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First report of the main vector of Dutch elm disease *Scolytus multistriatus* (Marsham, 1802) on elm and poplar trees in Lebanon (Coleoptera, Curculionidae, Scolytinae)

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Abstract. – In August 2017, the smaller European bark beetle, *Scolytus multistriatus* (Marsham, 1802) was recorded for the first time in Lebanon on elm trees in the Monastery of Deir Taanayel at Bekaa Valley. Infected trees were highly suffered from resin flows and yellowish on crowns with shot holes on barks. In May 2018, a survey conducted in the region indicated a high infestation of barks on elm and poplar trees in two areas: Taanayel and Ammiq. Both elm and poplar trees are commonly used in Lebanon as wind barriers in agricultural zones, as shelters on roads and important habitat for the wildlife and migratory birds in the wet zones of the valley. Isolation from symptomatic wood on culture media indicates the absence of the inset associated fungus, *Ophiostoma ulmi*, the agent causal of Dutch elm disease. Despite the absence of the pathogen disease, the occurrence of *S. multistriatus* could represent a serious threat to the biodiversity in the region.

Résumé. – **Premier signalement du vecteur principal de la graphiose de l'orme, *Scolytus multistriatus* (Marsham, 1802), au Liban (Coleoptera, Curculionidae, Scolytinae)**. En août 2017, *Scolytus multistriatus* (Marsham, 1802) a été détecté pour la première fois au Liban sur des ormes dans la ferme de Deir Taanayel. Les arbres infectés étaient fortement atteints par des écoulements de résine jaunâtres sur les couronnes avec des trous sur les écorces. Une enquête menée dans la région en mai 2018, a indiqué une forte infestation d'écorces des ormes et des peupliers dans deux zones : Taanayel et Ammiq. Les deux espèces d'arbres sont couramment utilisées au Liban comme brise-vent dans les zones agricoles, comme abris sur les routes et constituent un habitat important pour la flore et la faune aquatiques et les oiseaux migrateurs dans les zones humides de la région. L'isolement du bois infecté sur un milieu de culture a montré l'absence du champignon associé à l'insecte, *Ophiostoma ulmi*, agent responsable de la graphiose de l'Orme. La présence de *S. multistriatus* pourrait représenter une menace sérieuse pour la biodiversité de la région.

Keywords. – Bark beetle, *Ulmus sp*., *Populus sp*., Palaearctic region, European Elm Beetle, *Ophiostoma sp.*

Bark beetles comprise 225 genera with about 6,000 described species in the subfamily Scolytinae of the order Coleoptera (Bright & Skidmore, 2002; Alonso-Zarazaga & Lyal, 2009). Most of them breed in woody plants and feed on phloem and cambium of living, declining or even dead trees (Wood, 1982; Smith & Hulcr, 2015). The majorities of species are related to forest pests and cause mainly secondary damages as they attack trees weakened by drought, disease, injuries, or insect infestations (Furniss & Carolin, 1977). Eventually they contribute to the death of the trees, providing a useful function in the decomposition of dead wood and the recycling in the forest ecosystem. However, fewer species of bark beetle have the potential to cause significant damages and kill vigorous trees by passively introducing pathogenic fungi (Furniss & Carolin, 1977). *Scolytus* Geoffroy, 1762 (Scolytini) is a genus of true bark beetles. It contains 127 species distributed in the Nearctic, Palearctic, Oriental (Himalayan), and Neotropical regions (Wood & Bright, 1992; Smith & Cognato, 2013) and feeds exclusively on either hardwoods or conifers trees (Wood & Bright, 1992). In addition to the direct damage that they cause to forests, some *Scolytus* species are potential vectors for dangerous diseases. The Smaller European Elm Bark Beetle, *S. multistriatus* (Marsham, 1808), the large elm bark beetle, *S. scolytus* (Fabricius, 1775) and the American elm bark beetle known also

by the native elm bark beetle, *Hylurgopinus rufipes* (Eichhoff 1868), are the main vectors for Dutch elm disease (Collins *et al.*, 1936; Faccoli, 2001). This vascular wilt disease is caused by three species of the fungus Ascomycota *Ophiostoma: O. ulmi* Buisman Melin & Nannf; *O. novo-ulmi* Brasier and *O. himal-ulmi* Brasier & Mehrotra that killed millions of elm trees, *Ulmus spp.*, across Europe, United States of America, Canada, Himalaya and Japan (Furniss & Carolin, 1977; Bloomfield, 1979; Brasier & Mehrotra, 1995). Emerged adult beetles covered by fungal spores transmit the diseases during their feeding activity on healthy trees causing eventually their death (Bright, 1976; Negrón *et al.*, 2005).

The Palearctic bark beetles have been recently cataloged, of which 61 species within the genus *Scolytus* have been recorded (Knížek, 2011; Alonso-Zarazaga *et al*., 2017). In Lebanon, there is no study of the *Scolytus* fauna. However, two species are reported in the literature: 1) *S. rugulosus* (Müller, 1818) on apple, apricot, cherry and peach and 2) *S. amygdali* Guérin-Méneville, 1847, on almond, apricot, cherry and peach (Talhouk, 1969; FAO, 2013). Balachowsky (1963) recorded *Ruguloscolytus mediterraneus* Eggers, 1922, but it was later considered as a synonym of *S. rugulosus*.

During summer 2017, symptoms of wilt and dieback with shot hole on trunks appeared on elm trees in the village of Taanayel at the Bekaa Valley. The infected trees are located within the farm of the Monastery Deir-Taanayel at 33°48'N and 35°52′E (fig. 1). The monastery dates back to the end of the 19th century and it is well-known for its agricultural lands and its biodiversity with well-conserved woodlands, wetlands and wildlife. The elm trees are estimated to be around 70 years old and they are found associated with poplar trees, *Populus* sp., within a mixed forest of 7.5 ha and they are planted as hedges around boundaries of agricultural lands and along alleys of the farm.

Method of survey

In August 2017, a visit was conduct to the infected area to identify the causal agent of dieback on elm trees. By peeling off the bark of infected trees, galleries with radiating arms were observed indicating an attack by bark beetles. Samples of barks were collected and transported to the laboratory of entomology at the Lebanese Agricultural Research Institute (LARI) for examination.

In May 2018, a survey was carried out in two sites in the Bekaa Valley where elm trees are growing in large areas: the forest of the Monastery Deir-Taanayel and the Natural Reserve of Ammiq Wetland at West Bekaa situated at 9 km away from the first site (fig. 1). Elm and other grouped trees were checked for any abnormal symptoms. Samples were collected as follows: five infected elms and five infected poplars in Taanayel, and five infected elms in Ammiq were selected. Branches of about 45 cm length and 20-25 cm diameter from each selected tree were cut and transported to the department of plant protection at LARI for analysis. Samples were also taken from woods and branches used in the sawmill of the Monastery. In addition, two panel traps baited with alpha pinene were placed inside the forest of Deir-Taanayel and checked every week.

Adult beetles collected from the samples and the panel traps were identified by the laboratory of entomology. Because of the importance of some bark beetles in the dissemination of fungi, woody samples of elm have been tested for the presence of pathogenic fungi at the laboratory of mycology at LARI. Isolation was made on malt extract agar medium supplemented with streptomycin sulfate (500 ppm) from symptomatic tissues. Annual precipitation data from year 2009 until May 2018 were obtained from the weather station of LARI situated at Houch Ammiq near to Ammiq Wet Land.

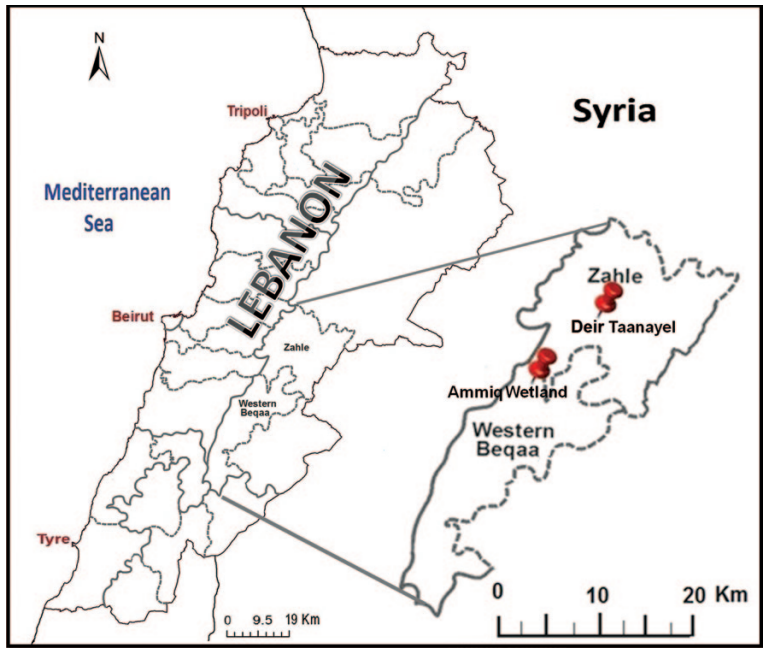

Fig. 1. – Map of Lebanon showing the two study sites where *Scolytus multistriatus* (Marsham) has been detected on elm and poplar trees.

Results

All adult beetles collected from elm barks during the visit in 2017 were identified as *Scolytus multistriatus* (fig. 2). Beetles are small dark reddish brown; body length ranges between 2.8-3.9 mm; front strongly flattened to behind eyes and finely aciculate-punctate; punctures of elytral striae and interstriae are subequal in size. Specimens are distinguished by the presence of lateral teeth on the apical margins of sternites 2-4 and by a median conical spine reaching anterior margin of sternite 2.

Seventy-six adult bark beetles were collected during the visit in May 2018 as follows: 17, 3 and 19 beetles from elm bark, poplar bark and panel traps of Deir-Taanayel respectively; 21 beetles from elm bark and 16 beetles from poplar bark of Ammiq Wetland. No insects were found in the samples taken from sawmill. All specimens collected from elm barks of both sites and from poplar barks of Ammiq site were belonging to *S. multistriatus*. One specimen of *S. rugulosus* and two specimens of *S. multistriatus* were collected from poplar barks of Deir-Taanayel. Isolation on agarized medium showed that the elm trees were free from any pathogen.

Fig. 2. – Adult of *Scolytus multistriatus* (Marsham).

Discussion

Scolytus multistriatus is known as the main vector of Dutch elm disease (*Ophiostoma ulmi*). It breeds in various species of elm trees *Ulmus* sp. (Ulmaceae) but prefers the American elm, *Ulmus*

americana L. Other elm trees reported as hosts are: *U. glabra* Huds (Mountain elm), *U. minor* Mill, (European field elm), *U. procera* Salisb. (English elm) and *U. pumila* L. (Dwarf elm). They colonize weakened or stressed trees (Wood, 1982) but according to Bright (1976), they could attack healthy and vigorous trees. In addition, they could attack other trees like *Populus* (Poplars) Salicaceae, *Prunus* (Stone fruit) Rosaceae, *Quercus* (Oak) Fagaceae, *Rhamnus* (Buckthorn) Rhamnaceae and *Tilia* (Limes) Tiliaceae (CABI, 2016).

The Smaller European Elm Beetle is native to the Palearctic region extending from Western Europe and North Africa to Eastern Europe, and Asia where it is reported in Iran, Turkey, Uzbekistan and Russia (Michalski, 1973; Alonso-Zarazaga *et al*., 2017). It has been introduced to Canada, United State of America, Mexico (Smith & Cognato, 2014), Australia (Neumann, 1987), New Zealand (Dick *et al*., 2000) and South America (Smith & Cognato, 2013). This article represents the first record of *S. multistriatus* in Lebanon with absence of the associated fungus.

The introduction of *S. multistriatus* to Lebanon is still unknown. The primary entry points must be the seaports where wood lumbers used in furniture and solid wood packaging materials (SWPM) used in international trade could carry all the stages of the beetles (Haack *et al.,* 2014). According to the Custom service (2017), Lebanon imports saw timber, lumber and logs mainly from Romania (31%), Turkey (18%), Russia (11%), China (9.3%) and Italy (8%), and from other Eastern Europe countries where the insect is reported. Despite the fact that the Ministry of Agriculture issued a legislation in October 2012 requiring to treat imported wood before exportation and to be free from all diseases (IPPC, 2012), the prevention of introduction of invasive bark beetle apparently failed.

The outbreak of *S. multistriatus* in the region could be the consequence of tree stress caused by the climate change. The climate of the Bekaa Valley is characterized by cold winters and rigorous summers with prolonged drought extending from May to October. However, Lebanon received over the past ten years limited rainfall and warm winter. Analyze of the weather data reveals a significant decline in rainfall and an increasing in the temperature during the last decade causing earlier and longer dry seasons. The region has received annually less than 500 mm since 2013 compared to 1063 mm in 2009 (fig. 3). The rainfall rarely exceeds 10 days with heavy intensity that prevents water rain from filtration into the soil. This decline has obliviously an impact on the ecosystem of the region. Bentz *et al*. (2010) indicated that water

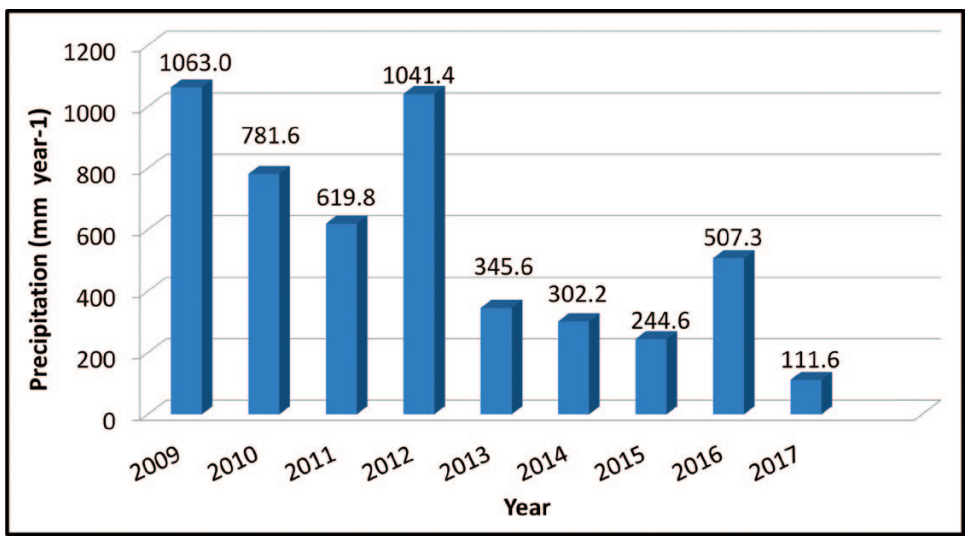

Fig. 3. – Annual rainfall in Ammiq site over the past years. Source: Department of Irrigation and Agrometeorology (LARI).

stress caused by drought can affect host susceptibility to insects by decreasing tree defense and vigor. According to Brown & Eads (1966), *S. multistriatus* reproduces in drought-stressed elms as well as in dying or dead branches. Based on this information, the prolonged drought witnessed in Lebanon can affect the vigor of the trees and make them more susceptible to pest attacks. The negative result of the isolation test indicates that the area is free from the Dutch elm disease. Two hypotheses can explain this result: the first one is that *S. multistriatus* did not carry the fungal pathogen through the wood trades into and within the country or the second one is that the elms present in both sites are resistant to the disease. Beydoun & Estephan (2005) studied the flora of Lebanon and reported *Ulmus minor* as the only species of elm in the region. Since *U. minor* is considered as sensitive species to Dutch elm disease, the second hypotheses is rejected. *U. minor* is found outside forest in association with ashes (*Fraxinus spp.*), poplars (*Populus spp.*), alders (*Alnus spp.*) and others forest trees mainly in two important sites at Bekaa Valley; the monastery of Deir Taanayel and the Ammiq Wetland (Beydoun & Estephan, 2005). Nevertheless, the existence of the vector in the region represents certainly a threat to the elm and poplar trees in Lebanon and the risk of the introduction of the Dutch elm disease is very high.

Conclusion

The natural reserve of Ammiq is considered with the monastery of Deir-Taanayel, as important staging and wintering areas for migratory waterbirds en route between Europe and Africa and important habitat for the aquatic flora and fauna of the region. The impact of the introduced bark beetle *S. multistriatus* on the biodiversity of these two sites is evident. Drought during the past recent years uncertainly affects the trees vigor and increases activity of the population of bark beetle. Although, the associated pathogen *Ophiostoma sp.* responsible for the Dutch elm disease is absent, the risk of its introduction and spread of *S. multistriatus* to new habitats are very high if no action is undertaken. Since the international trade activities are the primary pathways for the movement of the invasive species, phytosanitary measures such as quarantine control, fumigation in accordance with ISPM 15 and introduction of new varieties of elm trees resistant to the Dutch elm disease must be implemented.

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