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THE ALIEN PSYLLID *MACROHOMOTOMA GLADIATA* KUWAYAMA, 1908 (HEMIPTERA PSYLLIOIDEA HOMOTOMIDAE): SPREAD AND DAMAGE OF A RECENTLY RECORDED PEST OF *FICUS MICROCARPA* TREES IN TUNISIA ⁽¹⁾

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Elimem M., Lahfef C., Kalboussi M., Sakhraoui A., Bessouda B., Limem Sellemi E., Rouz S. - The alien psyllid *Macrohormotoma gladiata* Kuwayama (1908) (Hemiptera Psyllioidea Homotomidae); a new pest on *Ficus microcarpa* trees in Tunisia.

During an inventory study of Psyllioidea species carried out in Tunisia, the alien psyllid, *Macrohormotoma gladiata* Kuwayama, 1908 (Hemiptera Psyllioidea Homotomidae), recently recorded in the country, has been detected on ornamental *Ficus microcarpa*, in public and private parks and gardens in many locations of the urban areas of the governorates of Tunis and Ariana, showing a fast spread in the area. This psyllid species has been observed causing damages and vegetative disorders to *Ficus* trees, especially white wax secretion, leaf wrapping and honeydew excretion on leaves and twigs. The number of infested trees increased from our first observations in late 2020 to early 2021. An *Anthocoris* sp. (Hemiptera Anthocoridae) has been observed to naturally prey on *M. gladiata* in many investigated locations.

KEY WORDS: *Macrohormotoma gladiata*, *Ficus microcarpa*, predator, Tunisia, preliminary monitoring

INTRODUCTION

Psyllioidea is a highly diversified superfamily of Hemiptera Sternorrhyncha, which includes a number of species ranking between 3000 and 4000, according to the authors (MIFSUD *et al.*, 2010; MARTONI and BROWN, 2018; OUVARD, 2021). This insect group is very old and dates back from the late upper Cretaceous to early Eocene (OUVRARD *et al.*, 2013). Some species are used as biological control agents of plants; this is the case, for example, of *Arytainilla spartiophila* (Foerster) which is highly host specific on *Cytisus scoparius* (L.) Link (SYRETT *et al.*, 2007). A high number of psyllids are known as pests of many plants and are able to cause great economic losses (MARTONI and BROWN, 2018). Most psyllids are monophagous or oligophagous, with very few polyphagous species known worldwide (Ouvrard *et al.*, 2015). Most species are responsible for different kind of damages to their host plants (EL NASR and ABD-RABOU, 2012). Many of them cause crop diseases since they are vectors of bacteria, such as *Diaphorina citri* Kuwayama, causing citrus greening or huanglongbing which is associated to *Candidatus Liberibacter asiaticum* Jagoueix *et al.*, *Candidatus* L. africanus Jagoueix *et al.* and *Candidatus* L.

americanus Teixeira *et al.* (NAVA *et al.*, 2007), or *Bactericera trigonica* Hodkinson and *B. nigricornis* Foerster, vectors of *Candidatus Liberibacter solanacearum* Lefebvre *et al.* on Apiaceae (BEN OTHMEN *et al.*, 2019). Some psyllids build a protective covering made by white waxy secretions on leaves and twigs of their host plants and produce a large amount of honeydew on which epiphytic fungal species may develop, giving a black dirty appearance to leaves and affecting photosynthesis (EL NASR and ABD-RABOU, 2012; RADONJIC and HRNCIC, 2017).

Within the superfamily Psyllioidea, the genus *Macrohormotoma* Kuwayama (family Homotomidae) originates from the Indo-Australian region and presently includes 15 species developing on *Ficus* spp. trees (HOLLIS and BROOMFIELD, 1989; OUVARD, 2021). *Macrohormotoma gladiata* Kuwayama, 1908, is an oligophagous psyllid that attacks various *Ficus* species (MIFSUD and PORCELLI, 2012; RADONJIC and HRNCIC, 2017). Main host of *M. gladiata* is *Ficus retusa* L. (HOLLIS and BROOMFIELD, 1989). However, other *Ficus* species may be attacked, such as *Ficus benghalensis* L., *F. cuspidatocaudata* Hayata, *F. macrophylla* Desf. ex Pers., *Ficus microcarpa* L.f., *F. religiosa* L. (BELLA and RAPISARDA, 2014; EPPO, 2016; OUVARD, 2021).

According to OUVARD (2021), *M. gladiata* is of Asian origin. It has been reported in Asia in many countries such as China (HODKINSON, 1986), India (HAYAT and KHAN, 2014), Indonesia (CRAWFORD, 1928), Taiwan (YANG *et al.*, 2009), Japan and Malaysia (BURCKHARDT *et al.*, 2018). The first occurrence of this psyllid in the EPPO region has been reported in Spain (MIFSUD and PORCELLI, 2012; SANCHEZ, 2012). Then it has been reported in other European countries such as Malta (MIFSUD *et al.*, 2012), Italy (PEDATA *et al.*, 2012; BELLA and RAPISARDA, 2014; EPPO, 2016), France (ROBERTI *et al.*, 2016), Montenegro (RADONJIC and HRNCIC, 2017), Cyprus (COMPTON *et al.*, 2020), Gibraltar (MALUMPHY and GUILLEM 2020), Greece (MALUMPHY and GUILLEM, 2020) and Portugal (BELLA and AGUIAR, 2020). This species has been reported in the USA in California as new to North America (RUNG, 2016). In Africa, *M. gladiata* has been registered till now only in Algeria (GUENAOUI and OUVARD, 2016) and Morocco (MALUMPHY and GUILLEM, 2020) and very recently it has been recorded also in Tunisia (HARBI *et al.*, 2021).

Following its mentioned first detection in the country, this paper provides additional information on the spread and distribution of *M. gladiata* on *Ficus* trees in Tunisia, giving also data resulting from a monitoring of its natural predator detected in these newly invaded areas.

NEW FINDINGS AND SPREAD OF *MACROHOMOTOMA GLADIATA* IN TUNISIA

In the first record of *M. gladiata* in Tunisia (HARBI *et al.*, 2021), the presence of this insect is reported only for the urban area of the Belvedere Park, in Tunis, where it has been noted in September 2020. Additional and progressively increasing findings of the psyllid are reported in the present paper, showing its fast spread in the country.

Fig. I - Leaves and twigs of *Ficus microcarpa* covered by white waxy secretions and honeydew with dirty black appearance caused by fungi.

In particular, in October 03rd 2020, the first author noted unusual symptoms on *Ficus microcarpa* trees, with numerous leaves and twigs (especially new ones) covered by white waxy secretions and honeydew (Fig. I). Infested trees were located in an area along a main street and in a public park (4 and 3 trees, respectively) in Sidi-Bousaid (Tunis governorate, Tunisia). Twigs were collected, placed in plastic bags and transferred to the laboratory of Entomology at the Higher School of Agriculture of Mograne, where all developing stages of the pest were observed (Fig. II, 1, 2, 3). Specimens were preserved in 70% ethanol, for following dissection, slide mounting and morphological identification. From October 23rd 2020 till April 11th 2021, further inspections have been realized in different locations, in order to define the distribution of the insect in the country and monitor the degree of infestation in each area (Fig. III, Table 1).

IDENTIFICATION OF THE NEW PEST

All samples collected from different investigated sites and at different dates were preliminarily observed under a low magnification binocular microscope. Then, selected adults (males and females) were dissected and slide mounted, in order to observe taxonomically important body regions (e.g.: antennae, forewings, male and female genitalia) at a high magnification microscope. Identification, carried out based on the keys reported by MIFSUD and PORCELLI (2012), ROBERTI *et al.* (2016) and RADONJIC and HRNCIC (2017), led to the species *Macrohomotoma gladiata* Kuwayama, 1908.

According to CRAWFORD (1928), MIFSUD and PORCELLI (2012), ROBERTI *et al.* (2016) and RADONJIC and HRNCIC (2017), *M. gladiata* males (Fig. IV, 1) are about 2 to 2.3 mm and females (Fig. IV, 2) about 3 mm long. Head as wide as the thorax, strongly down-curved. Vertex about 2.5 times as wide as long. Antennae 10 segmented (Fig. IV, 4), thick (segments nearly half as thick as long), not longer than the head width (between eyes), yellowish-brown with last segment darker in color. Thorax, in profile, strongly arched, light to dark brown in color (Fig. IV, 1-2), with yellowish white stripes anterior to the base of forewings but without a dark stripe in the cubital area. Forewings transparent, with distinct and large brown-blackish markings proximal to vein Cu_{1b} and at apex of pterostigma, as well as with three spots in the radular areas (Fig. IV, 3); veins with no setae. Metatibiae without basal spine; with 4 apical internal spurs. Male genitalia with proctiger much wider than long and with two lobes posteriorly. Aedeagus long, with basal segment twice as long as the apical one (Fig. IV, 5). Female genitalia as in Fig. IV, 6. Nymphs light brown with brown wing pads; apical margin of the abdomen pointed (Fig. IV, 7).

EFFECT ON HOST PLANT AND DAMAGE

This psyllid negatively affects *Ficus* species by wrapping their leaves, especially on new growing shoots that will be also covered by abundant white waxy secretion and honeydew produced by the insect (MIFSUD and PORCELLI, 2012; BELLA and RAPISARDA, 2014; ROBERTI *et al.*, 2016; RADONJIC and HRNCIC, 2017).

Fig. II - *Macrohomotoma gladiata*: adult female (1); larva with white waxy secretion (2); larvae on *Ficus microcarpa* leaf (3).

Fig. III - Map of the investigated locations where *Macrohomotoma gladiata* has been detected (legend: SBS: Sidi-Bou-said Street, SBP: Sidi-Bousaid Park, MR: La Marsa, M1: Menzah 1, BLV: Belvedere; AN: Aouina, SK: La Soukra, KR: Kram, CA: Carthage-Amilcar).

Table 1 - Geographic localization of different investigated sites where *Macrohomotoma gladiata* has been detected.

Location	Governorate	Kind of location	Abbreviation	Geographic localization	Altitude (m)
Sidi-Bou-said	Tunis	Street	SBS	36°52'27.52"N 10°20'06.70"E	32
Sidi-Bou-said	Tunis	Public park	SBP	36°52'17.01"N 10°20'30.13"E	49
La Marsa	Tunis	Street	MR	36°53'10.05"N 10°19'23.30"E	14
Menzah 1	Tunis	Street	M1	36°50'13.90"N 10°10'55.24"E	2
Belvedere	Tunis	Street	BLV	36°49'39.58"N 10°11'03.46"E	7
Aouina	Tunis	Private garden	AN	36°51'07.46"N 10°15'24.07"E	1
La Soukra	Ariana	Street	SK	36°52'33.15"N 10°14'42.22"E	4
Kram	Tunis	Street	KR	36°50'11.94"N 10°18'59.25"E	6
Carthage-Amilcar	Tunis	Street	CA	36°51'12.73"N 10°19'38.31"E	12

Fig. IV- *Macrohomotoma gladiata*: adult male with thorax in profile view strongly arched (1); adult female in dorsal view (2); forewing (3); antenna (4); external male genitalia (5); external female genitalia (6); larva with apical margin of abdomen pointed (7).

Deformation of shoots and growth stunting are observed as additional damages to *Ficus* trees when infestations become important (RADONJIC and HRNCIC, 2017). The strong curled leaves protect nymphs of *M. gladiata* from insecticides and potential antagonists (MIFSUD and PORCELLI, 2012).

During our observations in different Tunisian locations, only *F. microcarpa* was attacked by *M. gladiata* although other *Ficus* species were growing nearby, such as *F. elastica*, *F. macrophylla* and *F. rubiginosa* Desf. ex Vent.. However, and according to PEDATA *et al.* (2012), BELLA and RAPISARDA (2014) and OUVARD (2021), *F. macrophylla* is among host plants that *M. gladiata* may attack.

As previously stated, attacks by *M. gladiata* were first observed by us in Sidi-Bousaid, in early October 2020, only on totally 7 *F. microcarpa* trees. Anyway, following monitoring activity performed till mid April 2021 evidenced how the number of infested trees rapidly increased, up to 53 total trees at the end of observations (38 along a main street and 15 in a public park, respectively). Similar increasing in the number of infested trees has been shown also in other investigated locations, especially in La Marsa (MR) with 18 trees on April 11th 2021 (Fig. V). Many colonies were observed especially on new shoots of *F. microcarpa*, that were easily detectable by the cottony aspect given by the high amount of white waxy secretions produced by the nymphs on leaves and twigs of the host plant (Fig. II, 3). All immature instars and adults (males and females) were observed hidden un-

der the white waxy secretions. The contemporary presence of all development stage of the insect indicates that generations overlap. This was reported also by MIFSUD

and PORCELLI (2012), BELLA and RAPISARDA (2014), LABORDA *et al.* (2015) and RADONJIC and HRNCIC (2017).

Fig. V. Monitoring of infested trees with *Macrohomotoma gladiata* populations in different investigated locations (legend: SBS: Sidi-Bousaid Street; SBP: Sidi-Bousaid Public Park; MR: La Marsa; M1: Menzah 1; BLV: Belvedere; AN: Aouina; SR: La Soukra; KR: Kram; CA: Carthage-Amilcar).

According to JIMENEZ-ALAGARDA *et al.* (2014), populations of *M. gladiata* in Valencia in Spain are very abundant from February to June. This is confirmed by our observations, with infestations becoming important starting from February. As already indicated by ROBERTI *et al.* (2016), at our observations and in almost all investigated locations this insect showed to be able of colonizing quickly all trees occurring in a row, with young infested shoots becoming deformed and stopping their development. SANCHEZ (2012) mentioned that this pest species spread rapidly in just some months along the Mediterranean coast of Spain.

NATURAL ENEMIES

During our monitoring of *M. gladiata* in different investigated locations in Tunisia, natural enemies were observed. Identification according to PÉRICART (1972) led to a true bug belonging to the family Anthocoridae and the genus *Anthocoris* Fallen (1814). This bug was present in five of the nine investigated locations: SBS, SBP, MR, SK and CA (Table 2). This indicates how natural biological control may be established in urban areas and reduce psyllid populations.

Table 2 - Distribution of *Anthocoris* sp. in different investigated locations

Location	Governorate	Kind of location	Abbreviation	Natural enemies
Sidi-Bousaid	Tunis	Street	SBS	+
Sidi-Bousaid	Tunis	Public park	SBP	+
La Marsa	Tunis	Street	MR	+
Menzah 1	Tunis	Street	M1	-
Belvedere	Tunis	Street	BLV	-
Aouina	Tunis	Private garden	AN	-
La Soukra	Ariana	Street	SK	+
Kram	Tunis	Street	KR	-
Carthage-Amilcar	Tunis	Street	CA	+

Legend: +; presence of *Anthocoris*, -; absence of *Anthocoris*.

The family Anthocoridae contains between 400 and 600 species worldwide; in particular, the genera *Orius* Wolff and *Anthocoris* are of great importance in biological control (ELIMEM *et al.*, 2018). According to LABORDA *et al.* (2015), *Anthocoris nemoralis* (Fabricius) is among the most abundant predator species that were found feeding on *M. gladiata* in urban *Ficus* trees in Valencia (Spain). MIFSUD and PORCELLI (2012) mentioned that predation by *Anthocoris* sp. may help to control *M. gladiata* and that the effectiveness of this natural biological control agent should be studied.

CONCLUSIVE REMARKS

The alien psyllid *M. gladiata* is considered as one of the most harmful pests on *Ficus* trees. It infests young twigs and leaves which will prevent trees, especially young ones, to grow, stop their development and let them die. In addition, in urban areas, the development of white waxy secretions is considered undesirable, since they fall to the ground under attacked trees and can interfere with people. The presence of honeydew makes damages more serious as long as it will attract ants and other pests, such as mealybugs, and allow sooty mold fungi developing, giving a black dirty appearance to plants and affecting their photosynthesis. All mentioned damages (direct and indirect) were observed by us during the investigation here reported, which make adequate control strategies needed in order to prevent diffusion of this pest to other regions of the country.

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