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Research Article

First systematic inventory of the jumping plant lice of Luxembourg (Hemiptera, Sternorrhyncha, Psylloidea)

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Abstract

Psyllids (superfamily Psylloidea), also known as jumping plant lice, are a group of plant-sap sucking Hemiptera having significant pest status for crops, forest trees and ornamental plants. Only seven species of psyllids have been recorded in Luxembourg so far. An additional group of seven species has been recorded exclusively, based on the findings of their galls or specific plant deformations; but no mention exists in literature on the actual collection of the inducing insect in Luxembourg. To fill this knowledge gap, field collections were carried out during the years 2019-2020. In addition, samples from 1999-2000 stored in the wet collection of the Musée National d'Histoire Naturelle de Luxembourg were studied. This research, in combination with information coming from literature, allowed us to list 48 species of the families Aphalaridae (5 species), Liviidae (5), Psyllidae (24) and Triozidae (14), though the presence of one species within the last family (*Trioza rhamni*) needs to be confirmed. Brief information on geographical distribution, biology and (if available) illustrations of diagnostic characters are provided on the psyllid species detected in Luxembourg so far.

Keywords

Psyllids, Luxembourg, species diversity, biology, ecology

Introduction

Psyllids (superfamily Psylloidea), also known as jumping plant lice, are a group of plant-sap sucking Hemiptera which may have significant pest status for crops, forest trees and ornamental plants due to their copious production of honeydew, their frequent coating with waxy secretions (smearing the canopy of infested plants), the injection of toxic saliva (causing necrosis, deformations or galls) and, last but not least, their responsibility in transmitting many pathogens to plants, mainly bacteria and especially phytoplasmas (Hodkinson 1974, Hodkinson 1984, Burckhardt 1994a, Burckhardt 2005, Munyaneza 2010, Haapalainen 2014, Ben Othmen et al. 2019). In spite of their importance, psyllids are still poorly known in Luxembourg; this is why their species composition, diversity and distribution need to be properly assessed.

According to literature, *Spanioneura buxi* (Linnaeus), *S. fonscolombii* Foerster and *Trichochermes walkeri* (Foerster) are the only species of Psylloidea whose presence in Luxembourg has been reported till now based on adult specimens (Baugnée 2001, O'Connor and Malumphy 2011, Eickermann et al. 2020). However, additional records of psyllids can be also considered, deriving from rich cecidological literature dealing with the presence of plants with galls or deformations probably induced by Psylloidea. Yet, these records need to be confirmed by finding the insects to which the effects on plants are attributed. In particular, Lambinon and Schneider (2004) investigated deformations caused to plants by *Cacopsylla mali* (Schmidberger), *C. melanoneura* (Foerster), *Livia junci* (Schrank), *Spanioneura buxi* (Linnaeus), *Psyllopsis fraxini* (Linnaeus), *Lauritrioza alacris* (Flor), *Trioza flavipennis* Foerster, *T. remota* Foerster and *T. rhamni* (Schrank), in addition to the ones caused by *T. walkeri* (already reported for Luxembourg). For *P. fraxini*, the authors reported the rear of the psyllid from leaf galls collected on *Fraxinus excelsior* L. from many localities in Luxembourg (Bettembourg, Bonnevoie, Bridel and Kleinbettingen). Similarly, they reported findings of eggs of *T. flavipennis* in pit galls found on leaves of *Aegopodium podagraria* L. For all remaining cecidia described, however, no indication was given on the finding of the causing insect. Deformations caused by three additional psyllid species [*Camarotoscena speciosa* (Flor), *Trioza centranthi* (Vallot) and *T. urticae* (Linnaeus)] were reported by Lambinon et al. (2012), who did not mention any finding of their causing insects. Deformations by *L. alacris* and *T. centranthi* and galls by *T. remota* were reported again by Schneider (2016) from new localities in Luxembourg. Only for *T. remota*, the author referred to the presence of an insect immature within each pit gall found on leaves of *Quercus petraea* (Matt.) Liebl. and *Q. robur* L. Cecidia caused by *C. speciosa*, *L. junci* and *T. flavipennis* were reported again by Burton et al. (2019), who explicitly mentioned for the first time the finding of nymphs of *C. speciosa* and their abundant wax secretion on the leaf deformations of *Populus nigra* L. and confirmed the occurrence of a *T. flavipennis* nymph in the concave leaf gall produced on *A. podagraria*.

Considering the available literature data, seven psyllid species were known for Luxembourg, based on observations of specimens (*Camarotoscena speciosa*, *Psyllopsis fraxini*, *Spanioneura buxi*, *S. fonscolombii*, *Trichochermes walkeri*, *Trioza flavipennis* and *T. remota*) and seven further species were only recorded, based on the findings of galls or deformations they cause to plants (*Cacopsylla mali*, *C. melanoneura*, *Livia junci*, *Lauritrioza alacris*, *Trioza centranthi*, *T. rhamni* and *T. urticae*).

Even when hypothesising that all psyllid records, based on findings of their galls, will be confirmed by collection of insect specimens, still the number of psyllid species presently known in Luxembourg is remarkably low, for example, when compared with faunas of neighbouring countries in the "Benelux" region": 69 species known in The Netherlands (den Bieman et al. 2019); at least 56 species in Belgium (Ouvrard 2021). Present knowledge on the psyllid fauna of Luxembourg appears weak also when considering the richness and composition of the regional flora (especially for plant groups that may host psyllid species), as assessed by Lambinon and Verloove (2012). The lack of a systematic inventory of the psyllids of Luxembourg, in combination with their ecological and partly agricultural significance, gave rise to the current manuscript.

Data resources

Study area

The Grand Duchy of Luxembourg is characterised by a temperate, semi-oceanic climate. Even though the area of the country is small (2,586 km^2) with a maximal Euclidean distance of 82 km from north to south and 57 km from east to west, Luxembourg offers quite diverse physiogeography with different climatological characteristics, associated vegetation and anthropogenic land use. Traditionally, Luxembourg is divided into two main ecoregions, the Oesling (32% of total area) and the Gutland (68%) (Dohet et al. 2008). The Oesling is located in the north of the country, in the border region between Belgium and Luxembourg – and is the eastern part of woody mountains called the Ardennes with highest altitude of 450 m a.s.l. Annual precipitation ranges from 800–1000 mm and annual mean air temperature is 7.5°C (Goergen et al. 2013). The region is characterised by meadows, pastures and forests of coniferous/deciduous trees. The Gutland shows a higher level of anthropogenic disturbance (including larger cities and industrial areas) and a longer vegetational period in comparison to the Oesling (Goergen et al. 2013). Annual precipitation ranges from 700–800 mm and annual mean air temperature is 9°C (Goergen et al. 2013). It can be divided into four sub-ecoregions: the Western and the Eastern Gutland, the Moselle Valley and the Minette Basin. Land use is quite diverse in the Gutland. Pastures are still common, while the acreage of arable land is increasing. Extended deciduous forests are typical for the Gutland (Dietz and Pir 2009). For the Western Gutland, secondary sandstones and sandy soils are common (Stevens et al. 2010) and the amount of precipitation is higher compared to the eastern part (Goergen et al. 2013). The Eastern Gutland is characterised by loam-loess-based soils and a more variable topography (Stevens et al. 2010). The Minette Basin is located in the south-western part of Luxembourg, next to the French border. It represents the former mining

district, due to the rich resources of iron ore. The Moselle Valley – along the border to Germany – represents the smallest ecoregion (1% of total area of Luxembourg). It is sunnier and also drier (less than 700 mm) in comparison to all other areas of the country. Due to these very specific climatic conditions, vineyards are prevalent and agriculture shows a higher level of intensification (Dohet et al. 2008). For further information about climatological characteristics of the different regions in Luxembourg, see Eickermann et al. (2014).

Field collection of psyllids, their preparation and identification (2019/2020)

Adult psyllids were collected during one year (July 2019 to June 2020) by beating host or shelter plants over a sweeping-net, from which the specimens were captured into plastic tubes containing 70% ethanol, thereby exploiting their natural aptitude to jump. When easily visible on the plants, nymphs were also collected by picking them directly and storing them in plastic tubes as described for the adults. If necessary, plants on which samples were collected (or parts of them) were stored in plastic bags and taken to the laboratory for their specific identification, according to Lambinon and Verloove (2012).

In the lab, all specimens collected in each tube were observed using a dissecting microscope (LEICA MZ7.5); in this phase, adults were separated by sex, counted and (where possible) identified. For samples whose observation under a dissecting microscope allowed the species identification, all specimens (adults and nymphs, if present) were stored in glass tubes containing 70% ethanol, each marked with a progressive collection number, corresponding to those of the general collection register containing complete data on the date and location of collection (including the geographical coordinates) and on the plant(s) on which the sample was recorded. In case a closer examination was needed to allow species identification, a maximum of six specimens (if available, three of each sex) were mounted on permanent microscope slides. For slide preparation, selected adults were firstly cleaned in 70% ethanol under gentle heating, then left to clear overnight in 10% potassium hydroxide (KOH), rinsed in a solution of 20% glacial acetic acid, dehydrated in 95% ethanol (for 10 minutes), placed in xylene for ≥ 10 minutes, mounted in Canada Balsam and allowed to dry in an incubator for 15 days at 35°C.

Each specimen was dissected in a drop of mounting medium before being mounted on the slide, in order to mount all different parts of the body separately: head (mounted dorsal uppermost), pronotum and forelegs, mouth parts, mesoscutum and forewings (dorsally), ventral mesothorax and mid-legs, metathorax, hind legs and abdomen (laterally, with well-exposed genitalia).

Photographs of morphological details (head, forewing, male and female terminalia) were made at the Musée National d'Histoire Naturelle de Luxembourg (MNHNL), from ethanol-preserved specimens of most of the species collected, using a Keyence VHX-6000 digital microscope.

With the exception of some special cases, for which we used literature specifically concerning the taxonomic group of the species to be identified, the material was identified

by using the taxonomic keys of Hodkinson and White (1979) and Ossiannilsson (1992), following the classification and nomenclature proposed by Burckhardt et al. (2021).

All the material studied, i.e. wet and slide mounted material, is stored at the MNHNL, apart from several specimens being part of abundant field collected samples, which are stored in the collections of the museum of the University of Catania (Italy).

Study of psyllid material from Malaise and Moericke traps (1999/2000)

During the years 1999-2000, an entomological collection campaign was carried out in Luxembourg by Evelyne Carrières, focussing on the national inventory of hoverflies (Syrphidae) (Carrières 2003). The project was financed by the MNHNL. Several Malaise and yellow Moericke traps were deployed in various areas of the country and regularly controlled every 2-4 weeks after initial installation. Many of the bulk samples collected during this campaign (and stored in the MNHNL wet collection) contained psyllid specimens, which, as part of the research aimed at compiling this manuscript, were sorted out, observed under a LEICA dissecting microscope, separated by sex, counted and (where possible) identified as already reported in the previous section. Additionally, in this case, all material identified by the simple use of a dissecting microscope has been stored in glass tubes containing 70% ethanol and marked with progressive collection numbers (different from those used for the field collected material). A general register has been prepared, containing complete data on collection localities (including the geographical coordinates) and the dates of exposure and removal of the traps. In case a more sophisticated approach was necessary to identify some material, permanent slides were prepared and identifications performed as described in the previous section. All material studied, both ethanol preserved or mounted on permanent slides, is stored at the MNHNL.

Results

Overall, the reliable bibliographic references (e.g. those reporting the actual collection of Psylloidea specimens), the field collections we made during 2019/2020 and the investigated Malaise trap material from 1999/2000 stored at the MNHNL allowed us to record a total of 47 species, belonging to the families Aphalaridae (5 species), Liviidae (5), Psyllidae (24) and Triozidae (13). For one additional species [*T. rhamni* (Schrank)], belonging to the family Triozidae, only records in literature are available relating to the presence of the galls it causes on the host plant; therefore, its presence in Luxembourg is highly probable, but needs to be confirmed by observations of psyllid specimens. The total dataset originating from the analysed 1999/2000 and 2019/2020 material can be retrieved from https://doi.org/10.15468/svfh53 (Rapisarda et al. 2021).

In the following, brief information is provided for all 48 species whose presence has been ascertained or, as reported above for *T. rhamni*, are very likely in Luxembourg. Depicted are head structures (Figs 1, 2, 3, 4), forewings (Figs 5, 6, 7, 8), female and male terminalia (Figs 9, 10, 11, 12, 13, 14, 15, 16).

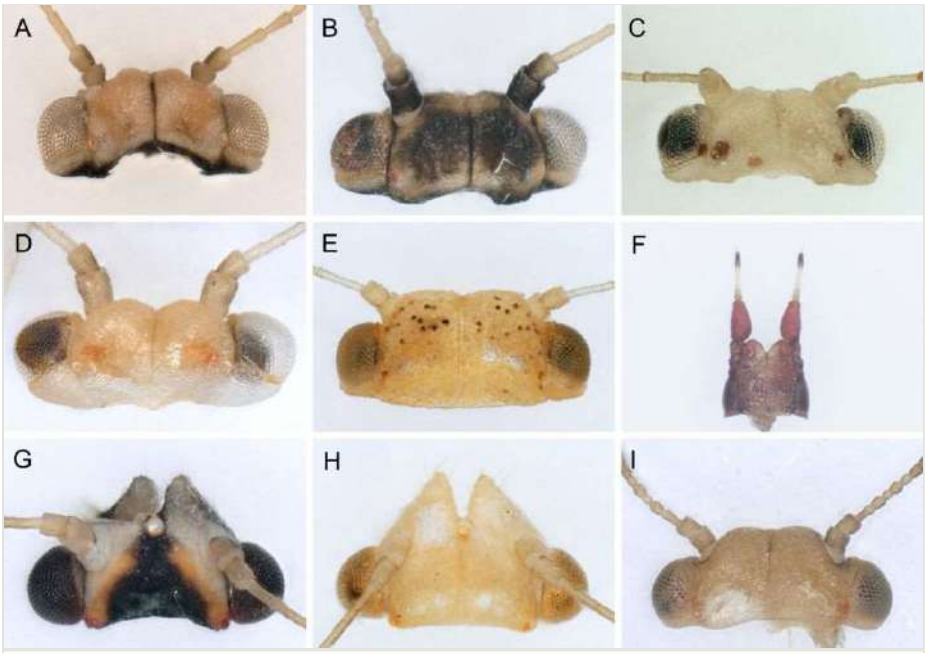

Figure 1. doi

Overview of head structures of psyllid species in Luxembourg (Aphalaridae, Liviidae).

A *Aphalara* sp. gr. *polygoni* Foerster, 1848 **B** *Craspedolepta nebulosa* (Zetterstedt, 1828) **C** *Craspedolepta nervosa* (Foerster, 1848) **D** *Craspedolepta subpunctata* (Foerster, 1848) **E** *Rhinocola aceris* (Linnaeus, 1758) **F** *Livia junci* (Schrank, 1789) **G** *Psyllopsis fraxini* (Linnaeus, 1758) **H** *Psyllopsis fraxinicola* (Foerster, 1848) **I** *Strophingia ericae* (Curtis, 1835).

Aphalaridae

Aphalara sp. gr. *polygoni* Foerster, 1848

(Figs 1, 5, 9)

Findings in Luxembourg. Personal field collection by the authors: Oesling: Fléiber (1 ♀, 20.VIII.2019, by general sweeping with net, including clover, *Phacelia* sp. and *Atriplex* sp.), Fussekaul (1 ♀, 22.VIII.2019, on *Rumex* sp.), Goebelsmuehle (2 ♀♀, 20.VIII.2019, on *Rumex* sp.); West Gutland: Eschdorf (2 ♀♀, 14.VIII.2019, on *Rumex* sp.).

Material studied in the MNHNL collection: Minette: Kockelscheuer, Conter Jans Boesch (1 ♀, 2.IX - 27.IX.1999, Malaise).

New record for Luxembourg: no member of the genus *Aphalara* Foerster has been recorded in Luxembourg so far; the identification of this taxon needs to be validated by the investigation of male specimens.

According to Burckhardt and Lauterer (1997b) and Cho et al. (2017b), species of this group have a Palaearctic distribution and live on plants of the family Polygonaceae, overwintering on shelter plants. Due to a high similarity of species within the genus *Aphalara* Foerster and the recent clarification of their taxonomic status (Burckhardt and Lauterer 1997b), many records of *A. polygoni* in various countries are doubtful. Hence, we decided to be more conservative by referring to the species group *A. polygoni* instead.

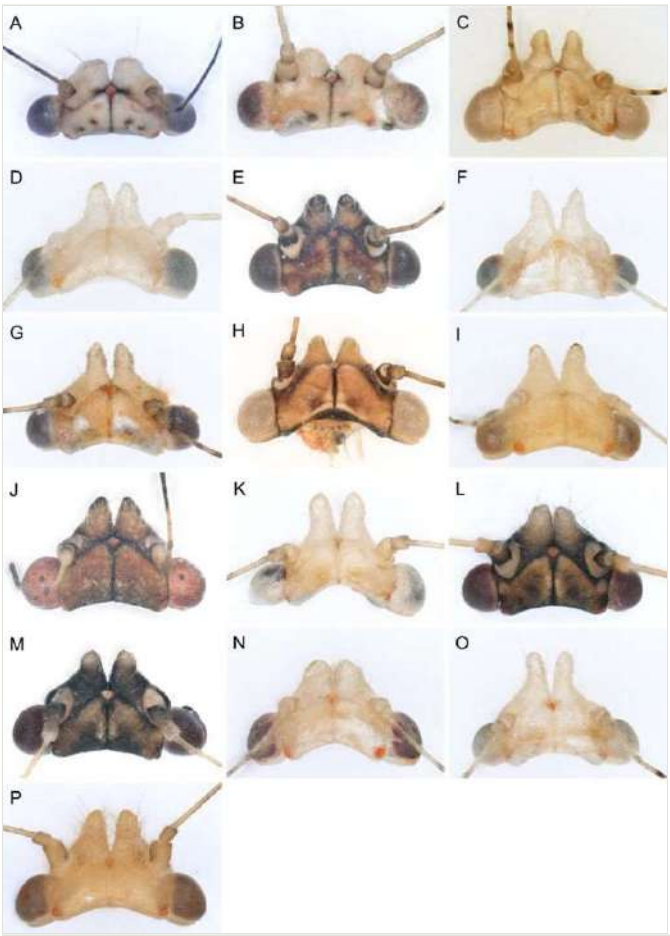

Figure 2. doi

Overview of head structures of psyllid species in Luxembourg (Psyllidae I).

A *Arytaina genistae* (Latreille, 1804) **B** *Arytainilla spartiophila* (Foerster, 1848) **C** *Cacopsylla affinis* (Löw, 1880) **D** *Cacopsylla ambigua* (Foerster, 1848) **E** *Cacopsylla crataegi* (Schrank, 1801) **F** *Cacopsylla mali* (Schmidberger, 1836) **G** *Cacopsylla melanoneura* (Foerster, 1848) **H** *Cacopsylla nigrita* (Zetterstedt, 1828) **I** *Cacopsylla peregrina* (Foerster, 1848) **J** *Cacopsylla* sp. gr. *pruni* (Scopoli, 1763) **K** *Cacopsylla pulchra* (Zetterstedt, 1838) **L** *Cacopsylla pyri* (Linnaeus, 1758) **M** *Cacopsylla pyricola* (Foerster, 1848) **N** *Cacopsylla pyrisuga* (Foerster, 1848) **O** *Cacopsylla rhamnicola* (Scott, 1876) **P** *Cacopsylla visci* (Curtis, 1835).

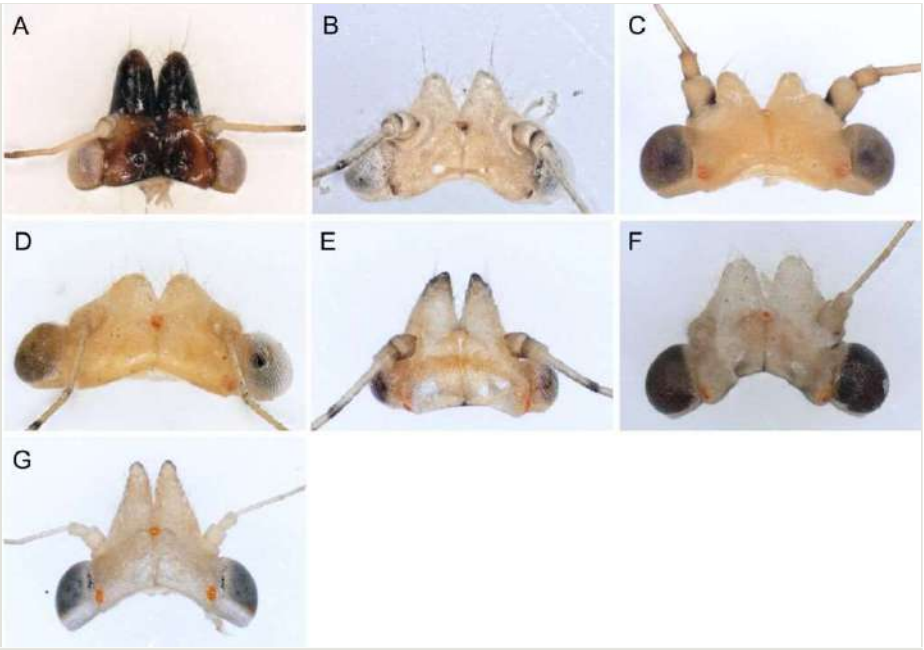

Figure 3. doi

Overview of head structures of psyllid species in Luxembourg (Psyllidae II).

A *Livilla ulicis* Curtis, 1836 **B** *Psylla alni* (Linnaeus, 1758) **C** *Psylla betulae* (Linnaeus, 1758) **D** *Psylla foersteri* Flor, 1861 **E** *Psylla hartigii* Flor, 1861 **F** *Spanioneura buxi* (Linnaeus, 1758) **G** *Spanioneura fonscolombii* Foerster, 1848.

***Craspedolepta nebulosa* (Zetterstedt, 1828)**

(Figs 1, 5, 9, 13)

Findings in Luxembourg. Personal field collection by the authors: West Gutland: Arsdorf (7 ♂♂, 5 ♀♀, 8.VI.2020, on *Epilobium angustifolium*).

New record for Luxembourg.

Geographical distribution. Apart from North Africa, *C. nebulosa* is widely distributed in the Holarctic Region, from Far East Russia to nearly all north and central Europe, through Central Asia and was recorded also in North America (Canada, USA) (Hodkinson and White 1979, Burckhardt 1983, Hodkinson 1988, Ossiannilsson 1992, Conci et al. 1993, Conci et al. 1996, Tishetshkin 2007, O'Connor and Malumphy 2011, Percy et al. 2012, Drohojowska and Burckhardt 2014, Ouvrard et al. 2015, den Bieman et al. 2019, Drohojowska and Klasa 2019).

Biology. Monophagous on *Epilobium angustifolium* L. (Onagraceae) (Hodkinson and White 1979, Burckhardt 1983, Hodkinson 1988, Ossiannilsson 1992, Conci et al. 1993, Conci et al. 1996, Tishetshkin 2007, Percy et al. 2012), on which it performs one generation per

year and overwinters as a nymph (usually 4th instar) on the roots. This psyllid causes both foliar (optional) and root galls. The former consist in downward foldings of the leaf margin, which in June-July, protect the eggs (arranged in a long line along the lower margin) and subsequently the young nymphs; these very soon (already at the 1st or 2nd instar) migrate to the roots, where they overwinter (Sampò 1975). Root galls are large, thread-like and tangled (Lauterer 1976).

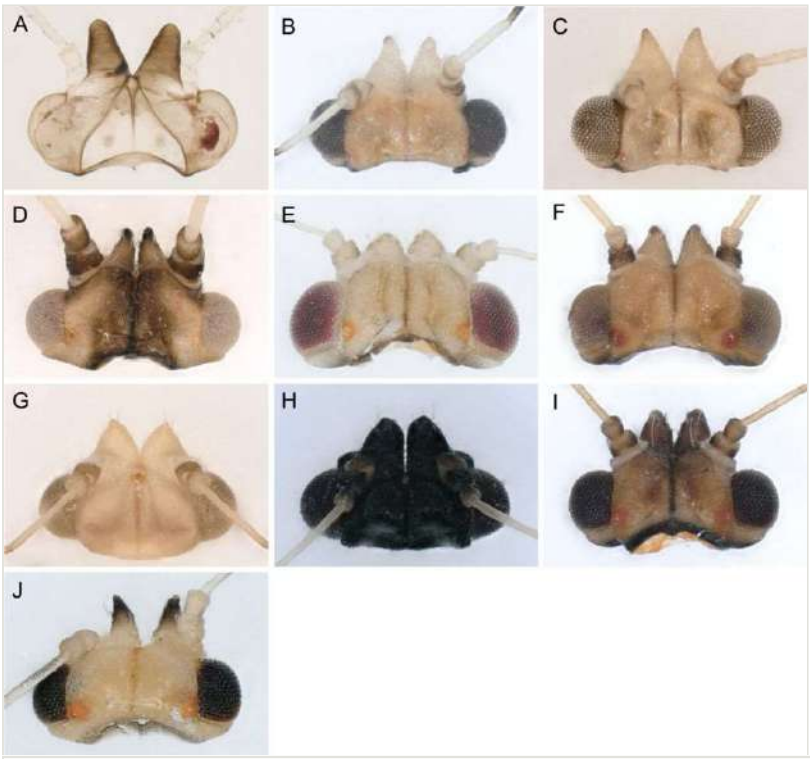

Figure 4. doi

Overview of head structures of psyllid species in Luxembourg (Triozidae).

A *Bactericera albiventris* (Foerster, 1848) **B** *Bactericera curvatinervis* (Foerster, 1848) **C** *Bactericera substriola* Ossiannilsson, 1992 **D** *Eryngiofaga lautereri* Loginova, 1977 **E** *Lauritrioza alacris* (Flor, 1861) **F** *Trioza abdominalis* Flor, 1861 **G** *Trioza cirsii* Löw, 1881 **H** *Trioza galii* Foerster, 1848 **I** *Trioza remota* Foerster, 1848 **J** *Trioza urticae* (Linnaeus, 1758).

***Craspedolepta nervosa* (Foerster, 1848)**

(Figs 1, 5, 9)

Findings in Luxembourg. Material studied in the MNHNL collection: East Gutland: Godbrange, Schléidelbierg (1 ♀, 27.V - 9.VI.1999, Malaise).

New record for Luxembourg.

Geographical distribution. Eurosiberian distribution, from Yakutskiya and Siberia, through Mongolia, Central European Russia and Iraq, to nearly all Europe (Wagner and Franz 1961, Loginova 1968, Loginova 1974, Hodkinson and White 1979, Burckhardt 1983, Rapisarda 1985, Burckhardt and Kofler 1991, Ossiannilsson 1992, Conci et al. 1993, Conci et al. 1996, Lauterer 1994, Lauterer 2001, Seljak 2006, Ripka 2009, Malenovský et al. 2011, O'Connor and Malumphy 2011, Malenovský and Lauterer 2012, Kanturski and Drohojowska 2013, Ouvrard et al. 2015, Serbina et al. 2015, den Bieman et al. 2019, Drohojowska and Klasa 2019).

Biology. Oligophagous on plants of the genera *Achillea* L. (especially *A. millefolium* L., but also *A. gerberi* Willd., *A. micrantha* Willd., *A. nobilis* L., *A. ptarmica* L.) and *Cirsium* Miller [especially *C. arvense* (L.) Scop.] (Asteraceae) (Wagner and Franz 1961, Loginova 1968, Loginova 1974, Hodkinson and White 1979, Burckhardt 1983, Burckhardt and Kofler 1991, Ossiannilsson 1992, Conci et al. 1993, Lauterer 1994, Conci et al. 1996, Lauterer 2001, Seljak 2006, Ripka 2008, Hodkinson 2009, Malenovský et al. 2011, Malenovský and Lauterer 2012). It develops one generation a year and overwinters as a nymph on the roots of its host plants (Lauterer 1991).

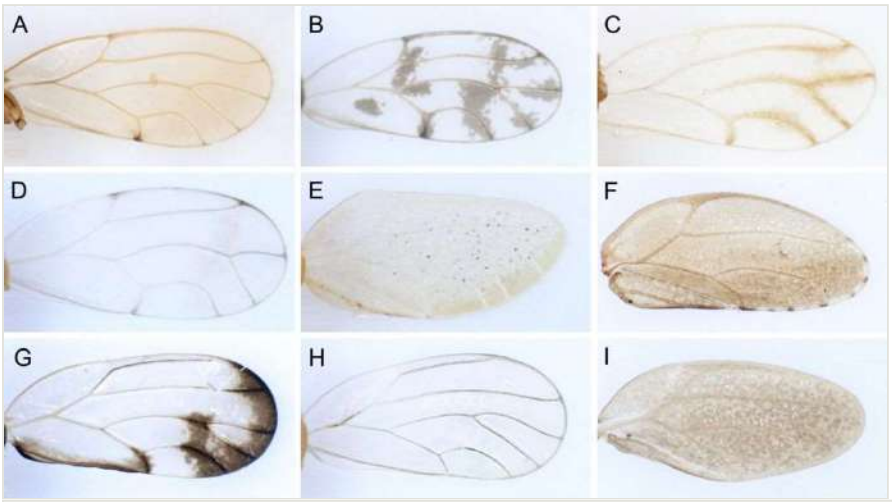

Figure 5. doi

Overview of forewings of psyllid species in Luxembourg (Aphalaridae, Liviidae).

A *Aphalara* sp. gr. *polygoni* Foerster, 1848 **B** *Craspedolepta nebulosa* (Zetterstedt, 1828) **C** *Craspedolepta nervosa* (Foerster, 1848) **D** *Craspedolepta subpunctata* (Foerster, 1848) **E** *Rhinocola aceris* (Linnaeus, 1758) **F** *Livia junci* (Schrank, 1789) **G** *Psyllopsis fraxini* (Linnaeus, 1758) **H** *Psyllopsis fraxinicola* (Foerster, 1848) **I** *Strophingia ericae* (Curtis, 1835).

***Craspedolepta subpunctata* (Foerster, 1848)**

(Figs 1, 5, 9, 13)

Findings in Luxembourg. Personal field collection by the authors: West Gutland: Arsdorf (4 ♂♂, 3 ♀♀, 3 nymphs, 8.VI.2020, on *Epilobium angustifolium*).

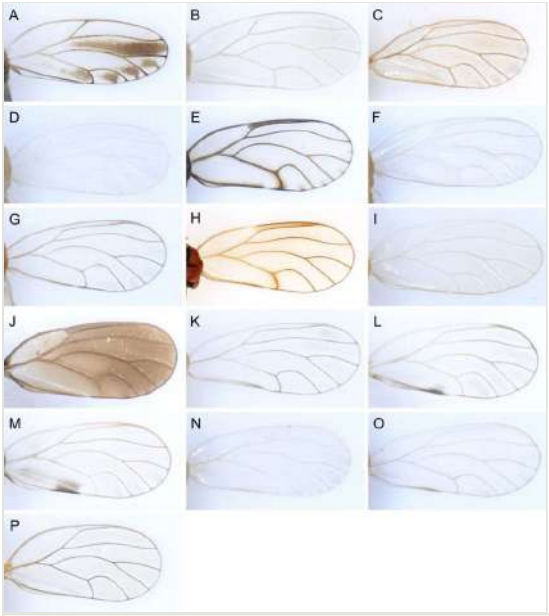

Figure 6. doi

Overview of forewings of psyllid species in Luxembourg (Psyllidae I).

A *Arytaina genistae* (Latreille, 1804) **B** *Arytainilla spartiophila* (Foerster, 1848) **C** *Cacopsylla affinis* (Löw, 1880) **D** *Cacopsylla ambigua* (Foerster, 1848) **E** *Cacopsylla crataegi* (Schrank, 1801) **F** *Cacopsylla mali* (Schmidberger, 1836) **G** *Cacopsylla melanoneura* (Foerster, 1848) **H** *Cacopsylla nigrita* (Zetterstedt, 1828) **I** *Cacopsylla peregrina* (Foerster, 1848) **J** *Cacopsylla* sp. gr. *pruni* (Scopoli, 1763) **K** *Cacopsylla pulchra* (Zetterstedt, 1838) **L** *Cacopsylla pyri* (Linnaeus, 1758) **M** *Cacopsylla pyricola* (Foerster, 1848) **N** *Cacopsylla pyrisuga* (Foerster, 1848) **O** *Cacopsylla rhamnicola* (Scott, 1876) **P** *Cacopsylla visci* (Curtis, 1835).

New record for Luxembourg.

Geographical distribution. Similar to *Craspedolepta nebulosa*, it is widely distributed in the north and central part of the Holarctic Region: from Far East Russia, through Central Asia, to nearly all north and central Europe and North America (Canada, USA) (Hodkinson and White 1979, Hodkinson 1988, Ossiannilsson 1992, Conci et al. 1993, Burckhardt 1994b, Conci et al. 1996, Tishetshkin 2007, Gertsson 2010, O'Connor and Malumphy 2011, Serbina et al. 2015, Drohojowska and Klasa 2019, den Bieman et al. 2019).

Biology. Monophagous on *Epilobium angustifolium* L. (Onagraceae). According to Lauterer and Baudys (1968), adults fly in late May/early June and lay eggs on leaves and stems in June; the 1st instar nymphs migrate to the roots, where they cause small galls, which grow with the development of the subsequent nymphal stages (2nd-4th instars); the 4th instar nymphs appear in late August – early September and spend the winter in the root galls; during the following May, these nymphs abandon the galls, climb up to the aerial part of the plant and produce the 5th instar nymphs, which in turn give rise to the new adults.

The gall caused by *C. subpunctata* is a conglomerate of tangled, enlarged and deformed rootlets, which reaches its maximum size (up to about one centimetre) in mid-September, when it contains one to three 4th instar nymphs.

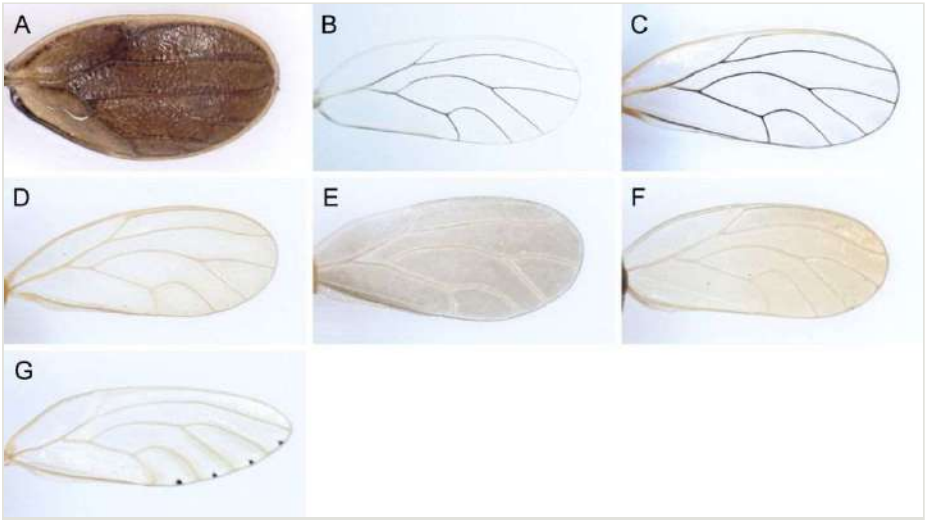

Figure 7. doi

Overview of forewings of psyllid species in Luxembourg (Psyllidae II).

A *Livilla ulicis* Curtis, 1836 **B** *Psylla alni* (Linnaeus, 1758) **C** *Psylla betulae* (Linnaeus, 1758) **D** *Psylla foersteri* Flor, 1861 **E** *Psylla hartigii* Flor, 1861 **F** *Spanioneura buxi* (Linnaeus, 1758) **G** *Spanioneura fonscolombii* Foerster, 1848.

***Rhinocola aceris* (Linnaeus, 1758)**

(Figs 1, 5, 9, 13)

Findings in Luxembourg. Personal field collection by the authors: Oesling: Marnach (1 ♀, 2.VI.2020, on *Pyrus communis*, occasional plant); West Gutland: Dondelange (1 ♂, 3 ♀♀, 28.V.2020, on *Acer campestre*), Esch-sur-Sûre (13 ♂♂, 24 ♀♀, 15.V.2020, on *A. campestre*; 3 ♂♂, 4 ♀♀, 15.V.2020, on *Acer* sp.), Préitzerdaul (1 ♂, 1 ♀, 20.V.2020, on *Populus tremula*, occasional plant); Moselle: Erpeldange (1 ♀, 7.V.2020, on *Crataegus monogyna*, occasional plant), Mondorf-les-Bains (8 ♂♂, 12 ♀♀, 18.V.2020, on *A. campestre*; 1 ♀, 18.V.2020, on *Salix* sp., occasional plant), Moutfort (3 ♂♂, 3 ♀♀, 1.VI. 2020, on *Acer platanoides*), Remich (9 ♂♂, 18 ♀♀, 8.V.2020, on *Acer* sp.).

Material studied in the MNHNL collection: East Gutland: Niederanven, Aarnescht (1 ♀, 9.VI - 25.VI.1999, Malaise).

New record for Luxembourg.

Geographical distribution. Widely distributed in the central-western part of the Palaearctic Region, with records from middle Asia, Caucasian Region (Armenia, Georgia), Turkey, nearly all Europe (except Ireland and Iberian Peninsula) and North Africa (Tunisia)

(Hodkinson and White 1979, Burckhardt 1988b, Burckhardt and Lauterer 1989, Ossiannilsson 1992, Burckhardt and Önuçar 1993, Conci et al. 1993, Conci et al. 1996, Seljak 2006, Ripka 2008, Gertsson 2010, Lauterer 2011, Malenovský et al. 2011, Kanturski and Drohojowska 2013, Ouvrard et al. 2015, Serbina et al. 2015, Drohojowska and Klasa 2019).

Biology. Strictly oligophagous on *Acer* spp. (Sapindaceae). Host plants: *Acer campestre* L., *A. platanoides* L., *A. pseudoplatanus* L., *A. tataricus* L. (Hodkinson and White 1979, Burckhardt 1983, Burckhardt 1984, Burckhardt 1988a, Burckhardt and Lauterer 1989, Ossiannilsson 1992, Conci et al. 1993, Conci et al. 1996, Lauterer 2001, Burckhardt 2002, Seljak 2006, Ripka 2008, Hodkinson 2009, Malenovský et al. 2011). Adults were also collected on *Betula pendula* Roth (Betulaceae), *Buxus sempervirens* L. (Buxaceae) and *Ulmus* spp. (Ulmaceae) (Burckhardt 1988a, Ripka 2008, Kanturski and Drohojowska 2013) which are "occasional plants". *Rhinocola aceris* performs one generation per year and, according to Lauterer (1991), overwinters in the egg stage and spends the summer in parapausa on its host plants.

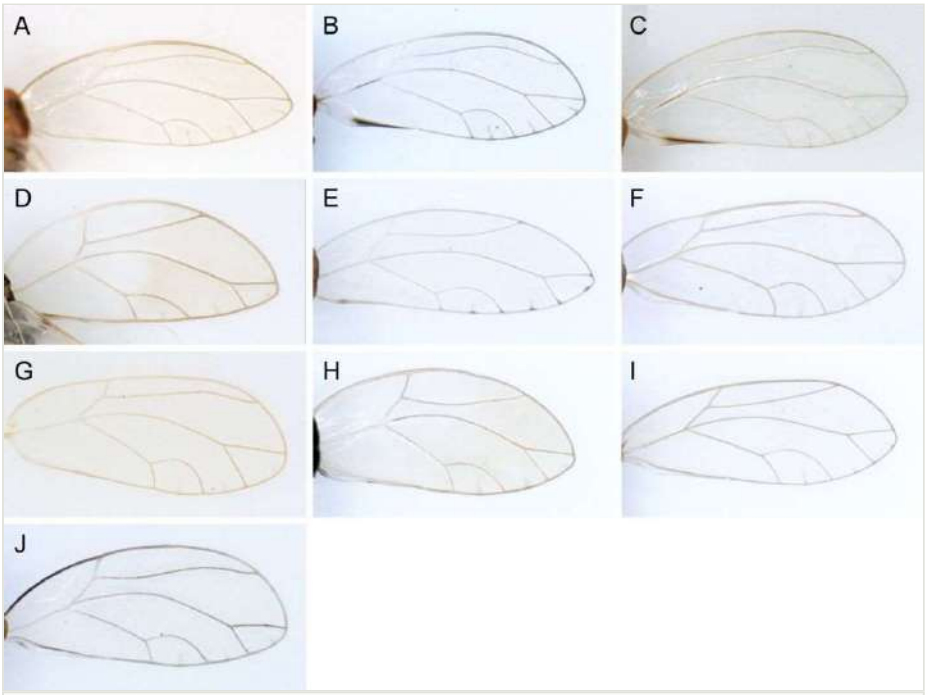

Figure 8. doi

Overview of forewings of psyllid species in Luxembourg (Triozidae).

A *Bactericera albiventris* (Foerster, 1848) **B** *Bactericera curvatinervis* (Foerster, 1848) **C** *Bactericera substriola* Ossiannilsson, 1992 **D** *Eryngiofaga lautereri* Loginova, 1977 **E** *Lauritrioza alacris* (Flor, 1861) **F** *Trioza abdominalis* Flor, 1861 **G** *Trioza cirsii* Löw, 1881 **H** *Trioza galii* Foerster, 1848 **I** *Trioza remota* Foerster, 1848 **J** *Trioza urticae* (Linnaeus, 1758).

Liviidae

***Camarotoscena speciosa* (Flor, 1861)**

Findings in Luxembourg. This species has not been found by the authors in Luxembourg so far. Nevertheless, findings of its leaf deformations produced on *Populus* sp. and *P. nigra* were reported by Lambinon et al. (2012) (Eastern Gutland: Ettelbruck) and the occurrence of its nymphs in the above galls was described by Burton et al. (2019) (Eastern Gutland: Mersch).

Geographical distribution. Present in almost all of Europe, *C. speciosa* extends its distribution also to the Middle East (Iraq, Turkey) and Central Asia (Caucasian Region, Mongolia, former south European Russia, Tadzhikistan, Turkmenistan, Xinjiang Chinese autonomous region) (Baeva and Kankina 1971, Hodkinson and White 1979, Ossiannilsson 1992, Burckhardt and Önuçar 1993, Conci et al. 1993, Rapisarda 1994, Nokkala 1995, Conci et al. 1996, Burckhardt and Mifsud 2003, Drees 2005, Seljak 2006, Ripka 2008, Mustafa et al. 2014, Serbina et al. 2015, den Bieman et al. 2019).

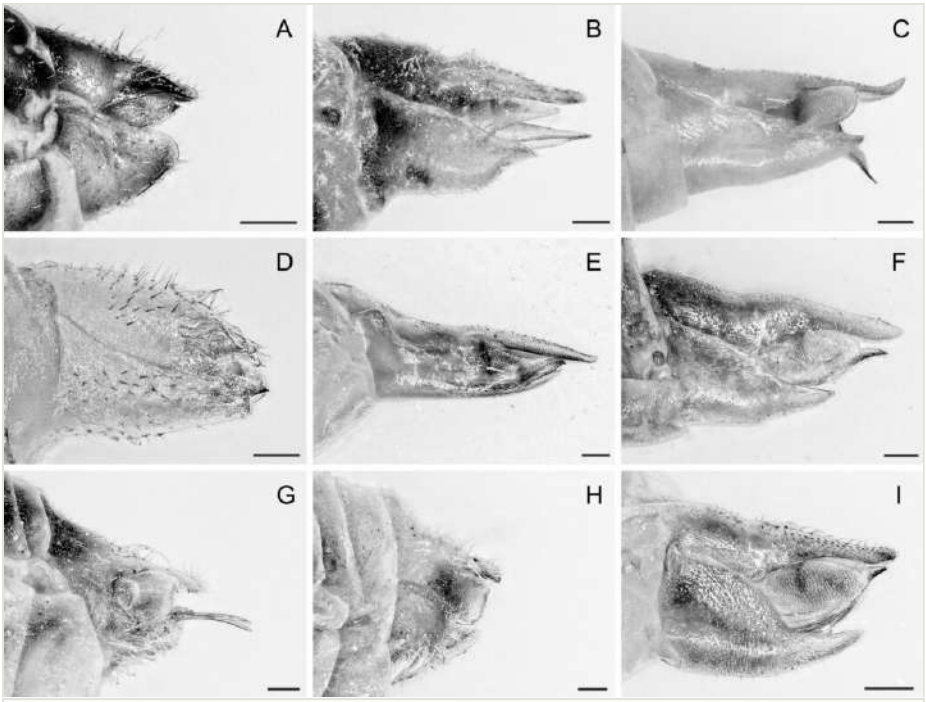

Figure 9. doi

Overview of female terminalia of psyllid species in Luxembourg (Aphalaridae, Liviidae).

A *Aphalara* sp. gr. *polygoni* Foerster, 1848 **B** *Craspedolepta nebulosa* (Zetterstedt, 1828) **C** *Craspedolepta nervosa* (Foerster, 1848) **D** *Craspedolepta subpunctata* (Foerster, 1848) **E** *Rhinocola aceris* (Linné, 1758) **F** *Livia junci* (Schrank, 1789) **G** *Psyllopsis fraxini* (Linnaeus, 1758) **H** *Psyllopsis fraxinicola* (Foerster, 1848) **I** *Strophingia ericae* (Curtis, 1835).

Biology. Oligophagous on plants of the genus *Populus* L. (amongst which, *P. alba* L., *P. nigra* L. and *P. tremula* L. are important hosts in Europe) (Salicaceae) (Hodkinson and White 1979, Ossiannilsson 1992, Burckhardt and Mifsud 2003, Tomasi 2003, Seljak 2006, Ripka and Kiss 2008, Mustafa et al. 2014), *C. speciosa* performs only one annual generation and overwinters as adults on shelter plants (conifers). Leaf galls produced by this psyllid, consisting in a winding up of the leaf margin (sometimes turning to reddish), are reported in older literature (Houard 1908, Houard 1909, Houard 1913, Ross and Hedicke 1927, Buhr 1964, Buhr 1965); however, *C. speciosa* does not seem to produce significant damage to infested poplar plants.

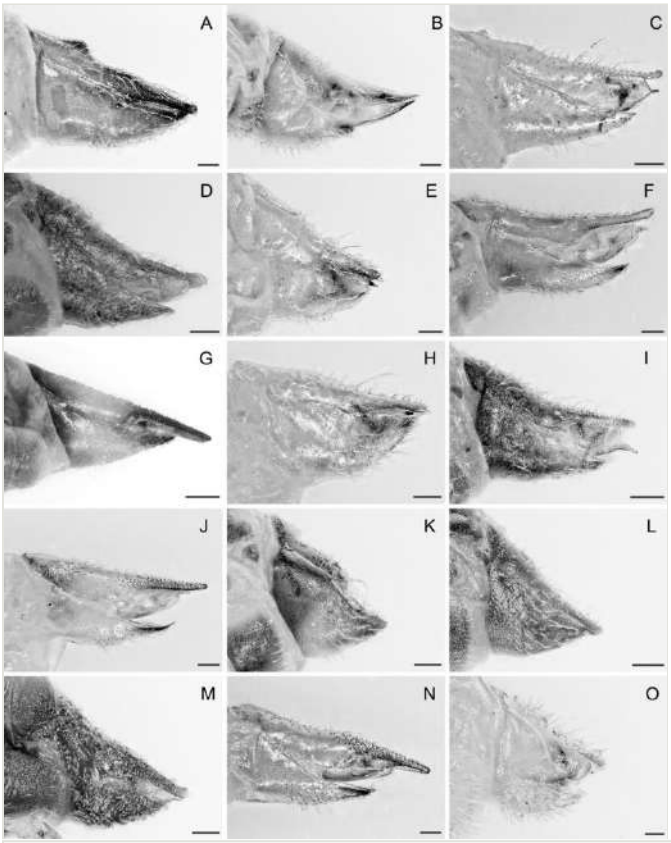

Figure 10. doi

Overview of female terminalia of psyllid species in Luxembourg (Psyllidae I).

A *Arytaina genistae* (Latreille, 1804) **B** *Arytainilla spartiophila* (Foerster, 1848) **C** *Cacopsylla ambigua* (Foerster, 1848) **D** *Cacopsylla crataegi* (Schrank, 1801) **E** *Cacopsylla mali* (Schmidberger, 1836) **F** *Cacopsylla melanoneura* (Foerster, 1848) **G** *Cacopsylla nigrita* (Zetterstedt, 1828) **H** *Cacopsylla peregrina* (Foerster, 1848) **I** *Cacopsylla* sp. gr. *pruni* (Scopoli, 1763) **J** *Cacopsylla pulchra* (Zetterstedt, 1838) **K** *Cacopsylla pyri* (Linnaeus, 1758) **L** *Cacopsylla pyricola* (Foerster, 1848) **M** *Cacopsylla pyrisuga* (Foerster, 1848) **N** *Cacopsylla rhamnicola* (Scott, 1876) **O** *Cacopsylla visci* (Curtis, 1835).

***Livia junci* (Schrank, 1789)**

(Figs 1, 5, 9, 13)

Findings in Luxembourg. Material studied in the MNHNL collection: Oesling: Eselborn, Bréichen (2 ♂♂, 2 ♀♀, 24.VIII - 22.IX.2000; 1 ♂, 19.X - 7.XI.2000, Malaise), Hoffelt, Sporbech (4 ♂♂, 7 ♀♀, 22.IX - 19.X.2000, Malaise), Sonlez, Pamer (10 ♂♂, 6 ♀♀, 3.VIII - 24.VIII.2000; 10 ♂♂, 3 ♀♀, 24.VIII - 22.IX.2000; 10 ♂♂, 6 ♀♀, 22.IX - 19.X.2000, Malaise); East Gutland: Wilferdange, Conzefenn (1 ♂, 3 ♀♀, 3.VIII - 24.VIII.2000; 1 ♂, 3 ♀♀, 22.IX - 19.X.2000, Malaise).

No explicit mention exists in literature on previous findings of this species in Luxembourg, though deformations it causes to inflorescences of *Juncus articulatus* L. are reported by Lambinon and Schneider (2004) and by Schneider (2016) (West Gutland: Hollenfels; Moselle: Remerschen). These authors, however, do not report any findings of this psyllid in or nearby the galls. Therefore, the present records represent the first direct observations of *L. junci* in Luxembourg.

Geographical distribution. *Livia junci* is spread all over the Palaearctic Region and has been found in nearly all of Europe, north Africa (Algeria, Morocco), the Middle East (Cyprus, Iran, Lebanon, Turkey) and central, south and eastern Asia (Caucasian Region, India, Kazakhstan, Kyrgyzstan, Primorsky Krai, Siberia, Tadzhikistan, Turkmenistan) (Hodkinson and White 1979, Ossiannilsson 1992, Burckhardt and Lauterer 1993, Burckhardt and Önuçar 1993, Conci et al. 1993, Conci et al. 1996, Zeidan-Gèze and Burckhardt 1998, Hodkinson and Bird 2000, Seljak 2006, Ripka 2008, Malenovský et al. 2011, O'Connor and Malumphy 2011, Burckhardt et al. 2018, den Bieman et al. 2019).

Biology. Oligophagous on many species of the genus *Juncus* L. (Juncaceae) (Hodkinson and White 1979, Burckhardt 1983, Burckhardt 1988a, Hodkinson 1986, Ossiannilsson 1992, Conci et al. 1993, Conci et al. 1996, Burckhardt 2005, Zeidan-Gèze and Burckhardt 1998, Hodkinson and Bird 2000, Seljak 2006, Ripka 2008, Drohojowska 2009a, Hodkinson 2009, Drohojowska 2009b, Malenovský et al. 2011, Burckhardt et al. 2018). It performs one generation per year and overwinters as adults on shelter plants (conifers). During spring, adults fly back to their host plants, on which they lay eggs. After hatching, nymphs move to the young shoots and start producing characteristic galls by transforming the inflorescences into masses of reddish small leaflets, very close to each other due to the sharp shortening of internodes (Darboux and Houard 1901, Kieffer 1901, Houard 1908, Houard 1909, Houard 1913, Ross and Hedicke 1927, Buhr 1964, Buhr 1965).

***Psyllopsis fraxini* (Linnaeus, 1758)**

(Figs 1, 5, 9, 13)

Findings in Luxembourg. Galls produced by this psyllid on *Fraxinus excelsior* L. are reported by Lambinon and Schneider (2004) (Oesling: Allerborn, Beiler, Biwisch, Clervaux, Hautbellain, Hosingen, Kiirchermillen, between Moersdorf and Langsur [*sic*!], Vianden; Moselle: Ahn, Bous, Deisermillen, Fausermillen, Grevenmacher, Mertert, Mondorf-les-

Bains, Stadtbredimus, Wasserbillig; Minette: Bettembourg, Belvaux, Dudelange, Esch-sur-Alzette, Gantenbeinsmühle, Hesperange, Rumelange, Schifflange, Noertzange, Oberkorn, Pétange, Prënzebierg; West Gutland: Beckerich, Bereldange, Bonnevoie, Bridel, Capellen, Cents, Grass, Haardt, Hamm, Hollerich, Howald, Kleinbettingen, Luxembourg Ville, Pulvermühle, Schleifmühle, Stadtgrund, Steinfort, Steinsel, Walferdange, Windhof; East Gutland: Beringen, Bettendorf, Betzdorf, Biirgerkräiz, Colmar-Berg, Diekirch, Ettelbruck, Gilsdorf, Hagelsdorf, Lintgen, Lorentzweiler, Marxmillen, Manternach, Moesdorf, Neudorf, Niederanven, Oetrange, Roodt-sur-Syre, Rosport, Uebersyren, Wecker, Warken). According to the same authors, the lab rearing from galls collected in some of the above locations always produced adults of *P. fraxini* .

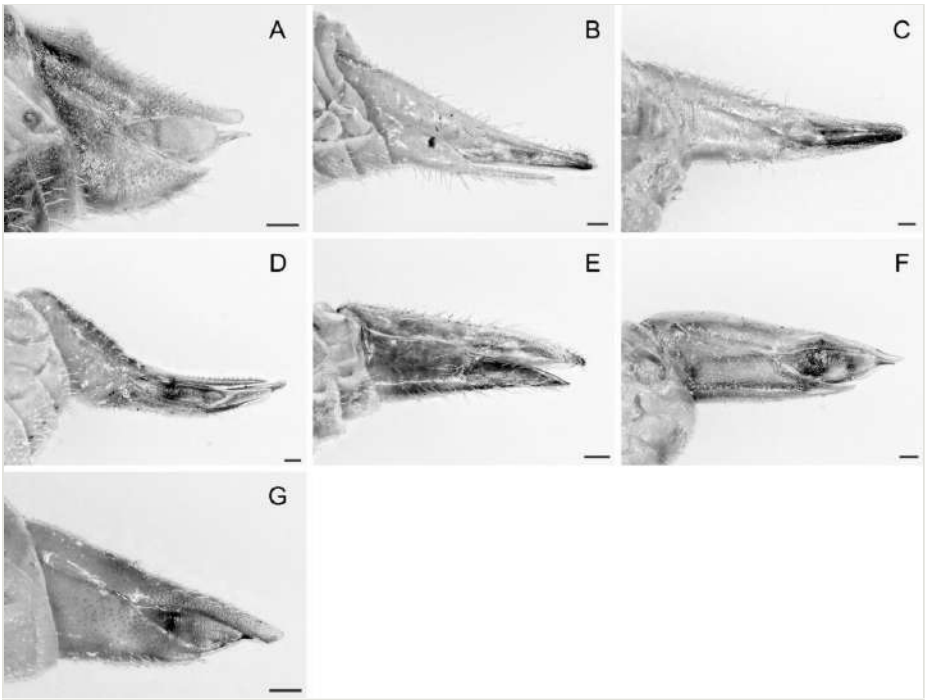

Figure 11. doi

Overview of female terminalia of psyllid species in Luxembourg (Psyllidae II).

A *Livilla ulicis* Curtis, 1836 **B** *Psylla alni* (Linnaeus, 1758) **C** *Psylla betulae* (Linnaeus, 1758) **D** *Psylla foersteri* Flor, 1861 **E** *Psylla hartigii* Flor, 1861 **F** *Spanioneura buxi* (Linnaeus, 1758) **G** *Spanioneura fonscolombii* Foerster, 1848.

Personal field collection by the authors: Minette: Kayl/Tetange (1 ♂, 2 ♀♀, 23.VII.2019, on *F. excelsior*).

Geographical distribution. Central Asian - European chorotype, diffused from the Himalayan Region (Uttaranchal) westwards to Iran and great parts of Europe (Hodkinson and White 1979, Ossiannilsson 1992, Burckhardt and Lauterer 1993, Conci et al. 1993, Seljak 2006, Ripka 2008, Gertsson 2010, Malenovský et al. 2011, O'Connor and

Malumphy 2011, Kanturski and Drohojowska 2013, Ouvrard et al. 2015, Serbina et al. 2015, Burckhardt et al. 2018, Drohojowska and Klasa 2019, den Bieman et al. 2019). Introduced to North America (USA; Hodkinson 1988) and the Australian Region (New Zealand and Tasmania; Hollis 2004, Martoni et al. 2018).

Biology. Strictly oligophagous on ashes (*Fraxinus* L., Oleaceae). According to the literature, this psyllid is common especially on *Fraxinus excelsior* L., but can be collected also on *F. americana* L., *F. angustifolia* Vahl, *F. aurea* Willd., *F. mandschurica* Rupr., *F. ornus* L., *F. oxycarpa* Willd., *F. pendula* (Aiton) Hoffmanns, *F. pennsylvanica* Marshall (Hodkinson and White 1979, Burckhardt 1983, Hodkinson 1988, Seljak 2006, Ripka 2008, Burrows 2012). On its host plants, *P. fraxini* performs 1-2 generations per year and overwinters in the egg stage.

This psyllid produces showy galls, widely described in literature (e.g. Darboux and Houard 1901, Houard 1908, Houard 1909, Houard 1913, Ross and Hedicke 1927, Buhr 1964, Buhr 1965, Sampò 1975), consisting in the downrolling of the leaf margin; the rolled up part becomes dilated, thickened, turgescent, conspicuously cross-linked in red and violet.

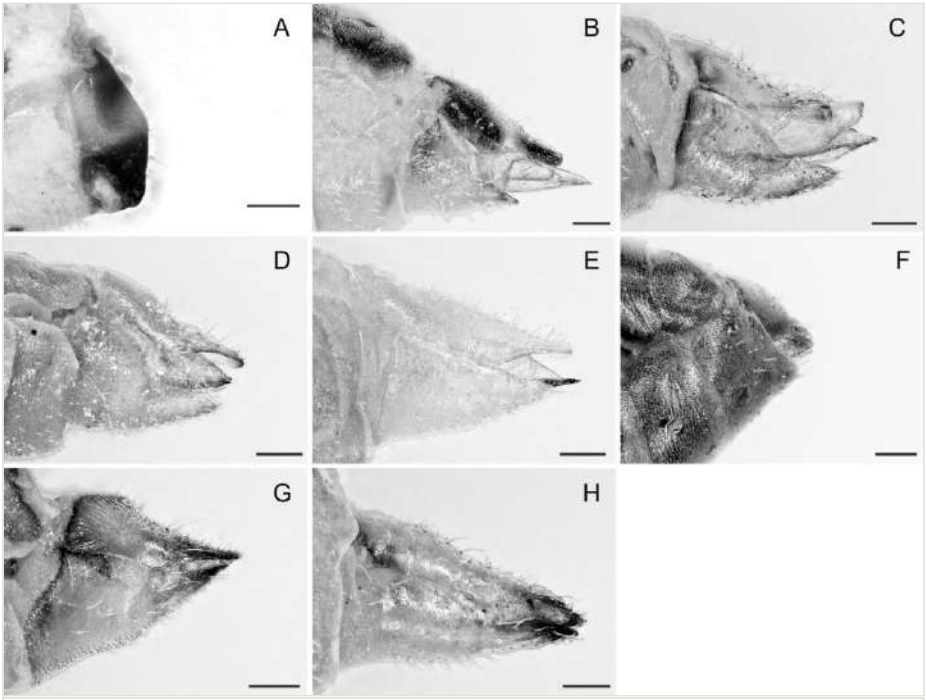

Figure 12. doi

Overview of female terminalia of psyllid species in Luxembourg (Triozidae).

A *Bactericera albiventris* (Foerster, 1848) **B** *Bactericera curvatinervis* (Foerster, 1848) **C** *Lauritrioza alacris* (Flor, 1861) **D** *Trioza abdominalis* Flor, 1861 **E** *Trioza cirsii* Löw, 1881 **F** *Trioza galii* Foerster, 1848 **G** *Trioza remota* Foerster, 1848 **H** *Trioza urticae* (Linnaeus, 1758).

***Psyllopsis fraxinicola* (Foerster, 1848)**

(Figs 1, 5, 9, 13)

Findings in Luxembourg. Personal field collection by the authors: West Gutland: Eschdorf (1 ♀♀, 14.VIII.2019, on *Fraxinus excelsior*; 1 ♀♀, 14.VIII.2019, on *Prunus* sp., occasional plant); Minette: Kayl/Tetange (3 ♂♂, 3 ♀♀, 23.VII.2019, on *F. excelsior*); Mosel: Bech/Kleinmacher (1 ♀, 30.VII.2019, on *F. excelsior*), Mondorf-les-Bains (1 ♂, 1 ♀, 1.VIII.2019, on *Populus cinerea*, occasional plant), Remich (1 ♂, 1.VIII.2019, on *F. excelsior*).

New record for Luxembourg.

Geographical distribution. Turanic-European-Mediterranean chorotype, diffused from Central Asia (Kazakhstan) westwards to the Caucasian Region (Armenia, Georgia), Turkey, nearly all of Europe and North Africa (Hodkinson and White 1979, Burckhardt 1983, Burckhardt 1988a, Burckhardt 1989, Burckhardt and Halperin 1992, Ossiannilsson 1992, Conci et al. 1993, Burckhardt and Önuçar 1993, Burckhardt 2005, Seljak 2006, Ripka 2008, Malumphy et al. 2009, Gertsson 2010, Malenovský et al. 2011, O'Connor and Malumphy 2011, Kanturski and Drohojowska 2013, Ouvrard et al. 2015, Serbina et al. 2015, Holzinger et al. 2017, Spodek et al. 2017, den Bieman et al. 2019). Introduced to the Americas (Canada, USA, South America; Hodkinson 1988, Percy et al. 2012, Castillo Carrillo et al. 2016) and the Australian Region (Australia, New Zealand; Hollis 2004, Percy et al. 2012, Martoni et al. 2018).

Biology. Strictly oligophagous on ashes (*Fraxinus* L., Oleaceae). Especially common on *Fraxinus excelsior* L. According to literature, this psyllid has been collected also on *F. angustifolia* Vahl, *F. dipetala* Hook. & Am., *F. ornus* L., *F. syriaca* Boiss. (Hodkinson and White 1979, Burckhardt 1983, Burckhardt 1988a, Burckhardt 1989, Hodkinson 1988, Burckhardt 2005, Seljak 2006, Ripka 2008, Drohojowska 2009a, Percy et al. 2012, Spodek et al. 2017), but it is not sure if they are host or casual plants. On its host plants, *P. fraxinicola* performs 1-2 generations per year and overwinters in the egg stage.

***Strophingia ericae* (Curtis, 1835)**

(Figs 1, 5, 9, 13)

Findings in Luxembourg. Personal field collection by the authors: West Gutland: Brouch (4 ♀♀, 15.V.2020, on *Calluna vulgaris*), Esch-sur-Sûre (1 ♂, 15.V.2020, on *C. vulgaris*). Material studied in the MNHNL collection: Oesling: Lellingen, Op Baerel (1 ♀, 8.VI - 20.VI. 2000, Moericke).

New record for Luxembourg.

Geographical distribution. *Strophingia ericae* is a typical European chorotype and is widespread in almost all Europe, though less common in the Mediterranean part of the continent (Iberian Peninsula, central and south Italy, Balkan Peninsula) (Hodkinson and White 1979, Burckhardt 1983, Ossiannilsson 1992, Conci et al. 1993, Conci et al. 1996,

Burckhardt 2005, Seljak 2006, Gertsson 2010, O'Connor and Malumphy 2011, Serbina et al. 2015, den Bieman et al. 2019).

Biology. Oligophagous on Ericaceae, with *Calluna vulgaris* (L.) Hull as main host plant (Hodkinson and White 1979, Burckhardt 1983, Ossiannilsson 1992, Conci et al. 1993, Conci et al. 1996, Seljak 2006), but also recorded on *Erica cinerea* L. and *Vaccinium uliginosum* L. (Hodkinson and White 1979, Hodkinson 1981, Burckhardt 2005). Eventual other plants should be considered as occasional hosts. Winter is spent by this psyllid as a nymph on the host plants. In north England, where the biology of *S. ericae* has been thoroughly investigated (Hodkinson 1973a, Hodkinson 1973b, Parkinson and Whittaker 1975), this psyllid develops its cycle in one year at low altitude and in two years at higher altitudes, thus presenting two physiological "races", characterised also by very small morphological differences. Studies on population dynamics of *S. ericae* are reported by Hodkinson (1973b).

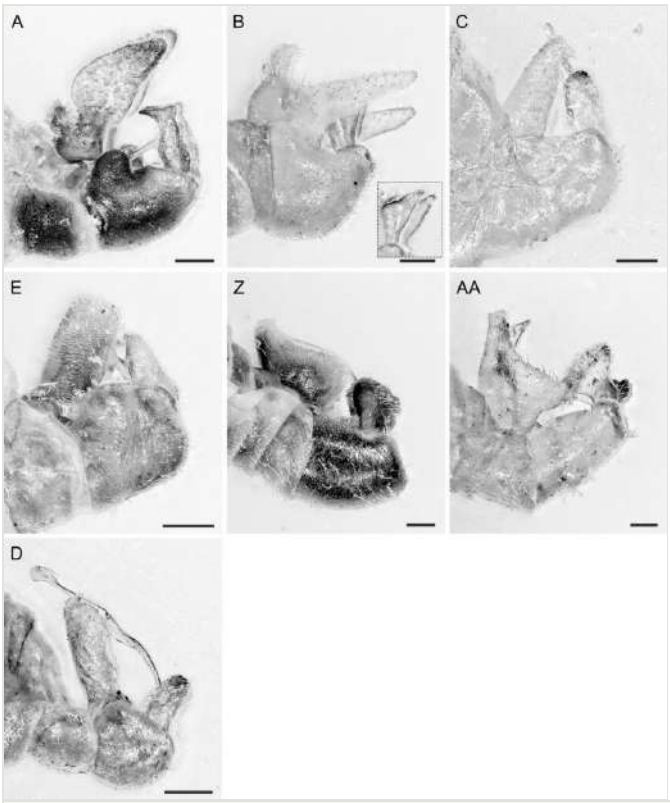

Figure 13. doi

Overview of male terminalia of psyllid species in Luxembourg (Aphalaridae, Liviidae).

A *Craspedolepta nebulosa* (Zetterstedt, 1828) **B** *Craspedolepta subpunctata* (Foerster, 1848) **C** *Rhinocola aceris* (Linnaeus, 1758) **D** *Livia junci* (Schrank, 1789) **E** *Psyllopsis fraxini* (Linnaeus, 1758) **F** *Psyllopsis fraxinicola* (Foerster, 1848) **G** *Strophingia ericae* (Curtis, 1835).

Psyllidae

Figs 2, 6, 10

***Arytaina genistae* (Latreille, 1804)**

(Figs 2, 6, 10, 14)

Findings in Luxembourg. Personal field collection by the authors: Oesling: Arsdorf (22 ♂♂, 39 ♀♀, 22.VIII.2019, on *Cytisus scoparius*), Berlé (1 ♂, 2 ♀♀, 20.VIII.2019, on *C. scoparius*); West Gutland: Bertrange (1 ♀, 7.VI.2020, on *C. scoparius*), Bridel (7 ♂♂, 11 ♀♀, 6.VIII.2019, on *C. scoparius*), Brouch (1 ♂, 1 ♀, 6.IX.2019, by general sweeping with net); Minette: Kayl/Tetange (1 ♀, 23.VII.2019, on *C. scoparius*).

Material studied in the MNHNL collection: Oesling: Basbellain, Klengelbaach (1 ♀, 24.VIII - 22.IX.2000; 1 ♀, 22.IX - 19.X.2000, Malaise), Eselborn, Bréichen (1 ♀, 3.VIII - 24.VIII.2000, Malaise), Goebelsmühle (3 ♂♂, 2 ♀♀, 13.IV - 27.IV.2000; 2 ♂♂, 5 ♀♀, 25.V - 8.VI.2000; 8 ♂♂, 4 ♀♀, 20.VI - 6.VII.2000; 13 ♂♂, 13 ♀♀, 6.VII - 3.VIII.2000; 1 ♂, 2 ♀♀, 3.VIII - 24.VIII. 2000; 4 ♂♂, 1 ♀, 24.VIII - 22.IX.2000; 1 ♂, 2 ♀♀, 22.IX - 19.X.2000, Malaise), Hoscheid, Molberlay (2 ♂♂, 1 ♀, 13.IV - 27.IV.2000; 4 ♂♂, 11 ♀♀, 20.VI - 6.VII.2000; 11 ♂♂, 14 ♀♀, 6.VII - 3.VIII.2000; 4 ♂♂, 8 ♀♀, 3.VIII - 24.VIII.2000; 2 ♂♂, 5 ♀♀, 24.VIII - 22.IX.2000; 1 ♀, 22.IX - 19.X.2000, Malaise), Lellingen, Op Baerel (2 ♂♂, 8.VI - 20.VI.2000; 3 ♂♂, 20.VI - 6.VII.2000, Malaise).

New record for Luxembourg.

Geographical distribution. Widespread in Europe and adventive in the USA, Canada (Nova Scotia) and New Zealand (Hodkinson and White 1979, Ossiannilsson 1992, Hodkinson and Hollis 1987, Hodkinson 1988, Conci et al. 1993, Conci et al. 1996, Seljak 2006, Percy et al. 2012, Serbina et al. 2015, Bleach 2019, den Bieman et al. 2019). Some of the geographical reports need confirmation, due to likely confusion with related species.

Biology. Probably oligophagous on plants of the genus *Cytisus* L. [especially *C. scoparius* (L.) Link] (Fabaceae) (Hodkinson and White 1979, Burckhardt 1983, Hodkinson and Hollis 1987, Hodkinson 1988, Ossiannilsson 1992, Conci et al. 1993, Conci et al. 1996, Burckhardt 2005, Seljak 2006, Syrett et al. 2007, Percy et al. 2012); its reports on other Genistinae (e.g. *Chamaecytisus* spp., *Genista tinctoria* L. and *Ulex europaeus* L.) are doubtful or need to be confirmed. This psyllid performs 2-3 (in southern Europe maybe more) generations per year, with an almost continuous development; it spends the winter in all developmental stages (especially as an adult) on its host plants.

***Arytainilla spartiophila* (Foerster, 1848)**

(Figs 2, 6, 10, 14)

Findings in Luxembourg. Personal field collection by the authors: Oesling: Urspelt (3 ♂♂, 16 ♀♀, 2.VI.2020, on *Cytisus scoparius*); West Gutland: Arsdorf (30 ♂♂, 20 ♀♀, 20.V. 2020, on *C. scoparius*; 4 ♀♀, 20.V.2020, by general sweeping), Bertrange (1 ♂, 24 ♀♀,

7.VI.2020, on *C. scoparius*), Brouch (40 ♂♂, 46 ♀♀, 15.V.2020, on *C. scoparius*), Dondelange (1 ♂, 1 ♀, 28.V.2020, by general sweeping), Elvange/Schweich (1 ♀, 28.V.2020, on *Prunus spinosa*, occasional plant; 1 ♂, 28.V.2020, on *Salix viminalis*, occasional plant), Esch-sur-Sûre (11 ♂♂, 12 ♀♀, 15.V.2020, on *C. scoparius*; 4 ♂♂, 7 ♀♀, 15.V.2020, on *P. spinosa*, occasional plant), Goesdorf/Bockholtz (1 ♂, 1 ♀, 20.V.2020, on *Acer pseudoplatanus*, occasional plant; 2 ♂♂, 6 ♀♀, 20.V.2020, on *Sonchus* sp., occasional plant), Hobscheid (4 ♂♂, 6 ♀♀, 28.V.2020, on *C. scoparius*; 1 ♂, 1 ♀, 28.V.2020, on *Malus* sp., occasional plant), Noerdange (1 ♀, 28.V.2020, on *Pyrus communis*, occasional plant), Strassen (19 ♂♂, 4 ♀♀, 28.V.2020, on *C. scoparius*; 3 ♂♂, 8.VI.2020, on *C. scoparius*); Minette: Belvaux (8 ♂♂, 3 ♀♀, 7.V.2020, on *C. scoparius*), Kayl (1 ♀, 20.V.2020, on *Malus* sp., occasional plant); Mosel: Mondorf (1 ♂, 18.V.2020, on *Acer campestre*, occasional plant; 1 ♂, 18.V.2020, on *Crataegus monogyna*, occasional plant).

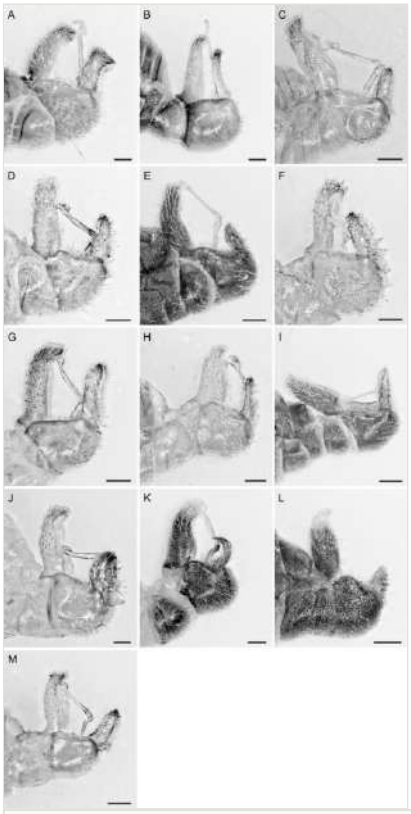

Figure 14. doi

Overview of male terminalia of psyllid species in Luxembourg (Psyllidae **I**).

A *Arytaina genistae* (Latreille, 1804) **B** *Arytainilla spartiophila* (Foerster, 1848) **C** *Cacopsylla affinis* (Löw, 1880) **D** *Cacopsylla ambigua* (Foerster, 1848) **E** *Cacopsylla crataegi* (Schrank, 1801) **F** *Cacopsylla mali* (Schmidberger, 1836) **G** *Cacopsylla melanoneura* (Foerster, 1848) **H** *Cacopsylla peregrina* (Foerster, 1848) **I** *Cacopsylla* sp. gr. *pruni* (Scopoli, 1763) **J** *Cacopsylla pulchra* (Zetterstedt, 1838) **K** *Cacopsylla pyri* (Linnaeus, 1758) **L** *Cacopsylla pyricola* (Foerster, 1848) **M** *Cacopsylla pyrisuga* (Foerster, 1848).

Material studied in the MNHNL collection: Oesling: Goebelsmühle (313 ♂♂, 594 ♀♀, 11.V - 25.V.2000; 384 ♂♂, 611 ♀♀, I nymph, 25.V - 8.VI.2000; 5 ♂♂, 6 ♀♀, 20.VI - 6.VII.2000; 4 ♂♂, 5 ♀♀, 6.VII - 3.VIII.2000; 1 ♂, 1 ♀, 24.VIII - 22.IX.2000; 1 ♂, 22.IX - 19.X.2000, Malaise), Hoscheid, Molberlay (1 ♀, 20.VI - 6.VII.2000, Malaise), Lellingen, Op Baerel (88 ♂♂, 87 ♀♀, 25.V - 8.VI.2000; 25 ♂♂, 33 ♀♀, 8.VI - 20.VI.2000; 2 ♂♂, 20.VI - 6.VII.2000, Malaise); West Gutland: Capellen, Werwelslach (1 ♂, 2 ♀♀, 27.V - 9.VI.1999, Malaise); East Gutland: Godbrange, Schléidelbierg (3 ♂♂, 7 ♀♀, 27.V - 9.VI.1999, Moericke), Niederanven, Aarnescht (3 ♂♂, 2 ♀♀, 27.V - 9.VI.1999, Malaise); Minette: Schifflange, Kayl, Brucherbierg (3 ♂♂, 5 ♀♀, 27.V - 9.VI.2000, Malaise); Moselle: Canach, Wéngertsbierg (6 ♀♀, 27.V - 9.VI.1999; 1 ♀, 9.VI - 25.VI.1999, Malaise).

New record for Luxembourg.

Geographical distribution. Widespread in central-western and southern Europe (Hodkinson and White 1979, Ossiannilsson 1992, Conci et al. 1993, Conci et al. 1996, Malumphy et al. 2009, O'Connor and Malumphy 2011, den Bieman et al. 2019). Introduced to North America (Canada, USA), Australia and New Zealand (Hodkinson 1988, Percy et al. 2012).

Biology. *Arytainilla spartiophila* is monophagous on *Cytisus scoparius* (L.) Link (Fabaceae), on which it spends its entire life cycle, performing a single generation per year and overwintering as egg. In the Northern Hemisphere, adults start to fly in mid-April and occur on the plants till the first half of June; from the second half of May, males start to decline in number and populations of this psyllid become female-biased (Wheeler 2017). For its exclusive monophagy on *C. scoparius* and the large populations, this psyllid can build up on Scotch broom in many European countries (especially in Great Britain) causing substantial damage; it has been artificially introduced and released for biological control in exotic habitats (such as California and New Zealand) where its host plant became invasive (Syrett et al. 2007, Hogg et al. 2015).

***Cacopsylla affinis* (Löw, 1880)**

(Figs 2, 6, 14)

Findings in Luxembourg. Material studied in the MNHNL collection: Oesling: Lellingen, Op Baerel (1 ♂, 25.V - 8.VI.2000, Malaise).

In the absence of male specimens, it is impossible to morphologically distinguish this species from *Cacopsylla melanoneura* (Foerster); for this reason, collections in Luxembourg of female specimens, here attributed to the more common species *C. melanoneura*, could also refer to *C. affinis*.

New record for Luxembourg.

Geographical distribution. Distributed in most of Europe, eastwards to Turkey and the Caucasian Region (Hodkinson and White 1979, Burckhardt 1983, Burckhardt 1988a, Ossiannilsson 1992, Conci et al. 1993, Burckhardt and Önuçar 1993, Conci et al. 1996,

Seljak 2006, Tedeschi et al. 2008, Ripka 2008, Ripka 2009, Malenovský et al. 2011, den Bieman et al. 2019).

Biology. Oligophagous on hawthorns (*Crataegus* spp.) (Rosaceae) (Burckhardt 1983, Burckhardt 1988a, Ossiannilsson 1992, Conci et al. 1993, Conci et al. 1996, Seljak 2006, Hodkinson 2009, Malenovský et al. 2011), *C. affinis* performs one generation per year and overwinters as adult on shelter plants, especially conifers and Fagaceae.

Economic significance. A controversial phytosanitary importance is attributed to this species as potential vector of phytopathogenic microorganisms, especially '*Candidatus* Liberibacter *europaeus*' (Tedeschi et al. 2009, Camerota et al. 2012) which should be considered, however, as an endophyte rather than a real pathogen (Raddadi et al. 2011).

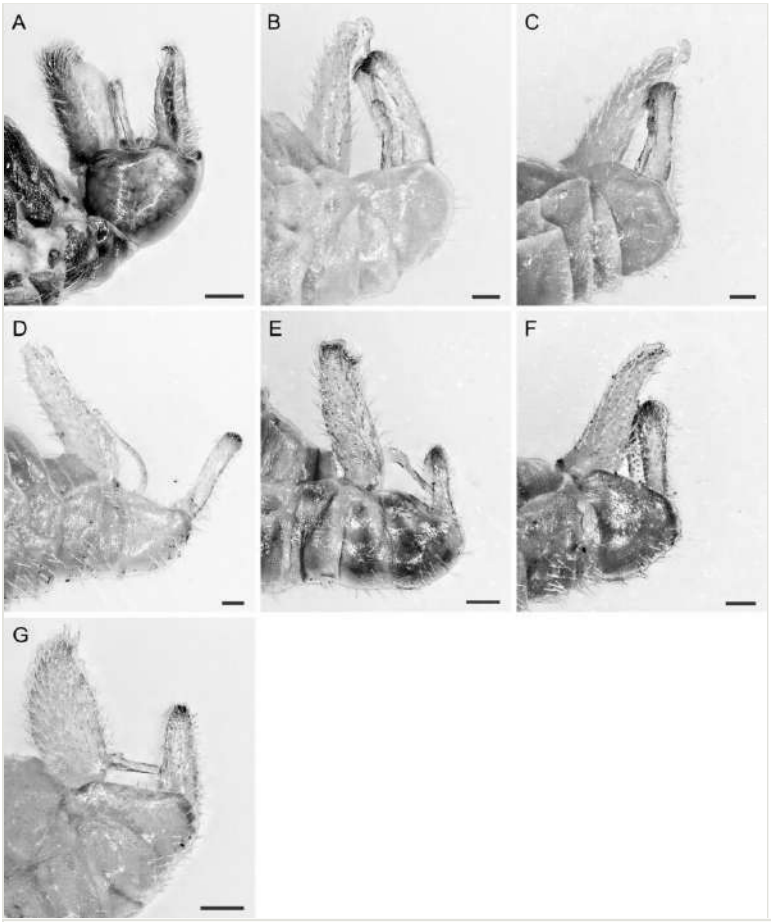

Figure 15. doi

Overview of male terminalia of psyllid species in Luxembourg (Psyllidae II).

A *Livilla ulicis* Curtis, 1836 **B** *Psylla alni* (Linnaeus, 1758) **C** *Psylla betulae* (Linnaeus, 1758) **D** *Psylla foersteri* Flor, 1861 **E** *Psylla hartigii* Flor, 1861 **F** *Spanioneura buxi* (Linnaeus, 1758) **G** *Spanioneura fonscolombii* Foerster, 1848.

***Cacopsylla ambigua* (Foerster, 1848)**

(Figs 2, 6, 10, 14)

Findings in Luxembourg. Personal field collection by the authors: West Gutland: Brouch (3 ♂♂, 8 ♀♀, 15.V.2020, on *Salix caprea*; 1 ♀, 15.V.2020, on *Salix viminalis*), Elvange/ Schweich (2 ♂♂, 28.V.2020, on *S. viminalis*), Strassen (3 ♂♂, 5 ♀♀, 27.IV.2020, on *S. caprea*); East Gutland: Rodenburg (1 ♀, 27.V.2020, on *S. caprea*).

Material studied in the MNHNL collection: East Gutland: Wilferdange, Conzefenn (1 ♀, 6.VII - 3.VIII.2000, Malaise).

New record for Luxembourg.

Geographical distribution. *Cacopsylla ambigua* is an Eurasian chorotype, especially having a wide distribution in Europe (Hodkinson and White 1979, Burckhardt 1988a, Ossiannilsson 1992, Conci et al. 1993, Conci et al. 1996, Lauterer and Burckhardt 1997, Labina 2006, Seljak 2006, Labina 2008, Ripka 2008, Inoue 2010, O'Connor and Malumphy 2011, Kanturski and Drohojowska 2013, Ouvrard et al. 2015, Serbina et al. 2015, Zendedel et al. 2016, Drohojowska and Klasa 2019, den Bieman et al. 2019).

Biology. Strictly oligophagous on *Salix* spp. (Salicaceae), being reported in literature from *S. alba* L., *S. atrocinerea* Brot., *S. aurita* L., *S. caprea* L., *S. cinerea* L., *S. elaeagnos* Scop., *S. incana* Schrank, *S. lapponum* L., *S. purpurea* L. and *S. viminalis* L. (Hodkinson and White 1979, Ossiannilsson 1992, Conci et al. 1993, Conci et al. 1996, Lauterer and Burckhardt 1997). On its host plants, it performs the entire developmental cycle, showing one or two generations per year and overwintering as egg or, according to Lauterer (1976), as 1st or 2nd instar nymph.

***Cacopsylla crataegi* (Schrank, 1801)**

(Figs 2, 6, 10, 14)

Findings in Luxembourg. Personal field collection by the authors: West Gutland: Strassen (1 ♂, 2 ♀♀, 27.IV.2020, on *Crataegus monogyna*).

Material studied in the MNHNL collection: West Gutland: Capellen, Werwelslach (1 ♀, 18.V - 27.V.1999, Moericke); East Gutland: Godbrange, Schléidelbierg (4 ♂♂, 1 ♀, 6.IV - 22.IV. 1999, Malaise); Minette: Niedercorn, Giele Botter (2 ♂♂, 25.VI - 12.VII.1999, Malaise); Moselle: Canach, Wéngertsbierg (1 ♂, 1 ♀, 22.IV - 11.V.1999; 1 ♂, 11.V - 27.V.1999; 1 ♂, 27.V - 9.VI.1999, Malaise).

New record for Luxembourg.

Geographical distribution. Widely distributed in the Palaearctic Region, from central-south Asia (west Himalayan Region, India, Iran, Caucasian Region) to nearly all parts of Europe and North Africa (Algeria, Morocco) (Hodkinson and White 1979, Burckhardt 1988a, Burckhardt 1989, Ossiannilsson 1992, Conci et al. 1993, Burckhardt and Lauterer 1993,

Conci et al. 1996, Seljak 2006, Ripka 2008, Ripka and Kiss 2008, Gertsson 2010, Malenovský et al. 2011, O'Connor and Malumphy 2011, Kanturski and Drohojowska 2013, Oettl and Schlink 2015, Ouvrard et al. 2015, Serbina et al. 2015, Burckhardt et al. 2018, Drohojowska and Klasa 2019, den Bieman et al. 2019).

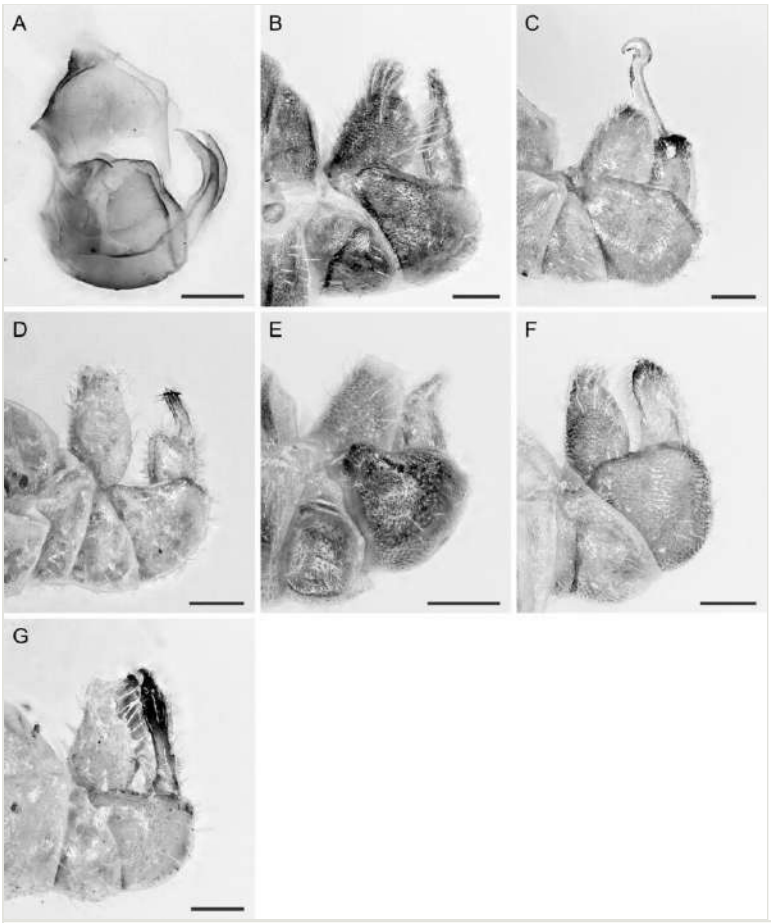

Figure 16. doi

Overview of male terminalia of psyllid species in Luxembourg (Triozidae).

A *Bactericera substriola* Ossiannilsson, 1992 **B** *Eryngiofaga lautereri* Loginova, 1977 **C** *Trioza abdominalis* Flor, 1861 **D** *Trioza cirsii* Löw, 1881 **E** *Trioza galii* Foerster, 1848 **F** *Trioza remota* Foerster, 1848 **G** *Trioza urticae* (Linnaeus, 1758).

Biology. Strictly oligophagous on hawthorns (*Crataegus* spp.) (Rosaceae), *C. crataegi* is mainly reported from *Crataegus monogyna* Jacq. and *C. oxyacantha* L. (Ossiannilsson 1992, Conci et al. 1993, Conci et al. 1996), being found also on other species, especially in Asia, such as *C. coccinea* L. or *C. pentagyna* Waldst. & Kit. ex Willd. (Ossiannilsson 1992). Besides its host plants and various occasional species, this psyllid can be found frequently on other Rosaceae, such as *Malus* spp., *Mespilus* spp. or *Sorbus* spp. (Burckhardt 1989,

Ripka 2008, Oettl and Schlink 2015). *Cacopsylla crataegi* performs only one generation per year and overwinters as an adult on shelter plants (conifers).

***Cacopsylla mali* (Schmidberger, 1836)**

(Figs 2, 6, 10, 14)

Findings in Luxembourg. Personal field collection by the authors: West Gutland: Dondelange (4 ♂♂, 2 ♀♀, 28.V.2020, on *Malus* sp.); Minette: Kayl (3 ♂♂, 6 ♀♀, 20.V.2020, on *Malus* sp.).

No explicit mention exists in literature on findings of this insect in Luxembourg, though the leaf deformations it produces on *Malus* sp. are reported by Lambinon and Schneider (2004) (West Gutland: Kirchberg). The authors, however, do not report any finding of this psyllid in or nearby the galls. Therefore, the present record represents the first direct observation of *C. mali* in Luxembourg.

Geographical distribution. *Cacopsylla mali* is widely distributed in the Eurasian Region: though not properly recorded in central Asia, it seems to occur from the Russian Far East, Japan and the Korean Peninsula to most of Europe (Hodkinson and White 1979, Burckhardt 1983, Kwon 1983, Burckhardt 1988b, Hodkinson 1988, Ossiannilsson 1992, Conci et al. 1993, Burckhardt and Önuçar 1993, Conci et al. 1996, Seljak 2006, Ripka 2008, Malumphy et al. 2009, Inoue 2010, Lauterer 2011, Malenovský et al. 2011, O'Connor and Malumphy 2011, Kanturski and Drohojowska 2013, Serbina et al. 2015, Drohojowska and Klasa 2019, den Bieman et al. 2019). It is known also from the Nearctic (USA, Canada) and Afrotropical (South Africa) Regions, as well as from Australia (Burckhardt 1988b, Hodkinson 1988, Burckhardt 1994a, Wheeler and Hoebeke 2005, Inoue 2010), where it likely has been introduced.

Biology. Strictly oligophagous on various species of the genus *Malus* Mill. (Rosaceae). In Europe, it can be found mainly on *M. domestica* Borkh. and *M. sylvestris* Mill. (Hodkinson and White 1979, Ossiannilsson 1992, Conci et al. 1993, Burckhardt 1994a, Conci et al. 1996, Ripka 2008, Inoue 2010). *Malus asiatica* Nakai, *M. baccata* (L.) Borkh. and *M. transitoria* (Batalin) C.K. Schneid. are reported as host plants of this psyllid in Asia (Kwon 1983, Li 2011). *Cacopsylla mali* performs one generation per year and overwinters as egg on its host plants. It often causes leaf alterations, corrugations and distortions (Buhr 1964, Buhr 1965). Similar to other species of the genus *Cacopsylla*, it may show a typical summer migration: part of the adults, which fed on the host plant for 2-3 weeks after emergence, migrate to other species of trees or shrubs, to re-immigrate to the host plants in September. Adults show a summer reproductive "parapause", which ends in autumn with a reactivation with their oogenesis (Lauterer 1991).

Economic significance. *Cacopsylla mali* is a secondary pest of apple trees in central Europe. In spite of old reports as a very harmful species, the damage it causes to crops is usually negligible. In recent studies, '*Candidatus* Phytoplasma *mali*', the etiological agent of the Apple Proliferation (AP) disease, has been detected also in various psyllid species, including *C. mali*, different from the two known vectors of this pathogen [*Cacopsylla*

melanoneura (Foerster) and *C. picta* (Foerster)] (Miñarro et al. 2016); yet the real potential of *C. mali* to transmit the disease is still unclear and warrants further investigation.

***Cacopsylla melanoneura* (Foerster, 1848)**

(Figs 2, 6, 10, 14)

Findings in Luxembourg. Personal field collection by the authors: Oesling: Marnach (9 ♂♂, 6 ♀♀, 2.VI.2020, on *Crataegus monogyna*); West Gutland: Arsdorf (1 ♂, 7 ♀♀, 1 nymph, 20.V.2020, on *C. monogyna*), Dondelange (4 ♂♂, 2 ♀♀, 28.V.2020, on *C. monogyna*), Elvange/Schweich (2 ♂♂, 2 ♀♀, 28.V.2020, on *C. monogyna*; 4 ♀♀, 28.V.2020, on *Prunus spinosa*, occasional plant), Esch-sur-Sûre (1 ♂, 1 ♀, 15.V.2020, on *Acer* sp., occasional plant), Préitzerdaul (1 ♂, 20.V.2020, on *C. monogyna*), Strassen (1 ♂, 3 ♀♀, 27.IV.2020, on *C. monogyna*), Useldange (1 ♂, 1 ♀, 28.V.2020, on *C. monogyna*); East Gutland: Bettendorf (1 ♀, 27.V.2020, by general sweeping with net, from *Salix* sp. and *Populus* sp., occasional plants); Moselle: Elvange/Burmerange (3 ♂♂, 5 ♀♀, 19.V.2020, on *C. monogyna*; 1 ♀, 19.V.2020, by general sweeping with net), Erpeldange (6 ♂♂, 3 ♀♀, 7.V. 2020, on *C. monogyna*), Mondorf (4 ♂♂, 5 ♀♀, 18.V.2020, on *C. monogyna*; 1 ♀, 28.V. 2020, on *Acer campestre*, occasional plant; 1 ♀, 28.V.2020, by general sweeping with net).

Material studied in the MNHNL collection: Oesling: Basbellain, Klengelbaach (1 ♀, 22.IX - 19.X.2000, Malaise), Lellingen, Op Baerel (3 ♂♂, 8 ♀♀, 25.V - 8.VI.2000, Malaise); West Gutland: Bertrange, Brill (8 ♂♂, 14 ♀♀, 15.III - 19.III.1999, Moericke), Capellen, Werwelslach (2 ♂♂, 1 ♀, 13.IV - 22.IV.1999; 1 ♀, 22.IV - 28.IV.1999; 2 ♀♀, 18.V - 27.V. 1999; 1 ♂, 2 ♀♀, 27.V - 9.VI.1999, Malaise); East Gutland: Godbrange, Schléidelbierg (44 ♂♂, 37 ♀♀, 6.IV - 22.IV.1999; 10 ♂♂, 2 ♀♀, 22.IV - 11.V.1999; 8 ♂♂, 11 ♀♀, 18.V - 27.V. 1999; 23 ♂♂, 23 ♀♀, 27.V - 9.VI.1999; 2 ♂♂, 5 ♀♀, 9.VI - 25.VI.1999; 1 ♂, 25.VI - 8.VII. 1999, Malaise), Koedange, Poenn (1 ♀, 11.III - 15.III.1999, Moericke), Niederanven, Aarnescht (5 ♂♂, 4 ♀♀, 22.IV - 11.V.1999; 2 ♀♀, 11.V - 27.V.1999; 1 ♀, 9.VI - 25.VI.1999, Malaise); Minette: Kockelscheuer, Conter Jans Boesch (1 ♀, 22.IV - 28.IV.1999, Malaise), Niedercorn, Giele Botter (2 ♂♂, 25.VI - 12.VII.1999, Malaise), Schifflange, Kayl, Brucherbierg (2 ♂♂, 3 ♀♀, 22.IV - 11.V.1999; 1 ♂, 1 ♀, 11.V - 27.V.1999; 2 ♂♂, 2 ♀♀, 27.V - 9.VI.1999, Malaise); Moselle: Canach, Wéngertsbierg (6 ♂♂, 5 ♀♀, 22.IV - 11.V.1999; 3 ♀♀, 11.V - 27.V.1999, Malaise).

In the absence of male specimens, it is impossible to morphologically distinguish this species from *Cacopsylla affinis* (Löw); for this reason, collections in Luxembourg of female specimens here attributed to *C. melanoneura* could refer to *C. affinis*. Identification tools of the two species by molecular methods have been studied by Tedeschi and Nardi (2010).

No explicit mention exists in literature on findings of *C. melanoneura* in Luxembourg, though its leaf deformations produced on *Crataegus monogyna* Jacq. are reported by Lambinon and Schneider (2004) (Minette: Bettembourg; Moselle: Canach; West Gutland: Bonnevoie, Kleinbettingen, Steinfort; East Gutland: Oberanven), who do not report, however, any finding of this psyllid in or nearby the galls. Therefore, the present records are the first direct findings of *C. melanoneura* in Luxembourg.

Geographical distribution. Palearctic chorotype, widespread and common from the Far East Asia (Japan) to almost all Europe and North Africa (Algeria), through various confirmed reports from Central Asia [Mongolia, Russia (Irkutsk and Siberia), Tadzhikistan, Uzbekistan] (Loginova 1968, Hodkinson and White 1979, Burckhardt 1988a, Burckhardt 1989, Ossiannilsson 1992, Conci et al. 1993, Conci et al. 1996, Lauterer 1999, Baugnée et al. 2002, Seljak 2006, Ripka 2008, Malumphy et al. 2009, Gertsson 2010, Malenovský et al. 2011, O'Connor and Malumphy 2011, Chireceanu and Fătu 2012, Ouvrard et al. 2015, Drohojowska and Klasa 2019, den Bieman et al. 2019).

Biology. Oligophagous on many Rosaceae, *C. melanoneura* primarily lives on plant species of the genus *Crataegus* L. (especially frequent on *C. monogyna* Jacq. and *C. oxyacantha* L., but also reported on *C. laevigata* (Poir.) DC. and *C. maximowiczii* C.K. Schneid. (Hodkinson and White 1979, Burckhardt 1983, Burckhardt 1988a, Burckhardt 1989, Ossiannilsson 1992, Seljak 2006, Ripka 2008, Hodkinson 2009, Malenovský et al. 2011). It can live even on *Malus* spp. (*M. communis* Desf., *M. domestica* Borck.), *Mespilus* spp. (*M. germanica* L.), *Prunus* spp. (*P. armeniaca* L.) and *Pyrus* spp. (*Pyrus communis* L.) (Ossiannilsson 1992, Conci et al. 1993, Conci et al. 1996, Seljak 2006, Ripka 2008, Hodkinson 2009, Malumphy et al. 2009). Furthermore, it can frequently be found on other occasional plants. It shows only one generation per year and overwinters in the adult stage on shelter plants (conifers); aestivation and overwintering habits of this species have been studied in detail by Pizzinat et al. (2011).

Economic significance. On hawthorn *C. melanoneura* is not a harmful species, if leaf deformations often caused by this insect are excluded, i.e. yellow to blood-red folds of the leaf margins. Nevertheless, phytosanitary importance of this species has recently been highlighted, for its ability to host and transmit phytopathogenic microorganisms of various cultivated Rosaceae (especially apple trees), such as '*Candidatus* Liberibacter *europaeus*' and '*Candidatus* Phytoplasma *mali*', the latter being the causative agent of the Apple Proliferation (AP) disease (Mayer et al. 2009, Tedeschi et al. 2009, Tedeschi et al. 2012, Camerota et al. 2012, Jarausch et al. 2012, Oettl and Schlink 2015, Kaya et al. 2016, Miñarro et al. 2016, Oppedisano et al. 2020

Given the phytosanitary importance of this species as a potential vector of phytopathogenic microorganisms, its actual distribution and pathogenicity in Luxembourg should be further investigated.

***Cacopsylla nigrita* (Zetterstedt, 1828)**

(Figs 2, 6, 10, 14)

Findings in Luxembourg. Material studied in the MNHNL collection: East Gutland: Wilferdange, Conzefenn (1 ♀, 22.IX - 19.X.2000, Malaise).

New record for Luxembourg.

Geographical distribution. Widely distributed in Europe, except its most western (e.g. Great Britain, France and Iberian Peninsula) and Mediterranean parts and reported also from the

Caucasian Region and eastwards to Japan (Ossiannilsson 1992, Conci et al. 1993, Conci et al. 1996, Lauterer and Burckhardt 1997, Seljak et al. 2008).

Biology. Strictly oligophagous on *Salix* spp. (Salicaceae), *C. nigrita* is reported especially on *S. caprea* L., *S. elaeagnos* Scop., *S. foetida* Schleicher, *S. helvetica* Vill., *S. lapponum* L., *S. myrsinifolia* Salisb., *S. phylicifolia* L., *S. purpurea* L. and *S. waldsteniana* Willd. (Ossiannilsson 1992, Conci et al. 1993, Conci et al. 1996, Ripka 2008, Seljak et al. 2008). It performs only one generation per year and overwinters as an adult on shelter plants (conifers).

***Cacopsylla peregrina* (Foerster, 1848)**

(Figs 2, 6, 10, 14)

Findings in Luxembourg. Personal field collection by the authors: Oesling: Marnach (11 ♂♂, 17 ♀♀, 2.VI.2020, on *Crataegus monogyna*), Wahl (2 ♂♂, 2 ♀♀, 14.VIII.2019, on *C. monogyna*); West Gutland: Arsdorf (2 ♀♀, 20.V.2020, on *C. monogyna*), Dondelange (3 ♀♀, 28.V.2020, on *C. monogyna*; 1 ♂, 1 ♀, 28.V.2020, on *Alnus glutinosa*, occasional plant), Elvange/Schweich (7 ♂♂, 7 ♀♀, 28.V.2020, on *C. monogyna*), Esch-sur-Sûre (1 ♀, 15.V.2020, on *C. monogyna*; 1 ♀, 15.V.2020, on *Acer* sp., occasional plant), Strassen (4 ♀♀, 27.IV.2020, on *C. monogyna*), Useldange (2 ♂♂, 2 ♀♀, 28.V.2020, on *C. monogyna*); Minette: Belvaux (9 ♂♂, 2 ♀♀, 8.VIII.2019, on *C. monogyna*; 1 ♂, 8.VIII.2019, on *Euonymus* sp., occasional plant), Dudelange (5 ♂♂, 3 ♀♀, 23.VII.2019, on *C. monogyna*), Kayl (4 ♂♂, 7 ♀♀, 11.VI.2020, on *Malus* sp., occasional plant), Kayl/Tetange (14 ♂♂, 10 ♀♀, 23.VII.2019, on *C. monogyna*), Vesquenhaff (7 ♂♂, 17 ♀♀, 30.VII.2019, on *C. monogyna*); Moselle: Elvange/Burmerange (8 ♂♂, 2 ♀♀, 19.V.2020, on *C. monogyna*), Erpeldange (15 ♂♂, 13 ♀♀, 3 nymphs, 7.V.2020, on *C. monogyna*), Mondorf (4 ♂♂, 3 ♀♀, 18.V.2020, on *C. monogyna*; 2 ♀♀, 18.V.2020, on *Acer campestre*, occasional plant), Moutfort (1 ♀, 1.VI.2020, on *Acer platanoides*, occasional plant), Remerschen (1 ♀, 28.V. 2020, on *Alnus glutinosa*, occasional plant).

Material studied in the MNHNL collection: Oesling: Lellingen, Op Baerel (2 ♂♂, 8.VI - 20.VI.2000, Malaise); East Gutland: Godbrange, Schléidelbierg (7 ♂♂, 4 ♀♀, 18.V - 27.V. 1999; 9 ♂♂, 4 ♀♀, 27.V - 9.VI.1999; 14 ♂♂, 10 ♀♀, 9.VI - 25.VI.1999; 1 ♂, 2 ♀♀, 25.VI - 8.VII.1999; 4 ♂♂, 4 ♀♀, 8.VII - 22.VII.1999; 3 ♂♂, 1 ♀, 22.VII - 5.VIII.1999; 2 ♂♂, 5.VIII - 19.VIII.1999; 1 ♀, 19.VIII - 2.IX.1999; 1 ♂, 2 ♀♀, 2.IX - 27.IX.1999, Malaise), Niederanven, Aarnescht (1 ♀, 11.V - 27.V.1999; 2 ♀♀, 27.V - 9.VI.1999; 3 ♂♂, 1 ♀, 9.VI - 25.VI.1999; 1 ♀, 5.VIII - 19.VIII.1999; 2 ♀♀, 2.IX - 27.IX.1999, Malaise).

New record for Luxembourg.

Geographical distribution. Widely distributed in the Palaearctic Region, where it is recorded from Japan and Far East Asia (Inoue 2010) and westwards through the temperate areas of Asia (Burckhardt 2005) and Turkey (Burckhardt and Önuçar 1993), to nearly all Europe and North Africa (Hodkinson and White 1979, Burckhardt 1988a, Ossiannilsson 1992, Conci et al. 1993, Conci et al. 1996, Burckhardt 2005, Seljak 2006, Ripka 2008, Malumphy et al. 2009, Gertsson 2010, Inoue 2010, Lauterer 2011, Malenovský et al. 2011, O'Connor

and Malumphy 2011, Kanturski and Drohojowska 2013, Serbina et al. 2015, Drohojowska and Klasa 2019, den Bieman et al. 2019). Recently recorded also from North America (Canada and USA; Wheeler and Stoops 2001, Wheeler and Hoebeke 2005), where it has been introduced.

Biology. Strictly oligophagous on hawthorns (*Crataegus* L., Rosaceae) (Hodkinson and White 1979, Burckhardt 1983, Burckhardt 1988a, Ossiannilsson 1992, Conci et al. 1993, Conci et al. 1996, Burckhardt 2005, Wheeler and Hoebeke 2005, Seljak 2006, Ripka 2008, Hodkinson 2009, Malumphy et al. 2009, Inoue 2010, Lauterer 2011, Malenovský et al. 2011). In Europe, preferably found on *Crataegus monogyna* Jacq. and *C. oxyacantha* L.; also frequent on other hawthorn species, such as on *C. arnoldiana* Sarg., *C. laevigata* (Poir.) DC or *C. maximowiczii* C.K. Schneid., especially in other geographical areas. On its host plants, this insect performs a single generation per year, with long-living adults during summer, when they frequently spread around also on occasional plants. Eggs are laid in late summer on the host plants (hawthorns) and overwinter. In recent studies, *C. peregrina* showed to be moderately associated with '*Candidatus* Liberibacter *europaeus*' (Tedeschi et al. 2009, Camerota et al. 2012), a phloem-limited Gram-negative bacterium infecting pear plants though producing no specific symptoms; therefore, thought to be an endophyte rather than a pathogen (Raddadi et al. 2011).

***Cacopsylla* sp. gr. *pruni* (Scopoli, 1763)**

(Figs 2, 6, 10, 14)

Two cryptic species, formerly considered as biotypes A and B, have been evidenced within *C. pruni*. They are ecologically and morphologically indistinguishable and partly overlap in their distributions (Sauvion et al. 2021), but show clear genetic differentiation with no hybrids detected (Sauvion et al. 2007, Peccoud et al. 2013, Peccoud et al. 2018). The identity of the material collected in Luxembourg still needs to be checked by molecular methods.

Findings in Luxembourg. Personal field collection by the authors: West Gutland: Arsdorf (1 ♂, 20.V.2020, on *Prunus spinosa*), Strassen (1 ♀, 27.IV.2020, on *P. spinosa*); Moselle: Elvange/Burmerange (1 ♀, 19.V.2020, on *P. spinosa*).

Material studied in the MNHNL collection: Oesling: Goebelsmühle (1 ♀, 25.V - 8.VI.2000, Malaise), Lellingen, Op Baerel (1 ♀, 25.V - 8.VI.2000; 1 ♀, 8.VI - 20.VI.2000; 2 ♂♂, 1 ♀, 20.VI - 6.VII.2000, Malaise); West Gutland: Capellen, Werwelslach (2 ♂♂, 7 ♀♀, 13.IV - 22.IV.1999; 3 ♀♀, 22.IV - 28.IV.1999; 6 ♂♂, 12 ♀♀, 11.V - 18.V.1999; 1 ♀, 18.V - 27.V. 1999; 1 ♂, 1 ♀, 27.V - 9.VI.1999, Malaise); East Gutland: Godbrange, Schléidelbierg (1 ♂, 1 ♀, 6.IV - 22.IV.1999; 2 ♀♀, 11.V - 18.V.1999; 2 ♀♀, 18.V - 27.V.1999, Malaise), Koedange, Poenn (1 ♀, 22.VII - 5.VIII.1999, Malaise), Niederanven, Aarnescht (1 ♂, 1 ♀, 22.IV - 11.V.1999, Malaise); Minette: Schifflange, Kayl, Brucherbierg (1 ♀, 22.IV - 11.V. 1999, Malaise); Moselle: Canach, Wéngertsbierg (2 ♂♂, 1 ♀, 22.IV - 11.V.1999; 2 ♂♂, 1 ♀♀, 11.V - 27.V.1999; 1 ♀, 25.VI - 8.VII.1999, 1 ♂, 5.VIII - 19.VIII.1999, Malaise).

New record for Luxembourg.

Geographical distribution. Central Asian-European chorotype; *C. pruni* has been recorded from the Mongolian Region (Irkutsk) westwards to the Iran, Caucasian Region (Azerbaijan, Georgia), Turkey and to nearly all of Europe (Hodkinson and White 1979, Burckhardt 1983, Ossiannilsson 1992, Burckhardt and Lauterer 1993, Conci et al. 1993, Conci et al. 1996, Burckhardt 2005, Seljak 2006, Sauvion et al. 2007, Ripka 2008, Gertsson 2010, Lauterer 2011, Malenovský et al. 2011, O'Connor and Malumphy 2011, Steffek et al. 2012, Kanturski and Drohojowska 2013, Drohojowska and Burckhardt 2014, Ouvrard et al. 2015, Drohojowska and Klasa 2019, den Bieman et al. 2019).

Biology. Though its adults have been found by chance also on occasional plants, such as *Crataegus* spp. or *Malus domestica* Borckh. (Oettl and Schlink 2015), *C. pruni* is strictly oligophagous on plants of the genus *Prunus* L. (Rosaceae), with *Prunus spinosa* L. being the most frequent host plant, but it can also be observed on *P. armeniaca* L., *P. avium* (L.) L., *P. cerasifera* Ehrh., *P. domestica* L., *P. insititia* L., *P. padus* L., *P. persica* (L.) Stokes and *P. salicina* Lindl. (Hodkinson and White 1979, Burckhardt 1983, Ossiannilsson 1992, Conci et al. 1993, Conci et al. 1996, Burckhardt 2005, Seljak 2006, Sauvion et al. 2007, Ripka 2008, Hodkinson 2009, Lauterer 2011, Malenovský et al. 2011, Steffek et al. 2012, Jarausch and Jarausch 2016). This psyllid species performs one generation per year and overwinters as an adult on shelter plants (conifers). Recent studies allowed us to understand the feeding behaviour on its winter shelter plants, through the application of electrical penetration graph (EPG) recordings and survival bioassays on different conifer species, as well as the analysis of chemical composition of their plant sap (Gallinger and Gross 2018).

Economic significance. Over the past few years, *C. pruni* has taken on a remarkable phytosanitary significance, for its ability to transmit '*Candidatus* Phytoplasma prunorum' (Carraro et al. 1998, Jarausch et al. 2001, Carraro et al. 2004), the causing agent of a complex of economically important disorders on *Prunus* plants (including cultivated *P. armeniaca*, *P. domestica* and *P. persica*), which are collectively referred to as European Stone Fruit Yellows (ESFY). Recently, it has been demonstrated how both putative species of the *C. pruni* complex can transmit and spread the pathogen (Marie-Jeanne et al. 2020). Over the past two decades, ESFY has been detected in most southern and central European countries, Middle East and North Africa (Sertkaya et al. 2005, Marcone et al. 2010, Ben Khalifa et al. 2011, Cieślińska 2011, Tedeschi et al. 2013, Allahverdi et al. 2014, Valasevich and Schneider 2016, Warabieda et al. 2017, Andrianjaka-Camps et al. 2018, Jarausch et al. 2019, Riedle-Bauer et al. 2019b), thus being one of the most serious pests in European stone fruit production and a potential threat for fruit crops worldwide, causing important economic damage.

Given its phytosanitary importance as a potential vector of serious phytopathogenic microorganisms, it would be worth monitoring the distribution and pathogenicity of the separate taxonomic entities within the *Cacopsylla pruni* complex in Luxembourg.

***Cacopsylla pulchra* (Zetterstedt, 1838)**

(Figs 2, 6, 10, 14)