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SHORT COMMUNICATION

New data on the parasitization of *Aleurothrixus floccosus* (Maskell) (Hemiptera: Aleyrodidae) in Greece

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Summary *Signiphora flavella* (Girault) (Hymenoptera: Signiphoridae) was recorded in 2022 as a new parasitoid species of the serious pest of citrus *Aleurothrixus floccosus* (Maskell) in Greece, in two different areas, i.e., the provinces of Laconia and Messinia. Previously, *Signiphora flavella* was recorded in Greece parasitizing *Hemiberlesia rapax* (Comstock) and *H. lataniae* (Signoret) in early 60s. It is mainly a parasitoid species of scale insects belonging to Diaspididae (Hemiptera: Coccomorpha), whiteflies, or a hyperparasitoid of aphelinids.

Additional keywords: biological control, parasitoid, *Signiphora flavella,* whitefly

The woolly whitefly, *Aleurothrixus floccosus* (Maskell, 1896) (Hemiptera: Aleyrodidae) was firstly recorded in Greece during 1991 at several urban areas of Athens (Greece) heavily infesting citrus trees (Katsoyannos, 1991). Later, it was confirmed invading all citrus cultivated areas of Greece. Successful biological control of this noxious species was conducted by introducing the exotic parasitoid *Cales noacki* Howard, 1907 (Hymenoptera: Aphelinidae) from Spain and France (Katsoyannos, 1991). The parasitoid was reared and massively released to the infested trees in numerous citrus growing areas of Greece (Katsoyannos, 1991; 1994; Katsoyannos *et al.,* 1997; 1998). The spectrum of natural enemies of *A. floccosus* consisted of the introduced parasitoid (*C. noacki*) and the native predator *Clitostethus arcuatus* (Rossi) (Coleoptera: Coccinellidae) feeding on eggs and early-instar nymphs of *A. floccosus*. During the period 1991-2005 studies on the ecology of *A. floccosus* in citrus cultivated areas (36 areas of Attica, Greece and 34 in the rest country), recorded that *C. noacki* was the main natural enemy of *A. floccosus*. In high infestation levels, the predators *C. arcuatus* and *Oenopia conglobata* (L.) have been drastically feeding upon *A. floccosus* (Kontodimas *et al.,* 2005).

Natural enemies of *A. floccosus* are referred in other areas of the world; Chile: *C. noacki, Eretmocerus paulistus* Hempel (Hymenoptera: Aphelinidae)*, Amitus spiniferus* (Brethes) (Hymenoptera: Platygastridae)*, Signiphora* sp. Ashmead (Hymenoptera: Signiphoridae) (Tello-Mercado and Zarzar-Maza, 2021), *Oligota pygmaea* and *Parastethorus histrio* (Coleoptera: Coccinellidae) (Rioja, *et al.,* 2015); Mexico: *Eretmocerus naranjae* Myartseva (Hymenoptera: Aphelinidae) (Myartseva and Coronado-Blanco, 2007); Brazil *Signiphora* sp. and *C. noacki* (Marsaro Júnior, *et al.,* 2015); California (USA): *Cales rosei* Mottern (Hymenoptera: Aphelinidae) (Mottern and Heraty, 2014); Dominican Republic and Florida (USA): *Encarsia dominicana* Evans (Hymenoptera: Aphelinidae) (Evans and Serra, 2002); France: *C. noaki* and

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Amitus spiniferus (Brèthes) (Hymenoptera: Platygastridae) (Onillon, 1988); Turkey: *C. noacki*, *C. arcuatus* Risso, *Cryptoleamus montrouzieri* Mulsant, *Chilocorus bipustulatus* L., *Serangium parcesetosum* Sicard (Coleoptera: Coccinellidae), *Conwentzia* sp. (Neuroptera: Coniopterygidae), and *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) (Telli and Yiğit, 2012); India: *Encarsia guadeloupae* Viggiani (Hymenoptera: Aphelinidae), *Pseudomallada astur* (Banks) (Neuroptera: Chrysopidae), and the entomopathogenic fungus, *Isaria fumosorosea* Wize (Hypocreales: Clavicipitaceae) (Sundararaj *et al.,* 2021).

Within the genus *Signiphora*, 50 species and numerous undescribed species have been particularly recorded in the Neotropical region. They have been reported as primary or secondary parasitoids of Diaspididae, Coccidae, Pseudococcidae, Aleyrodidae, while rarely of other Homoptera, and parasitoids of pupae of Tachinidae and Drosophilidae (Diptera) (Gibson *et al.,* 1997; Woolley, 1988; Noyes, 2023).

Signiphora flavella is a cosmopolitan and polyphagous species. It is distributed to Algeria, Argentina (Buenos Aires), Australia, Brazil, Chile (Pocochay, Santiago), Honduras, Greece (Crete), India (Shillong), Indonesia, Israel (Rehovot), Mexico (Amecameca), Morocco, New Zealand, Peru (Lima), Puerto Rico (Central Aguirre), South Africa, Spain, USA (California: Santa Barbara, Miami, New Orleans, San Antonio, San Diego), Venezuela (Trinidad, Tobago) (Woolley and Dal Molin, 2017; Schmidt *et al.,* 2019).

The hosts of *S. flavella* are mainly scale insects of the family Diaspididae: *Aonidiella aurantii* (Maskell), *A. ensifera* McKenzie, *Aspidiotus nerii* Bouché, *Chrysomphalus dictyospermi* (Morgan), *Comstockaspis perniciosa* (Comstock), *Hemiberlesia cyanophylli* (Signoret), *Hemiberlesia lataniae* (Signoret), *Hemiberlesia palmae* (Cockerell), *Lepidosaphes ulmi* (L.), *Oceanaspidiotus spinosus* (Comstock), *Pseudaonidia trilobitiformis* (Green), and *Pseudaulacaspis pentagona* (Targioni Tozzetti) (García Morales *et al.,* 2016). In a recent review, Woolley and Dal Molin (2017) have reported more hosts such as *Hemiberlesia rapax* (Comstock), *Aspidiotus cyanophylli* Signoret, *Serenaspis minima* (Maskell) under the synonym *Hemichionaspis minor* (Maskell), *Diaspis pentagona* Targioni Tozzetti, *Lepidosaphes beckii* (Newman), *Parlatoria pittospori* Maskell, *Pseudaulacaspis cockerelli* (Cooley), *Parlatoria pergandii* Comstock (Hemiptera: Diaspididae), and *A. floccosus*. Furthermore, *S. flavella* is referred as hyperparasitoid of Aphelinidae parasitoids (Hymenoptera), i.e., *Coccophagus* sp. Westwood (attacking *Saissetia persimilis* (Newstead)) and *Aspidiotiphagus citrinus* (Craw) (Woolley and Dal Molin, 2017).

In Greece, *S. flavella* has been found by DeBach on *H. rapax* and *H. lataniae* in early 60s (Woolley Dal Molin, 2017). In 2022, *S. flavella* was found to highly parasitise *A. floccosus* that heavily infested orange trees, *Citrus sinensis* (L.) Osbeck var. Valencia, in the area Vlachioti (Laconia province, Peloponnese, Greece) (36˚51′ N, 22˚41′ E; altitude: 14 m above sea level (a.s.l.)) (Fig. 1). The same year it was recorded parasitizing *A. floccosus* on *C. sinensis* var. Navelina in the area Asprochoma (Messenian province, Peloponnese, Greece) (37˚03′ N, 22˚03′ E; altitude: 5 m a.s.l.). In preliminary studies in Vlachioti, we found that *S. flavella* effectively parasitized *A. floccosus* infesting *C. sinensis* and developed higher population than *C. noacki.* In this area, the population composition of *S. flavella*/*C. noacki* was 69.4/30.4% during November 2022 on the examined samples of infested leaves. Considering the fact that *S. flavella* is recorded for the first time on *A. flocossus* in Greece after its first report on other hosts 70 years ago, further studies are needed on the biology and ecology of this species, that will clarify its role and importance on the biological control of the wooly whitefly.

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Figure 1. *Signiphora flavella* adults parasitizing *Aleurothrixus floccosus* colony infesting citrus.

Literature Cited

Evans, G.A. and Serra, C.A. 2002. Parasitoids associated with whiteflies (Homoptera: Aleyrodidae) in Hispaniola and descriptions of two new species of *Encarsia* Förster (Hymenoptera: Aphelinidae). *Journal of Hymenoptera Research*, 11(2): 197-212.

García Morales, M., Denno, B.D., Miller, D.R., Miller, G.L., Ben-Dov, Y. and Hardy, N.B. 2016. ScaleNet: A literature-based model of scale insect biology and systematics. Database. doi: 10.1093/database/bav118. http://scalenet.info [accessed on: 04-05-2023].

Gibson, G.A.P., Hubner, J.T. and Woolley, J.B. 1997. Annotated keys to the Genera of Nearctic Chalcidoidea (Hymenoptera). Ottawa, Canada: NCR Research Press. 794 p.

Katsoyannos, P. 1991. First record of *Aleurothrixus floccosus* (Mask.) (Homoptera: Aleyrodidae) in Greece and some observations on its phenology. *Entomologia Hellenica*, 9: 69-72.

Katsoyannos, P. 1994. Rearing method of *Cales noacki*, natural enemy of the wooly whitefly. *Agriculture Crop and Animal Husbandry*, 4: 32-34 (in Greek).

Katsoyannos, P., Ifantis, K. and Kontodimas, D.C. 1997. Phenology, population trend and natural enemies of *Aleurothrixus floccosus* (Hom.: Aleyrodidae) at a newly invaded area in Athens, Greece. *Entomophaga,* 42(4): 619-628. doi:10.1007/BF02769820.

Katsoyannos, P., Kontodimas, D.C. and Stathas, G.J. 1998. The innudative release of *Cales noacki* Howard (Hymenoptera: Aphelinidae), for curative treatment of *Aleurothrixus floccosus* (Maskell) (Homoptera: Aleyrodidae) on heavily infested citrus in Greece. *Annals del' Institut Phytopathologique Benaki,* (N.S.), 18: 121-134.

Kontodimas, D.C., Papanicolaou, N., Milonas, P., Stathas, G.J., Beris, E., Bertsouklis, K. and Lagoudakis, E. 2005. Wooly whitefly on citrus in Greece, during 1991-2005. *Proceedings of the 11th Panhellenic Entomological Congress*, 11-14 October, Karditsa – Greece, pp 12-20 (in Greek).

Marsaro Júnior, A.L., Filho, F.R., Raga, A. and Costa, V.A. 2015. New records of whiteflies (Hemiptera: Aleyrodidae) in Rio Grande do Sul state, Brazil. [Nuevos registros de moscas blancas (Hemiptera: Aleyrodidae) en Rio Grande do Sul, Brasil] *Idesia,* 33(1) : 143-145. doi:10.4067/S0718-34292015000100015.

Mottern, J.L. and Heraty, J.M. 2014. The dead can talk: Museum specimens show the origins of a cryptic species used in biological control. *Biological Control, 71*, 30-39. doi: 10.1016/j.biocontrol.2014.01.002.

Myartseva, S.N. and Coronado-Blanco, J.M. 2007. Species of *Eretmocerus* Haldeman (Hymenoptera: Aphelinidae) - parasitoids of *Aleurothrixus floccosus* (Maskell) (Homoptera: Aleyrodidae) of Mexico, with a description of a new species. Acta *Zoologica Mexicana*, 23 (1): 37-46.

Noyes, J.S., 2023. Universal Chalcidoidea Database. World Wide Web electronic publication. http://www.nhm.ac.uk/chalcidoids [accessed on: 11-05-2023].

Onillon, J.C. 1988. Lutte biologique et intégrée dans les vergers de citrus en zone méditerranéenne. *Entomophaga*, 33(4): 481- 494. doi:10.1007/BF02373184.

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Rioja, T., Ceballos, R., Rebolledo, R. and Vargas, R. 2015. Rearing and development of *Oligota pygmaea* and *Parastethorus histrio* (Coleoptera: Staphylinidae, Coccinellidae) feeding on *Oligonychus yothersi* (Acari: Tetranychidae) and survival on non-mite foods under laboratory conditions, *International Journal of Acarology,* 41(8): 681-687.

Schmidt, S., Hamid, H., Ubaidillah, R., Ward, S. and Polaszek, A. 2019. A review of the Indonesian species of the family Signiphoridae (Hymenoptera, Chalcidoidea), with description of three new species. *ZooKeys*, (897): 29-47. doi:10.3897/zookeys.897.38148.

Sundararaj, R., Krishnan, S. and Sumalatha, B.V. 2021, Invasion and expansion of exotic whiteflies (Hemiptera: Aleyrodidae) in India and their economic importance. *Phytoparasitica,* 49(5): 851-863.

Telli, Ö. and Yiğit, A. 2012. Natural enemies of citrus woolly whitefly, *Aleurothrixus floccosus* (Maskell) and nesting whitefly, *Paraleyrodes m*inei laccarino (Hemiptera: Aleyrodidae) in Hatay province, Turkey. [Hatay ili turunçgillerinde zararli Turunçgil pamuklu beyazsinegi, *Aleurothrixus floccosus* (Maskell) ve Turunçgil Ipek beyazsinegi, *Paraleyrodes minei* laccarino (Hemiptera: Aleyrodidae)' nin dogal düsmanlari] *Turkiye Entomoloji Dergisi*, 36(1): 147-154.

Tello-Mercado, V. and Zarzar-Maza, M. 2021. Population fluctuation and parasitism of *Aleurothrixus floccosus* (Hemiptera: Aleyrodidae) in citrus trees from Atacama Desert, Chile. [Fluctuación poblacional y parasitismo de *Aleurothrixus floccosus* (Hemiptera: aleyrodidae) en cítricos del desierto de Atacama, Chile]. *Revista Colombiana De Entomologia,* 47(1) doi:10.25100/SOCOLEN.V47I1.7806.

Woolley, J.B. and Dal Molin, A. 2017. Taxonomic revision of the *flavopalliata* species group of *Signiphora* (Hymenoptera: Signiphoridae). *Zootaxa*, 4315(1): 1-150. doi:10.11646/zootaxa.4315.1.1.

Woolley, J.B. 1988. Phylogeny and classification of the Signiphoridae (Hymenoptera: Chalcidoidea). *Systematic Entomology,* 13(4): 465-501. doi:10.1111/j.1365-3113.1988.tb00256.x.

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ΣΥΝΤΟΜΗ ΑΝΑΚΟΙΝΩΣΗ

Νέα στοιχεία επί του παρασιτισμού του *Aleurothrixus floccosus* (Maskell) (Hemiptera: Aleyrodidae) στην Ελλάδα

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Περίληψη Το είδος *Signiphora flavella* (Girault) (Hymenoptera: Signiphoridae) καταγράφηκε στην Ελλάδα κατά το έτος 2022 ως παρασιτοειδές του *Aleurothrixus floccosus* (Maskell) σε σοβαρές προσβολές του σε εσπεριδοειδή, στις περιοχές Λακωνίας και Μεσσηνίας. Προγενέστερα, κατά τις αρχές της δεκαετίας του 1960, το *Signiphora flavella* είχε καταγραφεί στην Ελλάδα ως παρασιτοειδές των *Hemiberlesia rapax* (Comstock) και *H. lataniae* (Signoret). Είναι παρασιτοειδές κυρίως κοκκοειδών εντόμων της οικογένειας Diaspididae (Hemiptera: Coccomorpha), αλλά και αλευρωδών, καθώς και υπερπαρασιτοειδές παρασιτοειδών που ανήκουν στην οικογένεια Aphelinidae.

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