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Glycaspis brimblecombei Moore, 1964 (Hemiptera Psyllidae) invasion and new records in the Mediterranean area

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ABSTRACT
Glycaspis brimblecombei Moore, 1964 (Hemiptera Psyllidae) is a sap-sucking insect known for being a severe pest in several *Eucalyptus* spp. This paper provides new information about the first record of *G. brimblecombei* in Algeria and Greece, and new information about its biology, analyzing the evolution and reasons of its expansion. It is also the first record of the parasitic wasp *Psyllaephagus bliteus* Riek in Algeria, frequently used as biological control of this psyllid. Samplings were carried out in European and North African Mediterranean countries from 2011 to 2013.

KEY WORDS *Glycaspis brimblecombei*; Psyllidae; *Psyllae phagusbliteus*; Mediterranean areas; invasion.

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INTRODUCTION

The red gum lerp psyllid, *Glycaspis brimblecombei* Moore, 1964 (Hemiptera Psyllidae), is a sap-sucking insect of Australian origin (Moore, 1964), which currently shows a widespread distribution outside its native range due to frequent introductions. It was detected in California, U.S.A. in 1998 (Brennan et al., 1999), in Mexico in 2000 (Castillo, 2003), in the Hawaiian Islands in 2001 (Nagamine & Heu, 2001), in Chile in 2002 (Sandoval & Rothmann, 2003), in Brazil (Santana et al., 2003) and Mauritius (Sookar et al., 2003) in 2003, in Madagascar in 2004 (Hollis, 2004), in Argentina in 2005 (Bouvet et al., 2005), in Ecuador in 2007 (Onore & Gara, 2007), in Venezuela (Rosales et al., 2008), Peru (Burckhardt et al., 2008) and Iberian Peninsula (Hurtado & Reina, 2008; Valente & Hoodkinson, 2009; Prieto-Lillo et al., 2009) in 2008, in Morocco in 2009 (Maatouf & Lumaret, 2012), in Italy in 2010 (Laudonia & Garonna, 2010) and recently in France (Cocquempot et al., 2012).

This psyllid is considered a serious pest that causes severe defoliation and some tree mortality on several *Eucalyptus* spp., being included in the EPPO list of quarantine species since 2002. It mainly feeds on *Eucalyptus camaldulensis* Dehnh., although it can also be found on other species including *E. rudis* Endl., *E. globulus* Labill., *E. diversicolor* F. Muell., *E. sideroxylon* A. Cunn. ex Woolls, *E. nicholii* Maiden et Blakely, *E. lehmannii* (Schauer) Benth., in California and *E. blakelyi* Maiden, *E. nitens* H. Deane et Maiden, *E. tereticornis* Sm., *E. dealbata* A. Cunn. ex Schauer, *E. bridgesiana* R. T. Baker, *E. brassiana* S.T. Blake, *E. mannifera* Mudie, in Australia (Moore, 1970; Brennan et al., 1999; 2001). However, in the Mediterranean area is primarily associated with red eucalyptus (*E. camaldulensis*), frequently used in urban and rural forestry programmes (Peris-Felipo et al., 2010).

G. brimblecombei can be distinguished from other species due to the length of its cephalic projections, located below the eyes and known as genal processes (Laudonia & Garonna, 2010). Adults show sexual dimorphism mainly on the body size, with females slightly larger than males (size varying between 2.5 and 3.1 mm). The body is light green, sometimes with yellow spots. During oviposition, females lay yellow ovoid eggs, individually or in groups and without any protection. Nymphs are yellowish orange with grey wing rudiments. Nymphs secrete honeydew, which builds a white cover for protection until the adult stage is reached. This cover, also called a shield, is conic in shape and is built by several layers linked to each other. The nymph and the protective shield, which reaches a maximum size of 3.0 × 2.0 mm (Ide et al., 2006), grow at the same rate.Oviposition takes place on leaves and, in the case of adverse weather; the eggs enter into a quiescence period until conditions become favourable. After hatching, nymphs rapidly develop into pupal instars, producing the protective shield and readying the insect for final development into adulthood (Laudonia & Garonna, 2010). Once the adult stage is reached, reproductive activity swiftly takes place, fertilized females oviposit and nymphs hatch a few days later, starting another cycle. *G. brimblecombei* may undergo a multivoltine cycle but variations of the life cycle have been observed in different geographical contexts. For instance, in Australia and California there are two to four generations per year whilst in Chile the life cycle is postponed for about one month during the spring-summer period (Hidalgo, 2005). In fact, biological control programs have been applied in Australia and California using the parasitoid *Psyllaephagus bliteus* Riek, as it is known for its efficiency in parasiting several psyllid species, including *G. brimblecombei* (Riek, 1962).

The present paper provides biological and distribution data of *G. brimblecombei* around the Mediterranean countries and information about its progressive expansion from the first record.

MATERIALS AND METHODS

Samples were carried out from 2011 to 2013 around the Mediterranean area excluding the eastern countries. In order to determine the degree of expansion of *Glycaspis* several *Eucalyptus* spp. (*E. camaldulensis*, *E. globulus*, *E. bosistoana* F. Muell. and *E. gomphocephala* A. Cunn. ex DC.) were checked. *Eucalyptus*-trees showing positive presence were sampled, and leaves and insects collected. The samples were either hand-picked or collected with entomological nets. Leaves were taken to the laboratory for observation under light stereomicroscope. Samplings around different areas of Valencia province (Spain) and North-West of Algiers (Algeria) were also taken to determine the presence of the parasitoid wasp *Psyllaephagus blitteus*.

RESULTS

The new records of *G. brimblecombei* increase our knowledge of its distribution in countries where it has not been discovered until this research such as Algeria and Greece.

Samples confirm that this psyllid is well established in South of Europe and North of Africa, having expanded very fast since the first time that was cited in Europe in 2008 (Spain) (Hurtado & Reina, 2008). During four years *G. brimblecombei* has spread throughout Eastern and Southern Spain (Peris-Felipo et al., 2010), Central and South of Italy (Laudonia & Garonna, 2010; Peris-Felipo et al., 2010) and France (Cocquempot et al., 2012), being now reported also in North-West of Algiers (Algeria) and the Peloponnese region (Greece) (Fig. 1).

There were differences between areas relating to the species of *Eucalyptus* infested by *Glycapsis*: *E. camaldulensis* was the only species affected in Europe while *E. gomphocephala* and to a lesser extent *E. globules*, were also infested in Algeria. There were no psyllids reported in *E. bosistoana*. In addition, in Algeria during 2012, samples to know the global population and activity of *G. brimblecombei* were done. In order to represent on the same graph the abundance, temperature (T) and precipitation (P), the Walter ratio (P = 3T) was used. The study shows that the population of *Glycaspis* was significantly higher from late May to early August in all regions, coinciding with low precipitations (less than 50 mm) and temperate temperatures (15 to 25ºC) (Fig. 2).

Despite reported damage caused by the species on *Eucalyptus* around the world, our observations have not revealed any negative effects so far,

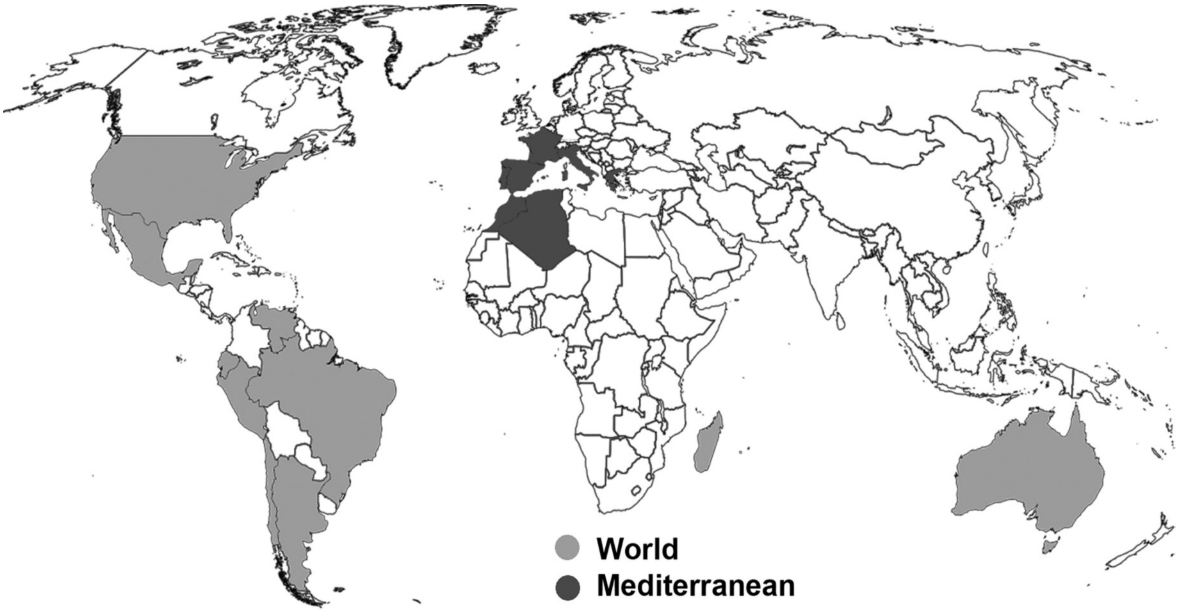


Figure 1. Distribution of *Glycaspis brimblecombei*.

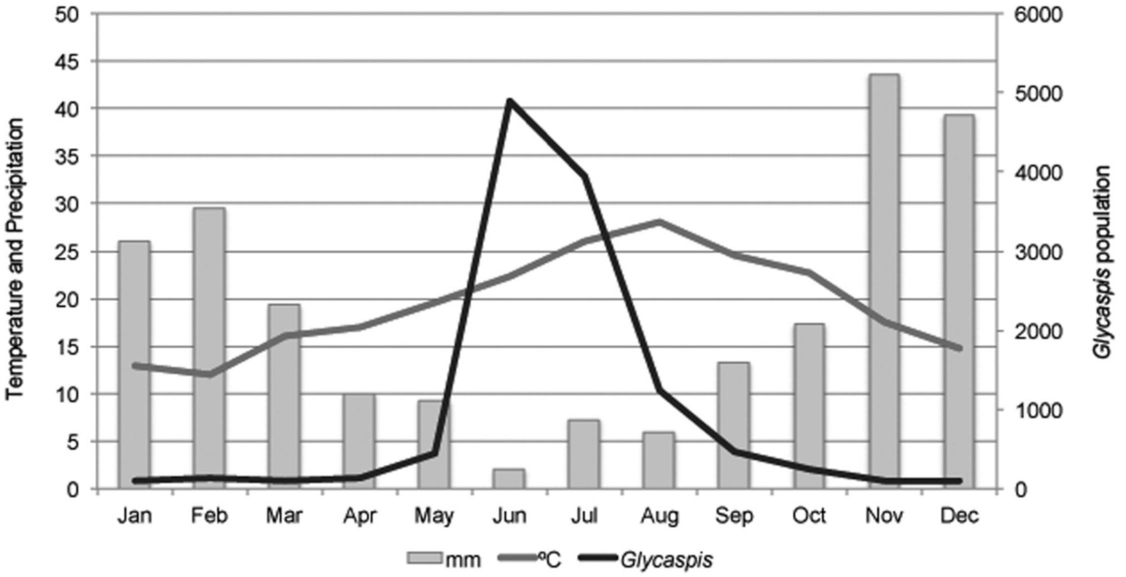


Figure 2. Evolution of the population of *Glycaspis brimblecombei* with temperature and precipitation in Algeria.

though it should be noted that further research is required. Although our research has not identified any significant effect on the trees' health-status, the attack of this sucking insect can indeed leave large quantities of honeydew on leaves, facilitating subsequent attacks by fungi resulting in fumagina syndromes. Moreover, when trees support high population levels, some discoloration of leaves or, at least, the adoption of a yellowish green colour has been detected. In fact, as time progresses, these fungi attacks produce leaf discoloration, falling, stunted growth and general abatement of plant vigour. This general deterioration could facilitate further attacks by other insect pests or the death of branches or even whole trees (Bouvert et al., 2005; Ide et al., 2006; Hurtado & Reina, 2008).

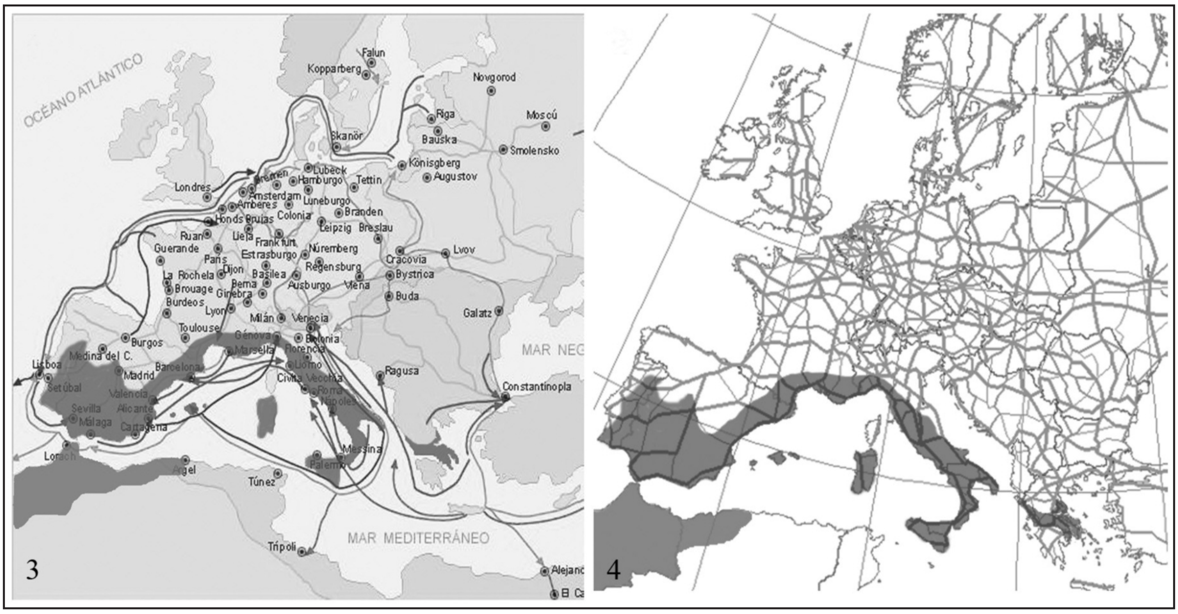
As a result, biological control programs using the natural wasp enemy *Psyllaephagus bliteus* has been used in Australia and California (Riek, 1962) and thus knowing the distribution of this encyrtid becomes relevant in the case of a pest. In Europe, this parasitoid wasp was discovered for the first time in different areas from Sicily (Italy) (Caleca et al., 2011) and Huelva (Spain) (Pérez-Otero et al., 2011) and this paper provides the first record in Algeria.

Once known *Glycaspis* biology, distribution and its expansion, next step was trying to answer the hypothesis about the means used for its dispersion. Countries connections were analysed finding that there were motorways and waterways linking all countries were *Glycaspis* was found (Figs. 3, 4).

On one hand, waterways data analyses demonstrate that Sea connection joins all Mediterranean countries were *Glycaspis* is present (Fig. 3). Checking carefully sea lanes it is possible to observe that there are numerous good routes from the Portuguese and Spanish area to other Spanish regions (i.e. Balearic Islands), areas (i.e. Sardinia) or countries (i.e. France, Greece, Italy or Algeria). On the other hand, motorways networks (Fig. 4) allow a good connection between Portugal, Spain, France and Italy thanks to the Mediterranean motorway. However, there is no connection with Greece, indicating that *Glycaspis* might have reached this country by the Mediterranean Sea. A similar situation could be applied to Italy, as the evolution of *G. brimblecombei* expansion shows it arrived to this area after being found in the Iberian Peninsula. However, in the central areas of Spain and Italy this possibility disappears and therefore a land-based expansion would be more feasible.

Despite that both motor and waterways are good candidates for explaining *Glycapsis* distribution, there is a lack of knowledge about the species biology and thus it is not possible to ignore ways of dispersion used by other arthropods such as the Aphids, which rely on the wind to colonize other trees. These data suggest that *Glycaspis* expansion was done via sea and land: the maritime route would have dominated in coastal areas while the land route would have encouraged its dispersion to offshore areas.

The rapid colonization of Mediterranean countries by *G. brimblecombei* demands the conduction of organic studies aimed at obtaining a better knowledge of its distribution, population characteristics, possible impact and potential natural enemies. Once these aspects are clarified, appropriated



Figures 3, 4. Waterways (Fig. 3) and motorways (Fig. 4) connections in Mediterranean countries with *Glycaspis*.

control measures should be adopted to prevent significant damage on trees and economic loss.

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