Symptoms caused by the invasive American buffalo treehopper *Stictocephala bisonia* Kopp & Yonke, 1977 (Insecta, Hemiptera) in Luxembourgish viticulture

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Abstract. This study provides the first documented discovery of symptoms caused by the cicada *Stictocephala bisonia* (buffalo treehopper) in Luxembourgish viticulture. Symptoms were found in 2022 in red grapevine cultivars, also in 2023 symptoms on vine plants occurred and two adults of the buffalo treehopper were caught. A characterisation of the resulting symptoms and a discussion on the species' potential pest status depending on annual meteorological conditions are provided.

Key words. Membracidae, *Stictocephala bisonia*, vineyard, phloem sap, leaf rolling, phytosanitary relevance, climate change.

1. Introduction

According to the annual Bulletin météorologique of the Administration des services techniques de l'agriculture (ASTA), the year 2022 was the warmest in Luxembourg since the beginning of measurements in 1838. It was characterized by periods of high air temperatures and extreme droughts, especially during the summer months. The precipitation in Remich/Luxembourg was with 696 mm lower than in the period from 2003 to 2022 (707 mm) (ASTA station Remich). During the summer months June to August, only 39% of the long-term average precipitation sum was reached (2022: 25 mm, 2003-2022: 64 mm). Due to the extreme dry season, no severe fungal disease symptoms occurred in the Moselle valley of Luxembourg. However, in September 2022, some striking symptoms occurred in several red cultivars in different vineyards of the Institut viti-vinicole (IVV) in Remich. These symptoms were caused by *Stictocephala bisonia* (Hemiptera: Membracidae), the buffalo treehopper (BTH), which is one of three cicada species of the family Membracidae that are spread in Europe, including Luxembourg (Niedringhaus et al. 2010a) and can reach 8-10 mm in size (Niedringhaus et al. 2010b, Mohr 2011). Members of this family have a high arched pronotum with very spreading extensions. The BTH is native

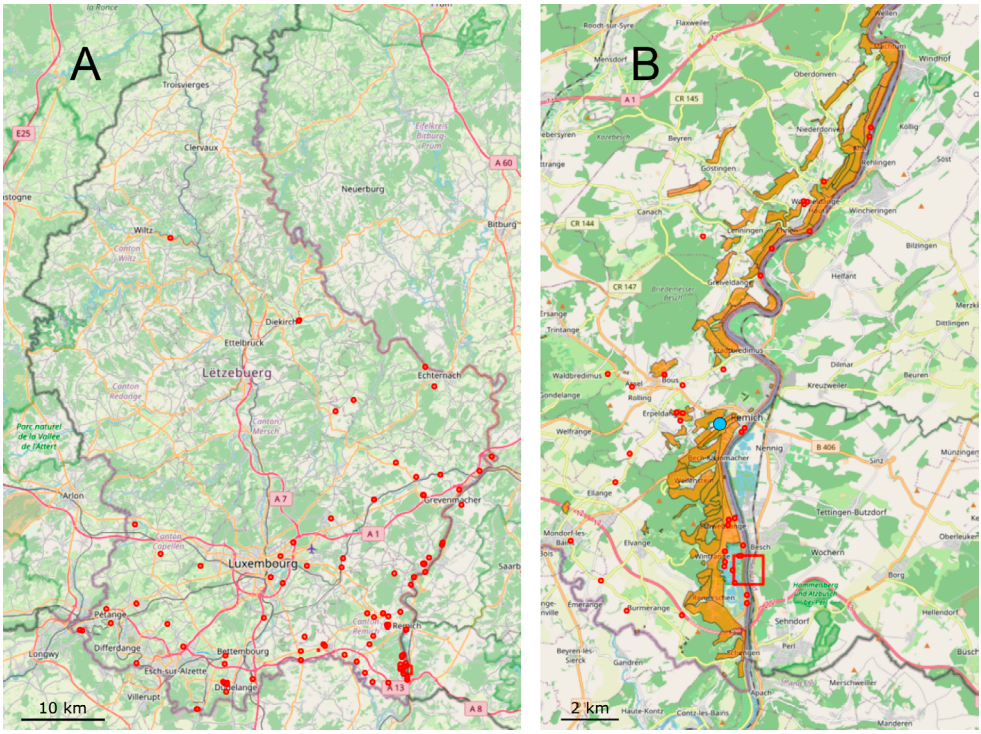


Fig. 1. Overview distribution of *S. bisonia* in Luxembourg (data: MNHNL, 2024). A. Across Luxembourg. B: Records in proximity to vineyards (orange areas) along the Moselle river. Blue dot: Sampling area of this study. The red square indicates a record with imprecise geographical coordinates.

to North America and was first introduced to Europe in Hungary in 1912, probably by fruit and vine scions (Hörren et al. 2019). For Luxembourg, *S. bisonia* was documented for the first time on 15th September 2002 near Remerschen by Robert Biedermann (Ries & Pfeiffenschneider 2024).

The BTH is an univoltine species and overwinters in egg stage (Niedringhaus et al. 2010b, Świerczewski and Stroiński 2011, Hörren et al. 2019). Oviposition occurs at temperatures around 22 °C. In general, the species prefers annual or young branches, mostly up to two years at a height of 1.5-2.5 m for oviposition (Świerczewski and Stroiński 2011). Typically, 5-12 eggs are laid into a single hole, which is formed by slitting the bark with the ovipositor. A total of up to 200 eggs can be laid by a single female (Schedl 1991). The 130x35 µm-sized eggs are white and oval-shaped (Chamont 2021). After emergence from the eggs, larvae are migrating toward herbaceous plants like *Trifolium* spp., *Plantago* spp. and *Taraxacum* spp. close to their initial host plants. After five moulting stages, the development is completed within 2 months (Linder et al. 2016). The optimal temperature for the development cycle is between 19-20 °C, while higher temperatures over 27 °C or periods of drought are unfavourable for the development of the larvae (Chamont 2021). Adults of the BTH can be found from July to the end of October (Niedringhaus et al. 2010a). Both, larvae and adults are living polyphagous (Hörren et al. 2019) by feeding on phloem saps, while the surplus of sugar is excreted (Niedringhaus et al. 2010a). Adults are generally found in tall perennials and mainly in Rosaceae, while larvae are feeding on herbaceous plants (Niedringhaus et al. 2010b).

The range of suitable habitats for the BTH is broad and includes the vegetation of banks, vineyards, and orchards, but also former quarries; in general, the species seems to prefer warm habitats (Hörren et al. 2019).

Economic damages to host plants are caused by feeding, but mainly by oviposition. The resulting wounds can be 2 mm deep and 3-4 mm long. If a plant is used for oviposition in consecutive years, it can be seriously damaged (Świerczewski and Stroiński 2011). Furthermore, the opened slits can be an entry point for secondary wood destroying fungi (Schedl 1991). The appearing leaf symptoms, such as rolling, yellowing, or reddening, are caused by the feeding activity of the adults (Świerczewski and Stroiński 2011). While in red cultivars the leaves and shoots are coloured red, the leaves of white cultivars are brightened up to a bright green to yellow. In viticulture symptoms can be confused with grapevine leafroll disease caused by different virus species or other grapevine yellows caused by phytoplasmas (Mohr 2011).

2. Materials and methods

During regular monitoring work on 05th September 2022 in the vineyards of the IVV in Remich (49.544949N, 6.355933E; 203 m a.s.l.) (Fig. 1B), rows of different cultivars were investigated. Striking red leaves were detected in the following varieties: Gamay, Gamaret, St. Laurent and Pinotin, planted in 2004 and 2011. Plants were stressed by drought and had a bright coloured canopy, so that the partly red coloured shoots and leaves were easy to detect. Some infested shoots were immediately brought to the National Museum of Natural History Luxembourg for microscopic investigation using a Keyence VHX-6000 digital microscope. Data from the ASTA weather station in Remich were used to compare the metrological conditions of the year 2022 to previous periods (Fig. 2).

3. Results

Red coloured leaves in red grapevine cultivars were observed in the upper parts of some shoots in September 2022 (Fig. 3), identified as symptoms of BTH (Fig. 4). Under the first

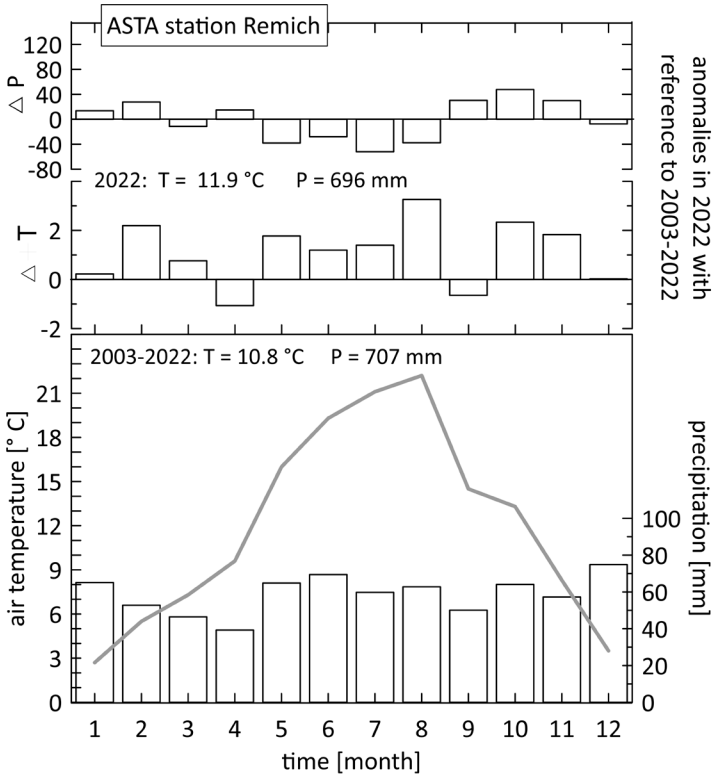


Fig. 2. Weather anomalies 2022 with reference to 2003-2022, provided by LIST.



Fig. 3. Characteristic red coloured part of the vine in experimental vineyards at IVV (Remich). Photo: D. Molitor, 19.09.2022.



Fig. 4. Adult of *S. bisonia* on vine shoot at IVV (Remich). Photo: K. Heilemann, 04.09.2023.

red leaf, the shoot was swollen, followed by a necrotic, brown tissue caused by the sucking activity of the BTH (Fig. 5). In Remich, symptoms were detected in 2022 only in red grape varieties, particularly in St. Laurent, Gamaret, Gamay, and Pinotin. The varieties were all planted in 2004 except for Pinotin, which was planted in 2011. Altogether, in 2022 no symptoms were found in white grape varieties.

The average temperature in Remich in 2022 was with 11.9 °C higher when compared to 10.8 °C in the reference period of 2003-2022. Especially May, June, July, and August were warmer compared to 2003-2022 (Fig. 2) and from June to August, only 39% of the long-term average precipitation sum was reached (2022: 25 mm, 2003-2022: 64 mm).



Fig. 5. Necrotic tissues on vine shoot caused by *S. bisonia*, Photo: A. Weigand, 23.09.2022, taken at MNHNL. Scale bar: 1 mm.

Today, 108 occurrences (29-05-2024) of the cicada are recorded in Luxembourg, with most of them concentrated in the south-eastern part of the country. In the south of the IVV, 16 recordings of BTH are mentioned, more precisely two locations in Remich, 11 in Remerschen, and three in Schwebsange (Ries & Pfeiffenschneider 2024).

4. Discussion

On 5th September 2022, we observed symptoms on grapevines at the Luxembourgish Moselle based on infestation by *S. bisonia,* the buffalo treehopper. It was the first time in Luxembourg that these symptoms were registered in viticulture. BTH is known as an occasional pest in vineyards and orchards, for example, in 2009 in South

Tyrol (Italy), nearly every new plantation of apple trees was damaged by this cicada species (Pernter 2009). The year 2009 was quite warm in South Tyrol with an annual average temperature of 13.3 °C, compared to the reference temperature of 30 years (1981-2010) of 11.8 °C. Precipitation was slightly lower than usual (640 mm to 700 mm on average). The months of April, May and June were warm and dry, in July some violent storms occurred, followed by a very hot August. In total, the months June, July and August were the warmest after 2003 (Anonymous, 2009). Since 1960 average temperatures in South Tyrol increased by 2.2 °C in summer and by 0.8 °C in winter (Zebisch et al. 2018).

In comparison, the average temperature in 2022 in Luxembourg was also higher than in previous years, with particularly warm summer months. It was the first year that the occurrence of BTH was quite frequent, so that symptoms in the vineyards of IVV Remich were not to oversee. It seems that warm summers are favouring the conditions for the spread of *S. bisonia* as it was the case in 2009 in South Tyrol and in 2022 in Luxembourg. In 2022, the average of the monthly temperatures between May and September in Remich/Luxembourg were higher than in the reference period and correspond to the temperature optimum of 19-20 °C of BTH (Chamont 2021). Therefore, an early oviposition was possible, and this allowed the adults to be active for a longer time span. The earlier appearance of the adults extends the period during which they can cause symptoms on the vines. Temperatures during larvae development were also above the mean, with several days reaching temperatures above 27 °C, which could be unfavourable for the development of the larvae (Chamont 2021). In addition, to the impact of air temperature, the year was dominated by drought, which could also be seen as unfavourable for larval development. However, single days with high temperatures during larval development seem not to have a negative impact on the population and the driest month was July (ASTA station Remich) when the larvae were already fully developed to adults. First occurrence of adults in 2023 was recorded on 21/07/2023 in the vineyards of IVV. In 2023 a high incidence of symptoms was confirmed in the experimental vineyards in Remich. Furthermore, two adults were caught in yellow water traps, as described by Eickermann et al. (2020), at the IVV during the season and one adult was observed on a vine shoot (Fig. 4). In contrast to 2022, symptoms were additionally observed in white grape cultivars.

Regarding the susceptibility of host plants to BTH, one-year-old apple trees in South Tyrol were more severely damaged than older trees, probably because the female of *S. bisonia* prefers one- to two-year-old branches for oviposition (Pernter 2009). In viticulture, it is common to use one-year-old wood as fruit cane for grape production, which underlines the potential risk of spreading BTH in viticulture. On the other hand, the age of the vines does not seem to be crucial, as the damaged vines in Remich were 11 to 18 years old.

Due to wounding by oviposition, secondary infections of the hostplant by fungi can occur as described by Pernter (2009) in apple orchards in South Tyrol. Fungi of the genus *Fusarium* colonized wounds, especially when oviposition occurred in early August, followed by humid and warm conditions (Pernter 2009). Whereas in orchards, fungi that colonise the entire trunk pose a high risk to the plant (Pernter 2009), no colonising secondary fungi were found in the Remich vineyards. Furthermore, damage was only found on individual one-year-old shoots, which is not critical for the whole plant as in the case of young apple trees. However, *Collophorina* species have been found in spore traps on vine shoots in Germany (Bien et al. 2020) so attention should be paid to the development of secondary fungi on infested wood.

The symptoms caused by *S. bisonia* were found during the regular monitoring work in the vineyards in 2022. Following this initial observation, more attention was paid to symptoms throughout the experimental area in 2022, but no further symptoms were observed. No symptoms were found in the white grape varieties

in 2022 when searching for symptoms in neighbouring rows after the first discovery in September. A possible explanation for this could be that the symptoms are less noticeable in the white varieties than in the red cultivars. In addition, the extremely dry vegetation period in 2022 was a major challenge for viticulture, with younger vines and plants with stunted growth being adversely affected by the conditions. For this reason, the fruit canes of the affected vines were removed at the IVV to preserve these plants. It is possible that potential damage caused by *S. bisonia* originally occurred more frequently but could not be detected later, because the severed shoots dried up and symptoms were no longer detectable.

5. Conclusion

Due to climate change, dryer and warmer seasons will become more frequent (Molitor and Junk 2019, Junk et al. 2024) and thus more frequent damages due to *S. bisonia* could occur, followed by the risk of secondary fungi infections. Consequently, assessment of this new pest at the Luxembourgish Moselle is recommended, also to validate susceptibility of different grape varieties in a changing environment. In the 2024 growing season, further data will be collected on the experimental field of the IVV. Furthermore, the occurrence of symptoms will be observed more closely in the next years as part of ongoing monitoring work.

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