1"; 395 m; 18<sup>th</sup> August 2015; 1 ♂; bowl trap.

*Liorhyssus hyalinus* has a cosmopolitan distribution in tropical and subtropical regions (Wachmann *et al.* 2007). In Europe, and probably favoured by global warming, *L. hyalinus* is becoming more frequent in Baden-Württemberg in southern Germany (Wachmann *et al.* 2007; R. Heckmann, personal observation) and its range is currently expanding as far north as Scandinavia (Hradil *et al.* 2007; Wachmann *et al.* 2007). In Switzerland, although historical records exist from the Cantons Bern, Vaud and Geneva (Frey-Gessner 1866a, 1866b), *L. hyalinus* has previously only been recorded in the southern and central Alpine Cantons Valais and Ticino, both of which are characterised by the abundance of xeric and warm habitats (Frey-Gessner 1866a, 1866b; Delarze & Dethier 1988; Giacalone *et al.* 2002; Göllner-Scheidt & Rezbanyai-Reser 2000; Witschi & Zettel 2002). Its frequency suggests that



Fig. 4. A male *Orius laevigatus laevigatus* (Fieber, 1860) from Zurich sampled during the Better-Gardens arthropod survey. The species can be morphologically distinguished from species of the *Heterorius* subgenus by the presence of black setae on the edges of the pronotum, and from *Orius niger* by the pale middle-legs and the slightly obscured hind-legs, which are all black in *O. niger*. Photograph by S. Mangili.

*L. hyalinus* is naturalized in Zurich, which is probably favoured by the heat island effect of the city and by the abundance of xeric habitats.

## COREIDAE

### *Leptoglossus occidentalis* (Heidemann, 1910)

1. allotment «Freilager West»; N 47°22'46.5", E 8°29'03.1"; 418 m; 17<sup>th</sup> August 2015; 1 nymph; bowl trap.

The North American «western conifer seed bug» *Leptoglossus occidentalis* was accidentally introduced to Europe in 1999 and was recorded for the first time in Switzerland in the Canton Ticino in 2001, where it is naturalized today (Colombi & Brunetti 2002; Wyniger 2007). The species further naturalized in the Canton Valais, and single individuals have also been found in the Cantons Basel-Stadt, Nidwalden, Zurich and Thurgau (Wyniger 2007; Schmidt *et al.* 2010; Heckmann & Blöchlinger 2013). The species has spread across Europe and is currently present in almost all countries (Aukema & Rieger 1999; Aukema *et al.* 2013). *L. occidentalis* can be easily identified by the conspicuous, partly leaf shaped hind legs. It is phytophagous and feeds on immature seeds and flowers of conifers. The species has a preference for Pinaceae, especially the genus *Pinus* and *Pseudotsuga menziesii*, but it has also been observed on *Abies*, *Cedrus*, *Juniperus* and *Picea* (Villa *et al.* 2001). Adults overwinter in wood crevices and under bark or similar structures. In autumn, they may enter buildings in large numbers and can become a nuisance pest (Wheeler 1992). In its native range, *L. occidentalis* is regarded as a pest and recent observations in southern European conifer forests show that there is also a serious potential threat in Europe (Luchi *et al.* 2012; Tamburini *et al.* 2012; Lesieur *et al.* 2014).

## PENTATOMIDAE

### *Halyomorpha halys* (Stål, 1855)

This East Asian bug was among the abundant and frequent bug species caught during the BetterGardens arthropod survey: 171 individuals (approx. 2 % of all true bugs captured) were caught in 55 gardens (approx. 65 % of all gardens surveyed) across the entire city (Fig. 5). This is notable because the species was first recorded in Switzerland only recently, which was also the first record in Europe (Wermelinger *et al.* 2008). *H. halys* was first discovered in the City of Zurich and has subsequently expanded (Wyniger & Kment 2010), mainly in Liechtenstein (Arnold 2009) and northern Switzerland (Haye *et al.* 2014; [www.halyomorphahalys.com](http://www.halyomorphahalys.com)). It has since been found in Germany (Heckmann 2012), France (Callot & Brua 2013), Italy (Maistrello *et al.* 2014), Hungary (Vétek *et al.* 2014), Greece (Milonas & Partsinevelos 2014), Austria (Rabitsch & Friebe 2015), Romania (Macavei *et al.* 2015) and Serbia (Šeat 2015). Taken together, these observations suggest that *H. halys* has a high potential for spreading and that it readily adapts to urban environments.

### *Nezara viridula* (Linnaeus, 1758)

1. private garden; N 47°22'53.1", E 8°30'05.3"; 408 m; 17<sup>th</sup> August 2015; 1 ♂; bowl trap.





Fig. 5. Occurrences and abundance of the alien true bug *Halyomorpha halys* (Stål, 1855) in the City of Zurich sampled during the BetterGardens arthropod survey between May 18th and August 19th 2015.

This is the first record of *Nezara viridula* in the Canton of Zurich. North of the Swiss Alps, this thermophilous species has been reported only in the Cantons of Basel-Stadt (Wyniger & Burckhardt 2003) and Basel-Land (Werner 2005), with numerous individuals and/or nymphs observed at these locations. Similar observations have been made in adjacent Germany (Baden-Württemberg), where the species has been reported, among others, from the goods station of Lörrach (R. Heckmann, personal observation). After the first accidental records in Baden-Württemberg (Rieger 1994; Voigt 1998), the later observations may indicate the beginning of a naturalization of the species in southern Germany and northern Switzerland. An historical designation as «*Nezara* Am. *S. prasina* L.» exists from the Canton of Graubünden (Killias 1874), but this record is probably due to a wrong synonymisation (Wyniger & Burckhardt 2003), since the taxon was not included in subsequent publications (Killias 1879). It is also possible that the individual was confused with the morphologically similar, and later reported, *Palomena prasina* (Killias 1879). South of the Swiss Alps, in the Canton Ticino, *N. viridula* has been reported frequently since the 19<sup>th</sup> century and is considered to be native there (Frey-Gessner 1863, 1866a, 1866b; De Carlini 1887; Göllner-Scheiding & Rezbanyai-Reser 1992, 2000; Otto 1992, 1996; Otto & Rezbanyai-Reser 1996; Giacalone *et al.* 2002). *N. viridula* has a cosmopolitan distribution in tropical and subtropical regions, where it is considered to be an agricultural pest because it feeds on immature fruits and seeds of crop plants (Panizzi 1997; Panizzi *et al.* 2000). In Europe *N. viridula* occurs in all Mediterranean countries and it is also established as an alien species in Great Britain, Belgium and northern Hungary (Aukema & Rieger 2009; Aukema *et al.* 2013). It is clearly shifting its range northwards in Europe, probably as a sign of climate change.

## CONCLUSION

The BetterGardens arthropod survey revealed the presence of two true bug species that are new to Switzerland and recorded several Mediterranean species for the first time in Northern Switzerland. These results are in line with the observation that urban areas are «ports of entry» for alien species (Rebele 1994; Kowarik 2011). Our results suggest that one important vector of such introductions may be the trade with ornamental plants (see also Trivellone *et al.* 2015 for leafhoppers). If so, urban gardens may represent a source of alien arthropods in urban ecosystems. The predominance of dry habitats in cities and the warmer climatic conditions with respect to the rural or natural surroundings, the «urban heat island effect» (Pickett *et al.* 2011), may subsequently favour the naturalization of such species. Whereas the introduction of alien species in cities is often perceived as a driver of biotic homogenization and associated loss of biodiversity (Knop 2016), we argue that the appearance of neobiota is an intrinsic property of urban ecosystems (Rebele 1994) and should not be interpreted as negative per se (Kowarik 2011; Marris 2011). In particular since there is increasing evidence that alien species also can deliver ecosystem functions and underlying ecosystem services in anthropogenic ecosystems (Ewel & Putz 2004; Hobbs *et al.* 2009; Kueffer & Kaiser-Bunbury 2014). Investigations should thus aim at studying possible impacts of such species, such as their roles and functions in urban trophic networks and community assemblages as well as their effects on city dwellers (Kowarik 2011).

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