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MANLIO SPECIALE, GIULIANO CERASA & GABRIELLA LO VERDE

FIRST RECORD IN EUROPE OF SEEDLINGS
OF *FICUS MACROPHYLLA* F. *COLUMNARIS* (*Moraceae*)
AND OF ITS POLLINATING WASP *PLEISTODONTES*
CF. *IMPERIALIS* (*Chalcidoidea Agaonidae*)

SUMMARY

Since the first half of the nineteenth century, several *Ficus* species have been introduced into Italy as ornamental trees throughout urban gardens and along urban roads. Because a relationship with an agaonid wasp is essential for the pollination and consequently for the production of fertile seeds of *Ficus* spp., the seedlings of other introduced fig species (*Ficus microcarpa* L. f., *Ficus rubiginosa* Desf. ex Vent. and *Ficus watkinsiana* F.M. Bailey) weren't found in Europe in conjunction with their pollinating wasps until more than a century after the figs' introduction. This study presents the first recorded observation of *Ficus macrophylla* f. *columnaris* (C. Moore) D. J. Dixon seedlings in Europe. The seedlings grew from fertile seeds pollinated by the Agaonid *Pleistodontes* cf. *imperialis*. As no other *F. macrophylla* seedlings have been found in any of the other historical gardens of Palermo where this species is present in spite of the occurrence of mature figs fruits, it is possible that the cracks of the terrace filled with soil and organic material where the plantlets were found could have created favorable microclimatic conditions quite similar to those that characterize the native distribution areas of this species.

Key words: *Ficus macrophylla* f. *columnaris*, Europe, Agaonidae fig wasp, *Pleistodontes* cf. *imperialis*

RIASSUNTO

Primo ritrovamento in Europa di plantule da seme di *Ficus macrophylla* f. *columnaris* (*Moraceae*) e del suo impollinatore *Pleistodontes* cfr. *imperialis* (*Chalcidoidea Agaonidae*). Diverse specie di *Ficus* sono state introdotte in Italia a partire dalla metà del IX secolo per scopi ornamentali. Poiché l'impollinazione delle specie di *Ficus* è attuata da Imenotteri Agaonidi con cui tali piante hanno un rapporto di mutualismo obbligato, il ritrovamento negli ultimi decenni di piante da seme di *Ficus microcarpa*, *Ficus rubiginosa* e *Ficus watkinsiana* è coinciso con il rinvenimento dei rispettivi pronubi. Nel presente lavoro si riporta il primo ritrovamento in Europa di plantule da seme di *Ficus macrophylla* Pers. f. *columnaris* e del suo impollinatore *Pleistodontes* cfr. *imperialis* Saunders, 1883. Poiché non

sono state rinvenute piantine nelle ville storiche di Palermo in cui *F. macrophylla* f. *columnaris* è presente, si ipotizza che il germogliamento dei semi e lo sviluppo delle plantule nelle fessure di un edificio nel centro storico di Palermo siano stati favoriti dalle particolari condizioni di insolazione e umidità che caratterizzano la terrazza in cui queste si sono sviluppate.

Parole chiave: *Ficus macrophylla* f. *columnaris*, Europa, Agaonidae, Pleistodontes cfr. *imperialis*

INTRODUCTION

A single *Ficus macrophylla* Pers. f. *columnaris* (C. Moore) D. J. Dixon was introduced into Palermo in the first half of the nineteenth century by Vincenzo Tineo, the Director of the Botanical Garden from 1814 to 1856. The plant came from a French nursery and was erroneously identified as *Ficus nervosa* Haenke (FICI & RAIMONDO, 2006). The *Ficus* was later described by Antonino Borzì, who also served as Director of the Botanical Garden from 1892 to 1921, as a separate species under the name *Ficus magnolioides* (BORZÌ, 1897). In the last century, *F. magnolioides* Borzì and *F. columnaris* C. Moore were synonymized with *Ficus macrophylla* Desf. ex Pers. (CORNER, 1965). GREEN (1986) considered *F. columnaris* as a subspecies of *F. macrophylla*. More recently, DIXON (2001) recognized two forms within *F. macrophylla*, i.e. *F. macrophylla* f. *macrophylla*, endemic to the eastern coast of the Australian mainland, and *F. macrophylla* f. *columnaris*, endemic to Lord Howe Island, a small islet in the Pacific Ocean 600 km east of Australia.

F. macrophylla has been planted as an ornamental tree throughout the urban gardens of Mediterranean Europe and North Africa. In Palermo (Sicily, Italy) several tens of historic *F. macrophylla* f. *columnaris* are present.

In each species in the genus *Ficus*, pollination is performed by one or more host-specific fig wasps belonging to the Agaonidae family (Hymenoptera Chalcidoidea) (ANSTETT *et al.*, 1997; WEIBLEN, 2002; COOK & WEST, 2005; MACHADO *et al.*, 2005). The mutualistic association between figs and their pollinators is considered a classic coevolution model and was long considered to be strictly specific (RAMIREZ, 1970; JANZEN, 1979; WIEBES, 1979; HERRE *et al.*, 1996, 2008; RASPLUS, 1996; WEIBLEN, 2002). However, several studies that also address the phylogenetic analysis of figs and fig wasps have demonstrated a more complex situation. The pollinating fig wasp's host specificity is in some cases less strict than previously believed and there is evidence of cryptic species complexes within some agaonid species (MICHALOU *et al.*, 1996; COOK & RASPLUS, 2003; MOLBO *et al.*, 2003; ZHANG *et al.*, 2004; HAINE *et al.*, 2006; JACKSON *et al.*, 2008; COMPTON *et al.*, 2009; MOE *et al.*, 2011; CORNILLE *et al.*, 2012; McLEISH & VANNOORT, 2012; SUTTON *et al.*, 2015).

Because fig trees depend for pollination on fig wasps, in Europe (Italy, Malta, Canary Islands) *Ficus microcarpa* L. f., the most common species planted in gardens and along urban roads, *Ficus rubiginosa* Desf. ex Vent. and *Ficus watkingsiana* F. M. Bailey seedlings were first recorded in conjunction with their pollinating wasps (LO VERDE *et al.*, 1991; SCHICCHI, 1999; DOMINA & MAZZOLA, 2002; LO VERDE *et al.*, 2007; LO VERDE & PORCELLI, 2010; MIF-SUD *et al.*, 2012; REYES-BETANCORT *et al.*, 2013) more than a century after the figs' introduction.

Concerning *F. macrophylla* pollination, the pollinator wasp for both forms is considered to be *Pleistodontes frogatti* Mayr, 1806 (BOUČEK, 1988; WIEBES, 1991; DIXON, 2001; LOPEZ-VAAMONDE *et al.*, 2002).

MATERIALS AND METHODS

After some *F. macrophylla* f. *columnaris* seedlings were observed in September 2015, a survey was carried out in the main historical gardens in which this plant is present, to verify the occurrence of other seedlings.

Moreover, a low number of dead females belonging to the genus *Pleistodontes* have been found by dissecting about 150 fig fruits collected in different gardens throughout Palermo. Specimens were examined through a Wild-Heerbrugg M8 stereomicroscope. A series of images was taken using a Leica DM2500 compound microscope and a Leica DFC450C mounted camera with Leica Application Suite software; photos were integrated using the freeware Combine ZP (HADLEY, 2011).

RESULTS

Ficus macrophylla f. *columnaris* (C.Moore) D.J.Dixon

In the month of September 2015, four *F. macrophylla* f. *columnaris* seedlings were found in Palermo near a large fig tree planted in the internal courtyard of Palazzo Butera. The fig plants were growing in the cracks of a terrace that had filled with soil and organic material. In spite of the small availability of substrate, specimens of *F. microcarpa* L. f., *Ficus carica* L. and *Ailanthus altissima* (Mill.) Swingle (Simaroubaceae) were also found growing in these cracks. In fact, these species are well known for their ability to grow in marginal conditions. The four young fig plants are probably 1-3 years old, they are about 50-60 cm tall, and their aerial roots are well developed (Figs 1-2).

Mature *F. macrophylla* f. *columnaris* fruits have been observed in Paler-



Fig. 1 — The plant that began the “casual alien” process of *Ficus macrophylla* f. *columnaris*. Behind it, just under the bench, one of the four discovered seedlings.



Fig. 2 — F1 seedling from *Ficus macrophylla* f. *columnaris*.

mo during the last few years, implying that its pollinator wasp is also present. However, in spite of the occurrence of mature figs fruits, no other *F. macrophylla* f. *columnaris* seedlings have been found in any of the other historical gardens where this species is present.

Pleistodontes cf. *imperialis* (*Chalcidoidea* *Agaonidae*)

In the *Agaoninae* genera, the *Pleistodontes* females can be easily distinguished by their elongated head, with long subparallel genae and mandibular appendages that usually bear more than 20 laminae (BOUČEK, 1988). The identification of the wasp females, carried out using the identification key provided by LOPEZ-VAAMONDE *et al.* (2002), did not lead to the expected species, *P. froggatti*, but to *Pleistodontes imperialis* Saunders, 1883. The main characteristics leading to this conclusion are the mandible teeth, which are inwards and not backwards, the mandibular appendages, which bear ventral lamellae and not rows of small teeth, the first two teeth of the mandibles not separated by a ridge, and the antennal scape not expanded over the pedicel (Fig. 3). In this study, we prefer to report our record as *Pleistodontes* cf. *imperialis*, because *P. imperialis* can be considered a species complex (SUTTON *et al.*, 2015) and the present observation could represent a new association between host fig and pollinator wasp species.

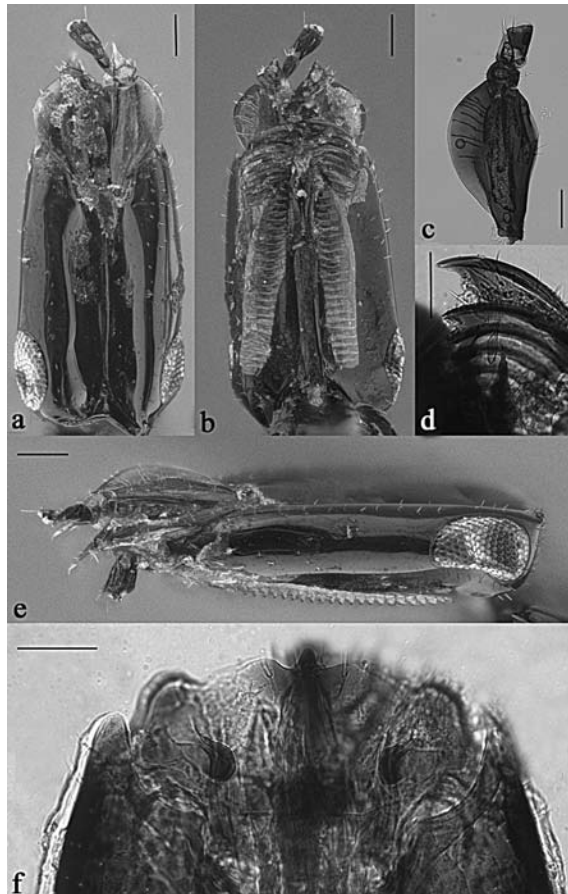


Fig. 3 — *Pleistodontes* cf. *imperialis*, female: a) head in dorsal view; b) mandibles; c) enlargement showing the antennal scape not expanded over the pedicel; d) enlargement showing first two teeth of the mandibles not separated by a ridge; e) head in lateral view; f) detail of clypeal margin with a small median lobe. (Scale bar = 50 µm).

CONCLUDING REMARKS

The presence of the pollinating fig wasps alone is not enough to determine fig germination and plant growth. We suppose that in the case of the *F. macrophylla* plantlets discovered in Palazzo Butera, this could have happened due to the favorable environmental conditions - particularly the sunny position and the frequent hosing off of the terrace, which provided microclimatic conditions quite similar to those that characterize the native distribution areas of this species.

The specific identity of the fig wasp species found inside the *F. macrophylla* siconia, which is different from the one known for this fig species until now, requires further studies. Other species in addition to *F. macrophylla* should also be analysed in order to have a more complete list of the agaonids that have been introduced into Palermo gardens and to assess the relationships with the *Pleistodontes* species previously found in *F. rubiginosa* and *F. watkinsiana* in the same city (LO VERDE *et al.*, 2007).

Currently, this is the first record of *F. macrophylla* f. *columnaris* seedlings in Europe. Considering the very particular microclimatic conditions of the site in which the “casual alien” reproduction of the *taxon* in question took place, everything seems to indicate that this is not a true naturalization, and certainly not an invasive one (CLEMENT & FOSTER, 1994). However, only careful observation of the phenomenon over a substantial period of time can provide any certainty regarding the phenomena’s intrinsic characteristics.

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Authors' addresses —M. SPECIALE, Orto Botanico e Herbarium Mediterraneum dell'Università degli Studi di Palermo, Via Lincoln, 2 - 90133 Palermo; e-mail: manlio.speciale@unipa.it; G. CERASA, G. LO VERDE, Dipartimento di Scienze agrarie e forestali, Viale delle Scienze, Ed. 5 - 90128 Palermo (I); e-mail: giulianocerasa@alice.it, gabriella.loverde@unipa.it.