Bulletin of Insectology ***66*** *(2): 273-281, 2013*
ISSN 1721-8861

The status of *Aleurocanthus spiniferus* from its unwanted introduction in Italy to date

Marilisa CIOFFI[1], Daniele CORNARA[1], Isabella CORRADO[1], Maurice Gerardus Maria JANSEN[2], Francesco PORCELLI[1]
[1]*Dipartimento di Scienze del Suolo, della Pianta e degli Alimenti sez Entomologia e Zoologia, Università degli Studi di Bari Aldo Moro, Italy*
[2]*Plant Protection Service, Wageningen, The Netherlands*

Abstract

Aleurocanthus spiniferus (Quaintance) (orange spiny whitefly, OSW) (Hemiptera Aleyrodidae) has been spreading in Puglia Region since its first report in Italy in 2008. The pest has gradually invaded the whole Lecce District thus expanding northward into Brindisi District. The pest will soon invade the citrus orchards on the Ionic Basilicata coast thus threatening the major Italian citrus orchards in Calabria and Sicily. The aleyrodid also threatens the national and international trade in plants and plant products because of the Quarantine status (EPPO A2) of the species. OSW is a major pest of Citrus; we also report more than thirty other host plant species belonging to twenty-two families infested by this pest; thus, cultivated and urban areas, parks and protected natural reserves are infested to varying degrees. Moreover, it disturbs natural and protected habitats, also forcing unwanted pesticide use in economic and recreation areas as in private gardens. Small-scale results of pesticide use are also discussed with special attention to citrus orchards. Soft soaps and wetting agents gave incomplete pest control while neonicotinoids (Imidacloprid) disrupt *Aleurothrixus floccosus* (Maskell) parasitoids complex eliciting secondary pest resurgence. Classical Biological Control (CBC) is forbidden in Europe by the Habitats Directive 92/43/EEC and in Italy by transposed regulations (DPR 357/1997, DPR 120/2003). Augmentative Biological Control (ABC) chances are discussed on the basis of trials to discover candidate effective indigenous natural enemies. Finally, we consider the OSW biocontrol in non-economic area as the most promising action in order to lower the pest pressure in orchards and, thus, the rise of pesticide-tolerant or -resistant pest strain.

Key words: faunistic, economic impact, alien species, new introduction.

Introduction

Until recently *Aleurocanthus* species had never been found in Europe and *Aleurocanthus ziziphi* Priesner et Hosny was considered the only species of the genus distributed in the Mediterranean North African and Middle Eastern countries (Martin *et al*., 2010). The recent discovery of orange spiny whitefly (OSW), *Aleurocanthus spiniferus* (Quaintance) (Hemiptera Aleyrodidae), in Italy is not only a significant species introduction but also a new challenge for whoever is involved in any activity of the *Citrus* producing chain. It affects the local economy and if nothing is done, and it will have a major impact on the economy of the Mediterranean citrus-producing region. This paper overviews several aspects of the pest introduction including its economic and ecological impact, thus calling for practical solutions.

Origin and status of the species

Quaintance (1903) described the species from material collected in Java by Marlatt in 1901. In 1925, Silvestri (1926; 1928), obtained a grant from the USDA to search for whitefly natural enemies. He travelled to Vietnam and Singapore, collected the species, as he published, and later reported by Russo (1959).

Natural enemies were therefore needed since the pest had already widely spread throughout tropical and subtropical countries.

The pest was also reported in Kenya and Tanzania (Newstead, 1911), Indonesia (Fletcher, 1919), Malaysia (Gater, 1924), India (Singh, 1931), Cambodia, Thailand (Takahashi, 1942), Japan, Marianas Islands, Mauritius (Moutia, 1955), Philippines (Peterson, 1955), Micronesia, Sri Lanka (Takahashi, 1956), Bangladesh (Alam *et al.*, 1965), Pakistan (Gentry, 1965), Hawaii, Sumatra (Weems, 1974). Later, OSW was also found in South Africa (van den Berg *et al.*, 1990).

After its long-range dispersion the pest was recorded in South Italy, Puglia near Supersano - Lecce District -, where it had become acclimatized and was locally spreading (Porcelli, 2008). Thus, OSW is now recorded in the EPPO area.

OSW is a quarantine species that prevents export of citrus fruits and plants to many countries. It threatens national and international trade of plants and plant products in the whole Mediterranean area and is a major concern for European *Citrus* growers today. In Italy *A. spiniferus* is the only black whitefly on *Citrus* and this eases its recognition during the inspection, and the more-often found puparia are black with an array of dorsal spines. Its quarantine status is both regulated by EPPO and EU directives. The genus *Aleurocanthus* Quaintance et Baker is regulated (as *Aleurochantus* species) by EU Annex IIA1 Council Directive 2000/29/EC (Anonymous, 2000). This bans the introduction and dissemination of all the species of the genus in all member states. *A. spiniferus* is an EPPO quarantine species now moved from A1 to A2 list (Anonymous, 2011). Outside the EPPO-region, it is recorded in the quarantine pest lists of Argentina, Bermuda, Chile, Ecuador, French

Polynesia, Israel, Mexico, Morocco, New Caledonia, New Zealand, Paraguay, Peru, Turkey, Uruguay (Opatowski, 2006) and NAPPO (Anonymous, 1997). Online pest data sheets are also available from Gyeltshen *et al.* (2010).

Pest identification and control

A. spiniferus identification requires slide mounting of puparia and taxonomic skills because of its similarity with *Aleurocanthus woglumi* Ashby, another *Citrus* major pest not yet introduced in the EPPO area (Anonymous, 1997). However, with skill and perfect specimens determination can be carried out with a stereomicroscope. Recently, two papers described new cryptic species and showed the importance of the study of sex-related dimorphism and the intraspecific variation of characters, the influence of the preparation technique on the interpretation of morphological characters and the general complexity of the genus (Dubey and Ko, 2012; Kanmiya *et al.*, 2011). On the basis of these papers, the confirmation of Jon Martin (Natural History Museum London) (Porcelli, 2008) and additional research, we confirm the identity of the Italian *A. spiniferus.* It is noteworthy that experience is a prerequisite for a reliable identification of specimens of this taxonomic complicated genus and the decrease of experienced taxonomic workers hampers the study of it.

A. spiniferus is a polyphagous insect, here reported to infest 90 plant species of 38 plant families. It is considered as one of the most destructive aleyrodid *Citrus* pests in tropical Asia and the seventh most important *Citrus* pest in Japan (Anonymous, 1975), in Australia (Gillespie, 2012) and USA (Jeffers, 2009).

A. spiniferus is a common and sometimes serious pest of *Citrus* and other plants in the Indo-Malayan region (Clausen *et al.*, 1978). It is also considered a pest of tea in the Guangdong province of China (Xie, 1993) and recorded as a serious pest of roses in India (David and Subramaniam, 1976).

In general, chemical control has not proved to be effective against orange spiny whitefly or other whiteflies (Gyeltshen *et al.*, 2010). Frequent use of pesticides is harmful to natural enemies, and inappropriate timing of sprays seems to contribute to the increased severity of infestation (Zhang, 2006).

A. spiniferus appears to be fairly well controlled by natural enemies in its native countries, but is liable to cause problems if introduced into new areas (Anonymous, 1997). Biological control, using hymenopteran parasites, has proved to be economic and effective in several regions of the world (Clausen *et al.*, 1978; Quezada, 1974; Smith, 1945).

Ten parasitoids of *A. spiniferus* are listed by Evans (Evans, 2008) and Silvestri (Silvestri, 1928). Eight species of this group are shared with the related *A. woglumi*, native from South-East Asia, which invaded Jamaica in 1913 (Swezey and Vasquez, 1991). Most species are small wasps belonging to the family Aphelinidae: *Ablerus connectans* Silvestri, *Encarsia divergens* (Silvestri), *Encarsia ishii* (Silvestri), *Encarsia merceti modesta* Silvestri, *Encarsia nipponica* Silvestri, *Encarsia opulenta* (Silvestri), *Encarsia smithi* (Silvestri), *Eretmocerus serius* Silvestri, *Eretmocerus silvestrii* Gerling. But also *Amitus hesperidum* Silvestri (Platygastridae) is mentioned.

The species was quickly brought under control in Japan by the introduction of *E. smithi* from China (Guangdong) in 1925, giving parasitoidism rates of 65-90% (Clausen *et al.*, 1978). The pest was under control on *Citrus* in Guam by importation and establishment of *E. smithi* and *A. hesperidum* from Mexico in 1952; however, whiteflies populations infesting *Rosa* spp. and *Vitis* spp. were controlled not so successfully (Clausen *et al.*, 1978). A study in Southern Africa (van den Berg *et al.*, 2000) shows that chemical control may succeed if a previous classical biological control campaign has lowered the pest population. This approach brought significant pest control within eight months from the release of *E. smithi* in commercial orchards with consequent mean parasitoidism rate of about 80% (van den Berg and Greenland, 1997).

E. smithi was also successfully introduced to Hawaii from Japan in 1974 to control the pest (Anonymous, 1975). In Micronesia, introduction of *E. smithi* from Guam (1988) has controlled the pest on *Citrus* within two years (Muniappan *et al.*, 1992; Suta and Esguerra, 1993).

The aim of this work is to assess the OSW status in Puglia and to suggest Augmentative Biological Control (ABC), a promising control means in Italy. Bio-control is needed to lower the pest population pressure in the country, thus making chemical control in orchards effective. This approach lowers the risk to elicit pesticide-tolerant or -resistant pest strains.

Materials and methods

During the period 2009-2011, in April and September, all municipalities in Lecce District were surveyed for the presence of *A. spiniferus*. Suitable host plants were checked for the presence of all stages (figures 1, 2, 3, 4), in orchards, private and urban gardens, ornamentals, tree-lined streets, park areas and natural reserves. More-

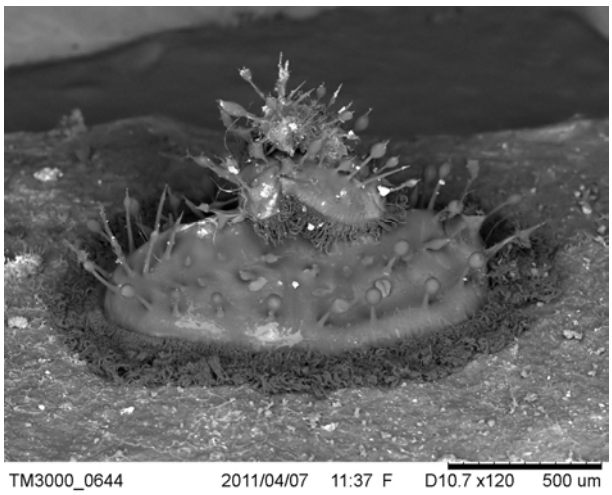

Figure 1. *A. spiniferus* puparium, note the long dorsal glandular spines and overlaying exuvia (SEM).

Figure 2. Juveniles and puparia underside a *Citrus* leaf.

Figure 3. Pedunculate egg attached to leaf host (SEM).

Figure 4. Adults in reproductive aggregation under an immature *Citrus* leaf.

over, in 2011 we inspected all municipalities on the border of Lecce-Brindisi and Taranto district, namely Torchiarolo, San Pietro Vernotico, Cellino San Marco, San Donaci, San Pancrazio Salentino, Avetrana and Manduria.

Inspections started in the city centre, they were then extended to boundaries and orchards, along the main routes looking for infested host plant species. We collected specimens mostly from young fully mature leaves on the basal part of the infested trees.

Contrary to leaves infested with puparia and eggs, which occur on all parts of trees, adults are easily detected on the lower leaf blade, at the twig-tip, and they look like dark spots. Aggregations of adults were scored on young leaves on the tree-top. Special attention was paid to the internal part of the crown where the pest was searched on shaded and overcrowded trees.

Pictures and notes were taken on site, but the material sampled was brought to the laboratory in plastic bags taking care to seal the infested material in order to prevent the escape of adults during transport.

Puparia were slide-mounted, either by quick-mounts method (Martin *et al.*, 2000) or in Canada balsam following the suggestions of Pizza and Porcelli (Pizza and Porcelli, 1993) and Martin (1999). Dense black puparia were bleached with a cold mixture of 30-volume ammonia and 20-volume hydrogen peroxide (Martin, 1999; Anonymous, 2004).

Mounted specimens were identified following Silvestri (Silvestri, 1928: taking into special account the note

on page 2; Bink-Moenen, 1983; Kanmiya *et al.*, 2011; Martin, 1987; 1999).

Laboratory observations were taken by stereomicroscope, light compound microscope equipped for bright field and phase contrast and Hitachi TM3000 low pressure Scanning Electron Microscope (SEM).

Small-scale breeding was set-up in Petri dishes to study predator behaviour and to obtain adults evasion from puparia. A Hitachi TM3000 SEM was used for electron microscopy observations and studies.

Monitoring results

The first *Citrus* infestation by *A. spiniferus* was recorded in Lecce District in April 2008 (Porcelli, 2008) in a *Citrus* backyard orchard. The pest was there at a low-level population for one to three years, without spreading. Later, by the end of 2008 *A. spiniferus* spread around, thus eliciting the alarm of the local growers. Countrywide collection activities showed that 13 municipalities in the Lecce District were invaded by *A. spiniferus* (Nutricato *et al.*, 2009): Alezio, Casarano, Collepasso, Gallipoli, Matino, Melissano, Parabita, Racale, Ruffano, Sannicola, Scorrano, Supersano and Taviano. At that time *A. spiniferus* appeared as a major pest to many wild and economic plants; however, it was restricted to a small area of Puglia Region.

At the end of 2009, the pest spread further infesting 68 of the 97 municipalities of Lecce District with a various degree in infestation intensity.

One year later, *A. spiniferus* infested 88 municipalities but was still absent in Diso, Guagnano, Melendugno, Novoli, Salice Salentino, Squinzano, Trepuzzi, Uggiano la Chiesa and Veglie. These nine uninfested municipalities are located along Brindisi-Taranto Districts border, on the Adriatic coast, at the north edge of the infested area.

During 2011 the pest spread into the villages alongside the Adriatic coast, only Diso and Melendugno being pest-free, apparently.

Inspections in April 2011 showed pest outbreaks in San Pancrazio Salentino, a village in Brindisi District where *A. spiniferus* was recorded for the first time on *Citrus limon* in a private garden.

Two maps report the spreading of the pest in Puglia Region (figure 5) and different infestation intensity (figure 6) by municipalities, both based on inspection results carried out to the end of 2011. The colour is related to the first pest presence in the area. In general, the older the infestation the higher the population; thus, the infestation level increases over time. Consequently, the most dense pest populations were found in the early infestation sites and at sea level. So, uninfested areas are green, low and moderately infested areas are yellow and orange, severely infested are red.

OSW is a very polyphagous insect species and infests Rutaceae, Vitaceae, Araliaceae, Ebenaceae, Leguminosae-Caesalpiniaceae, Malvaceae, Lauraceae, Moraceae, Punicaceae and Rosaceae in Italy. A detailed list of host plants is given in table 1. During our monitoring in Italy,

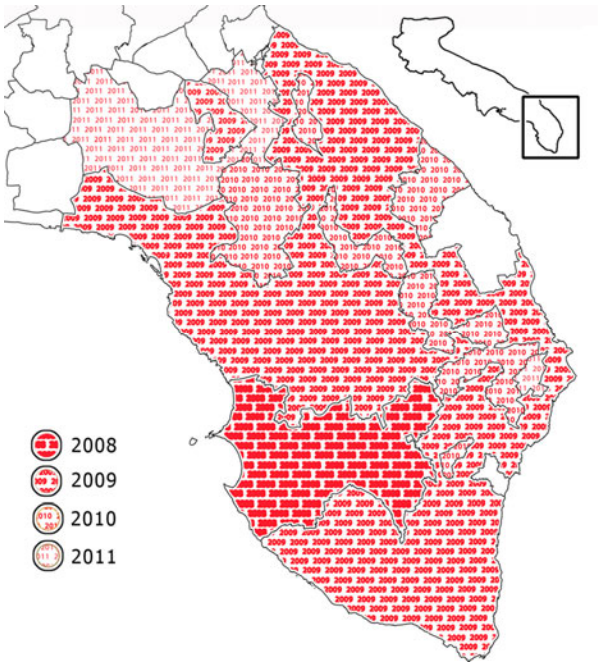

Figure 5. Spreading and distribution map of *Aleurocanthus spiniferus* up to 2011.

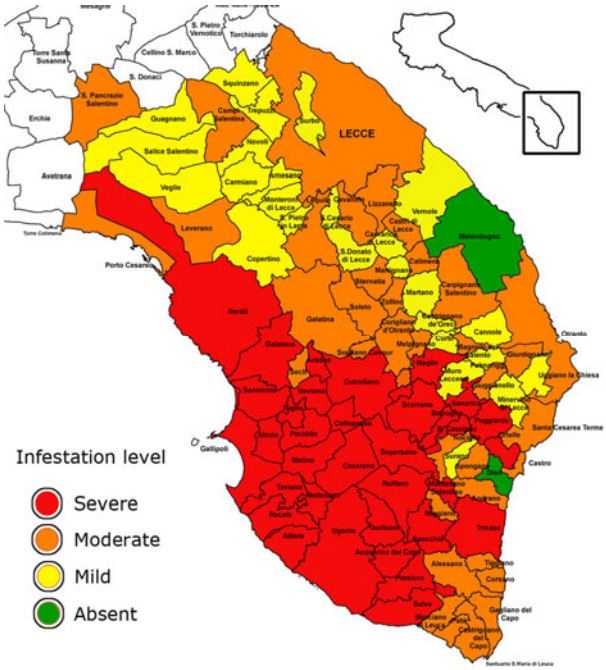

Figure 6. Infestation level of *Aleurocanthus spiniferus* in 2011.

A. spiniferus was found to infest leaves of unreported host plants in urban areas, parks and natural protected habitats such as *Citrus* spp., *Diospyros kaki*, *Ficus carica*, *Laurus nobilis*, *Malus* cv, *Morus alba*, *Punica granatum*, *Pyrus* spp., *Rosa* sp. and *Vitis* spp.

The pest also infests the wild flora such as *Hedera helix*, *Laurus nobilis*, *Prunus* sp. and *Salix* sp.

Table 1. Host plant species list of *A. spiniferus*.

Host plant families	Host plant species	References
Annonaceae	*Annona cherimola* × *squamosa* Mill.	Gillespie, 2012
	Annona muricata L.	Gillespie, 2012
	Annona reticulata L.	Takahashi, 1941b
	Annona squamosa L.	Takahashi, 1941b
	Rollinia deliciosa Saff.	Gillespie, 2012
Apocynaceae	*Plumeria rubra* L.	Martin, 1985
Araliaceae	*Hedera helix* L.	new record
	Fatsia sp.	new record
Arecaceae	*Cocos nucifera* L.	Evans, 2008
Asteraceae	*Synedrella nodiflora* (L.) Gaertn.	Gillespie, 2012
Betulaceae	*Alnus formosana* (Burkill) Makino	Dubey and Ko, 2011
Caesalpiniaceae	*Cassia siamea* Lam.	Gillespie, 2012
Chrysobalanaceae	*Maranthes corymbosa* Blume	Gillespie, 2012
Convolvulaceae	*Erycibe acutifoliae* Hayata	Takahashi, 1933
Ebenaceae	*Diospyros kaki* Thunb.	Kuwana, 1928
	Diospyros maritima Blume	Gillespie, 2012
Elaeocarpaceae	*Sloanea dasycarpa* (Benth.) Hemsl.	Takahashi, 1956
Ericaceae	*Rhododendron ellipticum* Maxim.	Dubey and Ko, 2011
Euphorbiaceae	*Macaranga tanarius* (L.) Müll. Arg.	Martin, 1999
	Manihot esculenta Crantz	Gillespie, 2012
	Sapium sebiferus (L.) Dum. Cours.	Mound and Halsey, 1978
Fabaceae	*Bauhinia championii* (Benth.) Benth.	Evans, 2008; Dubey and Ko, 2011
	Ceratonia siliqua L.	new record
	Entada phaseoloides (L.) Merr.	Martin, 1999
	Myroxylon japonicum (Thunb.) Makino	Kuwana, 1928
	Vigna sesquipedalis (L.) Fruwirth	Evans, 2008
Flacourtiaceae	*Casearia aculeata* Jacq.	Evans, 2008
	Scolopia oldhamii Hence	Dubey and Ko, 2011
Hamamelidaceae	*Liquidambar formosana* Hence	Takahashi, 1956
Lardizabalaceae	*Akebia lobata* Dekne.	Kuwana, 1928
	Akebia longiracemosa Matsum.	Dubey and Ko, 2011
Lauraceae	*Cinnamomum camphora* (L.) J. Presl.	Jeffers, 2009
	Laurus nobilis L.	new record
	Persea zuihoensis (Hayata) H.L. Li	Evans, 2008
	Phoebe formosana (Hayata) Hayata	Dubey and Ko, 2011
Lecythidaceae	*Barringtonia acutangulata* (L.) Gaertn.	Gillespie, 2012
Leguminosae	*Entada phaseoloides* (L.) Merr.	Gillespie, 2012
Malvaceae	*Gossypium* sp.	Jeffers, 2009
	Hibiscus cannabinus L.	Evans, 2008
	Hybiscus sp.	Martin, 1985
	Hibiscus rosa-sinensis L.	Gillespie, 2012
	Hibiscus tiliaceus L.	Martin, 1999
	Malva sp.	new record
	Urena lobata L.	Gillespie, 2012
Meliaceae	*Toona ciliata* M. Roem. (= *australis*)	Gillespie, 2012
Meliosmaceae	*Meliosma rigida* Siebold et Zucc.	Gillespie, 2012
Moraceae	*Ficus capensis* Thunb.	Evans, 2008
	Ficus carica L.	new record
	Ficus racemosa L.	Jeffers, 2009
	Ficus sp.	Martin, 1999
	Morus alba L.	new record
	Streblus sp.	Evans, 2008
Myrsinaceae	*Maesa perlaria* (Lour.) Merr.	Dubey and Ko, 2011
Myrtaceae	*Psidium guajava* L.	Jeffers, 2009
	Syzygium samarangenese (Blume) Merr. et L.M. Perry	Dubey and Ko, 2011
Piperaceae	*Piper kadsura* (Choisy) Ohwi	Dubey and Ko, 2011
Punicaceae	*Punica granatum* L.	new record
Rosaceae	*Cydonia* cv	new record

(Continued)

(Table 1 Continued)

Host plant families	Host plant species	References
Rosaceae	*Eriobotrya japonica* (Thunb.) Lindl.	Takahashi, 1934b
	Malus cv	new record
	Prunus armeniaca L.	new record
	Prunus persica (L.) Batsch	Jeffers, 2009
	Prunus serotina Ehrh.	Evans, 2008
	Prunus cv	new record
	Pyracantha coccinea M. Roem.	new record
	Pyrus communis L.	Jeffers, 2009
	Pyrus pyraster (L.) Du Roi	new record
	Pyrus pyrifolia (Burm. F) Nakai	Jeffers, 2009
	Pyrus serotina Rehder	Kuwana, 1928
	Pyrus cv	new record
	Rosa indica L.	Kuwana, 1928
	Rosa chinensis Jacq.	Mound and Halsey, 1978
	Rosa sp.	Dubey and Ko, 2008
	Rosa cv	Gillespie, 2012
Rubiaceae	*Gardenia jasminoides* J. Ellis	Dubey and Ko, 2011
	Mussaenda pubescens Dryand.	Dubey and Ko, 2011
Rutaceae	*Citrus aurantium* L.	Jeffers, 2009
	Citrus bigaradia Loisel.	Evans, 2008
	Citrus limon (L.) Burm. F.	Mound and Halsey, 1978
	Citrus sinensis (L.) Osbeck	Mound and Halsey, 1978
	Flindersia sp.	Gillespie, 2012
	Murraya koenigii (L.) Spreng.	Dubey and Ko, 2008
	Zanthoxylum [Fagara] nitidum (Roxb.) DC.	Takahashi, 1956
Sabiaceae	*Meliosma rigida* Siebold et Zucc.	Takahashi, 1933
Salicaceae	*Salix* sp.	Takahashi, 1956
Sapindaceae	*Cupaniopsis anacardiodes* (A. Rich.) Radlk.	Gillespie, 2012
	Ganophyllum falcatum Blume	Gillespie, 2012
Theaceae	*Camellia sinensis* (L.) Kuntze	Jeffers, 2009
Ulmaceae	*Aphananthe philippinensis* Planch.	Gillespie, 2012
Urticaceae	*Boehmeria densiglomerata* W.T.Wang	Dubey and Ko, 2011
	Boehmeria blinii H.Lév.	Dubey and Ko, 2011
Vitaceae	*Parthenocissus tricuspidata* (Siebold et Zucc.) Planch.	new record
	Vitis vinifera L.	Kuwana, 1928
	Vitis cv	new record

Discussion

Diso and Melendugno villages seem to be free from infestation, but we assume that a very low level of infestation may escape the sampler's efforts. Moreover, many host plants grow in backyards and private gardens and, thus, cannot be easily inspected.

Adults of *Aleurocanthus* are able to fly down-wind over a short distance, although this may not be a mode of long-range dispersal (Meyerdink *et al.*, 1979). It may move between countries on host plant material or possibly on fruits (Anonymous, 1997). *Aleurocanthus* spp. have been intercepted on the leaves of infested host plants moving in international trade (Anonymous, 1988). In our infestation we presume *A. spiniferus* was introduced in a single event.

The introduction of this whitefly species has had several consequences:

1. A strong disturbance of natural and artificial environments by an increase in the use of pesticides in economic and recreation areas and in private gardens. Moreover, it is spreading on the wild flora that is now the main pest reservoir in Italy.
2. Plants are damaged by sap-sucking and by excreting copious amounts of honeydew that coats leaf and fruit surfaces. Sooty mould develops quickly on this honeydew as flakes that can be peeled off from the leaves. The plant blackening reduces respiration and photosynthesis giving low quality, small and permanently black-stained products, resulting in plants and fruits non tradeable (figures 7 and 8).
3. In order to dispose blackened vegetation, growers severely prune infested branches in their orchards burning them, eventually. This measure resolves into re-sprouting of abundant twigs and, thus, into new intense infestations.
4. Weakening of severely infested trees results in discoloration of leaves and defoliation, dieback of branches and twigs, disfigured plants, deformed and dropping fruits.

The pest damages and destroys the orchards severely. Injuries resemble those of *A. woglumi*: ultimately trees

Figure 7. *Citrus* leaves blackened by sooty mould.

Figure 8. Harvested oranges ruined by sooty mould.

Figure 9. *C. arcuatus* larva preying on *A. spiniferus* immatures.

are stunted, cease to flower and to produce fruit, and may become so weakened that they are unable to withstand unfavourable soil or weather conditions and invasion by diseases (Russell, 1926).

In Florida and in the Gulf States whiteflies reduced *Citrus* production by over 45-50% if not properly managed (Bambara, 2011). Chemical control alone is both expensive and ineffective (Gyeltshen *et al.*, 2010) and, after overwintering as nymphs and puparia, infestations grow considerably in spring-summer starting from neglected orchards and wild flora.

Chemical control using neonicotinoids (Imidacloprid) is not an option in Italian *Citrus* orchards because it disrupts effective classical biological control against the woolly whitefly *Aleurothrixus floccosus* (Maskell) with consequent secondary pest resurgence and pesticide resistance. Moreover, the use of neonicotinoids is now restricted by the European Commission Implementing Regulation N° 485/2013 (Anonymous, 2013).

Low impact insecticides and fungicides like Soap Salts and Oils should be useful to control crawlers and sooty mould until the effective classical biological control establishment. Soft soaps and wetting agents gave incomplete pest control but can be considered for low infestation level containment.

All the same, pesticides should be distributed at very low population levels on young, fully extended leaves due to the oviposition preferences of the pest.

The spread of the pest remains unchallenged by indigenous natural enemies, because ineffective predators or parasitoids have been found on it, until now. Only larvae of *Clitostethus arcuatus* (Rossi) (Coleoptera Coccinellidae) were observed preying eggs and 1st and 2nd instar nymphs of *A. spiniferus* on infested plants (figure 9).

The introduction of such useful parasitoids, in particular *E. smithi*, in a CBC program seems to be the only effective measure to control *A. spiniferus* in Italy.

Moreover, CBC is prevented in Europe by the Habitats Directive 92/43/EEC and in Italy by transposed regulations (DPR 357/1997, DPR 120/2003) so we will try to discover effective indigenous natural enemies which may be useful in an ABC program, the only available chance at the moment.

In the present situation the only option for pest control is to find indigenous effective natural enemies by exposing infested *Citrus* plants as baits in semi-natural environments.

A. woglumi which is destructive in Central America and successfully biologically controlled in El Salvador (Caballero, 1992), Nicaragua (Swezey and Vasquez, 1991) and Dominican Republic (Pierre *et al.*, 2000), shares at least a part of the predator parasite complex with that of *A. spiniferus*. This experience shows that rapid response is crucial to minimize damages and spread of an introduced exotic pest (Pierre *et al.*, 2000).

Conclusion

A heavy infestation on *Citrus* caused by *A. spiniferus* was recorded for the first time in Lecce District in April 2008 (Porcelli, 2008). Presumably, OSW was acciden-

tally introduced from Southeast Asia, where it is indigenous, and it is a severe threat to *Citrus* crops.

During the period 2008-2011 *A. spiniferus* occupied the whole District of Lecce thus entering Brindisi District in San Pancrazio Salentino. The pest is fully acclimatized in South Italy where it finds the proper conditions to spread, damaging *Citrus* and other fruits and crops.

Besides it is rapidly spreading by transport of infested plant material. Passive pest dispersion should be checked in order to avoid unwanted dissemination on major routes. This will preserve major *Citrus*-production areas in Calabria and Sicily.

Moreover, we must pay special attention to competitive displacement abilities of this exotic species in order to preserve natural and protected environments. Important to note is that native and exotic ornamental plant species play a major role as pest reservoirs, thus compromising chemical control efforts.

Neither classical biological control nor augmentative biological controls are effective or possible today.

The situation is an economically and ecologically important issue, not only for Italy but also for the whole Mediterranean region. In Central America there is a lot of experience with the release of parasites and predators of the related *A. woglumi* under different circumstances.

Therefore, it is urgent to develop and implement new regulations to permit CBC based on a proper risk-assessment of the natural enemy.

Acknowledgements

We acknowledge Mr Pasquale Trotti for preparing the illustration and SEM imaging of OSW puparium and egg.

References

ALAM M. Z., AHMED A., ALAM S., ISLAM M. A., 1965.- A review of research Division of Entomology (1947-1964).- Dacca Agricultural Information Service & East Pakistan agricultural Research Institute.

ANONYMOUS, 1975.- USDA, Outbreaks and new records, United States Department of Agriculture.- *FAO Plant Protection Bulletin*, 23: 27-28.

ANONYMOUS, 1988.- *List of intercepted plant pests: Fiscal Year 1987*.- United States Department of Agriculture, Animal and Plant Health Inspection Service, Washington, DC, USA.

ANONYMOUS, 1997.- Data sheets on quarantine pests: *Aleurocanthus spiniferus*.- CABI and EPPO. [online] URL: http://www.eppo.org/QUARANTINE/insects/Aleurocanthus_spiniferus/ALECSN_ds.pdf (accessed 1st July 2008)

ANONYMOUS, 2000.- Council Directive 2000/29/EC of 8 May 2000 on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community + Annexes I-IX.- *Official Journal of the European Communities*, L 169.

ANONYMOUS, 2004.- Diagnostic protocols for regulated pests. PM 7/35 *Bemisia tabaci*.- *EPPO Bulletin*, 34: 155-157.

ANONYMOUS, 2011.- EPPO A2 List of pests recommended for regulation as quarantine pests (version 2011-09). [online] URL: http://www.eppo.int/QUARANTINE/listA2.htm

ANONYMOUS, 2013.- Commission Implementing Regulation (EU) No 485/2013. Official Journal of the European Union, L 139 (EN), 25.5.2013 plus Annexes I &II.

BAMBARA S., 2011.- Citrus whitefly on gardenia. [online] URL: http://www.ces.ncsu.edu/depts/ent/notes/O&T/shrubs/note152/note152.html

BINK-MOENEN R. M., 1983.- Revison of the African whiteflies (Aleyrodidae).- *Monografieën van de Nederlandse Entomologische Vereniging*, 10: 1-211.

CABALLERO R., 1992.- Whitefly fauna of Central America and Colombia. 133 pp., *Thesis*, University of Kansas, USA.

CLAUSEN C. P., BARTLETT B. R., DEBACH P., GOEDEN R. D., LEGNER E. F., MCMURTRY J. A., OATMAN E. R., BAY E. C., ROSEN D., 1978.- Introduced parasites and predators of arthropod pests and weeds: A world review.- *United States Department of Agriculture, Agriculture Handbook*, 480: 1-545.

DAVID B. V., SUBRAMANIAM T. R., 1976.- Studies on some Indian Aleyrodidae.- *Records of The Zoological Survey of India*, 70: 133-233.

DUBEY A. K., KO C. C., 2012.- Sexual dimorphism among species of *Aleurocanthus* Quaintance and Baker (Hemiptera: Aleyrodidae) in Taiwan, with one new species and an identification key.- *Zootaxa*, 3177: 1-23.

EVANS G., 2008.- The whiteflies (Hemiptera: Aleyrodidae) of the world and their host plants and natural enemies. [online] URL: http://www.se.barc.usda.gov/whitefly/wfframe.htm

FLETCHER T. B., 1919.- Aleyrodidae on citrus plants. Second hundred notes on Indian insects.- *Agricultural Research Institute Pusa Bulletin*, 89: 90.

GATER B. A. R., 1924.- Insect pests of Lubuan and adjacent islands.- *Malayan Agriculture*, 12: 374-406.

GENTRY J. W., 1965.- Crop insects of Northeast Africa-Southeast Asia.- *Agricultural Research Service, United States Department of Agriculture, Agriculture Handbook*, 273: 1-210.

GILLESPIE P. S., 2012.- A review of the whitefly genus *Aleurocanthus* Quiantance & Baker (Hemiptera: Aleyrodidae) in Australia.- *Zootaxa*, 3252: 1-42.

GYELTSHEN J., HODGES A., HODGES G. S., 2010.- Orange spiny whitefly, *Aleurocanthus spiniferus* Quaintance (Insecta: Hemiptera: Aleyrodidae), University of Florida, Institute of Food and Agricultural Sciences (IFAS). [online] URL: http://entnemdept.ufl.edu/creatures/citrus/orange_spiny_whitefly.htm (accessed 17 May 2012).

JEFFERS L., 2009.- New pest advisory group report. *Aleurocanthus spiniferus* Quaintance: Orange Spiny Whitefly Hemiptera/Aleyrodidae. *In litteris*

KANMIYA K., UEDA S., KASAI A., YAMASHITA K., SATO Y., YOSHIYASU Y., 2011.- Proposal of new specific status for tea-infesting populations of the nominal citrus spiny whitefly *Aleurocanthus spiniferus* (Homoptera: Aleyrodidae).- *Zootaxa*, 2797: 25-44.

KUWANA I.,1928.- Aleyrodidae or white flies attacking citrus plants in Japan.- *Department of Agriculture and Forestry Japan: Scientific Bulletins*, 1: 41-78.

MARTIN J. H., 1985.- The Whitefly of New Guinea (Homoptera: Aleyrodidae).- *Bulletin of the British Museum (Natural History) Entomology*, 50 (3): 303-351.

MARTIN J. H., 1987.- An identification guide to the common whitefly pest species of the world (Homoptera, Aleyrodidae).- *Tropical Pest Management*, 33 (4): 298-322.

MARTIN J. H., 1999.- The whitefly fauna of Australia (Sternorrhyncha: Aleyrodidae), a taxonomic account and identification guide.- *Technical Paper CSIRO Entomology*, 38: 1-197.

MARTIN J. H., MIFSUD D., RAPISARDA C., 2000.- The whiteflies (Hemiptera: Aleyrodidae) of Europe and the Mediterranean Basin.- *Bulletin of Entomological Research*, 90: 407-448.

MEYERDINK D. E., HART W. G., BURNSIDE J., 1979.- Marking and dispersal study of the citrus blackfly. *Aleurocanthus woglumi*.- *Southwestern Entomologist*, 4: 325-329.

MOUND L. A., HALSEY S. H., 1978. *Whitefly of the world*.- British Museum (Natural History) and John Wiley & Sons, Chichester, UK.

MOUTIA L. A., 1955.- The commoner insect pests of orchards, food crops, vegetables, flower gardens and household in Mauritius.- *Mauritius Department of Agriculture Bulletin*, 91: 1-79.

MUNIAPPAN R., MARUTANI M., ESGUERRA N., 1992.- Establishment of *Encarsia smithi* (Silvestri) (Hymenoptera: Aphelinidae) on Pohnpei for control of the orange spiny whitefly, *Aleurocanthus spiniferus* (Quaintance) (Homoptera: Aleyrodidae).- *Proceedings Hawaiian Entomological Society*, 31: 243.

NEWSTEAD R., 1911.- On a collection of Coccidae and Aleurodidae, chiefly African, in the collection of the Berlin Zoological Museum.- *Mitteilungen aus dem Zoologischen Museum in Berlin*, 5: 155-174.

NUTRICATO S., D'ONGHIA A. M., FEDELE A., FILÌ V., GARONNA A. P., GUARIO A., GUASTAMACCHIA F., MAZZEO M., PARISI V., PERCOCO A., PIZZA M., ZECCA F., PORCELLI F., 2009.- Nuovo Aleirode da quarantena segnalato in Puglia.- *Informatore Agrario*, 65 (30): 57-59.

OPATOWSKI D., 2006.- Bilateral quarantine arrangement between the Department of Agriculture of the Republic of South Africa (DoA SA) and the Plant Protection and Inspection Services of Israel (PPIS) regarding the conditions for the importation of fresh grapes (*Vitis vinifera*) from the Republic of South Africa into Israel.

PETERSON G. D., 1955.- Biological control of the orange spiny whitefly in Guam.- *Journal of Economic Entomology*, 48: 681-703.

PIERRE C., KAIRO M., LOPEZ V., 2000.- Evaluation of citrus blackfly (*Aleurocanthus woglumi*) management in Dominica, pp. 1-61. In: *Workshop Report FAO-TCP/DMI/8922*, Fisheries Complex, Roseau 12-13 December 2000.

PIZZA M., PORCELLI F. 1993.- Sull'allestimento di preparati microscopici di pupari di aleirodidi (Homoptera).- *Bollettino della Società Entomologica Italiana*, 125 (1): 3-5.

PORCELLI F., 2008.- First record of *Aleurocanthus spiniferus* (Homoptera: Aleyrodidae) in Puglia, Southern Italy.- *EPPO Bulletin*, 38 (3): 516-518.

QUAINTANCE A. L., 1903.- New oriental Aleurodidae.- *The Canadian Entomologist*, 35: 61-64.

QUEZADA J. R., 1974.- Biological control of *Aleurocanthus woglumi* (Homoptera: Aleyrodidae) in El Salvador.- *Entomophaga*, 19: 243-254.

RUSSELL L. M., 1962.- The citrus blackfly.- *FAO Plant Protection Bulletin*, 10: 36-38.

SILVESTRI F., 1926.- Descrizione di tre specie di *Prospaltella* e di una di *Encarsia* (Hymenoptera: Chalicididae) parasite di *Aleurocanthus* (Aleyrodidae).- *Eos, Madrid*, 2: 179-189.

SILVESTRI F., 1928.- Contribuzione alla conoscenza degli Aleurodidae (lnsecta: Hemiptera) viventi su *Citrus* in Estremo Oriente e dei loro parassiti.- *Bollettino del Laboratorio di Zoologia Generale e Agraria*, 21: 1-60.

SILVESTRI F., 1959.- *Ricordi e itinerari scientifici*.- Genovese Imp., Napoli, Italy.

SINGH K., 1931.- A contribution towards our knowledge of the Aleyrodidae (Whiteflies) of India.- *Memoirs of the Department of Agriculture in India. Entomological series*, 12: 1-98.

SMITH H. D., 1945.- Citrus blackfly on the west coast of Mexico and the importation and colonization of *Eretmocerus serius* Silv. for its control.- *Fitofolio*, 4: 67-103.

SUTA A. R., ESGUERRA N. M., 1993.- Recent history of biological control in the freely associated states of Micronesia.- *Micronesica*, 4: 61-64.

SWEZEY S. L., VASQUEZ E. C., 1991.- Biological control of citrus blackfly (Homoptera: Aleyrodidae) in Nicaragua.- *Environmental Entomology*, 20: 1691-1698.

TAKAHASHI R., 1933.- Aleyrodidae of Formosa, Part II.- *Report / Department of Agriculture, Government Research Institute, Formosa*, 60: 1-24.

TAKAHASHI R., 1934.- Aleyrodidae of Formosa, Part III.- *Report / Department of Agriculture, Government Research Institute, Formosa*, 63: 39-71.

TAKAHASHI R., 1941.- Some foreign Aleyrodidae (Hemiptera) III. Species from Hongkong and Mauritius.- *Transactions of the Natural History Society of Formosa*, 31: 351-357.

TAKAHASHI R., 1942.- *Aleurocanthus* of Thailand and French Indo-China (Homoptera: Aleyrodidae).- *Kontyû*, 16: 57-61.

TAKAHASHI R., 1956.- Insects of Micronesia: Homoptera: Aleyrodidae.- *Insects of Micronesia*, 6 (1): 1-13.

VAN DEN BERG M. A., GREENLAND J., 1997.- Classical biological control of *Aleurocanthus spiniferus* (Hem.: Aleyrodidae), on citrus in Southern Africa.- *Entomophaga*, 42: 459-465.

VAN DEN BERG M. A., BEDFORD E. C. G., CILLIERS C. J., 1990.- Spiny blackfly, *Aleurocanthus spiniferus* (Hemiptera: Aleyrodidae), a new pest of citrus in South Africa.- *Phytophylactica*, 22 (2): 257-258.

VAN DEN BERG M. A., HOPPNER G., GREENLAND J., 2000.- An economic study of the biological control of the spiny blackfly, *Aleurocanthus spiniferus* (Hemiptera: Aleyrodidae), in a citrus orchard in Swaziland.- *Biocontrol Science and Technology*, 10 (1): 27-32.

WEEMS H. V., 1974.- Orange spiny whitefly, *Aleurocanthus spiniferus* (Quaintance) (Homoptera: Aleyrodidae).- *The Florida Department of Agriculture and Consumer Services' Division of Plant Industry Entomology Circular*, 151: 1-2.

XIE Z. L., 1993.- Investigation of the structure sequence of insect populations in the tea gardens of Guangdong province (China).- *Tea in Guandong*, 1: 2-10.

ZHANG Q. B., 2006.- The reasons for rampage of citrus spiny white fly and its control.- *South China Fruits*, 2: 20-21.

Authors' addresses: Marilisa CIOFFI (marilisa.cioffi@libero.it), Daniele CORNARA (danielecornara@gmail.it), Isabella CORRADO (corradoisabella@libero.it), Francesco PORCELLI (corresponding author: francesco.porcelli@uniba.it), Dipartimento di Scienze del Suolo, della Pianta e degli Alimenti sez Entomologia e Zoologia, Università degli studi di Bari "Aldo Moro", via Amendola 165/a, 70126 Bari, Italy; Maurice Gerardus Maria JANSEN (m.g.m.jansen@minlnv.nl), Plant Protection Service, PO Box 9102, 6700 HC Wageningen, The Netherlands.

Received April 15, 2013. Accepted September 2, 2013.