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First record of Bondar's Nesting Whitefly, Paraleyrodes bondari Peracchi (Hemiptera: Aleyrodidae) in Bangladesh: its morpho-molecular identification and coexistence with other whitefly species

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Abstract

The Bonder's nesting whitefly, *Paraleyrodes bondari* (Peracchi) (Hemiptera: Aleyrodidae) is an invasive whitefly insect pest native to Brazil, recognized for its high adaptability as well as extensive host range, although coconut (*Cocos nucifera* L.) is the main preferred host plant. Coconut is an economically important tropical fruit crop in Bangladesh, valued for its high market demand, source of consistent income for the growers, and livelihood support. We made an extensive survey on the whitefly infestation of coconut by the construction of distinctive woolly wax nests on the abaxial surfaces of palm leaflets in the south-western region of Bangladesh and recorded the presence of Bonder's Nesting Whitefly (BNW), *P. bondari*, for the first time in Bangladesh through morphological and molecular analysis. Morphological characterization based on the presence of 'X'-shaped oblique greyish bands on its wings, oval-shaped eggs with stalk or pedicel, flat puparium with no tail-like structure, and molecular identification based on the mtCOX1 gene confirmed the BNW's identity. Phylogenetic analysis using the Maximum Likelihood method placed the isolates within the *P. bondari* clade with strong bootstrap support. We also found that the co-existence of *P. bondari* and *Aleurodicus rugioperculatus* on coconuts suggests simultaneous invasion of both species from the New World. The polyphagous nature of the non-native BNW warrants stringent quarantine protocols to prevent its further spread to other coconut-growing areas, as well as the urgency of developing effective, sustainable management strategies to protect high-value coconut and other tropical crops from potential economic losses.

Introduction

Coconut farming is an important occupation in Bangladesh; it provides a consistent income stream to growers regularly. Coconut production in the south-western regions of Bangladesh plays a vital role in the local economy and supports the livelihoods of many people across the coconut value chain. More than 900 species of pests are associated with the coconut palm. This includes both invertebrates and vertebrates (Kumara et al., 2015). Among invertebrates, the coconut eriophyid mite (*Aceria guerreronis* K.) and rhinoceros beetle (*Oryctes rhinoceros*) are two major insect pests of coconut in Bangladesh and have been causing serious damage to coconut (Islam et al., 2018; Sarker et al., 2022). But rugose spiraling whitefly, *Aleurodicus rugioperculatus* Martin (RSW) have been emerged as a significant threat in Bangladesh in 2019, causing severe damage to coconut palms. It is believed that this insect is largely responsible for the recent decline in coconut production in Bangladesh (Das et al., 2023).

Whiteflies (Hemiptera: Aleyrodidae) are sap-feeding, small (1–3 mm in length), polyphagous insect pests that superficially resemble tiny moths (Ouvrard and Martin, 2018). More than 1550 species of whiteflies belonging to 192 genera have been documented globally (Sadhana et al., 2023). Both male and female whiteflies and their nymphs are typically located on the undersides of leaves where they consume phloem sap and serve as carriers for various plant viruses (Sani et al., 2020).

Globalization of agricultural trade has led to the deliberate or accidental introduction of many quarantine pests, diseases, and weeds (USDA, 2000). These introduced or invasive pests pose a major threat to the

local biodiversity and, in some cases, seriously threaten the country's food security. In the last 20 years, several whitefly species have been introduced in Bangladesh and have become a major threat to our field and horticultural crops (Dutta et al., 2019). Among whitefly species, *Bemisia tabaci* and *Aleurodicus dispersus* are considered two destructive insect pests of vegetables and fruit crops, respectively, in Bangladesh (Khatun et al., 2018; Rashid et al., 2003). Additionally, the rugose spiralling whitefly (RSW) (*Aleurodicus rugioperculatus* Martin), an invasive insect pest that was first identified in Bangladesh in 2019 on coconut palms in the south-western part of the country (Dutta et al., 2019). This destructive pest was identified in India in 2016 on coconut (Sundararaj and Selvaraj, 2017). Worldwide, it has 118 host plants, but in Bangladesh, 61 host plants were identified through a baseline survey study across the country (Das et al, 2023). Coconut is the most preferred host plant, followed by banana and guava.

Recently, whitefly complex was noticed on coconut palms in some south-western districts of Bangladesh. In the whitefly groups or complex, we have noticed a new whitefly species along with *A. rugioperculatus* and *A. dispersus* that is smaller than RSW and has distinct wing characteristics. The targeted or new whitefly species was taken to the laboratory for morpho-molecular study. The newly identified species exhibited distinct oblique grey bands and formed woolly wax nests on the abaxial surface of coconut leaflets. It was exclusively noticed feeding on coconut leaflets previously colonized by *Aleurodicus rugioperculatus.* Based on morphological identification and confirmed by mtCOI gene sequencing, in this paper, we report the occurrence of the neotropical invasive BNW, *Paraleyrodes bondari* Peracchi, in Bangladesh for the first time. It is to be mentioned here that *P. bondari* was first identified in India in 2019 (Josephrajkumar et al., 2019) and in Sri Lanka in 2024 (Mathula et al., 2024). It has been reported that *P. bondari* has emerged as a new threat in coconut-producing countries due to its higher reproductive potential than that of RSW and the lack of potential parasitoids in field conditions (Gopianand et al., 2023; Josephrajkumar et al., 2019). Thus, the present research work was carried out to study the morpho-molecular characterization of Bonders Nesting Whitefly, *Paraleyrodes bondari*, as well as the level of co-existence with other whiteflies on coconut plants.

Materials and Methods

Sample collection

Whitefly samples were collected from six districts in the south-western region of Bangladesh, an exclusively coconut-producing area (Table 1). The host plants were both native and imported dwarf coconut varieties. For morphological study, the adult whiteflies along with woolly nests, egg spirals, and puparium were carefully collected from infested coconut leaflets and immediately transferred to Petri dishes. Whitefly samples were also collected and kept in a Falcon tube containing 99% ethyl alcohol for molecular study. Both types of samples (dry and alcohol preserved) were then carried to the Laboratory, Department of Entomology, Bangladesh Agricultural University, Bangladesh, for their morpho-molecular characterization. Dry samples were stored at 4°C for morphological studies, and alcohol-preserved samples were stored at -20°C until the process for DNA extraction.

Table 1
Whitefly survey locations (districts) in the South-Western part of Bangladesh, along with their respective geographical coordinates and host plants

Locations (Districts)	Sample code	Geographical Coordinates	Host Plant
Jashore	BNW1	23.1641° N, 89.2065° E	Coconut
Khulna	BNW2	22.8373° N, 89.5400° E	Coconut
Bagerhat	BNW3	22.6552° N, 89.7780° E	Coconut
Shatkhira	BNW4	22.7217° N, 89.0682° E	Coconut
Magura	BNW5	23.4878° N, 89.4284° E	Coconut
Kushtia	BNW6	23.9089° N, 89.1222° E	Coconut

Morphological characterization

Different morphological features like egg laying pattern, egg and puparia characteristics, as well as physical features of the adults of the three collected whiteflies were observed under a Zoom Stereomicroscope (SM-1TS-144S-10M, AmScope, USA). The presence or absence of egg stalk, puparium characteristics, as well as the presence of cross-mark on the wing were considered as the most important diagnostic features to identify Bondar's Nesting Whitefly from other whitefly species (Rao et al., 2023; Mathula et al., 20204; Josephrajkumar et al., 2020).

Molecular characterization

Genomic DNA was extracted from individual adults of *P. bondari* collected from the south-western districts of Bangladesh using the FavorPrep^{TM}Tissue Genomic DNA Extraction Mini Kit (Cat No. FATGK001, Favorgen, Taiwan) as per the manufacturer's guidelines, and the DNA concentration was measured using a nanodrop spectrophotometer. A fragment of approximately 700bp of the mitochondrial cytochrome c-oxidase subunit I (mtCOI) gene was amplified by using the universal primers (LCO1490, 5'-ggtcaacaaatcataaagatattgg-3' and HC02198: 5'- taaacttcagggtgaccaaaaaatca-3' (Folmer et al. 1994). The polymerase chain reaction (PCR) (25µl volume) was carried out in a thermal cycler (SimpliAmp^{TM}Thermal Cycler, Applied Biosystem) with the following cycles; initial denaturation 94°C for 120s as followed by 35 cycles of denaturation 94°C for 60s, annealing 55°C for 60s, extension 72°C for 90s and final extension 72°C for 7 min. The amplified products were analyzed in a 1.5% agarose gel, stained with ethidium bromide (10 ng µL-1), and visualized under UV light. The expected size (700bp) of the PCR products was compared to the DNA ladder to confirm the presence of the amplified products.

Sequencing of amplicons and assignment of phylogenetic divisions

The amplicons were purified using the FavorPrep™ GEL/PCR Purification Kit (https://www.favorgen.com/) and sent to Macrogen for sequence determination. The obtained DNA sequences were checked and manually edited using FinchTV software (digitalworldbiology.com/FinchTV) and then analyzed for nucleotide similarity against the GenBank database using the BLAST (http://www.ncbi.nlm.nih.gov). Based on BLAST homology results using COI gene fragments, whitefly species were confirmed. Reference sequences of the *P. bondari* COI gene reported from other countries were retrieved from GenBank and included in the analysis (Table 2). Multiple sequence alignments were made, and the maximum likelihood algorithm based on the Kimura 2-parameter model was used to infer the evolutionary relationship between the various samples, and a phylogenetic tree was constructed using 1000 bootstrap replicates in MEGA 12.

Co-existence of whiteflies

Co-existence of three whiteflies, namely, Spiraling Whitefly (SW), Rugose Spiralling Whitefly (RSW), and Bondar's Nesting Whitefly (BNW) on coconut plants was assessed. At first, three infested coconut plants were selected, and then three fronds per plant and three leaflets per frond were selected randomly. That means twenty-seven leaflets were used from three coconut plants to find out the co-existence. The total whiteflies (RSW, BNW & SW) were counted from each leaflet, and percent whiteflies was calculated accordingly. A final mean value (%) for each whitefly was calculated from three coconut plants. Data were collected from six districts in the South-Western region of Bangladesh.

Table 2
List of nucleotide sequences of the COI gene retrieved from GenBank to construct phylogenetic tree

No.	NCBI Accession Number	Species	Location
1	MW488198.1	*Paraleyrodes bondari*	India
2	MW041899.1	*Paraleyrodes bondari*	India
3	MK343480.1	*Paraleyrodes bondari*	India
4	ON142331.1	*Paraleyrodes bondari*	India
5	OP326719.1	*Paraleyrodes bondari*	India
6	PP077190.1	*Paraleyrodes minei*	China
7	MK776865.1	*Paraleyrodes minei*	India
8	MK490947.1	*Paraleyrodes minei*	India
9	HM150635.1	*Paraleyrodes pseudonaranjae*	China
10	PV474288.1	*Paraleyrodes pseudonaranjae*	India
11	PP133087.1	*Aleurodicus dispersus*	India
12	PV612638.1	*Aleurodicus rugioperculatus*	Bangladesh
13	KY574537.1	*Aleurodicus rugioperculatus*	India
14	HQ923134.1	*Bombyx mori* (Out group)	Australia

Results

Morphological Identity of Bonder’s Nesting Whitefly

The typical morphological features of Bonder Nesting Whitefly (BNW) and its differences with spiraling whitefly and rugose spiraling whitefly have been shown in Fig. 1 and Fig. 2. Morphological identification of BNW through egg, puparium, and adult characteristics and their differences with the rest of other two species have been described below:

Eggs

Adult BNW lay eggs in clusters around the wooly wax nest (Fig. 1B). Eggs are stalked or have short pedicel, a unique trait not observed in other two species (Fig. 2). Moreover, the spiralling whitefly and rugose spiraling whitefly lays eggs in a spiral pattern and eggs are covered with dense cottony masses but Bondar’s Nesting Whitefly laid eggs in clusters and not covered with cottony masses (Fig. 2).

The puparium

The puparium of *Aleurodicus dispersus* is convex and has prominent two-tailed projections, giving it a distinctive appearance from the rest of the whitefly species. *Aleurodicus rugioperculatus* puparia are also convex but typically have single tail-like projections that are straight and prominent. In contrast, *Paraleyrodes bondari* puparia, however, are flat and have no tail-like projections; rather have prominent silken threads emerging from their dorsum and marginal hairs, a feature absent in the other two whitefly species (Fig. 1D & 2).

Adults

The spiraling whitefly, *Aleurodicus dispersus*, is slender, measuring 2.1–2.3 mm in length, and is entirely white with unmarked wings. In contrast, *Aleurodicus rugioperculatus* is more robust, slightly larger at 2.3–2.5 mm in length, and exhibits greyish-brown mottling or irregular patterns on both of the forewings. *Paraleyrodes bondari*, the smallest of the three, measuring approximately 0.90-1.0 mm in length and is distinguished by an 'X'-shaped oblique greyish marking on the forewings. This 'X'-shaped marking on the wings is the most important diagnostic feature for the identification of *Paraleyrodes bondari*, which was observed in the specimens studied.

Nesting behaviour

Paraleyrodes bondari is unique, as adults construct the woolly wax nest and reside in nests that are more or less demarcated. This nesting behavior is absent in the other two species. Both *Aleurodicus dispersus* and *Aleurodicus rugioperculatus* lay eggs in a spiral pattern.

Molecular confirmation and phylogenetic tree analysis

About 700bp PCR products of COI gene fragments were successfully amplified visible through electrophoresis analysis in all the samples, collected from six locations of the South-Western region of Bangladesh (Table 1), and sequences were obtained. Based on the nucleotide sequence analysis through NCBI, all our isolates (BNW1 to BNW6) shared 99–100 percent similarity with previously reported sequences of *Paraleyrodes Bondari* having accession numbers MK343480.1, MW041899.1, MW488198.1, ON142331.1, and ON146291.1. The obtained sequences from our isolates were deposited in the NCBI databases and received corresponding accession numbers (PV596240.1, PV596241.1, PV596242.1, PV596243.1, PV596244.1, and PV596245.1). By analysing the phylogenetic tree, it is found that all the samples of *Paraleyrodes bondari* collected from Bangladesh formed a single clade along with the other *P. bondari* reported from India (Fig. 3). *P. bondari* is closely related to *Paraleyrodes minei*, with strong bootstrap support, suggesting they are distinct but genetically similar species within the genus *Paraleyrodes*. In contrast, *Aleurodicus dispersus* and *Aleurodicus rugioperculatus* form separate clades, indicating clear genetic divergence from *Paraleyrodes* species. These findings highlight the distinct evolutionary lineages within the family Aleyrodidae, with *Paraleyrodes* and *Aleurodicus* species forming separate clusters in the phylogenetic tree (Fig. 3).

Co-existence of BNW with other whitefly species

The percent co-existence of three whitefly species on coconut palm has been shown in Table 3. In all the studied locations, the majority of the populations were *A. rugioperculatus* and *P. bondari*, while *A. dispersus* was very scant or absent. Approximately 30–63% of *P. bondari* was observed to co-exist with *A. rugioperculatus* in our studied locations. The highest, 63.30% *P. bondari*, was observed in Jashore, which was closely followed by Khulna (54.91%) and Bagerhat (52.80%). However, during our survey period, *P. bondari* populations in Shatkhira, Magura, and Kushtia were relatively lower than those of populations of *A. rugioperculatus* in Jashore, Khulna, and Bagerhat, but it may increase over time. The population of *A. dispersus* was very scant (0.00 to 2.25%) on coconut palms, which indicates that coconut palms are not the major host of it. However, a complex of invasive whitefly species has become a serious threat to coconut production in Bangladesh.

Table 3
Percentage of coexistence of *A. rugioperculatus, P. bondari*, and *A. dispersus* in six south-western districts of Bangladesh

Locations	%*A. rugioperculatus*	%*P. Bondari*	%*A. dispersus*
Jashore	35.50	63.30	1.20
Khulna	43.25	54.91	1.84
Bagerhat	45.60	52.80	1.60
Shatkhira	52.35	46.15	1.50
Magura	61.25	38.75	0.00
Kushtia	68.50	29.25	2.25

Discussion

The presence of the neotropical invasive whitefly, *Paraleyrodes bondari*, in the south-western districts of Bangladesh has been confirmed through morphological and molecular analysis. The rugose spiralling whitefly, *Aleurodicus rugioperculatus*, was first identified in Bangladesh in 2019, which drastically reduced coconut production across the country (Dutta et al., 2019). Five years later, in 2024, another whitefly, Bondar's Nesting Whitefly (BNW), was introduced in Bangladesh and emerged as a big threat to the coconut industry. The *Paraleyrodes bondari* is native to Brazil, first described on citrus in 1971 (Peracchi, 1971), and later it was identified in Madeira in 1995 (Martin, 1996). Then this pest moved to Hawaii in 2003 and to Florida, USA in 2011 (Stocks, 2012), where it was considered an emerging pest. This invasive whitefly was first identified in India in 2019 (Josephrajkumar et al., 2019) and in Sri Lanka in 2024 (Mathula et al., 2024). In Bangladesh, *P. bondari* was first observed in Khulna and Bagerhat districts on coconut palms, and these two districts are very famous for coconut production. Within a short time, we have identified this pest in neighboring districts like Jashore, Kushtia, Magura, and Shatkhira. There is the possibility that this insect has already proliferated in other districts of

Bangladesh. Woolly nest, stalked eggs, flat puparium with no tails, and the presence of 'X'-shaped oblique greyish marking on the wings are the most distinguished morphological features for the identification of *P. bondari*, and later the species was confirmed through mtCOI gene sequencing. BLAST analysis revealed that the observed species showed 99–100% nucleotide identity with the sequence of *Paraleyrodes bondari*, reported from India, USA, China, and other regions (Banumathi et al., 2021; Shivaji Thube et al., 2020; Josephrajkumar et al., 2019; Dickey et al., 2015).

Coconut farming is an important occupation in Bangladesh; it provides a consistent income stream to growers regularly. There are several coconut-based industries in the south-western part of the country, and thousands of people lead their livelihoods across the coconut value chain. Coconut mite (*Aceria guerreronis* K.) and rhinoceros beetle (*Oryctes rhinoceros*) are two important insect pests of coconut in Bangladesh (Islam et al., 2018; Sarker et al., 2022), but the invasive whitefly, *A. rugioperculatus*, has emerged as a potential threat for coconut palms since 2019. Since its invasion, coconut production reduced drastically as both nymphs and adult insects impact the vitality of coconut plants by sucking cell sap. Another invasive whitefly, *P. bondari*, has recently emerged in Bangladesh and has been found to co-exist with other whitefly species on the same leaflets of coconut palms.

However, in Bangladesh, the array of host plants of *P. bondari* has not yet been studied, but globally it has an extensive host range, co-exists with other whitefly species, and causes severe damage (Vidya et al., 2019; Josephrajkumar, 2019; Peracchi, 1971; Omongo et al., 2018; Sadhana et al., 2021a,b; Sundararaj et al., 2021). In Jashore, Khulna, and Bagerhat districts of Bangladesh, the majority of the whiteflies were *P. bondari*, but in the other districts, approximately 30–45% were *P. bondari. A. dispersus* was very scant or absent on coconut palms as its native host plant is guava (Rashid et al., 2003). This simultaneous presence indicates a potential overlap in ecological niches or habitat utilization among these species. The co-existence of *P. bondari* with other whiteflies has previously been reported in India (Josephrajkumar et al., 2019; Vidya et. al., 2019; Selvaraj et.al., 2021). Furthermore, *P. bondari, A. rugioperculatus*, and *A. dispersus* have been observed to coexist within the same coconut leaflets in Sri Lanka (Mathula et al., 2024). The simultaneous presence of Bondar's Nesting Whitefly (BNW) and the sweet potato whitefly, *B. tabaci*, in agricultural systems, particularly on cotton (Sadhana et al., 2021a, b) and cassava (Isabirye, 2021), has attracted considerable scientific interest. The coexistence of these exotic whitefly species, which exhibit similar behavioral and ecological traits, necessitates precise identification to facilitate comprehensive studies on their bioecology, interactions with natural enemies, and the development of effective management strategies. It was observed that the co-occurrence of *P. bondari* and *A. rugioperculatus* under favorable weather conditions significantly reduced the pestiferous potential of *A. rugioperculatus* in the Pollachi region (Josephrajkumar et al., 2020). The association of nesting whiteflies with *A. rugioperculatus* not only impeded the developmental progression of the whiteflies but also facilitated increased parasitism by *E. Guadeloupe* on *A. rugioperculatus*. This phenomenon may reflect a competitive behavioral strategy employed by *P. bondari*, which would potentially contribute to controlling pest populations through indirect ecological interactions (Mathula et al., 2024).

Conclusion

The presence of Bonder Nesting Whitefly, *Paraleyrodes bondari*, as a new whitefly species is confirmed in Bangladesh by morpho-molecular study. This species was identified on coconut palms in the south-western districts of Bangladesh and co-existed with another invasive whitefly, *Aleurodicus rugioperculatus*, in the same leaflets of coconut palms. In some districts, *P. bondari* populations were higher than those of *A. rugioperculatus*. Due to its high reproductive potential as well as the absence of specific natural bio-control agents, BNW presents a substantial risk to the agricultural sector. As a new whitefly species in Bangladesh, further studies are warranted to develop sustainable management practices by studying its bio-ecology, insect-weather factor interaction, reproductive potential, as well as exploring BNW-specific natural enemies, especially predators, parasitoids, and pathogens.

Declarations

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Authorship contribution: GD: Study conception and design, fund management, interpretation of results, final manuscript preparation; **MSR:** Sample collection from the field and Morphology study; **MTTH:** Molecular study; **MMU:** Result interpretation and draft manuscript preparation; **MMR**: Molecular study and manuscript review.

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Conflict of interest: The authors declare no competing interests.

References

1. Banumathi, K., Murugan, M, Jayakanthan, M. (2021). Whitefly diversity in the vegetable ecosystem of Tamil Nadu. https://www.ncbi.nlm.nih.gov/nucleotide/MW488186.1
2. Das, G., Uddin, M. M., Roy, B. K. & Ahmed, M. S. (2023). Identification of rugose spiraling whitefly infesting host plants in Bangladesh and assessment of its damage severity. *American Journal of Entomology*, *7*(1), 1-8. doi: 10.11648/j.aje.20230701.11
3. Dickey, A. M., Stocks, I. C., Smith, T., Osborne, L. & McKenzie, C. L. (2015). DNA barcode development for three recent exotic whitefly (Hemiptera: Aleyrodidae) invaders in Florida. *Florida*

Entomology, 98:473-478.

4. Dutta, N. K., Sarker, D., Begum, K., Sarkar, M. A., Islam, M. I. & Rahman, M. M. (2019). First record of the invasive rugose spiraling whitefly, *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae) in Bangladesh with its host range and status as a coconut pest. *Bangladesh Journal of Entomology*, 29(2), 73-83.
5. Gopianand, L., Kathirvelu, C. & Ayyasamy, R. (2023). Comparison of Biology and Reproductive Potential of Two Invasive Coconut Whiteflies, *Aleurodicus rugioperculatus* Martin and *Paraleyrodes bondari* Peracchi through an Age-Stage, Two-Sex Life Table Approach. *Uttar Pradesh Journal of Zoology*, 44(23): 52-60. DOI: 10.56557/UPJOZ/2023/v44i233765
6. Isabirye, Z. (2021). The distribution and abundance of bonder's nesting whitefly *(Paraleyrodes bondari)* on cassava in Busukuma sub-county, Wakiso District, Uganda (Doctoral dissertation, Makerere University).
7. Islam, M. N., Islam, I. & Shamsunnahar, M. (2018). Management of coconut mite in Bangladesh involving communities as implementers. *Coconut Research and Development Journal*, 34(2): 1-11. DOI: https://doi.org/10.37833/cord.v34i2.13.
8. Josephrajkumar, A., Mohan, C., Babu, M., Prathibha, P. S., Hegde, V. & Krishnakumar, V. (2020). Diagnosis of invasive whitefly species co-occurring on coconut. *Current Science*, *119*(7), 1101-1105. doi: 10.18520/cs/v119/i7/1101-1105.
9. Josephrajkumar, A., Mohan, C., Babu, M., Krishna, A., Krishnakumar, V., Hegde, V. & Chowdappa, P. (2019). First record of the invasive Bondar's nesting whitefly, *Paraleyrodes bondari* Peracchi, on coconut from India. *Phytoparasitica*, *47*(3), 333-339. https://doi.org/10.1007/s12600-019-00741-2
10. Khatun, M. F., Jahan, S.M.H., Lee, S. & Lee, K.Y. (2018). Genetic diversity and geographic distribution of the *Bemisia tabaci* species complex in Bangladesh. *Acta Tropica,* 187(13). DOI:10.1016/j.actatropica.2018.07.021
11. Kumara, A.D.N.T., Chandrashekharaiah, M., Kandakoor, S.B. & Chakravarthy, A.K. (2015). Status and Management of Three Major Insect Pests of Coconut in the Tropics and Subtropics. *In New Horizons in Insect Science: Towards Sustainable Pest Management, Springer*: 359-381.
12. Martin, J.H. (1996). Neotropical whiteflies of the subfamily Aleurodicinae established in the western Palaearctic (Homoptera: Aleyrodidae). *Journal of Natural History*, 30(12), 1849–1859. https://doi.org/10.1080/00222939600771081
13. Mathula, M., Gnaneswaran, R., Sivakalai, K., Thilaksika, V., Luckshika, M.R. & Arani, B. (2024). First report of invasive nesting whitefly *Paraleyrodes bondari* Peracchi (Hemiptera: Aleyrodidae): Impact on coconut palm (Cocos nucifera L.) in Jaffna, Sri Lanka. *Insect Environment*, *27*(3). https://doi.org/10.55278/qxzd1701.
14. Omongo, C. A., Namuddu, A., Okao-Okuja, G., Alicai, T., van Brunschot, S., Ouvrard, D., & Colvin, J. (2018). Occurrence of Bondar's nesting whitefly, *Paraleyrodes bondari* (Hemiptera: Aleyrodidae), on cassava in Uganda. *Revista Brasileira de entomologia*, 62, 257–259. https://doi.org/10.1016/j.rbe.2018.10.001

15. Ouvrard, D., Martin, J.H. (2018). The Whiteflies-Taxonomic checklist of the world's whiteflies (Insecta: Hemiptera: Aleyrodidae). https://doi.org/10.5519/0095728.
16. Peracchi, A. L. (1971). Two Aleyrodid pests of Citrus in Brazil (Homoptera, Aleyrodidae). *Arquivos do Museu Nacional*, 54, 145–151.
17. Rao, N.B.V.C., Ramani, B.S., Bhagvan, B.V., Sabana, A.A. & Rajesh, M.K. (2023). New report on the invasive Bondar's nesting whitefly (*Paraleyrodes bondari* Peracchi) on oil palm in India. *Journal of Plantation Crops*, 51(2): 65-70. DOI: https://doi.org/10.25081/jpc.2023.v51.i2.7817.
18. Rashid, M.M., Hossain, M., Alam, M.Z., Ibrahim, M. (2003). Seasonal Abundance and Control of Spiraling Whitefly, *Aleurodicus dispersus* Russel on guava. *Pakistan Journal of Biological Sciences*, *6*(24), 2050-2053. DOI:10.3923/pjbs.2003.2050.2053
19. Sadhana, V., Senguttuvan, K., Murugan, M., Manikanda, B. N, Sathiah, N. (2021b). First record of Bondar's nesting whitefly, *Paraleyrodes bondari* peracchi (Hemiptera: Aleyrodidae), occurrence and infestation in the cotton ecosystem of Tamil Nadu, India. *Journal of Pharma Innovation*, 10(10S), 1278-1284.
20. Sadhana, V., Senguttuvan, K., Murugan, M. & Sathiah, N. (2021a). Efficacy of newer insecticides against whitefly, *Bemisia tabaci* (Hemiptera: Aleyrodidae) on cotton. *Madras Agricultural Journal*, 108.
21. Sadhana, V., Senguttuvan, K., Murugan, M. & Suriya, S. (2023). Review on exotic Bondar's nesting whitefly, *Paraleyrodes bondari* Peracchi infestation on multiple cropping systems.
22. Sani, I., Ismail, S.I., Abdullah, S., Jalinas, J., Jamian, S. & Saad, N. (2020). A review of the biology and control of whitefly, *Bemisia tabaci* (Hemiptera: Aleyrodidae), with special reference to biological control using entomopathogenic fungi. *Insects*, *11*(9), 619. doi: 10.3390/insects11090619.
23. Sarker, B.C., Rahman, M.J., Islam, M.R., Sarker, D., Dutta, N.K., Begum, K., Islam, M.M. & Nasir, M. (2022). Development of Integrated Crop Management Technologies for Higher Production of Coconut in Bangladesh, Sub-project Completion Report. P-60.
24. Selvaraj, K., Sumalatha, B.V. (2021). New distributional record of Neotropical coconut whitefly. *Insect Environment,* 24(2), 23–235.
25. Shivaji T. H., Thava, P. P. R., JosephRajKumar, A., Merin, B., Santhosh, K.P. & Nirmal, K.B.J. (2020). *Paraleyrodes bondari* isolate BNWKa1 cytochrome C oxidase subunit I (COX1) gene, partial cds; mitochondrial. https://www.ncbi.nlm.nih.gov/ nuccore/MW041899.1.
26. Stock,s I.C. (2012). Bondar's Nesting Whitefly, *Paraleyrodes bondari*, a Whitefly (Hemiptera: Aleyrodidae) New to Florida Attacking Ficus and Other Hosts. *Pest Alert*.
27. Sundararaj, R., Selvaraj, K. (2017). Invasion of rugose spiralling whitefly, *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae): a potential threat to coconut in India. *Phytoparasitica*, 45: 71-76. DOI:10.1007/s12600-017-0567-0
28. Sundararaj, R., Krishnan, S. & Sumalatha, B. V. (2021). Invasion and expansion of exotic whiteflies (Hemiptera: Aleyrodidae) in India and their economic importance. *Phytoparasitica*, 49(5), 851–863. DOI: 10.1007/s12600-021-00919-7

29. U.S. Department of Agriculture (USDA). 2000. Pest Risk Assessment for Importation of Solid Wood Packing Materials into the United States. U.S. Department of Agriculture, Animal and Plant Health Inspection Service and U.S. Forest Service, Washington, D.C.
30. Vidya, C.V., Sundararaj, R., Dubey, A.K., Bhaskar, H., Chellappan, M. & Henna, M.K. (2019). Invasion and establishment of Bondar's nesting whitefly, Paraleyrodes bondari Peracchi (Hemiptera: Aleyrodidae) in the Indian mainland and Andaman and Nicobar Islands. *Entomon,* 44(2), 149–154. DOI: 10.33307/entomon.v44i2.443
31. Yin, J., Wang, C., Li, Y., Luo, Z., Li, J., Zhang, R., Wang, X. & Shan, H. (2024). First report of the nesting whitefly, *Paraleyrodes minei* Iaccarino (Homoptera: Aleyrodidae), a new sugarcane pest in Yunnan, China. *Phytoparasitica*, 52(5):82. https://doi.org/10.1007/s12600-024-01203-0

Figures

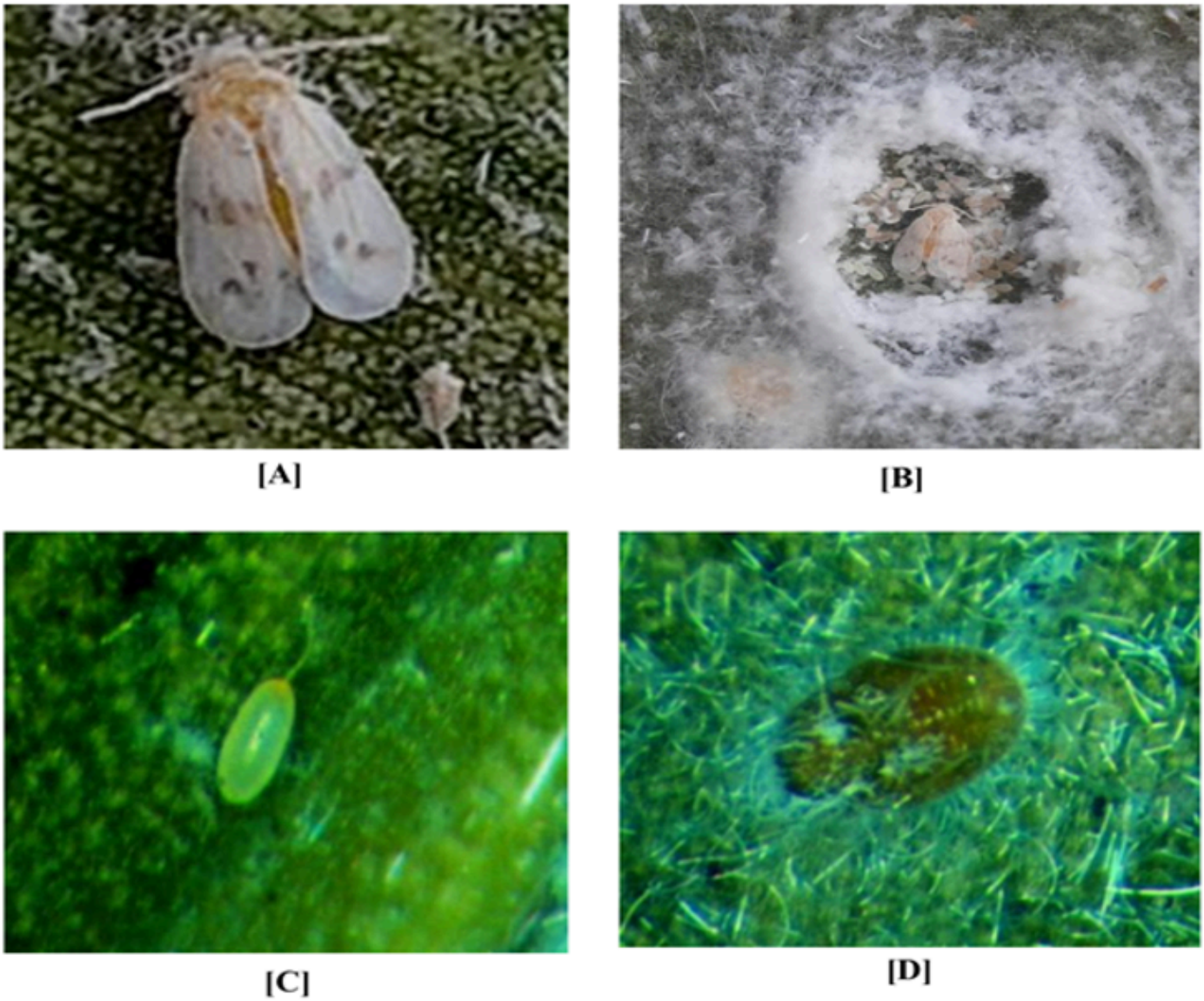


Figure 1

Typical morphological features of Bondar's Nesting Whitefly. (A) Adult with X-shaped marking on the wings (B), Adults in woolly wax nest (C), Stalked egg (D), Puparium with filaments or setae at the margin, and absence of tail-like structure

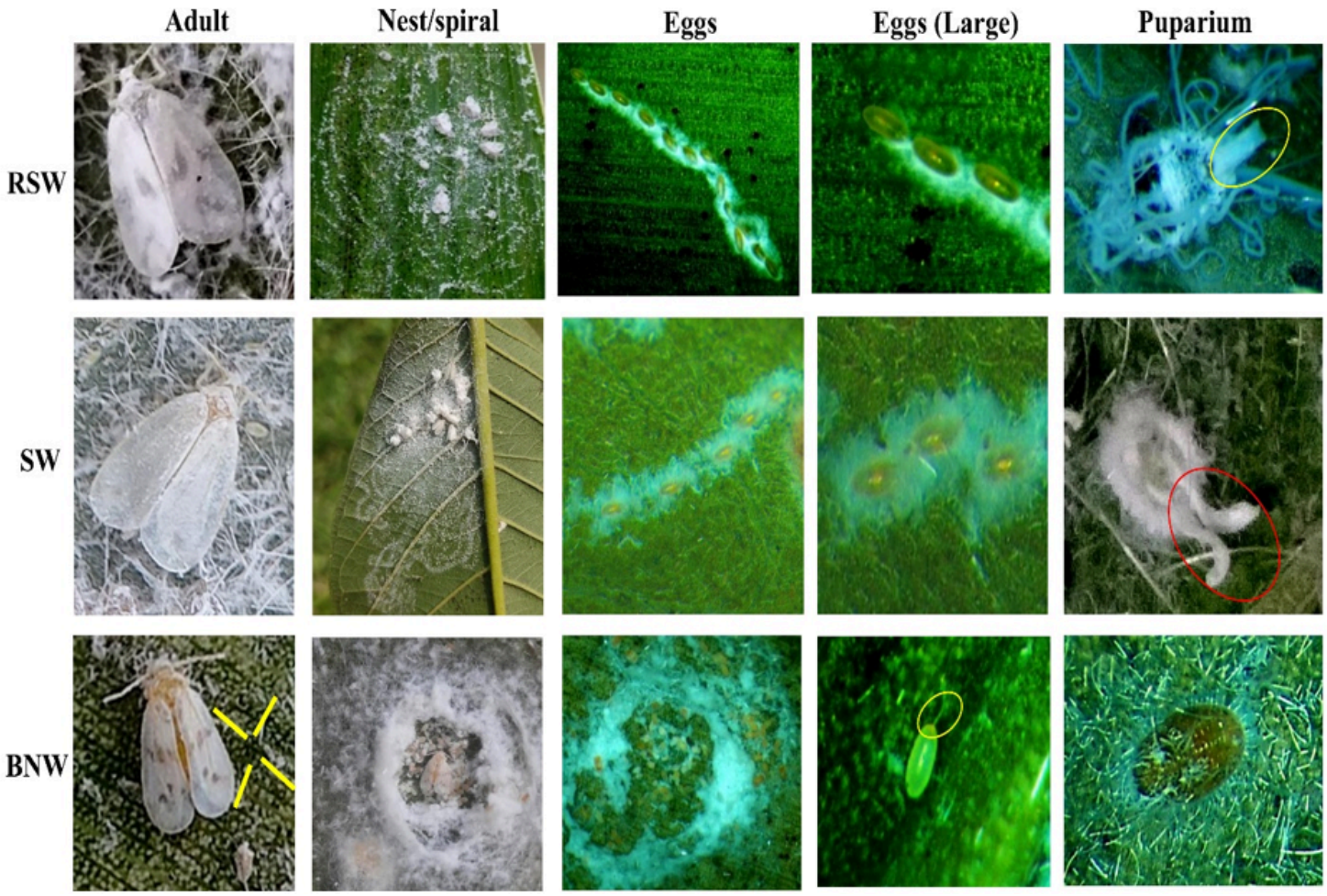


Figure 2

Morphological differences among the three collected species of whitefly from Bangladesh. RSW: Rugose Spiraling Whitefly, SW: Spiraling Whitefly, BNW: Bondar's Nesting Whitefly. The yellow circle denotes single and the red circle denotes two-tailed like projections in RSW and SW, respectively. In case of BNW, the yellow cross mark indicates an X-shaped marking on the forewing, the yellow circle on eggs denotes the stalk or pedicel in the egg.

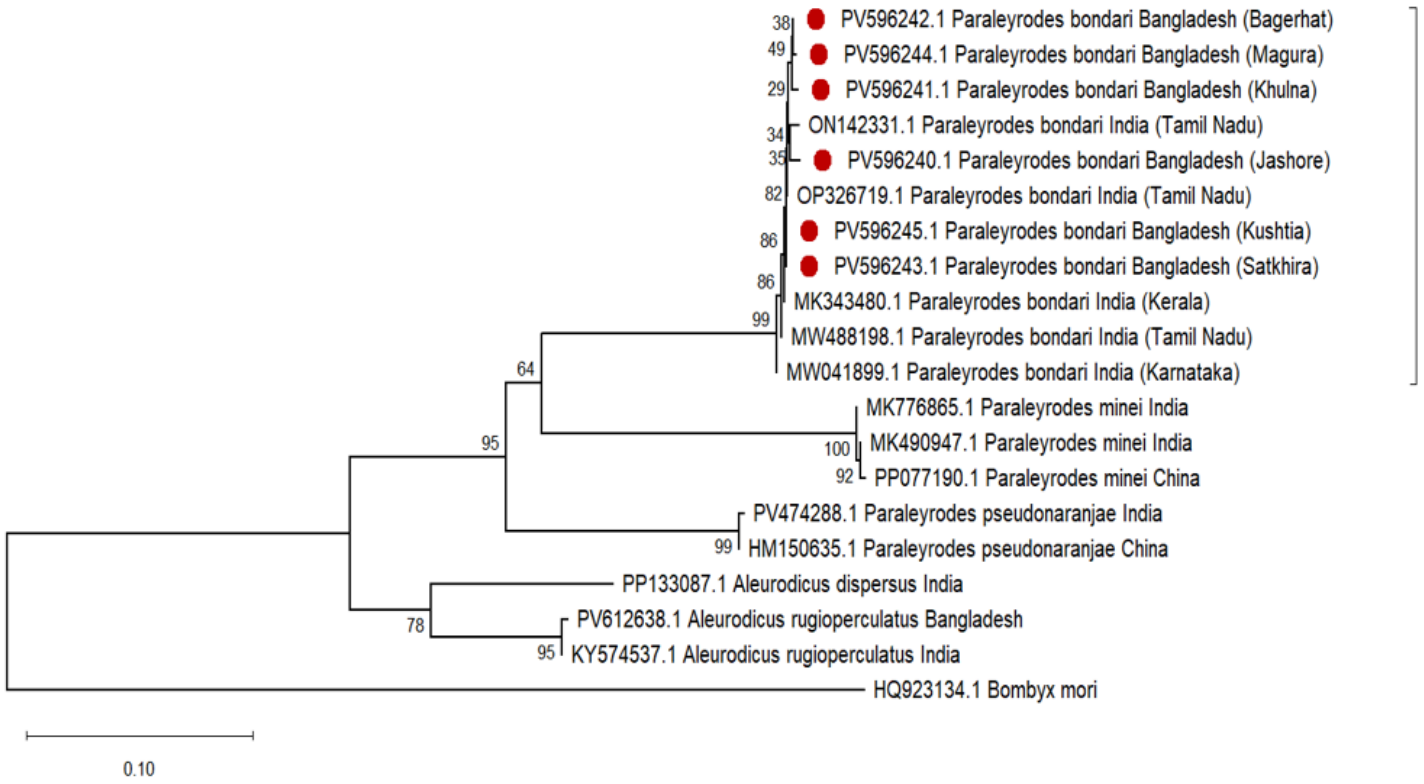


Figure 3

Phylogenetic tree of Bondar's Nesting Whitefly collected from Bangladesh along with others reported from elsewhere (Table 2), constructed based on the Maximum-Likelihood (ML) method using mitochondrial COI gene sequence. Bootstrap values are displayed at each node.