STUDY AND DISTRIBUTION OF NEW INVASIVE PEST, RUGOSE SPIRALLING WHITEFLY *ALEURODICUS RUGIOPERCULATUS* MARTIN IN OIL PALM.

Abstract

Rugose Spiralling Whitefly (RSW), *Aleurodicusrugioperculatus* Martin (Hemiptera: Sternorrhyncha: Aleyrodidae), is an invasive and destructive pest that invaded India in 2016, causing significant damage to coconut and other host crops in states like Tamil Nadu, Kerala, Karnataka, and Andhra Pradesh. RSW infestation stresses plants by depleting water and nutrients through feeding, coupled with excessive honeydew excretion that facilitates the growth of sooty mold, thereby reducing photosynthetic efficiency. In the present study, field surveys were conducted across major oil palm-growing districts of Telangana, including BhadradriKothagudem and Khammam, to assess the pest's distribution, damage intensity, infestation levels, and host range.This research provides critical insights for developing effective pest management strategies to mitigate the impact of RSW on economically significant crops.

Fifty host plants from 29 families were identified as hosts for RSW. Of these, 10 plants, including coconut, oil palm, banana, sapota, mango, and guava, supported all life stages of RSW, while the remaining host plants exhibited only the egg stage. The damage caused by RSW was particularly severe in coconut, oil palm, sapota, mango, and guava, highlighting their susceptibility. This comprehensive study underscores the varying levels of host suitability and damage intensity across different plant species, providing valuable insights into the pest's biology and its impact on key agricultural crops.

1. Introduction

The rugose spiralling whitefly (RSW), *Aleurodicusrugioperculatus* Martin, an invasive species, was first reported feeding on gumbo limbo (*Bursera simaruba*) in South Florida in 2009. In India, it was initially observed on coconut (*Cocos nucifera*) in Pollachi, Tamil Nadu, during August 2016 (Selvaraj *et al.,* 2016: Sundharaj and Selvaraj, 2017) Subsequently, RSW was found feeding on banana, Indian almond, sapota, maize, oil palm,

mango, cashew, custard apple, and various ornamental plants across Karnataka, Kerala, Andhra Pradesh, Telangana, Goa, Assam, and more recently in West Bengal, Lakshadweep, Maharashtra, Gujarat, Odisha, Chhattisgarh, and Meghalaya. Continuous feeding by nymphs and adults causes water and nutrient loss in host plants, while the release of honeydew on the upper surfaces of lower leaves promotes the growth of sooty mold. This sooty mold significantly reduces the plant's photosynthetic efficiency, further impacting its health and productivity (Capinera,2008). In the Indian subcontinent, this invasive pest has spread to numerous locations, colonizing a wide range of host plants. Previous studies reported infestation levels of 40–60% on coconut and 25–40% on banana. In several areas of Tamil Nadu and Kerala, the infestation was severe enough to cause complete drying of banana leaves (Selvaraj *et al.*, 2016).

In India, six species known to infest coconut palms are *Aleurocanthusarecae* David and Manjunatha, *Aleurodicusdispersus* Russell, *Aleurodicusrugioperculatus* Martin, *Aleurotrachelus atratus* Hempel, *Paraleyrodesminei* Iaccarino, and *Paraleyrodesbondari*Peracchi (Selvaraj *et al.*, 2019).

Several natural enemies, such as *Encarsiaguadeloupae* Viggiani (Hymenoptera: Aphelinidae), *Encarsiadispersa*, chrysopids, and coccinellids, were observed feeding on RSW. A notable degree of shared parasitism was identified between coconut and intercrop herbivores, indicating that pest populations could be suppressed through indirect interactions. Given the rapid spread of RSW, it is essential to study the extent of damage across various agroclimatic zones in Telangana, identify its favourable hosts and natural enemies, and analyze its coexistence patterns. With these objectives, the present study was conducted to examine the distribution, host range, and status of the invasive rugose spiralling whitefly (*Aleurodicusrugioperculatus*) in Telangana.

2. Materials and Methods

Identification of host range and estimation of extent of damage by *A. rugioperculatus* in Telangana

Using the scale and infestation index formula developed by Srinivasan *et al*. (2016), the identified host plants were surveyed and assessed to evaluate the extent of Rugose Spiralling Whitefly infestation across various host plants.

Table: 1 Damage rating scale for the infestation of *A. rugioperculatus*

No. of egg spirals /leaflet	**Grade**	**Category**	**Infestation Index**
No spirals – Sooty mold encrustation noticed	0	Nil	0.0
Less than 10 spirals/leaflet – Presence of Sooty mold encrustation in 5 to 6 lower fronds	1	low	0.01 -1.00
10 to 20 spirals/leaflet -Presence of Sooty mold encrustation in 10 to 12 fronds	2	Medium	1.01 – 2.00
More than 20 spirals/leaflet - Presence of Sooty mold encrustation in more than 12 fronds	3	High	2.01 - 3.00

The infestation index for RSW was computed in coconut and oil palm based on the formula given below to categorize the coconut and oil palm gardens as low, medium and high intensity infestation by RSW.

$$\text{Infestation index} = \frac{(\text{No. of palms under scale } 0 \times 0) + (\text{No of palms under scale } 1 \times 1) + (\text{No of palms under scale } 2 \times 2) + (\text{No of palms under scale } 3 \times 3)}{\text{Total no. of palms observed}}$$

3. Results and Discussion

Understanding the host range of a pest is crucial for developing an effective Integrated Pest Management (IPM) strategy. Given that *A. rugioperculatus* is a relatively new invasive pest in India, and specifically in Telangana, the present study aims to

identify its host range. This information will help assess the pest's potential impact, particularly on horticultural crops in the region.

In the present study, comprehensive surveys were conducted in the BhadradriKothagudem and Khammam districts of Telangana, providing valuable insights into the host range of *A. rugioperculatus* (RSW). During the study period, *A. rugioperculatus* was recorded on 50 plant species across 29 families, each harboring different life stages of the pest. Of these, 17 families were represented by a single species, while five families Poaceae,Asparagaceae, Strelitziaceae,Anacardiaceae and Annonaceae each hosted two species. Six families— Moraceae, Euphorbiaceae, Fabaceae, Malvaceae, Anacardiaceae and Annonaceae each hosted three species. Notably, 22 new host plants for RSW were identified: *Coccinia grandis, Curcumallonga, Magnolia champaca, Pongamia pinnata, Cassia angustifolia, Hyophorbelagenicaulis, Jatropha curcas, Saracaasoca, Acalypha wilkesiana, Dypsislutescens, Dracaena refexa, Epipremnumaureum, Canna indica, Sterliziareginae, Ixora coccinea, Aegelmarmelos, Grewia asiatica, Citrus ssp, Annona reticulata, Aloe vera, Ficus religiosa and Mentha spicata*.

Among the recorded hosts, coconut (*Cocos nucifera*), oil palm (*Elaeis guineensis*),sapota(*Achras zapota*), Guava (*Pisidium guajava*) and Banana (*Musa paradisiaca)* were found to be heavily infested with *A.rugioperculatus*, likely due to the pest's host preference, which is primarily driven by its nutritional needs. The infestation of RSW was also observed on the reproductive parts of banana, guava, mango and sapota, where egg spirals and sooty mold deposition were evident, as shown in Plate 4 respectively.

Interestingly, some plant species such as castor, maize, banyan tree and sugarcane appeared to deter the complete development of RSW, though adult whiteflies were still observed feeding and laying eggs on these plants. The hosts listed in Table 2and depicted in Plate 1 supported all life stages of RSW (from egg to adult). Among the identified hosts, plants from families like Arecaceae and Strelitziaceae were particularly favored by the pest for infestation.

Host that supported all the life stages are ivy gourd, banyan tree, champak, karanj, cassia, acalypha, butterfly palm, travellers tree, song of india, devil`s ivy, oil palm,

coconut, phalsa, sweet orange, mango, banana, sapota, guava, custard apple, jack fruit, indian almond, aloe, neem.

Host that supported both egg and adult stages are Drumstick, sugarcane, turmeric, castor, jatropha, bird of paradise, ixora.

Host that supported only egg stages are ivy gourd, drum stick, maize, sugar cane, banyan tree, turmeric, castor, champak, karanj, cassia, royal bottle palm, jatropha, ashoka, acalypha, butterfly palm, hibiscus, spider plant, travellers tree, song of india, devil`s ivy, canna, bird of paradise, silver oak tree, ixora, areca nut, cashew nut, cocoa, oil palm, coconut, napier grass, bael, phalsa, sweet orange, citrus, water rose apple, ramphal, mango, banana, sapota, guava, custard apple, jack fruit, jamun, indian almond, aloe, neem, camphor tree, indian gooseberry, peppel, mint.

During the study, it was observed that intercropping might be a primary factor contributing to the widespread prevalence of *A. rugioperculatus* (RSW) on multiple host plants. Intercropped plants initially serve as substrates for egg-laying and pest development. While early infestations were unstable, over several generations, the pest became well-established on these new host plants. Eventually, these hosts acted as sources of inoculum, facilitating the spread of the pest to other plants.

The infestation of RSW was also observed in nurseries, orchards, horticultural gardens, and plantations along highways. When the surface characteristics of a new host plant differed from those of previous hosts, the pest appeared to modify its feeding habits to adapt to the new host. This adaptation may be attributed to epigenetic changes in the pest, enabling it to survive on the new plant species.

Whittaker (1970) suggested that allelochemicals present in various plant species can significantly influence the growth and development of feeding insects. This may explain the higher incidence of*A.rugioperculatus* on certain crop families, such as Arecaceae, Musaceae, and Myrtaceae.

Mannion (2010) documented a wide range of host plants for RSW, including woody ornamentals, palms, and fruits. In Florida, between 2009 and 2012, 22% of the RSW-infested hosts were palm species, 16% were gumbo limbo, 10% were *Calophyllumsp.*, 9% were avocado, 4% were dark olive, and 3% were various mango varieties (Francis *et al.*, 2016). Shanas*et al.* (2016) reported a total of 17 plant species

from 11 families as preferred hosts of RSW in Kerala. Selvaraj *et al.* (2016) observed 25–40% leaf infestation on banana, with total leaf drying in several areas of Tamil Nadu and Kerala.

Srinivasan *et al*. (2016) recorded several preferred hosts, including coconut, sapota, custard apple, citrus, nutmeg, hibiscus, banana, okra, and guava, as well as alternate hosts such as parthenium, cassava, arecanut, and pepper. However, not all of these hosts supported the complete life cycle of the pest in Tamil Nadu.

Selvaraj *et al.* (2019) documented the incidence of RSW in West Bengal on a range of host plants, including coconut, banana, mango, sapota, Spanish cherry, hibiscus, guava, citrus, jamun, ficus, custard apple, arecanut, jackfruit, water apple, akashmoni, areca palm, and betel vine.

The findings of the present study are consistent with those of previous researchers, including Mannion (2010), Francis *et al*. (2016), Shanas*et al*. (2016), Selvaraj *et al.* (2016), Srinivasan *et al.* (2016), and Selvaraj *et al*. (2019).

In the present study, nine ornamental plants were observed that did not support all stages of *A. rugioperculatus*(RSW). This finding aligns with the observations of Krishnarao*et al.* (2019), who noted that while certain ornamental plants did not facilitate the complete development of RSW, adult whiteflies were still attracted to these plants for feeding and egg-laying. In field crops like maize and sugarcane, only eggs were recorded, with no other developmental stages of the pest. This is consistent with the findings of Bhavani *et al.* (2020), who reported that while distinctive egg spirals were found on leaves, no nymphs or pupae were observed.

The results are in agreement with the findings of Elango and Nelson (2020) and Alagar *et al.* (2020), who also reported that neem and Indian almond supported only the egg stage of RSW when compared to the present study.

The study also recorded 22 new host plants, indicating that the host range of RSW is expanding, with new reports emerging from different areas. The spread of the pest appears to be influenced by the transport of planting material containing various developmental stages of the pest, as well as human activity. Additionally, prevailing winds and favourable climatic conditions play a significant role in the pest's dispersal to new areas. Given that whiteflies can survive extreme weather conditions and have a

high dispersal rate, effective management of this pest will require the adoption of an integrated pest management (IPM) strategy.

Sl.no	Common Name	ScientificName	Order	Family	LifeStage			No. of egg spirals/leaf let/leaf	Grade	Category
					Egg	Nymph	Adult			
Vegetable crops										
1	Ivy gourd	*Coccinia grandis*	Cucurbitales	Cucurbitaceae	+	+	+	<10	1	Low
2	Drum stick	*Moringa oleifera*	Brassicales	Moringaceae	+	-	+	<10	1	Low
Field crops										
1	Maize	*Zea mays*	Poales	Poaceae	+	-	-	<10	1	Low
2	Sugar cane	*Saccharumofficinarum*	Poales	Poaceae	+	-	+	<10	1	Low
Forest tree										
1	Banyan tree	*Ficus benghalensis*	Rosales	Moraceae	+	+	+	<10	1	Low
Spices										
1	Turmeric	*Curcuma longa*	Zingiberales	Zingiberacecae	+	-	+	<10	1	Low
Oil seed crop										
1	Castor	*Ricinus communis*	Malpighalies	Euphorbiaceae	+	-	+	<10	1	Low
Avenue trees										
1	Champak	*Magnolia champaca*	Magnoliales	Magnoliaceae	+	+	+	10-20	2	Medium
2	Karanj	*Pongamia pinnata*	Fabales	Fabaceae	+	+	+	10-20	2	Medium
3	Cassia	*Cassia angustifolia*	Fabales	Fabaceae	+	+	+	10-20	2	Medium

Table: 2Crops identified inwhich alllifestages of*A. rugioperculatus*noticed inTelangana during 2022-2024

Table :3 Crops identified inwhich alllifestages of*A. rugioperculatus*noticed inTelangana during 2022-2024

Sl.no	Common Name	ScientificName	Order	Family	LifeStage			No. of egg spirals/leaflet/leaf	Grade	Category
					Egg	Nymph	Adult			
Oranamental crops										
1.	Royal bottle palm	*Hyophorbelagenicaulis*	Arecales	Arecaceae	+	-	-	<10	1	Low
2.	Jatropha	*Jatropha curcas*	Malpighiales	Euphorbiaceae	+	-	+	<10	1	Low
3.	Ashoka	*Saracaasoca*	Fabales	Fabaceae	+	-	-	<10	1	Low
4.	Acalypha	*Acalypha wilkesiana*	Malpighiales	Euphorbiaceae	+	+	+	<10	1	Low
5.	Butterfly palm	*Dypsislutescens*	Arecales	Arecaceae	+	+	+	<10	1	Low
6.	Hibiscus	*Hibiscus rosa-sinensis*	Malvales	Malvaceae	+	-	-	<10	1	Low
7.	Spider planet	*Chlorophytum comosum*	Asparagales	Asparagaceae	+	-	-	<10	1	Low
8.	Travellers tree	*Ravenalamadagascariensis*	Zingiberales	Strelitziaceae	+	+	+	10-20	2	Medium
9.	Song of India	*Dracaena reflexa*	Asparagales	Asparagaceae	+	+	+	<10	1	Low
10	Devil`s ivy	*Epipremnumaureum*	Alismatales	Araceae	+	+	+	<10	1	Low

Table:4 Crops identified inwhich alllifestages of*A. rugioperculatus*noticed inTelangana during 2022-2024

Sl.no	Common Name	ScientificName	Order	Family	LifeStage			No. of eggspirals/ leaflet/leaf	Grade	Category
					Egg	Nymph	Adult			
Ornamental crops										
1.	Canna	*Canna indica*	Zingiberales	Cannaceae	+	-	-	<10	1	Low
2	Bird of paradise	*Strelitzia reginae*	Zingiberales	Strelitziaceae	+	-	+	10-20	2	Medium
3.	Silver oak tree	*Grevillea robusta*	Proteales	Proteaceae	+	-	-	<10	1	Low
4.	Ixora	*Ixora coccinea*	Gentianales	Rubiaceae	+	-	+	<10	1	Low
Plantation crops										
1.	Areca nut	*Areca catechu*	Arecales	Arecaceae	+	-	-	<10	1	Low
2.	Cashew nut	*Anacardium occidentale*	Sapindales	Anacardiaceae	+	-	-	<10	1	Low
3.	Cocoa	*Theobroma caca*	Malvales	Malvaceae,	+	-	-	<10	1	Low
4.	Oil palm	*Elaeis guineensis*	Arecales	Arecaceae	+	+	+	>20	3	High
5.	Coconut	*Cocos nucifera*	Arecales	Arecaceae	+	+	+	>20	3	High
Fodder crops										
1.	Napier grass	*Pennisetum purpureum*	Poales	Poaceae	+	-	-	<10	1	Low

S. No.	Common Name	ScientificName	Order	Family	LifeStage			No. of egg spirals/leaflet/leaf	Grade	Category
					Egg	Nymph	Adult			

S. No.	Common Name	ScientificName	Order	Family	LifeStage			No. of egg spirals/	Grade	Category
					Egg	Nymph	Adult			
Fruit crops										
1.	Bael	*Aegle marmelos*	Sapindales	Rutaceae	+	-	-	<10	1	Low
2.	Phalsa	*Grewia asiatica*	Malvales	Malvaceae	+	+	+	<10	1	Low
3.	Sweet orange	*Citrus sinesis*	Sapindales	Rutaceae	+	+	+	<10	1	Low
4.	Citrus	*Citrus ssp*	Sapindales	Rutaceae	+	-	-	<10	1	Low
5.	Water Rose apple	*Syzygiumaqueum*	Myrtales	Myrtaceae	+	+	-	<10	1	Low
6.	Ramphal	*Annona reticulata*	Magnoliales	Annonaceae	+	-	-	<10	1	Low
7.	Mango	*Mangifera indica*	Sapindales	Anacardiaceae	+	+	+	<10	1	Low
8.	Banana	*Musa spp.*	Zingiberales	Musaceae	+	+	+	>20	3	High
9.	Sapota	*Manilkara zapota*	Ericales	Sapotaceae	+	+	+	Spirals on entire leaf	3	High
10	Guava	*Psidium guajava*	Myrtales	Myrtaceae	+	+	+	>20	3	High

Table: 5 Crops identified inwhich alllifestages of*A. rugioperculatus*noticed inTelangana during 2022-2024

								leaflet/leaf		
	Fruit crops									
1.	Custard apple	*Annona squamosa*	Magnoliale	Annonaceae	+	+	+	<10	1	Low
2.	Jack fruit	*Artocarpus heterophyllus*	Rosales	Moraceae	+	+	+	<10	1	Low
3.	Jamun	*Syzygiumcumini*	Myrtales	Myrtaceae	+	-	-	<10	1	Low
4.	Indian Almond	*Terminalia catappa*	Myrtales	Combertacea	+	+	+	<10	1	Low
	Medicinal crop									
1.	Aloe	*Aloe vera*	Asparagales	Asphodelaceae	+	+	+	<10	1	Low
2.	Neem	*Azadirachta indica*	Sapindales	Meliaceae	+	+	+	<10	1	Low
3.	Camphor trees	*Cinnamomum camphora*	Laurales	Lauraceae	+	-	-	<10	1	Low
4.	Indian gooseberry	*Phyllanthus emblica*	Malpighiales	Phyllanthaceae	+	-	+	<10	1	Low
5.	Peppel	*Ficus religiosa*	Rosales	Moraceae	+	-	+	<10	1	Low
6.	Mint	*Mentha*	Lamiales	Lamiaceae	+	-	+	<10	1	Low

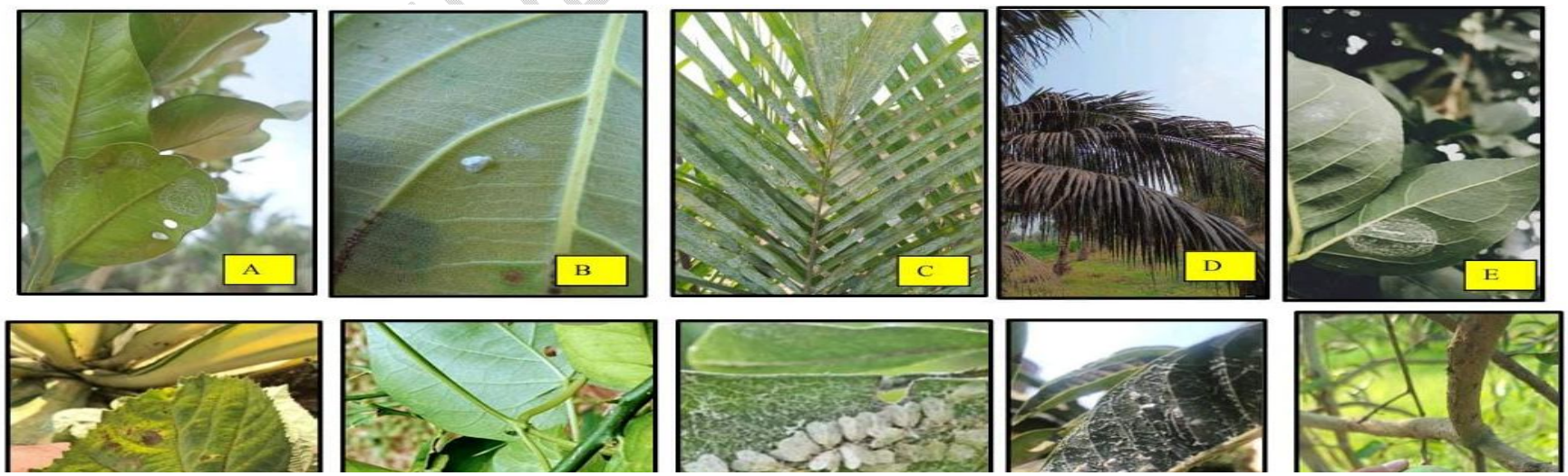
Table: 6 Crops identified inwhich alllifestages of*A. rugioperculatus*noticed inTelangana during 2022-2024

Plate: 1 Host plants of *A. rugioperculatus* A) Ivy gourd B) Drumstick C) Maize D) Sugar cane E) Banyan tree F) Travellers tree G) Castor H) Champak I) Karanj

Plate: 2Host plants of *A. rugioperculatus* A) Cassia B) Royal bottle palm C) Jatropha D) Ashoka E) Acalypha F) Butterfly palm G)Jasmine H)Sugarcane I)Napier grass J) Custard apple

Plate: 3Host plants of *A. rugioperculatus*A) Jack fruit B) Spider planet C) Travellers tree D)Song of India E) Devils ivy F) Canna G) Bird of paradise H)Silver oak tree I) Ixora J) Areca nut

Plate: 4Host plants of *A. rugioperculatus*A) Cashew nut B) Cocoa C) Oil palm D)Coconut E) Bael F) Phalsa G) Sweet orange H) Water rose apple I) Ram phal J) Mango fruit.



Conclusion

Rugose Spiralling Whitefly: Distribution, Host Range, and Management Strategies

The Rugose Spiralling Whitefly (RSW), *Aleurodicusrugioperculatus* Martin, is an invasive pest that first appeared in India in 2016, severely affecting crops like coconut, oil palm, banana, sapota, mango, and guava. RSW depletes plant water and nutrients and promotes sooty mold growth through honeydew secretion, significantly reducing photosynthetic efficiency.

A field study conducted across Telangana, particularly in BhadradriKothagudem and Khammam districts, identified 50 host plants from 29 families. While 10 crops, including coconut and oil palm, supported all life stages of RSW, other plants predominantly exhibited only the egg stage. Infestation was particularly severe in coconut and oil palm, with intercropping identified as a key factor in RSW's spread.

Infestation levels were classified into low, medium, and high categories based on egg spiral counts, and a damage rating scale was established. Several ornamental plants and field crops like maize and sugarcane only supported the egg stage, suggesting partial host suitability. Additionally, 22 new host plants were identified, indicating an expanding host range.

Natural enemies, including *Encarsiaguadeloupae* and other parasitoids, were observed, showing potential for biological control. However, RSW's adaptability to new hosts and rapid dispersal due to favourable conditions highlight the urgency of adopting Integrated Pest Management (IPM) strategies.

This study emphasizes understanding host suitability, infestation patterns, and natural enemies to mitigate RSW's impact on economically significant crops in India. Effective management will require a combination of cultural practices, biological control, and targeted use of insecticides.

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