

New host plant records of rugose spiralling whitefly, *Aleurodicus rugioperculatus* Martin (Hemiptera: Sternorrhyncha: Aleyrodidae) in diverse habitats

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Summary

The current study focused on assessing the prevalence of invasive whitefly infestation in diverse habitats in the Saurashtra region of Gujarat. The study revealed the presence of *Aleurodicus rugioperculatus* Martin, specifically in *Punica granatum*, *Ficus religiosa*, *Ficus benghalensis*, *Borassus flabellifer*, *Cordia myxa*, *Pennisetum purpureum*, *Azadirachta indica* and *Citrus limon* during the survey conducted in 2023–24. This infestation of *Aleurodicus rugioperculatus* Martin with different host plants marks the first documented occurrence of this novel invasive whitefly species affecting India. These findings highlight the need for further research and management strategies to address the threats posed by this invasive pest.

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Keywords: *Aleurodicus rugioperculatus*, *Azadirachta indica*, *Borassus flabellifer*, *Citrus limon*, *Cordia myxa*, *Ficus religiosa*, *Ficus benghalensis*, Invasive pest, *Pennisetum purpureum*, *Punica granatum*, Rugose spiralling whitefly

Introduction

Exotic whiteflies have invaded several nations, directly resulting in losses to horticulture, forestry, and agriculture. Whiteflies are members of the order Hemiptera and the solitary superfamily Aleyrodoidea of the suborder Sternorrhyncha. There are several species of whiteflies, including 35 species in the genus *Aleurodicus* Douglas (Haldhar et al. 2015; Elango et al. 2019). India is home to several commercially important species of whiteflies, with 442 species belonging to 63 genera. Two invasive whiteflies entered India in 1995 and 2014: the spiralling whitefly *Aleurodicus dispersus* Russell (David & Regu 1995) and the solanum whitefly *Aleurothrixus trachoides* (Back) (Dubey & Sundararaj 2015). Another invasive species that has surfaced recently is the rugose spiralling whitefly, *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae). Sundararaj & Selvaraj (2017) reported that this pest infests coconut palms (*Cocos nucifera* L.) in Pollachi, Tamil Nadu, India. *A. rugioperculatus* is a member of the *Aleurodicus niveus* species group and was initially reported in Belize (Martin 2004). According to Martin (2008), it was first discovered in Belize, Guatemala, and Mexico before spreading to 22 other Central and South American nations, including Florida and the USA. After invading Florida in 2009 and Guatemala in 2012 (Stocks

& Hodges 2012; Haldhar 2021), its range in the United States expanded dramatically. According to Antonio et al. (2016), the rugose spiralling whitefly is highly polyphagous, infesting 118 hosts from 43 different plant families, including significant crops in the US economy. India is the only nation in the East where this whitefly has been introduced. First discovered in oil palm plantations, it has since been observed feeding on a variety of plants in Kerala, Karnataka, Andhra Pradesh, Telangana, Assam, Goa, and more recently in Gujarat, West Bengal, Maharashtra, Lakshadweep, Chhattisgarh, Odisha, and Meghalaya. It has also been observed to feed on coconut, Indian almond, cashew, banana, maize, sapota, mango, and several ornamental plants (Pradhan et al. 2021). Jethva et al. (2020) reported this on coconuts in Gujarat. Because rugose spiralling whiteflies are polyphagous, their host range has expanded as their infestation has grown over time and extended throughout the southern regions of India. The rugose whitefly feeds on the host plant, depleting water and nutrients, creating honeydew that coats the lower leaves and encourages the establishment of sooty mold. Sooty mold on the top leaf surface may inhibit plant photosynthesis, even if it does not directly cause plant diseases. Owing to the rapid and invasive dissemination, of rugose spiralling whitefly a survey was carried out in fruit orchards in the Saurashtra district of Gujarat, India, during 2023–24.

Material and Methods

Investigation of the invasion of the pest *A. rugioperculatus* in the fruit orchards of the Saurashtra region in Gujarat, India, spanned across various districts,

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including Amreli, Gir-Somnath, Junagadh, Bhavnagar, Jamnagar, Rajkot, Dwarka, Porbandar, and Diu (U.T.) during 2023-24 (Table 1; Figure 1). The survey methodology consisted of randomly selecting areas within Saurashtra where fruit cultivation was prevalent. Rugose spiralling whitefly specimens were collected from different host plants. These specimens were

carefully preserved in 70% high-grade ethyl alcohol to aid their subsequent identification (Morphological and Molecular) (Haldhar & Singh 2014). Detailed records were meticulously maintained during the collection process, documenting relevant information such as the host plant species, latitude, and longitude of the location.

Table 1. *Aleurodicus rugioperculatus* reported from different areas of Saurashtra

S. No.	Name of Place	Latitude	Longitude	Indicator	Common name	Scientific name	Family	Ecosystem	Life stages	Parasitism by <i>Encarsia</i> spp.	Accession number
1.	Village: Abhalva Ta.: Girgadhda Dist.: Gir Somnath	20°57'34.4"N	70°49'19.7"E		Neem	<i>Azadirachta indica</i> A. Juss	Meliaceae	Forest	E, A	-	PQ237014
2.	Village: Surva Ta.: Talala Dist.: Gir Somnath	21°02'43.1"N	70°37'59.5"E		Citrus	<i>Citrus limon</i> (L.) Burm	Rutaceae	Horticultural	E, N, A	-	PQ237118
3.	Village: Dhamlej Ta.: Sutrapada Dist.: Gir Somnath	20°46'58.4"N	70°36'30.8"E		Citrus	<i>Citrus limon</i> (L.) Burm	Rutaceae	Horticultural	E, N, A	-	PQ237140
4.	Village: Panchpipalava Ta.: Kodinar Dist.: Gir Somnath	20°47'45.2"N	70°49'08.9"E		Palmyra palm	<i>Borassus flabellifer</i> L.	Arecaceae	Forest	E, N, A	-	PQ217852
5.	Village: Chikhali Ta.: Una Dist.: Gir Somnath	20°47'11.0"N	70°51'27.7"E		Hybrid Napier grass	<i>Pennisetum purpureum</i> S.	Poaceae	Agricultural	E, A	-	PQ217914
6.	Village: Malgam Ta.: Kodinar Dist.: Gir Somnath	20°47'39.8"N	70°48'29.8"E		Assyrian plum	<i>Cordia myxa</i> L.	Boraginaceae	Forest	E	-	PQ218764
7.	Village: Bhalka Ta.: Veral Dist.: Gir Somnath	20°54'53.8"N	70°23'01.3"E		Peepal	<i>Ficus religiosa</i> L.	Moraceae	Forest	E, N	++	PQ225997

8.	Village: Mithapur Ta.: Veraval Dist.: Gir Somnath	20°55'05. 8"N	70°25'30. 3"E		Peepal	<i>Ficus religiosa</i> L.	Moraceae	Forest	E, N	++	PQ2259 86
9.	Village: Moti fafani Ta.: Kodinar Dist.: Gir Somnath	20°49'36. 4"N	70°47'55. 0"E		Banyan	<i>Ficus benghalensis</i> L.	Moraceae	Forest	E, N, A	+++	PQ2194 62
10	Village: Ronaj Ta.: Kodinar Dist.: Gir Somnath	20°48'48. 4"N	70°43'59. 0"E		Peepal	<i>Ficus religiosa</i> L.	Moraceae	Forest	E, N	++	PQ2259 84
11	Village: Nani fafani Ta.: Kodinar Dist.: Gir Somnath	20°49'35. 6"N	70°48'35. 8"E		Banyan	<i>Ficus benghalensis</i> L.	Moraceae	Forest	E, N, A	+++	PQ2194 72
12	Village: Velva Ta.: Kodinar Dist.: Gir Somnath	20°48'36. 4"N	70°48'42. 0"E		Banyan	<i>Ficus benghalensis</i> L.	Moraceae	Forest	E, N, A	+++	PQ2187 84
13	Village: Bamnasa Ta.: Talala Dist.: Gir Somnath	21°02'00. 7"N	70°42'33. 5"E		Neem	<i>Azadirachta indica</i> A. Juss	Meliaceae	Forest	E, A	-	PQ2394 20
14	Village: Jantrakhadi Ta.: Kodinar Dist.: Gir Somnath	20°46'38. 2"N	70°47'43. 5"E		Palmyra palm	<i>Borassus flabellifer</i> L.	Arecaceae	Forest	E, N, A	-	PQ2376 89
15	Village: Mitiyaj Ta.: Kodinar Dist.: Gir Somnath	20°48'54. 1"N	70°45'27. 9"E		Pomegranate	<i>Punica granatum</i> L.	Punicaceae	Horticultural	E, N	-	PQ2376 87
16	Village: Panadar Ta.: Kodinar Dist.: Gir Somnath	20°45'59. 6"N	70°41'12. 0"E		Hybrid Napier grass	<i>Pennisetum purpureum</i> S.	Poaceae	Agricultural	E, A	-	PQ2376 86

E - Hosts supporting up to egg stage; E, N – Hosts supporting both egg and nymphal stages; E, N, A- Hosts supporting egg, nymphal, and adult stages; + denotes – presence (number of + denotes their relative abundance); - denotes absence



Figure 1. Graphical presentation of survey area and location where *A. rugioeperculatus* reported from new host plant

Molecular analysis

Adult *A. rugioeperculatus* were collected and preserved in 70 % high-grade alcohol and used for molecular studies. Samples were surface sterilized with 3% NaOCl, and rinsed two to three times with sterile water before DNA was isolated using the Hot Sodium Hydroxide and Tris (HotSHOT) method. The purity and concentration of the extracted DNA were determined using a NanodropOne™ spectrophotometer (ThermoFisher Scientific, Waltham, MA, USA). The mitochondrial cytochrome c oxidase subunit I (*mtCOI*) gene (667 bp) was amplified with polymerase chain reaction (PCR) using universal primers (forward primer LCO 1490-5 GGTCAACAAATCATAAAGATATTGG-3 and reverse primer HCO 2198-5 TAAACTTCAGG GTGACCAAAAATCA-3) (Vrijenhoek, 1994). PCR was performed in a total reaction volume of 20 µl using a thermal cycler (Eppendorf Mastercycler™, Hamburg, Germany). The amplified DNA products were separated on a 1.0% agarose gel, stained with ethidium bromide (10 mg/ml), and quantified using NanodropOne™ at A260/280 nm. The resultant PCR product was purified using the PureLink™ PCR Purification Kit (Thermo Fisher Scientific) and then sequenced in both directions using double-pass Sanger dideoxy DNA sequencing with designated *mtCOI* forward and reverse primers. The *A. rugioeperculatus mtCOI* sequences were deposited to GenBank (Table 1). Sequence similarity was evaluated by comparing the reference sequences obtained from the National Center for Biotechnological Information (NCBI) (Bethesda, MD, USA). The BLASTn search engine's *mtCOI* gene homology search (<https://blast.ncbi.nlm.nih.gov/Blast.cgi>) confirmed species identity. A phylogenetic tree was constructed

using all the available *A. rugioeperculatus mtCOI* sequences from the NCBI GenBank database. Clustal W Multiple sequence alignments in Bioedit Sequence Alignment created a similarity region that was utilized to generate the dendrogram in MEGA-XI using the neighbour-joining method with 1000 iterations (Kimura 1980; Felsenstein 1985; Saitou and Nei, 1987; Thompson et al. 1994; Tamura et al. 2021).

Result and Discussion

Morphological identification

The pest species were determined based on the physical traits observed in specimens from the puparium and adult stages (Figure 2). Adult *A. rugioeperculatus*, which is approximately three times larger than common whiteflies, exhibits a sluggish nature. This species has a close resemblance to the *A. disperses*. Distinguishing features of adults include irregular light brown bands spanning across their wings. Additionally, male adults possess elongated pincer-like structures at the tip of their abdomen, although these may not always be discernible. When examining the undersides of the leaves, an oval-shaped nymph is covered with a white waxy substance. The rugose spiralling whitefly undergoes five developmental stages. Initially, the first instar, known as the crawler stage due to its mobility, emerges from the egg and seeks a feeding site using its needle-like mouthparts to extract plant sap. As they progress through their life cycle, these crawlers molt into immobile, initially flat, oval shapes that gradually become more convex. Nymphs range in colour from light to golden yellow and produce dense, cottony wax along with long, thin waxy filaments that increase in density over time. The puparium of this species is identifiable by its distinct features: a broad, heart-shaped opening with

spiny structures at the base underneath, rough texture on the top side, and two fine hairs positioned near the middle on the underside. Moreover, the lingual head extended beyond the opening, terminating in a sharply pointed tip adorned with fine spines, and four hairs clustered near the tip. Small compound pores were present in the seventh and eighth abdominal segments, the rough texture of the opening cover, and the unusually narrow and sharply pointed shape of the lingual apex

with a patterned edge (Figure 2). The pest *A. rugioeperculatus* (Hymenoptera: Sternorrhyncha: Aleyrodidae) was identified using a combination of reference keys provided by Martin (2004); Stocks & Hodges (2012); Rao et al. (2018); Josephraj Kumar et al. (2023); Selvaraj et al. (2024). These references collectively provided the necessary criteria for accurately identifying and confirming the whitefly species observed in this study.

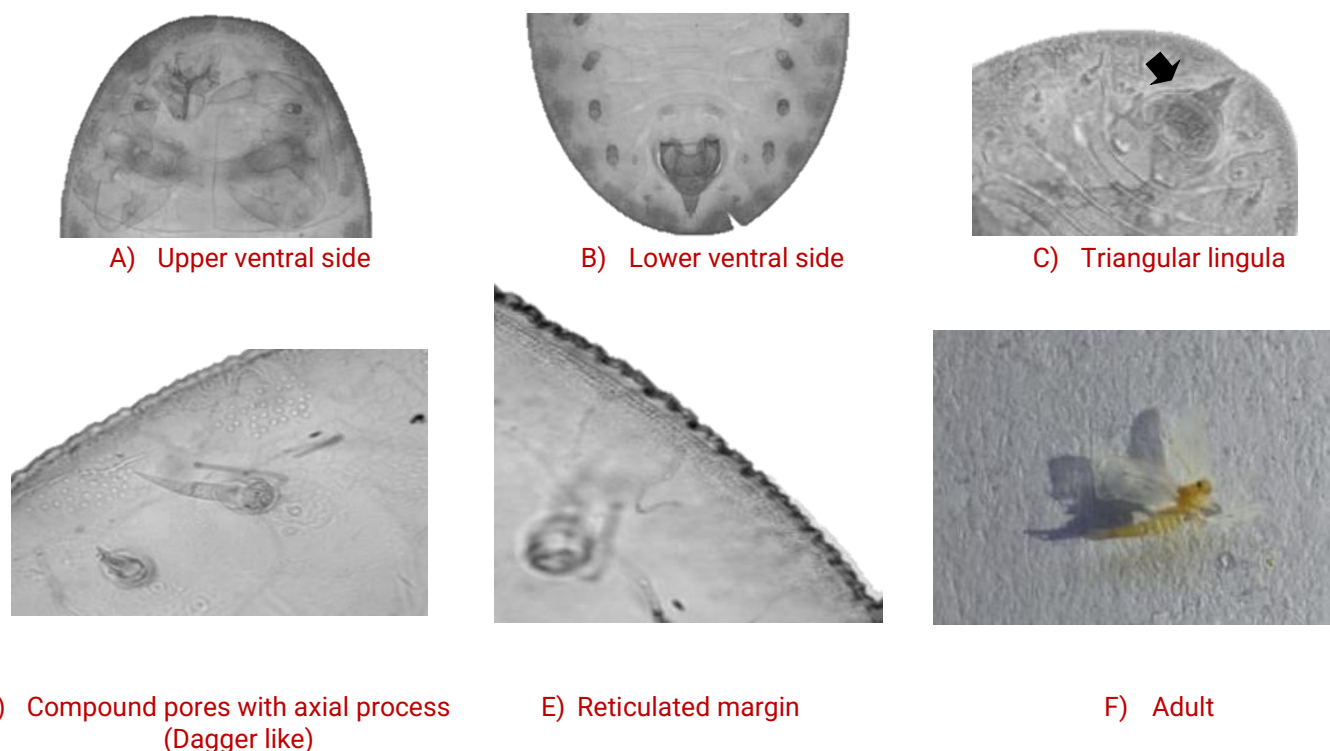


Figure 2. Morphological identification of puparium and adult of *A. rugioeperculatus*

Molecular identification

Additionally, phylogenetic analysis of aligned *A. rugioeperculatus* sequences from this study was conducted using MEGA XI software with 1000 bootstrap replications. Sequences of *A. rugioeperculatus* similar to those of the current specimens were retrieved from the NCBI GenBank database. A phylogenetic tree was constructed using the neighbour-joining method. To build the evolutionary tree, sequences from specimens and reports from India were used. The phylogenetic tree was divided into two main branches (Figure 3.); in the first main branch is subdivided into five clade each clade contains different sequences of *A. rugioeperculatus* population from different habitat were placed together viz., Banyan- Moti fafari (PQ219462); Nani fafari (PQ219472), Neem- Bamnasa (PQ239420) and Pomegranate- Mitiyaj (PQ237687) exhibited distribution under clade 1 alongwith NCBI database isolates viz., Coimbatore, Tamilnadu (MK159733); Bengaluru, Karnataka (MT526907) and population of *A. rugioeperculatus* from Peepal- Ronaj (PQ225984), Hybrid Napier grass- Chikhali (PQ217914), Palmyra palm- Jantrakhadi (PQ237689), Banyan- Velva (PQ218784) were distributed under clade 2 which consisted sequences of *A. rugioeperculatus* from Venkataramannagudem, Andhra Pradesh (ON739181); Bengaluru, Karnataka (OM368661). The populations of

Peepal- Bhalka (PQ225997), Mithapur (PQ225986), Neem- Abhalvad (PQ237014), Citrus- Surva (PQ237118) and Assyrian plum- Malgam (PQ218764) were distributed under clade 3 which consisted sequences of *A. rugioeperculatus* from Coimbatore, Tamilnadu (MK159741); Coochbehar, West Bengal (OQ835715); Coimbatore, Tamilnadu (MK159724); Pollachi, Tamilnadu (KY492358). Clade 4 & 5 contain the populations of Coimbatore, Tamilnadu (MK159740) and Kerala, India (MH321182) which are similar to the above three clades. The second main branch contained a single clade (Clade 6) in which Palmyra palm- Panch pipalava (PQ217852), Hybrid Napier grass- Panadar (PQ237686), Citrus- Dhamlej (PQ237140) along with Bengaluru, Karnataka (MT676410) and Coimbatore, Tamilnadu (MK159730). The phylogenetic similarity of sequences indicated that although the specimens were collected from geographically nearer areas it portrayed similarity, but from different crops (Table 1) similarity was changed viz., Population of *A. rugioeperculatus* collected from banyan at moti fafari, nani fafari and neem at bamnasa showed the similar to Coimbatore (T.N.) and Bengaluru (K.T.) populations. However, the population of banyan at velva was similar to Venkataramannagudem (A.P.) and Bengaluru (K.T.) and neem at from abhalvad was similar to the Coimbatore (T.N.), Coochbehar (W.B.) and Pollachi (T.N.) populations. The collected population of *A.*

rugioeperculatus from peepal at ronaj was similar to the populations of Venkataramannagudem (A.P.) and Bengaluru (K.T.). However, the populations of peepal at bhalka were similarities with the Coimbatore (T.N.), Coochbehar (W.B.) and Pollachi (T.N.) populations. The *A. rugioeperculatus* collected from palmyra palm at jantrakhadi and hybrid napier grass at chikhali show the similarities with the populations of Venkataramannagudem (A.P.) and Bengaluru (K.T.). However, the populations of palmyra palm at panch pipalava and hybrid napier grass at panadar, was similar

with Bengaluru (K.T.) and Coimbatore (T.N.). The populations of *A. rugioeperculatus* from citrus at surva was similar to Coimbatore (T.N.), Coochbehar (W.B.) and Pollachi (T.N.) populations. However, the dhamlej populations shows similarity with the Bengaluru (K.T.) and Coimbatore (T.N.) populations. This suggests significant inter-strain or species divergence, and the findings clearly reveal the existence of four distinct clades of *A. rugioeperculatus* across various habitats in the Saurashtra region.

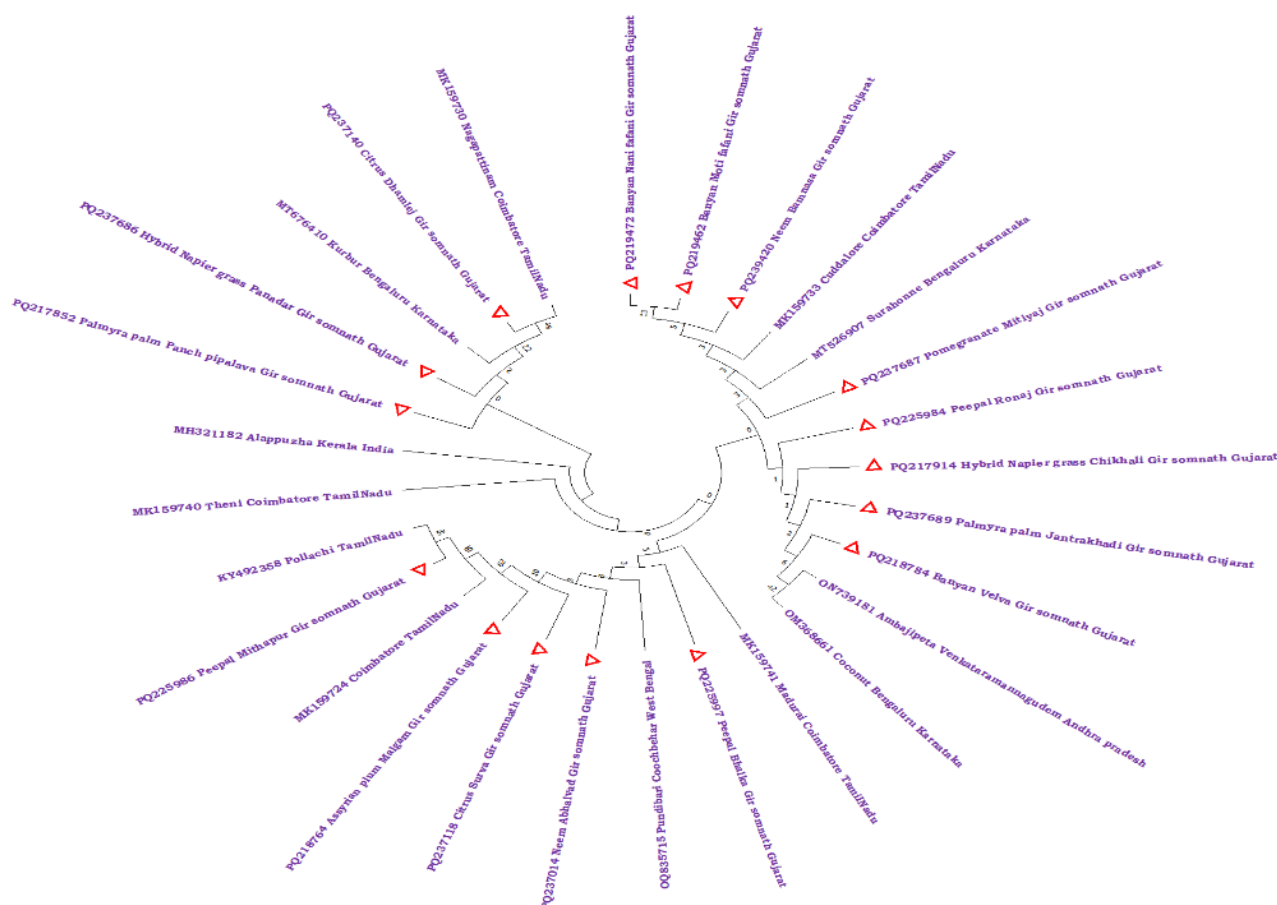


Figure 3. Phylogenetic tree constructed using the neighbour joining method based on the mitochondrial cytochrome oxidase subunit I (*mtCOI*) of *A. rugioeperculatus* sequences

Damage symptoms

In our survey, we meticulously documented the prevalence of *A. rugioeperculatus* infestation across a diverse range of host plants, including banana, coconut, mango, sapota, and guava, among others. Notably, we discovered novel host plants susceptible to infestation, such as banyan, peepal, pomegranate, palmyra palm, Cordia, neem, and Napier grass, across various locations with its ecosystem, were host plants found (Table 1). This comprehensive observation sheds light on the expansion of the host range of *A. rugioeperculatus*. Infested *P. granatum* leaves become wrinkled, crinkled, and curled because of sap sucking by *A. rugioeperculatus* (Figure 4) in the horticultural ecosystem. Additionally, adults lay eggs directly on the surface of *P. granatum* fruits (Figure 4), reducing their market value. Infestations of these whiteflies with egg and nymphal stages were

exclusively observed in the mature leaves of *F. religiosa* (Figure 5). Significant infestation of all stages of *A. rugioeperculatus* was observed in the leaves of *F. benghalensis*, mainly concentrated on the lower surface (Figure 6). This finding highlights the *F. benghalensis* as a critical host plant, potentially acting as a reservoir or "banker crop" for this invasive pest. A smaller *B. flabellifer* plant, commonly known as palmyra palm, has emerged as a new host for *A. rugioeperculatus*, with the observed presence of eggs, nymphs, and adult whiteflies. Additionally, a synergistic relationship was observed between *A. rugioeperculatus* and ants (Figure 7). Spiralling egg clusters were discovered in *C. myxa* plants (Figure 8). Females of *A. rugioeperculatus* laid eggs on *P. purpureum* (Figure 9), *A. indica* (Figure 10) and *C. limon* (Figure 11) plants near a coconut orchard. During the survey immature stages of *A. rugioeperculatus* were

parasitized by *Encarsia* spp. (Figure 12) on *F. religiosa* and *F. benghalensis* (Table 1).

Although *A. rugioperculatus* was previously recognized, Sundararaj and Selvaraj first detected this species in India on coconuts in Tamil Nadu in 2017. However, over time, this invasive species has proven its capacity to infect new hosts and spread rapidly throughout the nation. Shanas et al. (2016) reported that the invasion of *A. rugioperculatus* in Kerala affected a range of plant species. These included coconut, banana, wild jackfruit, jackfruit, Brahma's banyan, mango, guava, brown salwood, Malabar tamarind, portia tree, wire weed, Indian almond, Rangoon creeper, golden trumpet, oleander, garden croton, and crown thorns. Bhavani et al. (2020) recorded the presence of an invasive pest, *A. rugioperculatus* infestation on mature sugarcane fields in Andhra Pradesh, with infestation levels varying between 2% and 10%. Additionally, this study highlighted the existence of natural predators within the sugarcane ecosystem, including *Scymnus nubilus*, *Chilocorus nigrita*, *Cryptolaemus montrouzieri*, and *Encarsia guadelopae*. Jethva et al. (2020) documented the invasion of *A. rugioperculatus* in several plant species for the first time in India and Gujarat state, marking significant discoveries in pest surveillance. In their study, the first confirmed reports of RSW infestation were recorded on Groundnut, Custard Apple, Sorghum, and Curry Tree in India, expanding the known host range of this invasive pest within the country. Additionally, RSW was observed for the first time on Coconut, Sapota, Mango, Banana, Guava, Papaya, White Wax Jambu, and Indian almonds specifically in Gujarat state, highlighting the novel occurrence of RSW infestation in this region. Pradhan et al. (2021) conducted a survey in Karnataka and revealed that 35 plant species were affected by *A. rugioperculatus* infestation. *Cocos nucifera*, *Musa* sp., and *Terminalia catappa* were heavily infested. Sugarcane, cashews, and maize were identified as host plants for the first time in Karnataka. Severe infestation was observed in *Manilkara zapota*, *Dyopsis lutescens*, *Annona reticulata*, and *Annona squamosa*. Moderate infestations were noted in *Canna indica*, *Strelitzia reginae*, *Terminalia arjuna*, *Psidium*

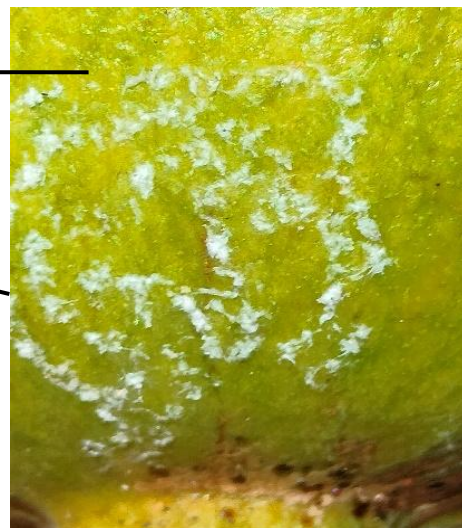
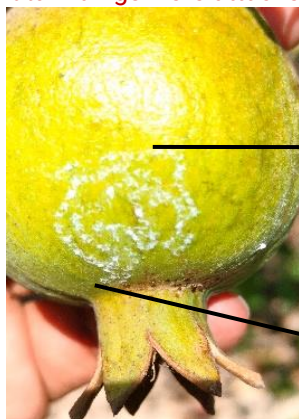
guajava, *Magnolia champaca*, *Anacardium occidentale*, *Roystonea regia*, *Syzygium cumini*, *Artocarpus heterophyllus*, *Calophyllum inophyllum*, *Citrus aurantiifolia*, *Mangifera indica* and *Areca catechu*. Negligible infestations were observed in *Thespesia populnea*, *Piper betle*, *Elaeis guineensis*, *Zea mays*, *Ficus elastic*, *Saccharum officinarum*, *Hibiscus rosasinensis*, *Syzygium samarangense*, *Licuala grandis*, *Combretum indicum*, and *Ficus religiosa*. This broad host range highlights the adaptability and versatility of *A. rugioperculatus* for exploiting different plant species for feeding and reproduction. Sri et al. (2022) reported infestations of *A. rugioperculatus* in various hosts, including plantation crops, fruit crops, medicinal plants, spices, ornamentals, avenue trees, vegetables, and field crops, spanning 24 different families. Nandhini and Srinivasan (2023) conducted an extensive survey in Tamil Nadu to investigate the expanding host range of the rugose spiralling whitefly. Their findings revealed that the pest was present on approximately 67 host plants, including coconut plants. They observed that host plants with higher populations of *Encarsia* parasitoids could assist in biological pest suppression. Upon analyzing the host range, they discovered that *A. rugioperculatus* could complete its life cycle and emerge as adults in only six hosts: coconut, teak, banana, guava, maize, and Spanish cherry. Additionally, five other hosts, including *Annona muricata*, *A. squamosa*, *A. reticulata*, *Theobroma cacao*, and *Ficus religiosa*, supported *A. rugioperculatus* up to the nymphal stage and housed a greater significant number of *Encarsia guadeloupae* parasitoids. These identified hosts could serve as banker crops in and around coconut plantations, facilitating the emergence of parasitoids and aiding in biological control of the target pest. The ability of *A. rugioperculatus* to infest multiple hosts poses significant challenges for agricultural management and control efforts, as it can lead to widespread damage across diverse agricultural and horticultural systems. Further research on the host preference and interactions of RSW with different plant species is necessary to gain a comprehensive understanding of its biology and ecology.



A) *P. granatum* leaves were invaded with *A. rugioperculatus*



B) *P. granatum* twigs were attacked with *A. rugioeperculatus*



C) *P. granatum* fruits were invaded by *A. rugioeperculatus*

Figure 4. Various parts of *P. granatum* affected by *A. rugioeperculatus* infestation



Figure 5. *A. rugioeperculatus* infested leaves of *Ficus religiosa*



Figure 6. *A. rugioperculatus* infested leaves of *Ficus benghalensis*



Figure 7. *A. rugioperculatus* infested leaves of *B. flabellifer*



Figure 8. *A. rugioperculatus* infested leaves of *C. myxa*



Figure 9. *A. rugioperculatus* infested leaves of *P. purpureum*



Figure 10. *A. rugioperculatus* infested leaves of *A. indica*



Figure 11. *A. rugioperculatus* infested leaves of *C. limon*

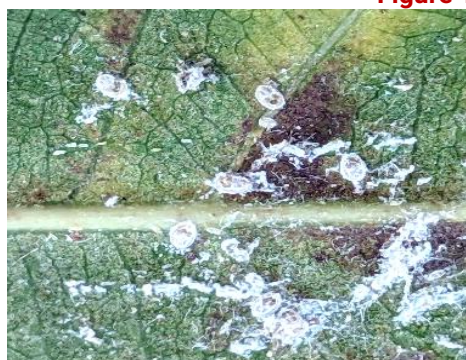


Figure 12. Parasitized nymph of *A. rugioperculatus*

Conclusion

During the investigation period from 2023-24, *A. rugioeperculatus* was identified for the first time in *Punica granatum*, *Ficus religiosa*, *Ficus benghalensis*, *Azadirachta indica* and *Citrus limon* in Gujarat, while *Borassus flabellifer*, *Cordia myxa*, *Pennisetum purpureum* were recorded for the first time in India. The presence of this invasive species on different host plants poses a significant threat to the cultivation of vital crops in the region. This finding highlights the need for ongoing surveillance and monitoring efforts to monitor the spread of invasive pests and mitigate their impact on agricultural productivity in Gujarat and across India.

Declaration of interests

The authors have no conflict of interest to declare.

Data Sharing

All relevant data are within the manuscript

References

- Antonio WF, Stocks IC, Smith TR, Boughton AJ, Mannion CM & Osborne LS. 2016. Host plants and natural enemies of rugose spiralling whitefly (Hemiptera: Aleyrodidae) in Florida. *Florida Entomologist*, 99(1): 150-153.
- Bhavani B, Kishore VP & Bharatha LM. 2020. First report of rugose spiralling whitefly, *Aleurodicus rugioeperculatus* Martin, an invasive pest on sugarcane in Andhra Pradesh, India. *Journal of Entomology and Zoology Studies*, 8(6): 1993-1999.
- David BV & Regu K. 1995. *Aleurodicus dispersus* Russell (Aleyrodidae: Homoptera), a whitefly pest new to India. *Pestology*, 19(3): 5-7.
- Dubey AK & Sundararaj R. 2015. A new combination and first record of genus *Aleurothrixus* Quaintance & Backer (Hemiptera: Aleyrodidae) from India. *Biosystematica*, 9 (1&2): 23-28.
- Elango KS, Jeyarajan N, Sridharan S, Paranidharan V & Balakrishnan S. 2019. Biology, distribution and host range of new invasive pest of India coconut rugose spiralling whitefly *Aleurodicus rugioeperculatus* Martin in Tamil Nadu and the status of its natural enemies. *International Journal of Agriculture Sciences*, 11(9): 8423-8426.
- Felsenstein J. 1985. Confidence limits on phylogenies: An approach using the bootstrap. *Evolution*, 39:783-791.
- Haldhar SM and Singh R S. 2014. Report of *Dictyla cheriani* Drake (Hemiptera: Tingidae) on Indian Cherry (*Cordia myxa* L.) in Rajasthan, India: incidence and morphometric analysis. *Indian Journal of Agricultural Sciences* 84 (1): 128-130.
- Haldhar SM. 2012. Report of *Homoeocerus variabilis* (Hemiptera: Coreidae) on khejri (*Prosopis cineraria*) in Rajasthan, India: incidence and morphometric analysis. *Florida Entomologist*, 95 (4): 848-853.
- Jethva D, Kachot A & Wadaskar P. 2020. New record of rugose Spiralling Whitefly, *Aleurodicus rugioeperculatus* Martin (Hemiptera: Aleyrodidae) on different host plants in India and Gujarat. *Journal of Entomology and Zoology Studies*, 8: 2111-2114.
- Jethva DM, Wadaskar PS & Kachot AV. 2020. First report of rugose spiralling whitefly, *Aleurodicus rugioeperculatus* Martin (Hemiptera: Aleyrodidae) on coconut in Gujarat, India. *Journal of Entomology and Zoology Studies*, 8: 722-725.
- Josephraj Kumar A, Anes KM, Babu M, Pratibha PS, Sajan JV & Hegde V. 2023. Exotic whiteflies and Conservation Biological Control in Coconut System. In *IOP Conference Series: Earth and Environmental Science* (Vol. 1179, No. 1, p. 012006). IOP Publishing.
- Kimura M. 1980. A simple method for estimating evolutionary rate of base substitutions through comparative studies of nucleotide sequences. *Journal of Molecular Evolution* 16:111-120.
- Martin JH. 2004. The whiteflies of Belize (Hemiptera: Aleyrodidae) Part 1 - Introduction and account of the subfamily Aleurodicinae Quaintance & Baker. *Zootaxa*, 681: 1-119.
- Martin JH. 2008. A revision of *Aleurodicus* Douglas (Sternorrhyncha, Aleyrodidae), with two new genera proposed for palaeotropical natives and an identification guide to world genera of Aleurodicinae. *Zootaxa*, 1835: 1-100.
- Haldhar SM, Bhargava R, Singh RS, Krishna H and Sharma SK. 2015. First Report of *Colotis amata* (Lepidoptera: Pieridae) on *Salvadora persica* (Capparales: Salvadoraceae) in Rajasthan, India: Incidence and Morphometric Analysis. *Florida Entomologist*, 98(2): 442-445.
- Pradhan SK, Shylesha AN, Selvaraj K & Sumalatha BV. 2021. Distribution, host range and status of invasive rugose spiralling whitefly, *Aleurodicus rugioeperculatus* Martin (Hemiptera: Aleyrodidae) in Karnataka. *Agricultural Research*, 1-7.
- Rao NC, Roshan DR, Rao GK & Ramanandam G. 2018. A review on rugose spiralling whitefly, *Aleurodicus rugioeperculatus* martin (Hemiptera: Aleyrodidae) in India. *Journal of Pharmacognosy and Phytochemistry*, 7(5): 948-953.
- Saitou N & Nei M. 1987. The neighbour-joining method: A new method for reconstructing phylogenetic trees. *Molecular Biology and Evolution*, 4: 406-425.
- Selvaraj K, Sumalatha BV, Sundararaj R, Venkatesan T, Shylesha AN & Sushil SN. 2024. Guide on Diagnosis of Invasive Whiteflies and Their Natural Enemies. *Technical Bulletin* No. 1/2021, pp. 8-12.
- Shanas S, Joseph J, Tom J & Anju K G. 2016. First report of the invasive rugose spiralling whitefly, *Aleurodicus rugioeperculatus* Martin (Hemiptera: Aleyrodidae) from the old world. *Entomon*, 41(4): 365-368.
- Stocks IC & Hodges G. 2012. The rugose spiralling whitefly, *Aleurodicus rugioeperculatus* Martin, A new exotic whitefly in South Florida (Hemiptera: Aleyrodidae). Florida Department of Agriculture and Consumer Services, Division of Plant Industry. Retrieved from <https://ccmedia.fdacs.gov/content/download/25204/file/aleurodicus-rugioeperculatus-pest-alert.pdf>
- Tamura K, Stecher G & Kumar S. 2021. MEGA 11: Molecular Evolutionary Genetics Analysis Version 11. *Molecular Biology and Evolution* <https://doi.org/10.1093/molbev/msab120>.
- Thompson JD, Higgins DG & Gibson TJ. 1994. CLUSTAL W: improving the sensitivity of progressive multiple sequence alignment through sequence weighting, position-specific gap penalties and weight matrix choice. *Nucleic. Acids. Res.* 22(22): 4673-4680.
- Vrijenhoek R. 1994. DNA primers for amplification of mitochondrial cytochrome c oxidase subunit I from diverse metazoan invertebrates. *Mol. Mar. Biol. Biotechnol.* 3:294-299.

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