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Invasion of the palm infesting whitefly, *Aleurotrachelus atratus* Hempel (Hemiptera: Aleyrodidae) in the Oriental region

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Abstract Infestation of the highly invasive whitefly *Aleurotrachelus atratus* Hempel (Hemiptera: Aleyrodidae) is reported for the first time from India as well as from the Oriental region. The pest was found colonizing coconut palm, *Cocos nucifera* (Arecaceae) and ornamental areca palm, *Dypsea lutescens* (Arecaceae) in Mandya and Mysore districts of Karnataka during February, 2019. Whitefly specimens were collected from infested palm plants and the identity of the species is confirmed by morphological characteristics. No parasitisation was observed but four species of predators viz., *Dichochrysa astur* (Neuroptera: Chrysopidae), *Cybocephalus* spp. (Coleoptera: Nitidulidae), *Chilocorus nigrata* and *Jauravia pallidula* (Coleoptera: Coccinellidae) were found feeding on this invasive species. The severity of the infestations and its impact on coconut as well as other crop plants in India is discussed.

Keywords Invasive · Coconut · *Aleurotrachelus atratus* · Predator · Oriental region

Introduction

The enormous increase in the volume, diversity and swiftness of movement of plant products throughout the world has led to a proliferation and dissemination of invasive species, particularly ones closely associated with plants, such as scale insects and whiteflies (Wosula et al. 2018). Increased trade, transport and travel are the major drivers of bioinvasions and will continue to increase as a by-product of globalization (USDA 2001) and invasive exotic species move from one region of the world to others. So far, more than 110 exotic insect species had been reported from India, of which, whiteflies and mealybugs constitute a major part of the invasion (Mandal 2011). In India, 463 whiteflies species belonging to 68 genera are known are known to feed on many agricultural, horticultural and forestry crop plants which include four recently invaded species viz., solanum whitefly, *Aleurothrixus trachoides* (Back) on 24 host plants (Sundararaj et al. 2018), rugose spiralling whitefly, *Aleurodicus rugioperculatus* Martin on coconut and several horticultural and ornamental plants (Sundararaj and Selvaraj 2017), Bondar's nesting whitefly, *Paraleyrododes bondari* Peracchi (Josephraj Kumar et al. 2019) and *P. minei* Iaccarino on coconut (ICAR-CPCRI 2018). During February 2019, one more palm infesting, highly invasive whitefly species, *Aleurotrachelus atratus* Hempel (Hemiptera: Aleyrodidae) was found colonizing on members of Arecaceae viz., coconut, (*Cocos nucifera*) and ornamental areca palm (*Dypsea alutescens*) at Mysore and Mandya districts of Karnataka, India.

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The genus *Aleurotrachelus* is one of the largest genera of whiteflies and currently containing 74 species worldwide with 12 species known to occur in the Afrotropical region (Evans 2008) and so far only four species viz., *A. corbetti* Takahashi, *A. longispinus* Corbett, *A. multipapillus* Singh and *A. tuberculatus* Singh have been reported from India (Sundararaj and Pushpa 2011). *A. atratus* is a Neotropical whitefly, originally described by Hempel (1922). Algumas espécies novas de Hemipteros da familia Aleyrodidae. Notas Preliminares editadas pela redacao da Museu Paulista, 2 (1): 3 - 10. (2010) from Brazil and reported widely in the tropics and subtropics and colonize on more than 110 plant species belonging to Arecaceae, Rutaceae, Solanaceae, Cycadaceae and Lauraceae (Malumphy and Treseder 2011).

A. atratus has spread rapidly in the Neotropical region viz., Antigua, Bahamas, Barbados, Bermuda, Brazil, Colombia, Guyana, Nevis, Puerto Rico, Venezuela and USA, (Florida) probably due to anthropogenic activities such as trade in ornamental palms (Howard et al. 2001). It is now found in Africa, North and South America, Central America and the Caribbean, Europe and Oceania (Borowiec et al. 2010). Due to its invasiveness and extensive host range, the species was considered as a pest of significant economic status. In the Comoro Islands, *A. atratus* was responsible for an economic loss of 55% to local coconut producers in 2002 (Yousoufa et al. 2006). It corroborates the report of (Borowiec et al. 2010) that *A. atratus* is increasing its distribution and damage to palms. This is the first report of this pest from India as well as in the Oriental region. Its occurrence, severity, host range, natural enemies and impact on coconut cultivation in India are discussed in this communication.

Materials and methods

Identification and material examined Whitefly specimens were collected from infested plants (Coconut & Areca palm) by senior author and Sumalatha, B.V from several locations in Mandya (12.5644° N, 76.7337° E) and Mysore districts (12.1873° N, 76.3637° E) of Karnataka. Furthermore, heavily infested leaves were kept in separate containers to study parasitoids. Puparia from which adult have emerged were mounted following the method given in Dubey and David (2012). Identification of whitefly is confirmed based on the puparial

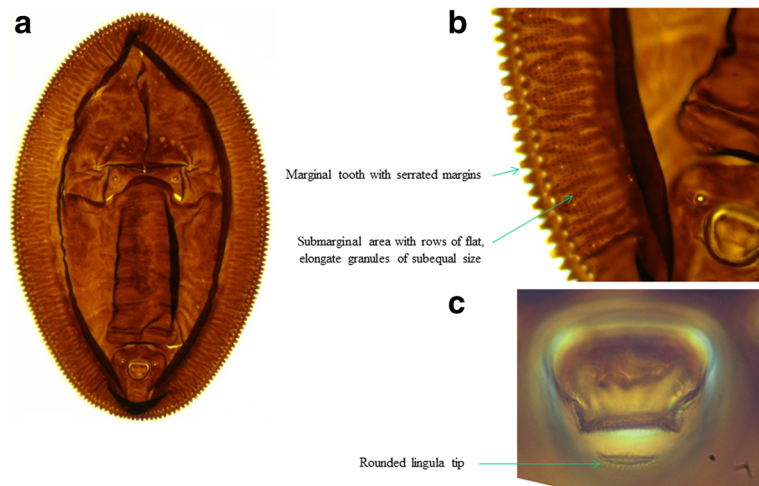
taxonomic characteristics specific to the species and also by matching with characteristics specified in the keys of (Wosula et al. 2018) were made by using Nikon Optiphot T-2 EFD microscope. The confirmed mounted slides were deposited in the collection of ICAR- National Bureau of Agricultural Insect Resources, Bengaluru, India (accession number NBAIL/HEM-ALEU/1234–2019) and available in the personal collection of K. Selvaraj. *A. atratus* population and intensity of damage on five randomly selected coconut palms per garden at three strata (upper, medium, lower leaves) was assessed at five locations in both Mandya and Mysore districts.

Results and discussion

Identification of the species The identity of the whitefly is confirmed using best mounted slides as *Aleurotrachelus atratus* Hempel (Hemiptera: Aleyrodidae) based on the specific puparial taxonomic characteristics, which includes, Elongate oval puparium with entire dark cuticle (Fig. 1a); marginal teeth separated, with converging subtruncate or rounded apices, each one with serrated margins (Fig. 1b); absence of first abdominal and mesothoracic setae, metathoracic setae extending beyond 2nd abdominal segment, 8th abdominal setae longer than the vasiform orifice, caudal setae very long and set on tubercles; submarginal area with rows of flat, elongate granules of subequal size; lingula tip rounded (Fig. 1c). The studied specimens were in the collection of ICAR-NBAIR.

Diagnosis and life stages of *A. atratus* Eggs and larvae of *A. atratus* occur on the underside of palm fronds, and when abundant they are highly conspicuous due to the dense flocculent white wax which covers the black pupae. Eggs are stalked, initially creamy white and turn to dark brown before hatching (Fig. 2a). The first instars have four pairs of wax plumes excreted by glands at the base of dorsal setae (Fig. 2c). Each dorsal seta has curving longitudinal grooves that guide the wax flakes as they are secreted from the seta base and all the nymphal stages are black. Puparia are elliptical, black, 1.0–1.1 mm long with a long marginal white wax fringe and dorsal wax filaments that often completely cover the insect (Fig. 2c). When the wax is removed, each puparium can be seen to have a distinct diagnostic pair of submarginal longitudinal cephalothoracic folds that extend

Fig. 1 Morphological characteristics of *Aleurotrachelus atratus* puparium: **a.** Mounted puparium, **b.** Margin and Submarginal area, **c.** Vasiiform orifice

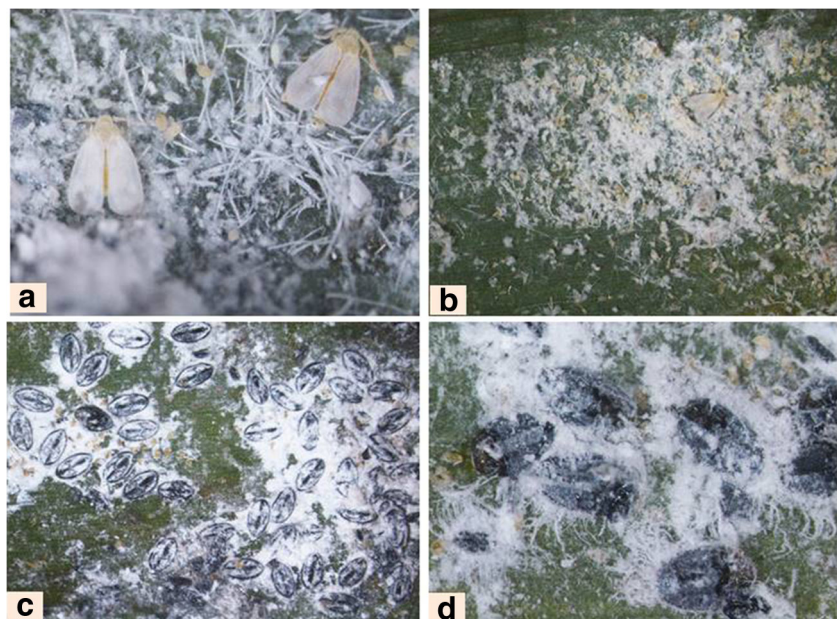


into the abdomen (Fig. 2d). Total duration for the pre-imaginal development of *A. atratus* is around 48 days at 25–27 °C (Borowiec et al. 2010). Adults differ from the recently invaded whiteflies infesting palms; smaller than *Aleurodicus rugioperculatus* but larger than *P. bondari* and *P. minei* and without any wavy marking on the wings. *A. atratus* can be easily diagnosed from its closely related and other recently invaded species *Aleurothrixes trachoides* (Back) by elongate oval puparium, the marginal teeth having crenulations on their sides, the pattern of the tile-like sculpturing on the submargin, and the rounded lingula tip which is not bilobed (Fig. 2).

Symptoms of damage Found infesting mainly on the under surface of leaflets in groups ranging from 97 to 186 nymphs per group with 3 to 48 groups per leaflet (Fig. 3a). In severe cases more than 60% coverage of leaflet by the nymphs resulting in chlorosis or necrosis and loss of vigour with drying of leaflets (Fig. 3b). Further indirect damage is caused by the excreted honeydew that serves as a medium for the growth of sooty moulds (Fig. 3c).

Host plants Coconut palm, *Cocos nucifera* (Arecaceae) and ornamental areca palm, *Dypsea lutescens* (Arecaceae). The intensity and severity is more on

Fig. 2 Life stages of *A. atratus*: **a.** Adult and eggs stage, **b.** First instar nymphs, **c.** Pupa with wax fringe, **d.** Pupa without wax



coconut palm than the ornamental palm. *A. atratus* has been recorded mostly (96%) in the family Arecaceae and coconut is the most commonly reported host including two highly important crops, citrus and aubergine (Malumphy and Treseder 2011).

Natural enemies Considering the economic importance of new invasion of *A. atratus* in India, an attempt to find natural enemies revealed no parasitisation but four species of predators such *Dichochrysa astur* (Banks) (= *Mallada astur* (Banks)) (Neuroptera: Chrysopidae) (Fig. 4a), *Jauravia pallidula* (Motschulsky), *Chilocorus nigrita* (Fabricius) (Coleoptera: Coccinellidae) (Fig. 4b–c), *Cybocephalus* spp. (Coleoptera: Nitidulidae) (Fig. 4d) were found feeding in the field condition. Kityo et al. (2017) reported four parasitoid species viz.,

Encarsia basicincta, *Eretmocerus cocois*, *Encarsia* sp. and *Signiphora* sp. are suppressing the whitefly population. However, in India, no parasitisation was observed on this species.

Impact on coconut and other crops

India being the largest coconut producing country in the world, contributes 31% of global production. Coconut palm provides food security and livelihood opportunities to more than 12 million people in India, covering 16 states and three Union Territories. Coconut and coconut products are gaining global importance as a contributing factor to the health, nutrition and wellness of human

Fig. 3 Symptoms of damage of *A. atratus*: **a.** completely covered under surface of coconut leaves, **b–c.** Different life stages on leaflets, **d.** Severity of infestation

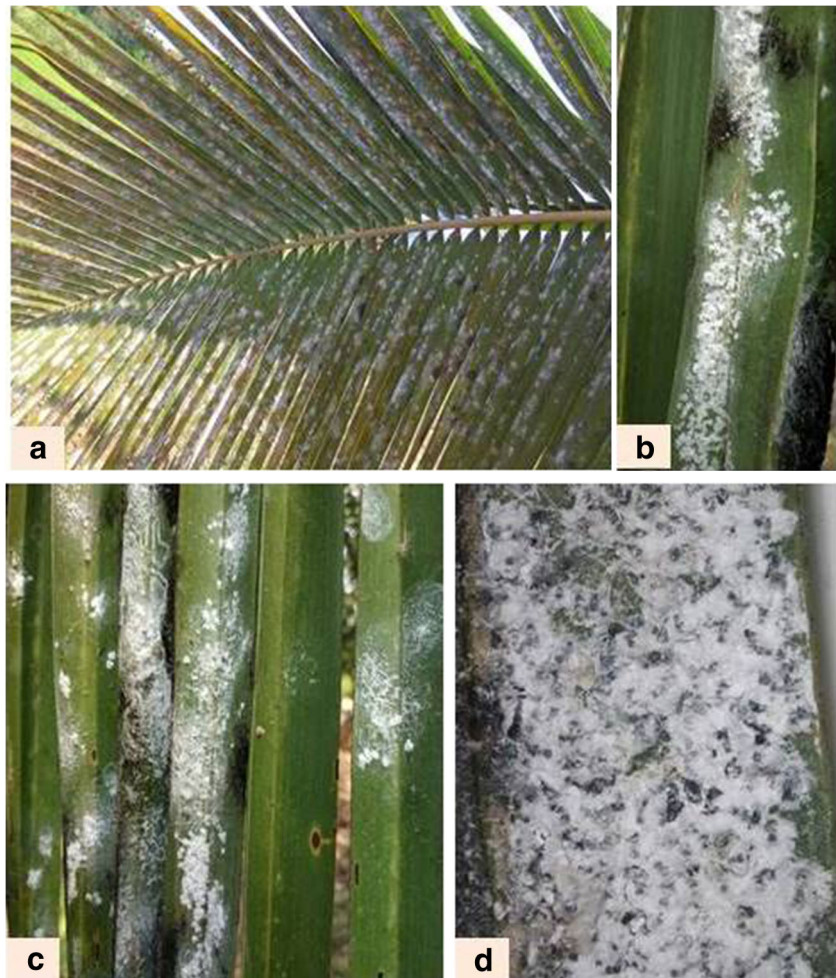
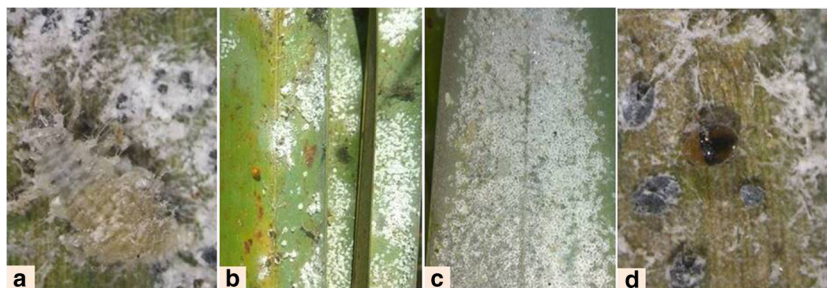


Fig. 4 Natural enemies of *A. atratus*: **a.** *Dichochrysa astur*, **b.** *Jauravia pallidula*, **c.** *Chilocorus nigrita*, **d.** *Cybocephalus* spp.



being. India ranks second in terms of productivity (10,349 nuts / ha) next to Brazil (11,574 nuts / ha), among the major coconut growing countries (Murthy 2018). With the current report of *A. atratus*, altogether 464 species of whiteflies belonging to 68 genera are known from India in which so far six species viz., *Aleurocanthus arecae* David & Manjunatha (David and Manjunatha 2003), *Aleurodicus dispersus* Russell (Prathaban 1996), *Aleurodicus rugioperculatus* Martin (Selvaraj et al. 2016; Selvaraj et al. 2017) and *P. bondari* and *P. minei* (Mohan et al. 2019) are known to infest coconut. Among these whiteflies infesting coconut except *Aleurocanthus arecae*, all others are invasive to India. Sundararaj and Selvaraj (2017) reported severe colonisation of *A. rugioperculatus* and its economic impact on coconut production during 2016. Selvaraj et al. (2017) reported severe outbreak of *A. rugioperculatus* in Mysore and Mandya districts previously with the infestation about 20–35% in coconut. The present observation revealed that *A. rugioperculatus* seems to be slowly getting replaced by *A. atratus* as only few colonies or nil colonies / population (10–15 life stages/leaflet) could be seen in the same infested leaflet as interspecific competition is more common in Hemiptera and Homoptera because of their life-history traits, such as their aggregated and sedentary lifestyle. Thus danger posed by *A. atratus* seems to be higher than *A. rugioperculatus* and is likely to spread to other coconut producing states in India and extent its host ranges on other Arecaceae palms, Solanaceae and Rutaceae plants.

Kityo et al. (2017) reported two parasitoids, *Encarsia basicincta* and *Eretmocerus cocois* as efficient natural enemies for the suppression of this coconut whitefly population. However, In India, nil natural parasitism either by native or exotic parasitoid could be observed thus indicating that pest was introduced probably without natural enemies complex into India. Therefore, it could be a potential threat to

coconut cultivation as well as a threat to environmental tourism in India if unchecked. In view of above to develop effective management strategies, intensive surveys for its distribution, host range, intensity and natural enemies has been initiated. Red pest alert note issued to all other stakeholders to lookout its occurrence on other locations and host plants as soon as they notice this potential pest.

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Compliance with ethical standards

Conflict of interest No conflict of interest among authors.

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