ASEAN FAW ACTION PLAN
Supporting IPM Across Southeast Asia

Pacific Community
Communauté du Pacifique

PPPO
PACIFIC PLANT PROTECTION ORGANIZATION (PPPO)

Palm Pests and Diseases + Biosecurity

Webinar Series

Part 1: 2 April 2024

Supported by
Australian Government
Department of Foreign Affairs and Trade

The session will be recorded.
A copy will be shared 1 week after this session.

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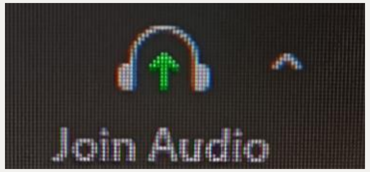
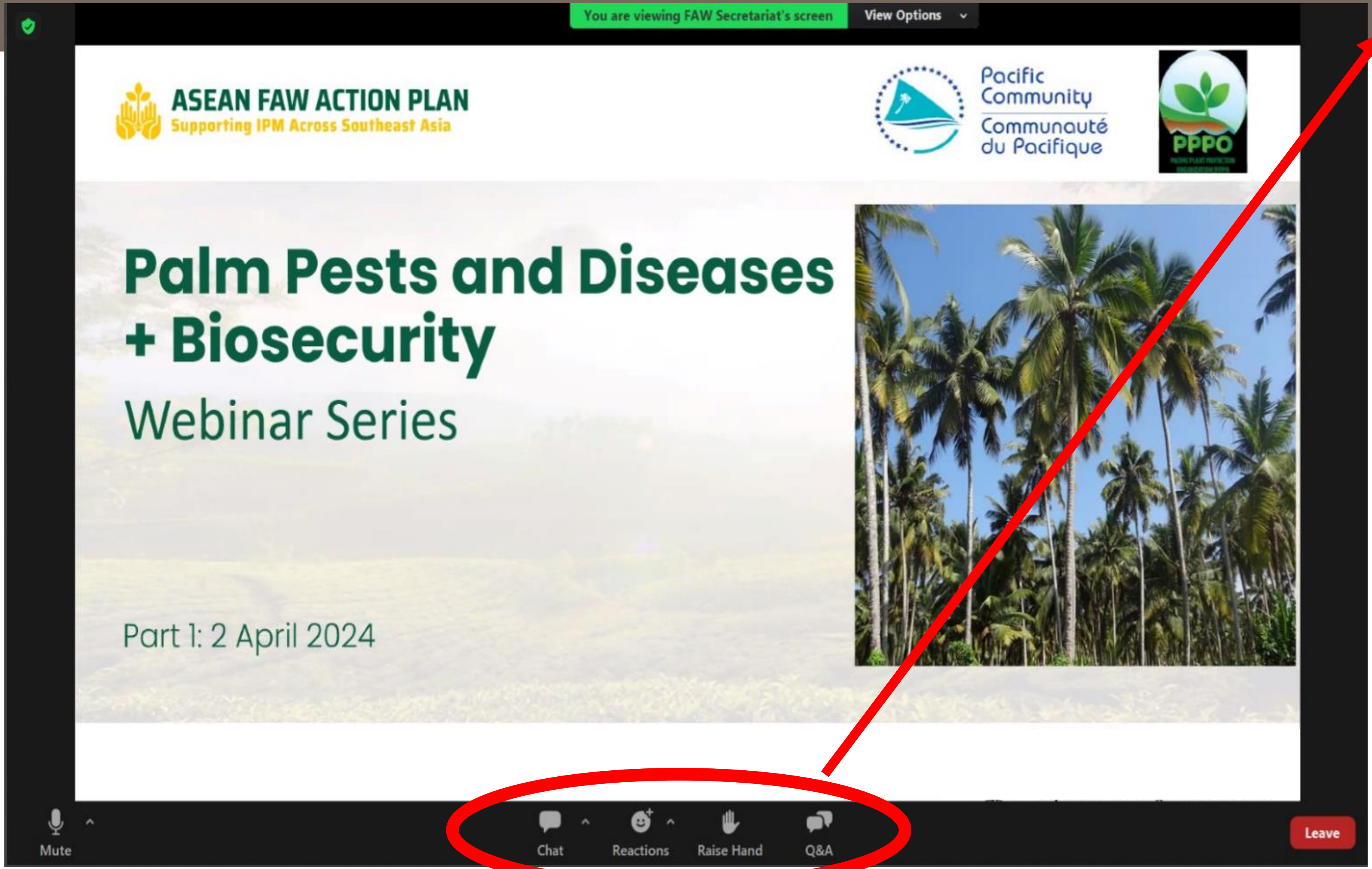
Technical issues?

- **Audio**
  - Click "Join Audio" and check the volume
  - Click the speaker icon
    (if using a mobile phone) and make sure it is on
  - Check connection to speaker
    (if using a desktop/laptop)
- **Try logging off and on**
- Send a message to us in the chat box

"Join Audio"



A recording of the webinar will be made and be distributed 1 week after this session



1. Use the Q&A box to ask questions to the speakers

2. Use Chat to make a comment to everyone (e.g. thank a speaker, share a link, highlight an important point)

3. Use Reactions if you want to share a reaction quickly – thumbs up, congratulations, etc.

4. Use Raise Hand if you would like to talk – please be short (no more than 1 minute)

Palm Pests and Diseases + Biosecurity
2024 webinar schedule

Part 1
2 April
Pests

Part 2
23 April
Diseases

Part 3
21 May
Future Strategies & Activities

Pacific Conference
2-5 July
Pacific Conference

ASEAN FAW ACTION PLAN
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Pacific Conference

"Minimising the economic impact of the Coconut Rhinoceros Beetle and other major pests of coconut through innovative and participatory research outreach actions."

Second notice and call for abstracts

Towards an action plan to minimise the impacts of Coconut Rhinoceros Beetle and other major insect pests of coconut in the Pacific Islands:

Global status, genetics, distribution and control.

Deadline: 31st May 2024

See https://www.spc.int/updates/news/media-release/2024/01/second-notice-and-call-for-abstracts-towards-an-action-plan-to

Information for delegates and participants

1- Dates and venue

The Coconut Pest conference will be held from **2nd -5th July 2024 at the Solomon Islands National University, Honiara, Solomon Islands.**

2- Sponsors of the event

The major sponsor of the event is the Ministry of Foreign Affairs and Trade (New Zealand). The other sponsors include the Crawford Fund, ASEAN FAW Action Plan, the International Coconut Genetic Resources Network (COGENT) and the Solomon Islands National University (SINU).

3- Organisation of the meeting

The conference is hosted by the Pacific Community (SPC) and Solomon Islands National University (SINU) in collaboration with the International Coconut Genetic Resources Network (COGENT).

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Red Palm Weevil
Video Series

Identification, Biology, Damage,
Control Measures + Research
Completed soon

Red Palm Weevil Project:
Terengganu, Malaysia: 5-7 March 2024

Agenda

Time (SGT)	Agenda	Speaker
11:00	**Welcome & Remarks**	ASEAN Action Plan SPC
11:05	**Poll**	
11:10	**Introduction**	
11:15	**Speaker 1:** The invasive Red Palm Weevil (*Rhynchophorus ferrugineus*) in Malaysia	Dr Wahizatul Afzan Azmi Universiti Malaysia Terengganu, Malaysia
11:30	**Q & A Session**	
11:40	**Speaker 2:** The invasion of Black Headed Caterpillar (*Opisina arenosella*) into Vietnam	Dr Le Khac Hoang, Nong Lam University, Vietnam & Dr Dang Hoa Tran, Hue University, Vietnam
11:55	**Q & A Session**	

Time (SGT)	Agenda	Speaker
12:05	**Speaker 3:** The Pacific response to the Coconut Rhinoceros Beetle (CRB)	Dr Mark Ero, Pacific Community (SPC)
12:20	**Q & A Session**	
12:30	**Speaker 4:** Coconut pest management options through the lens of genomics - case study of CRB-G	Dr Wee Tek Tay, CSIRO, Australia
12:45	**Q & A Session**	
12:55	**Closing & Feedback Poll**	
13:00	**End**	

Poll

know the audience

Q1: What best describes your current role?

- Farmer/Agricultural Worker
- Researcher – Entomologist
- Researcher - Other
- Government/Policy
- Private sector
- Agricultural extension worker (working directly with farmers)
- Student
- Other (feel free to tell us in the chat box)

Q2: What palm pest do you **know the most about?**

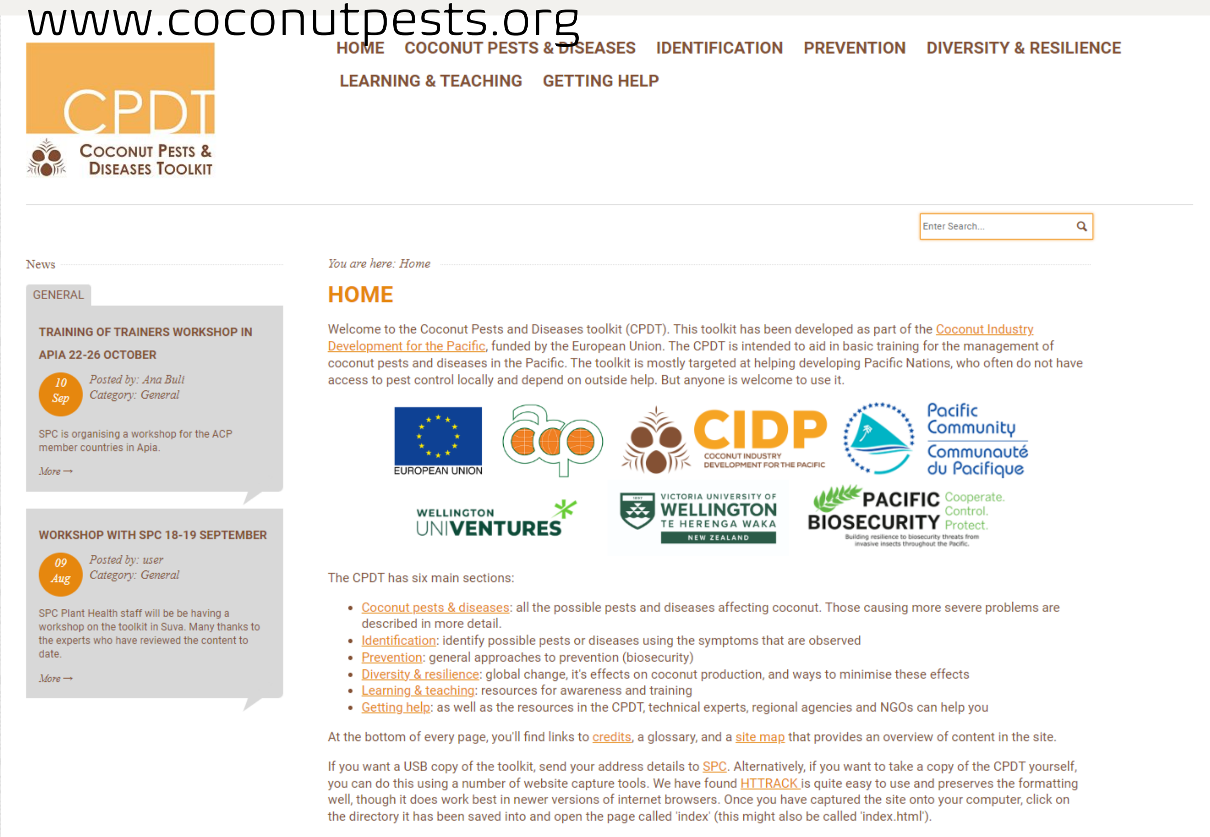
- Coconut Rhinoceros Beetle (CRB)
- Black Headed Caterpillar
- Red Palm Weevil
- Other (specify in chat)
- I don't really know much about palm pests

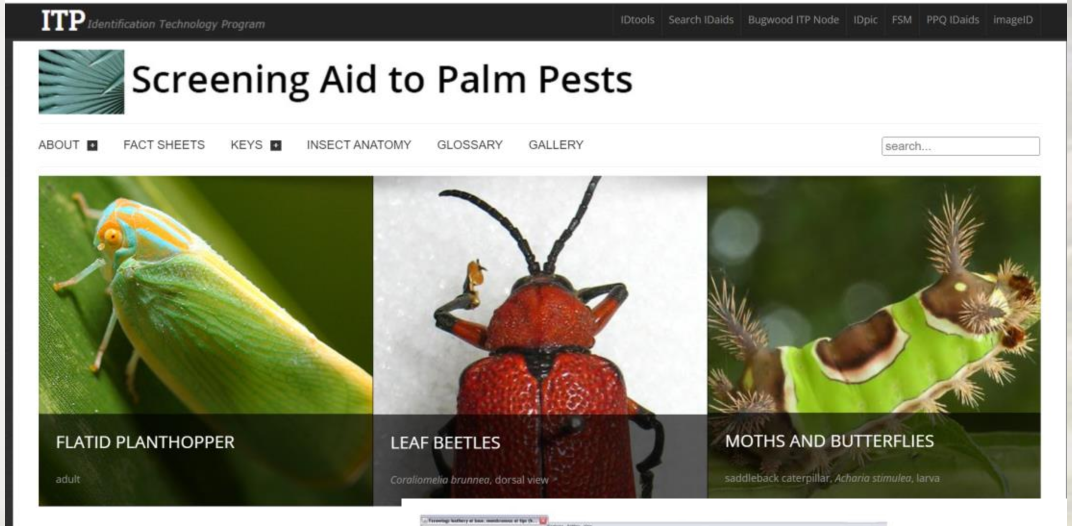
Introduction

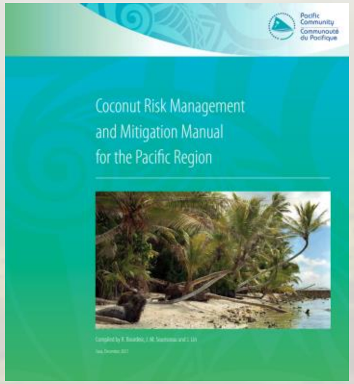
- An introduction to some key coconut pests in the wider region
- A chance to share work and strategies across Southeast Asia and the Pacific for prevention, preparedness and sustainable control.
- An opportunity to learn about new research and management strategies and meet new people working in this area
- Potential to identify new collaborations or understand new ways of thinking.

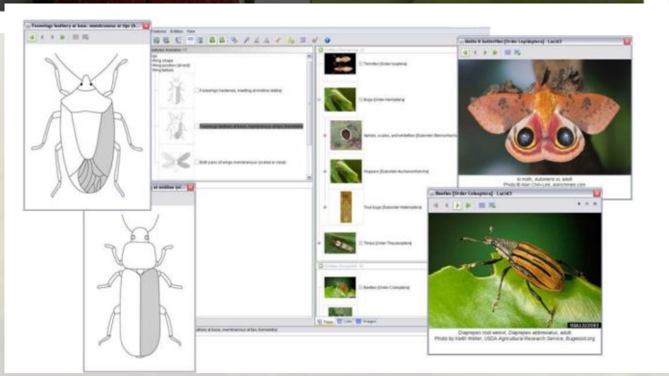
Tools and support

www.coconutpests.org









PEST INFESTATION IDENTIFICATION IN COCONUT TREES USING DEEP LEARNING

Creating a Robotic Solution for Coconut White Fly Control

Smart Palm: An IoT Framework for Red Palm Weevil Early Detection

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UNIVERSITI MALAYSIA TERENGGANU

UMT

The Invasive Red Palm Weevil (RPW), *Rhynchophorus ferrugineus* in Malaysia

Dr. Wahizatul Afzan Azmi
Senior Lecturer (Entomology)

Outline

1. Introduction to Red Palm Weevil (RPW)
2. Current status of attack in Malaysia
3. How RPW kill the coconut palm?
4. Current management control of RPW
5. Current research activity at UMT
6. Conclusion & potential future research

Introduction

- Red Palm Weevil (RPW), *Rhynchophorus ferrugineus* (Coleoptera: Dryopthoridae)
- Serious pest for major cultivated palms (coconut palm, date palm and oil palm).
- Pest to 29 different palm species (Malumphy & Moran, 2009)
- Infestation of RPW cannot be detected in the early stage.
- Larvae are concealed, only adults are exposed.
- A threat to Malaysia's coconut and oil palm industry.

Adult of RPW

Larvae of RPW

- **Taxonomic Position**

  Class: Insecta, Order: Coleoptera,

  Family: Curculionidae,

  Species: *Rhynchophorus ferrugineus* Oliver

- **Common Names**

  Red Palm Weevil (RPW), Asiatic Palm Weevil, Coconut Weevil, Red Stripe Weevil

- **Reason for Inclusion**

  A2 list of EPPO (European and Mediterranean Plant Protection Organization) as a serious pest (EPPO, 2007).

- **Pest Importance**

  - Coconut palm: India, Sri Lanka, Indonesia, Burma, Punjab, Pakistan (Nirula, 1956; Menon & Pandalai, 1960; Kaakeh *et al.,* 2000)

  - Oil palm: India (Misra, 1998)

  - Date palm: Middle East (EPPO, 2008)

Host Plants

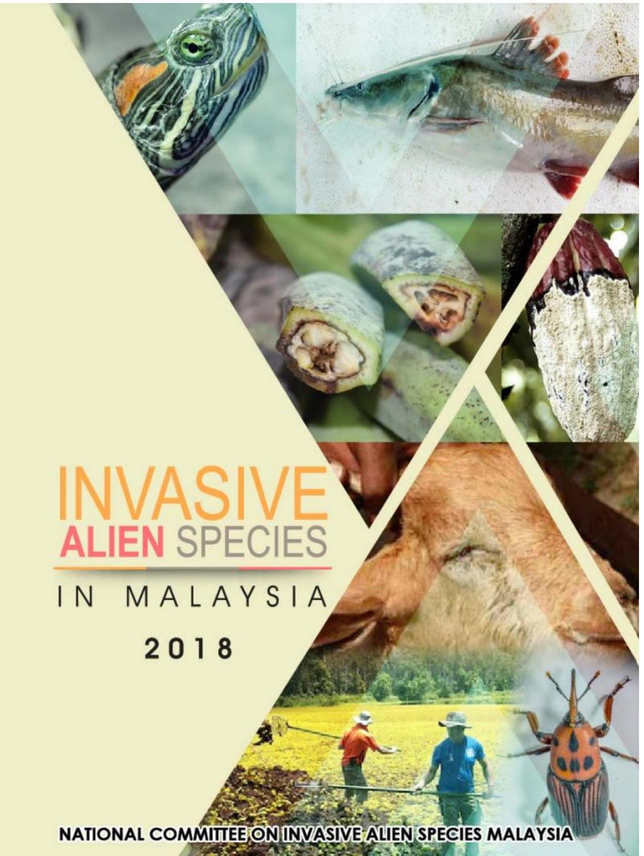
Pest of more than 29 palm species belonging to 16 different genera (EPPO, 2007; Wahizatul et al., 2017).

TABLE 1. LIST OF HOST PLANTS FOR THE RED PALM WEEVIL, *Rhynchophorus ferrugineus* IN SOUTH EAST ASIA (Murphy and Briscoe, 1999; DoA, 2016)

Host species	Common name	Location of records
Areca catechu	Betel nut palm	Philippines
Arenga pinnata	Sugar palm	Indonesia, Philippines
Borassus flabellifer	Toddy palm	India, Indonesia
Caryota cumingii	Fishtail palm	Philippines
Caryota maxima	Pugahan	Philippines
Cocos nucifera	Coconut palm	Malaysia, Indonesia, Thailand, Philippines, India, Sri Lanka
Corypha elata	Buri palm	Philippines
Corypha gebanga	Gebong	Indonesia
Elaeis guineensis	Oil palm	India, Indonesia, Philippines
Livistona decora	Ribbon fan palm	Malaysia
Livistona chinensis	Chinese fan palm	Malaysia
Metroxylon sagu	Sago palm	Malaysia, Indonesia
Oncosperma horridum	Nibong palm	Indonesia
Oncosperma tigillarium	Nibong palm	Indonesia, Philippines
Roystonea regia	Royal palm	Malaysia, Philippines
Phoenix canariensis	Date palm	Malaysia, India, Indonesia

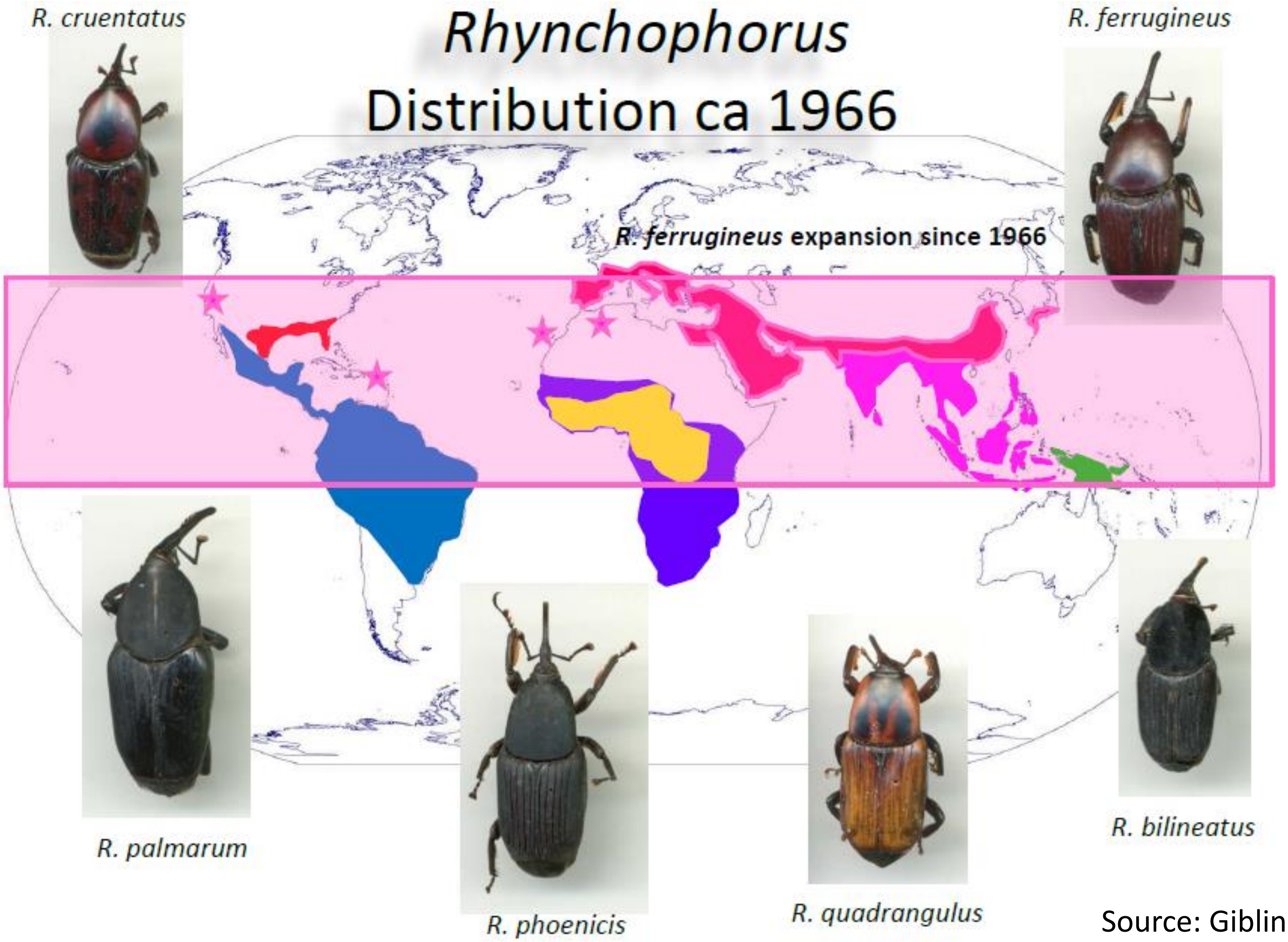
Cultivation of coconut & date palm

- Coconut cultivated in 92 countries (26 million ha)
- Indonesia, Philippines, India, Sri Lanka
- > 14 countries infested with RPW (15%)
- Date palm grown in 30 countries (12 million ha)
- Saudi Arabia, Egypt, Iran
- > 15 countries infested with RPW (50%)



(July 19, 2011) RPW is locally gazetted as harmful pest based on Plant Quarantine Act, 1976

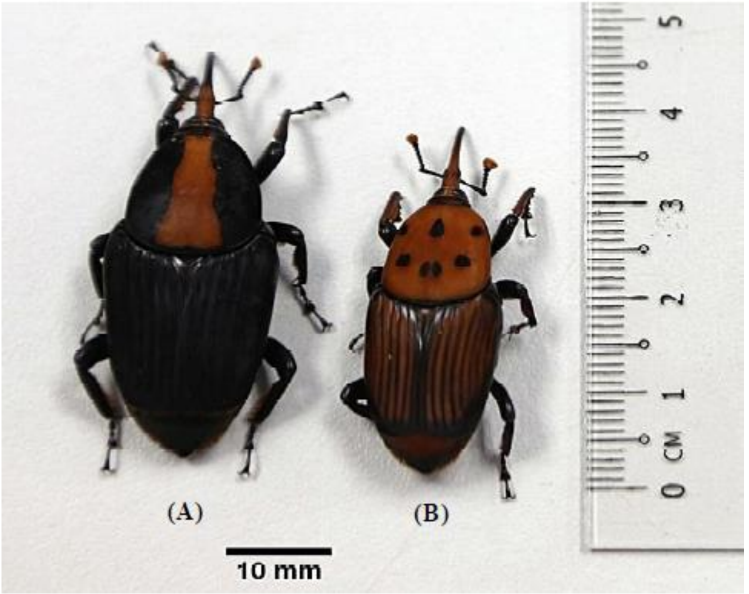
Rhynchophorus
Distribution ca 1966



Source: Giblin-Davies, 2010

There are 10 species under genus *Rhynchophorus*:

1. *R. bilineatus*
2. *R. depressus*
3. *R. palmarum*
4. *R. niger*
5. *R. phoenicis*
6. *R. signaticollis*
7. *R. cycadis*
8. *R. asperulus*
9. *R. ferrugineus*
10. *R. vulneratus* synonym *R. schach*



(A) *Rhynchophorus vulneratus* (Red Stripe Weevil)
(B) *Rhynchophorus ferrugineus* (Red Palm Weevil)

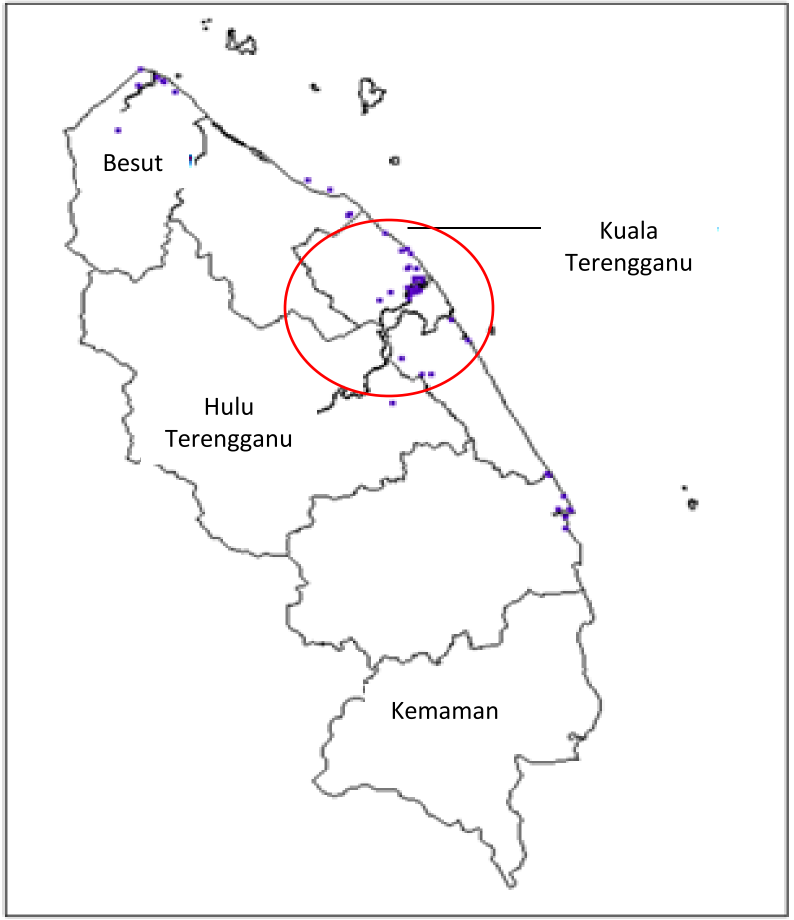
In Malaysia, 2 species of *Rhynchophorus* could be found:

- *Rhynchophorus vulneratus* (Red Stripe Weevil)
- *Rhynchophorus ferrugineus* (Red Palm Weevil)

Current Status of RPW Attack in Malaysia

- RPW was reported in the east coast of Peninsular Malaysia in the early 2007.
- In July 2011, an intensive survey on the RPW infestation sites revealed that RPW had infested in 858 locations in over 800 ha of coconut plantations, villages and in FELDA plantations of Terengganu (Wahizatul et al., 2013).
- In 2020, the RPW has been reported in most states of Peninsular Malaysia (Dept. of Agriculture, 2020) – now causing severe damage to coconut palms.

Distribution of RPW in Terengganu (2007)



Distributions of RPW in Terengganu, Malaysia. Purple dots indicate the RPW-infested areas (DOA, 2007)

Common cultivars of coconut palms attacked by RPW:

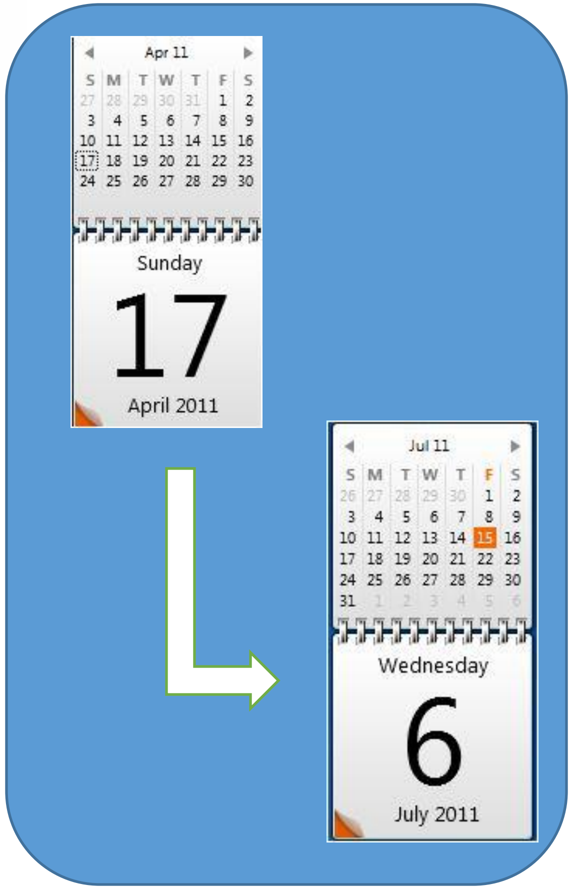
Aromatic Dwarf (Pandan)

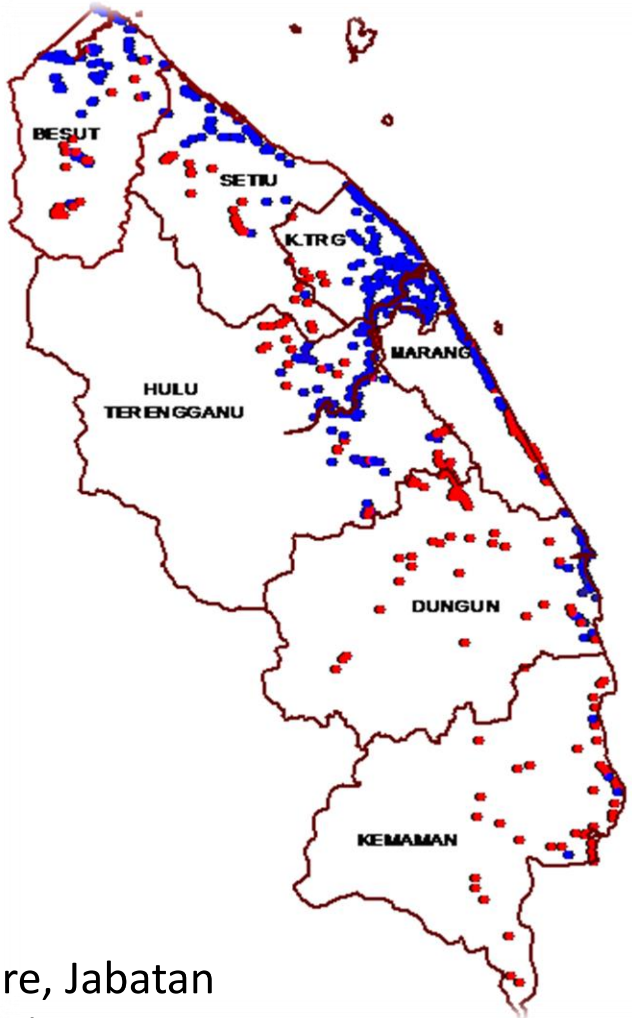
MAWA

Malayan Tall

MATAG

Current Status of Attack in Terengganu (2011)





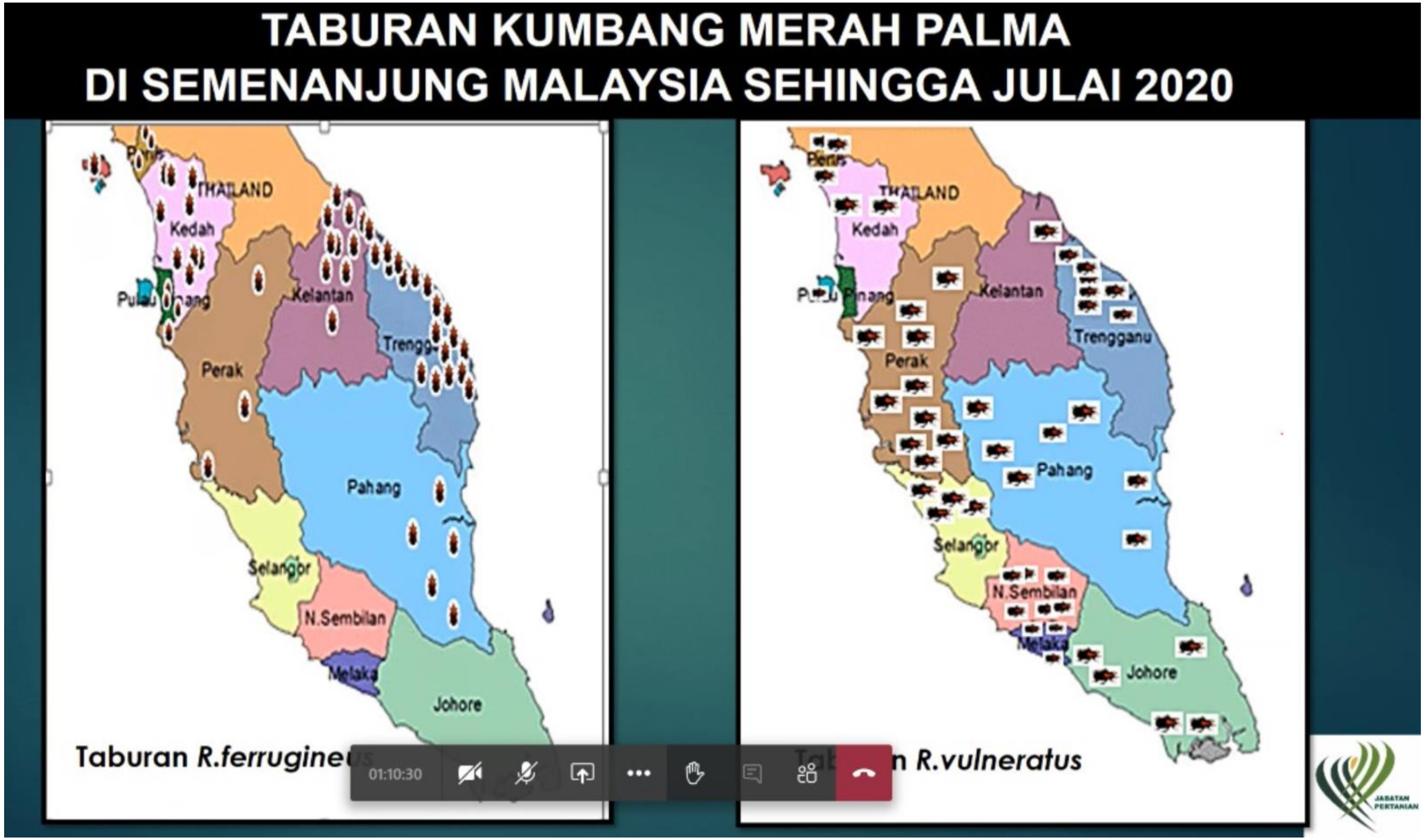
R. ferrugineus

R. vulneratus

Map of Terengganu

Sources : Department of Agriculture, Jabatan Pertanian Negeri Terengganu (2011)

Current Status of Attack in Malaysia (2020)

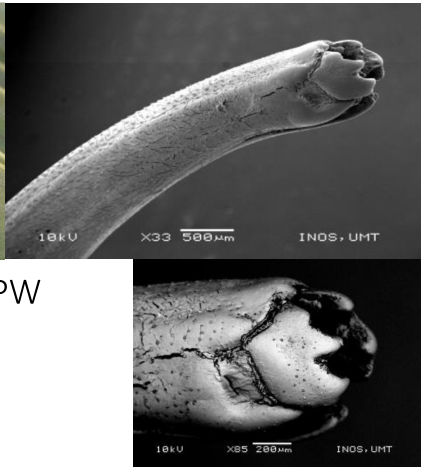


2020: RPW has been reported in most states of Peninsular Malaysia

Source: JK Teknikal RPW, Jab. Pertanian Malaysia (2020)

How did RPW kill the coconut palm?

Female adult of RPW

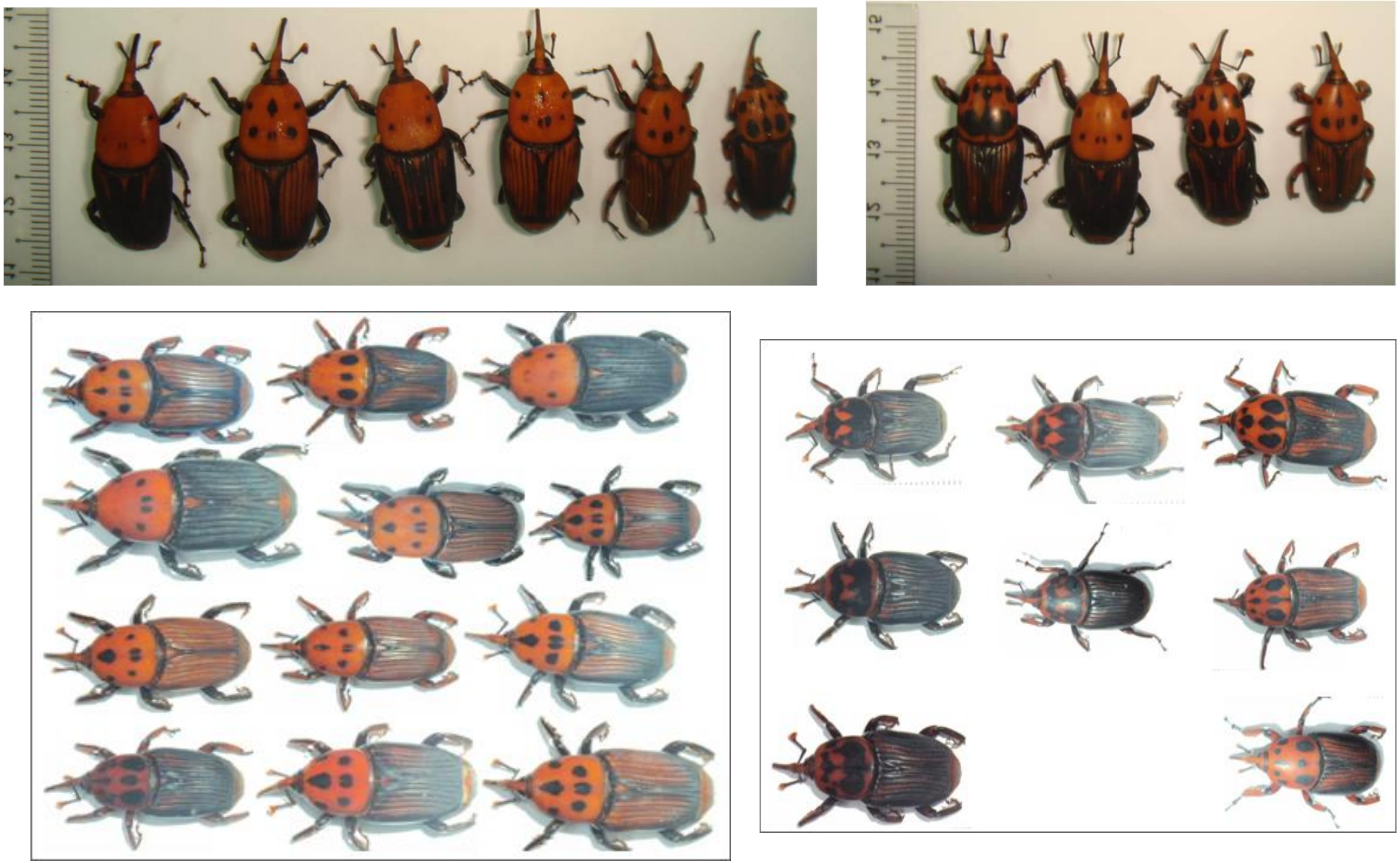


Wounded tissue of palms

Infested palms

Symptom of umbrella-shaped/skirting-shaped leaves

Infested palms died



Some variations in adult sizes, colours, number, shape and distribution of pronotal markings on the reddish-brown of *R. ferrugineus* collected in Terengganu.

Different Colours of Elytra Surface &
Different Hind Wing Venations and Patterns

RPW damage to coconut palms

Location: Rhu Tapai & Merang, Terengganu
Photo taken by: Yeung, A.W.S, Abdul Rahman, A.R.

RPW damage to coconut palms

RPW damage to coconut palms

Various stages co-exist in the same host

In 2016, the RPW has been reported in five states – Perlis, Kedah, Pulau Pinang, Terengganu and Kelantan.

Kosmo! 21 Julai 2016

VARIA

Kumbang merah palma perosak tanaman palma

LARVA memakan tisu pada pokok membuatkan pokok diserang penyakit dan mati.

Kumbang merah palma (Rhynchophorus ferrugineus) atau Red Palm Weevil (RPW) adalah sejenis kumbang daripada keluarga Curculionidae (Coleoptera). Ia merupakan perosak utama bagi tanaman palma seperti kelapa, kelapa sawit dan kurma.

RPW merupakan serangga perosak dalam kumpulan perosak yang menyerang pokok kelapa (Cocos nucifera) di Malaysia. Perosak ini mula dikesan buat pertama kali di kawasan Lapangan Terbang Pengkalan Chepa, Kelantan pada Oktober 2005.

Simptom utama kerosakan akibat serangan RPW adalah pucuk akan menjadi layu, diikuti dengan daun-daunnya. Apabila serangan menjadi teruk, pucuk daun dan pelepah akan menunjukkan simptom kekuningan.

Kadangkala kehadiran perosak ini dapat dikesan apabila aktiviti memakan di dalam pokok kelapa dapat didengar dari luar. Serangan peringkat akhir akan menyebabkan bahagian crown pokok kelapa patah dan mati.

BH ONLINE — Khamis, 21 Julai 2016 - 12:51PM

SEMASA

AHAD, 31 JANUARI 2016 @ 5:47 PM

RM4j untuk hapus kumbang merah palma

KETUA Pengarah Pertanian, Datuk Ahmad Zakaria Mohamad Sidek.

PASIR PUTEH: Jabatan Pertanian memperuntukkan RM4 juta mulai tahun ini bagi membendung, mengawal dan menghapus kumbang merah palma (RPW).

Ketua Pengarah Pertanian, Datuk Ahmad Zakaria Mohamad Sidek, berkata kumbang berkenaan yang mula dikesan sejak 2010, berupaya merosakkan pokok jenis palma seperti kurma, kelapa dan kelapa sawit.

"Kumbang berkenaan dipercayai masuk ke negara ini menerusi pintu sempadan di Terengganu, Kelantan, Perlis, Kedah dan Pulau Pinang dan telah merosakkan 465 pokok kelapa dan 335 pokok kurma di seluruh negara.

"Jika kumbang itu tidak dikawal, kita bimbang ia akan mengancam jutaan hektar tanaman kelapa sawit di negara ini," katanya kepada pemberita selepas melawat kebun kurma di Kampung Wakaf di sini, hari ini.

Beliau berkata kumbang berkenaan mengorek masuk ke dalam pokok palma dan memusnah tisu di dalam pokok, menyebabkan batang pokok mudah patah dan musnah dalam masa singkat.

RM4 juta untuk hapus ancaman kumbang merah palma

Bernama | Januari 31, 2016 15:54 MYT

Kumbang berkenaan mengorek masuk ke dalam pokok palma dan memusnah tisu di dalam pokok, menyebabkan batang pokok mudah patah dan musnah dalam masa singkat. - Gambar fail

PASIR PUTEH: Jabatan Pertanian memperuntukkan sebanyak RM4 juta mulai tahun ini bagi membendung, mengawal dan menghapus kumbang merah palma (RPW).

Ketua Pengarah Pertanian Datuk Ahmad Zakaria Mohamad Sidek berkata kumbang tersebut yang mula dikesan sejak 2010, berupaya merosakkan pokok jenis palma seperti kurma, kelapa dan kelapa sawit.

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...aman kelapa sawit d... akaf di sini, hari ini.

...musnah tisu di ...ngkat.

...an sehingga kini

Sinar ONLINE — TELUS & TULUS

300 hektar tanaman diserang kumbang merah palma

16 FEBRUARI 2016

Gambar hiasan

Ancam industri sawit

Jabatan Pertanian banteras kumbang ancam pokok palma

NUR FATIEHAH ABDUL RASHID | 11 April 2016 4:00 PM

Ahmad Zakaria Mohamed Sidek melihat pokok kurma yang musnah akibat serangan kumbang perosak ketika melawat ladang kurma di Kampung Wakaf Pasir Puteh Kelantan, baru-baru ini.

Kumbang Merah Palma (RPW) atau n... ...fiknya Rhynchoporus ferrugineus adalah sejenis kumbang perosak beri... ...g menyerang tanaman palma seperti kelapa, kurma dan tanaman hiasan je...

Serangga perosak ini perlu dibendung dan dikawal dengan segera kerana berpotensi untuk mengancam industri kelapa sawit yang menyumbang sebanyak RM63 juta setahun kepada ekonomi negara.

Kumbang berbahaya yang tergolong dalam order Coleoptera dan keluarga Curculionidee itu dipercayai berasal dari negara Asia Tropika dan telah dilaporkan merebak ke tanaman di beberapa buah negara bermula di Afrika, Eropah dan Mediterranean pada tahun 1980-an.

Serangan RPW pertama kali direkod pada tahun 1994 di Sepanyol, kemudian di

Utusan PENYEBAR FIKIRAN RAKYAT MALAYSIA
WWW.UTUSAN.COM.MY
AGROMEGA ISNIN 20 MEI 2013 M/S 8-9

MegaAgro

Kumbang perosak ancam tanaman sawit

Kumpulan penyelidik Jabatan Pertanian dan UMT buat kajian intensif

AgroMega

Kelebihan perangkap kumbang merahPhero My RPW trap

HUBUNGI SKUAD KOTA TINGGI
MASTURAH SURADI - 019 7905287

Pantau serangan kumbang perosak

Kemasukan perosak RPW itu boleh menjejaskan tanaman kelapa, kelapa sawit

KOTA TINGGI - Jabatan Pertanian negeri hanya melaksanakan aktiviti pemantauan serangan kumbang jalur merah dan kumbang bintik merah yang juga dikenali sebagai Red Palm Weavil (RPW) ke atas tanaman palma, khususnya tanaman kurma pada ketika ini.

Pengarahnya, Ahmad Kamil Mohd Yunus berkata, pihaknya juga ingin menjelaskan bahawa JPNJ tidak mempunyai kerjasama dengan mana-mana individu, syarikat swasta, badan bukan kerajaan (NGO) atau badan-badan berkanun dalam aktiviti atau program pengeluaran anak benih

AHMAD KAMIL

tan hanya melaksanakan pemantauan penggunaan racun makhluk perosak RPW di dalam kawasan tanaman kurma bagi memastikan serangan adalah terkawal dan tidak mengancam industri ke-

Sebahagian pegawai dan penduduk merakamkan gambar kenangan sempena Program Khidmat Bakti Pegawai Pertanian Negeri Johor anjuran Persatuan Perkhidmatan Pegawai Pertanian (Perpeta) Negeri Johor di Dewan Terbuka Kampung Temenin Baru.

Malaysia Palm Oil Board (MPOB) juga sedang dilaksanakan bagi memantau aktiviti RPW di lokasi tanaman kelapa sawit," katanya selepas merasmikan Program

ran Persatuan Perkhidmatan Pegawai Pertanian (Perpeta) Negeri Johor di Dewan Terbuka Kampung Temenin Baru, dekat sini.

Hadir sama, Ketua

Temenin, Zainor Musa dan Timbalan Pengarah Pertanian (Operasi), Norzita Hashim.

Ahmad Kamil berkata, bawah Akta Kuarantin Tumbuhan 1976 yang di-

memang tidak dibenarkan diimport ataupun dibawa masuk.

Ini kerana katanya, ia berkaitan dengan kemasukan perosak berbahaya yang bukan sahaja boleh menjejaskan tanaman itu sendiri tetapi melibatkan tanaman kelapa dan kelapa sawit seterusnya menjejaskan ekonomi negara.

"Buat masa kini kalau kita menemui perosak ini, notis akan dikeluarkan bagi mengawal dan memusnahkan tanaman ini.

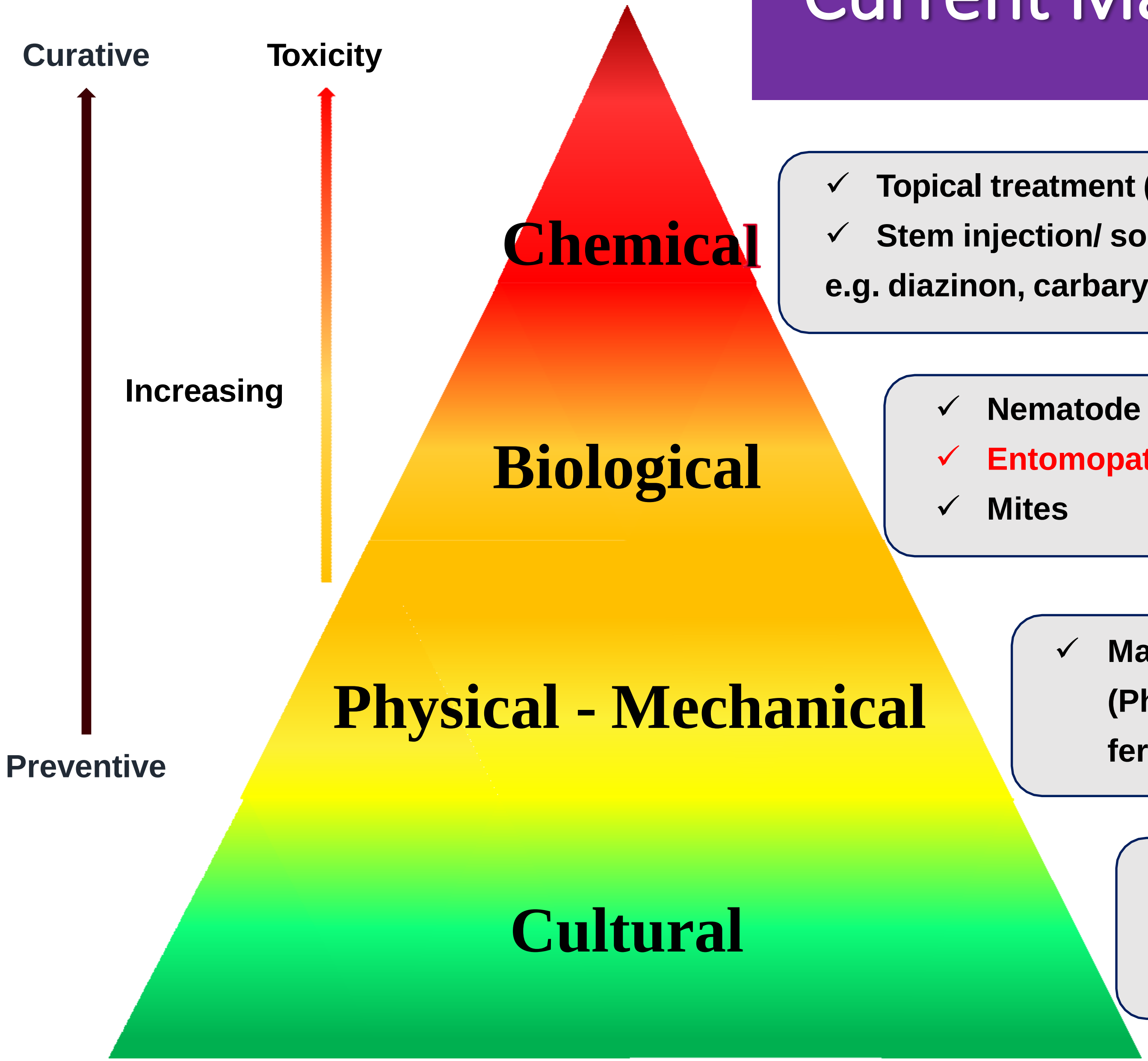
"Jika sabit kesalahan, pihak terbabit akan dikenakan denda RM10,000 dan segala kos


The symptoms of RPW attack……


The symptoms of RPW attack.....cont....

HOW ABOUT OIL PALM INDUSTRY ???

Current Management Control of RPW



- ✓ Topical treatment (small trees);
- ✓ Stem injection/ soil drenching (tall trees)

e.g. diazinon, carbaryl, nurelle, monocrotophos

- ➢ Harmful effectson the ecosystem & environment

- ✓ Nematode
- ✓ Entomopathogenic fungus (EPF)
- ✓ Mites

- ➢ High degree of specificity
- ➢ Environmental friendly

- ✓ Mass trapping (Pheromone: ferrugion, ferrolure of tripheron)

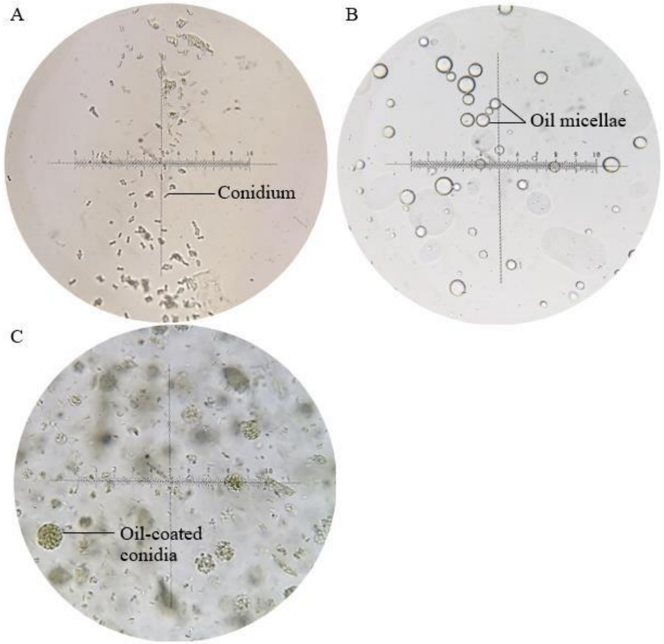
- ➢ Current practice used
- ➢ Practical

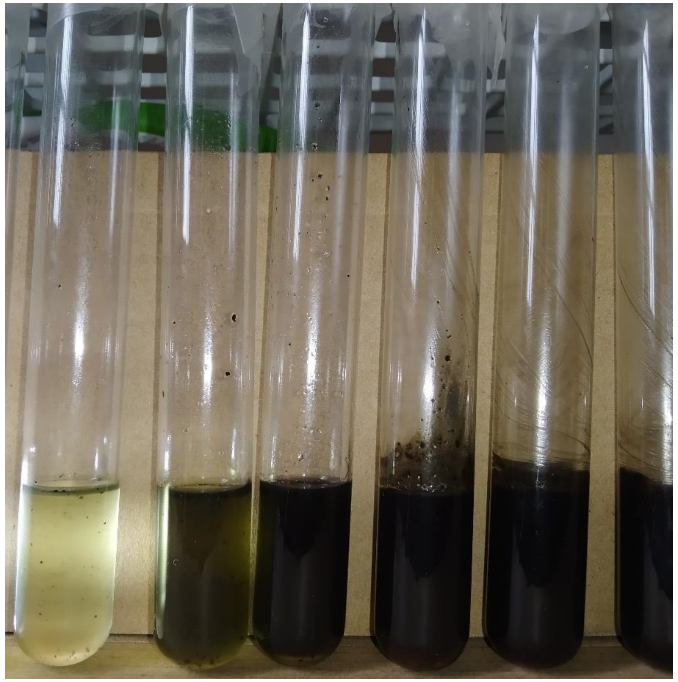
- ✓ Clean cultivation
- ✓ Sanitation

- ➢ Labour intensive
- ➢ Costly

Source: Adopted from FAO-CIHEAM, 2017

Current Research Activity at UMT

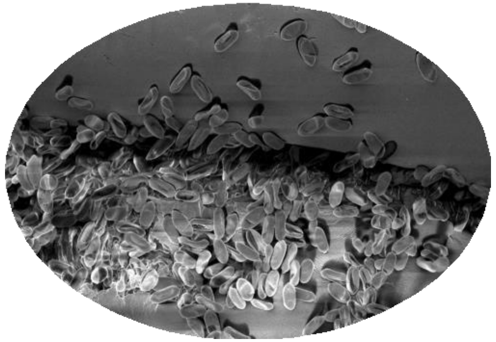




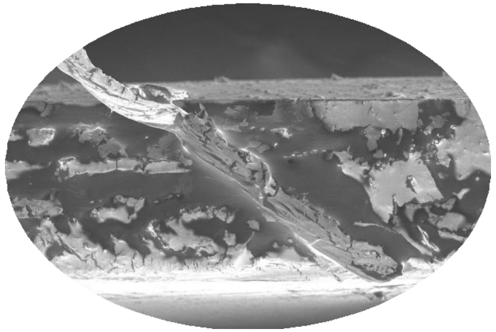
Potential of nano-formulated *Metarhizium anisopliae* for control of Red Palm Weevil, *Rhynchophorus ferrugineus*)

The Infection Process

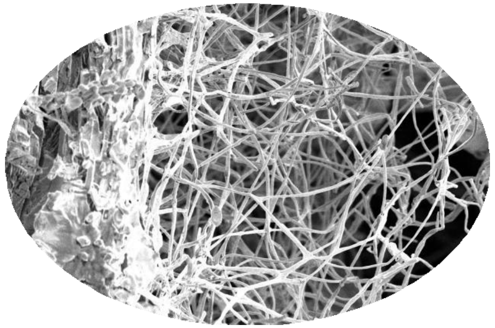
1. Adsorption of conidia



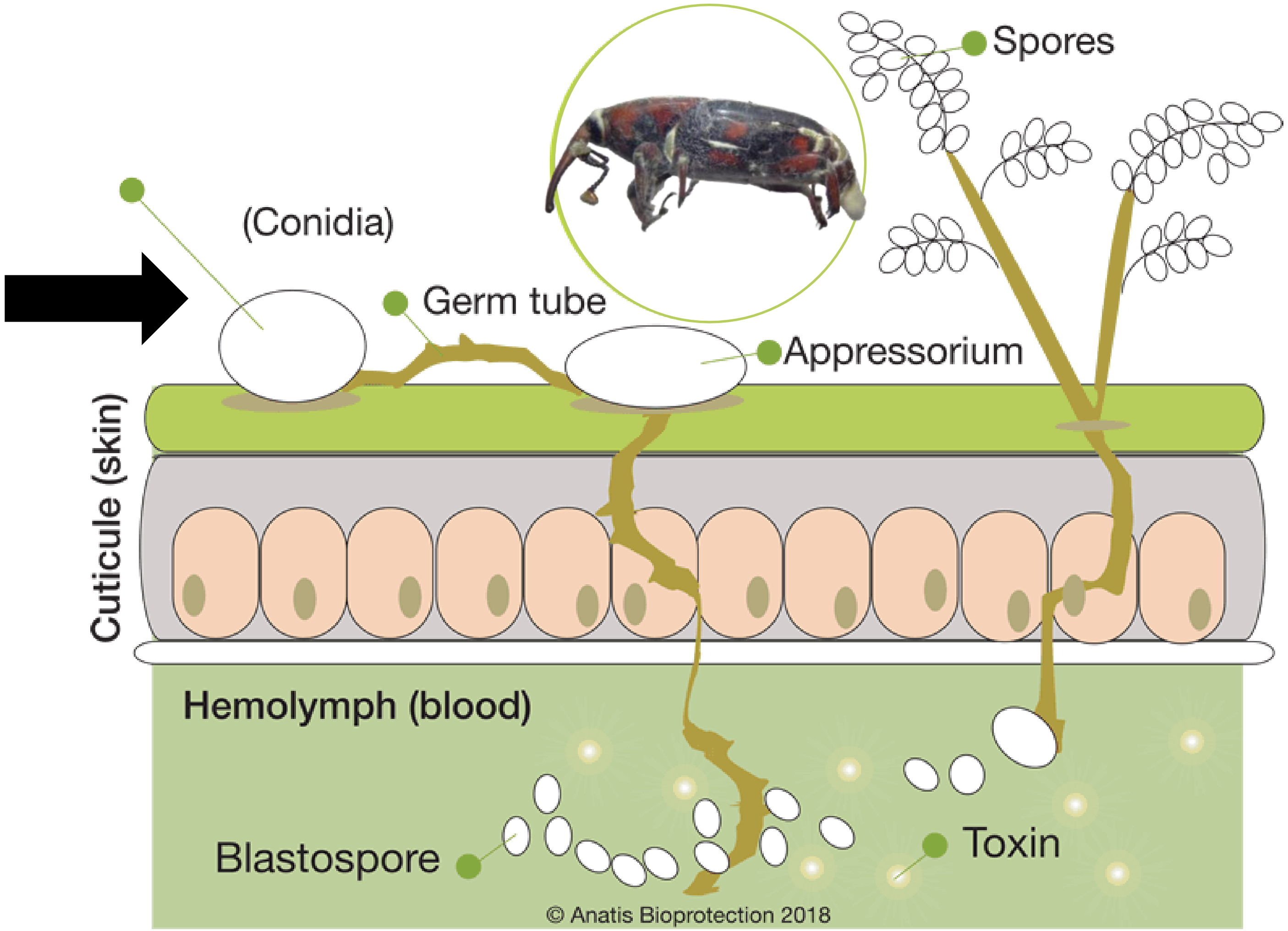
2. Penetration of hyphae across insect cuticle and toxin production



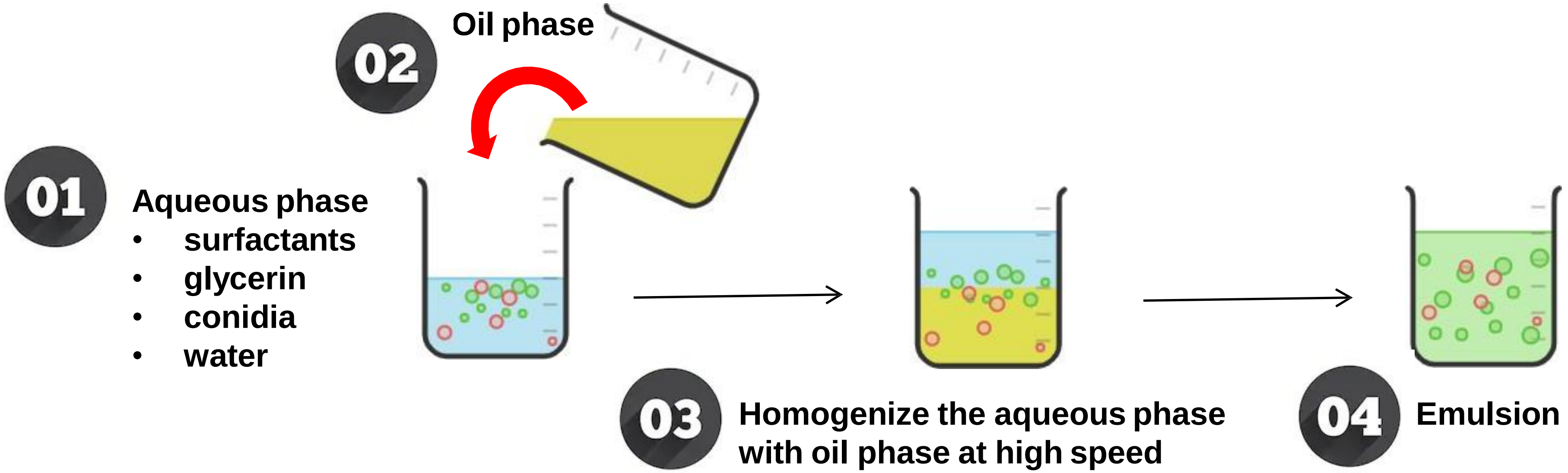
3. Proliferation; fungal hyphal growth within the abdominal region



SEM images: Cheong J.L., 2018



Exploring Bioformulation: Emulsion formulation



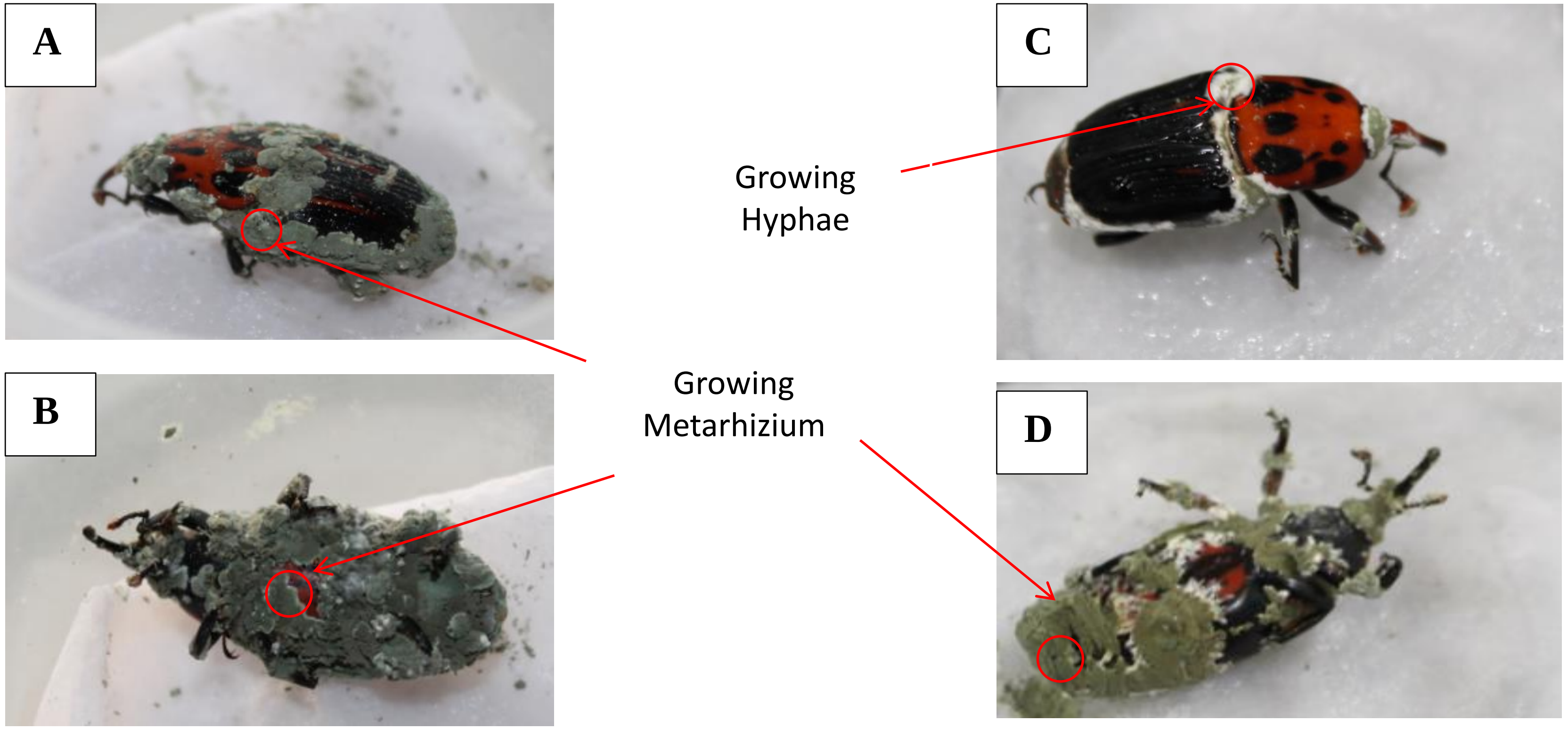
Appropriate formulations can improves the performance of ***Metarhizium anisopliae* (Isolate MetGra-4)** spores under unfavourable environmental conditions,

- ✓ **increase persistency**
- ✓ **enhances infectivity**

as compared to conventional water-based formulations

The pathogenicity test showed that the concentration of 10^7 spores per mL of Met-Gra4 may killed 100% of the adult RPW between 12-14 days after treatment.

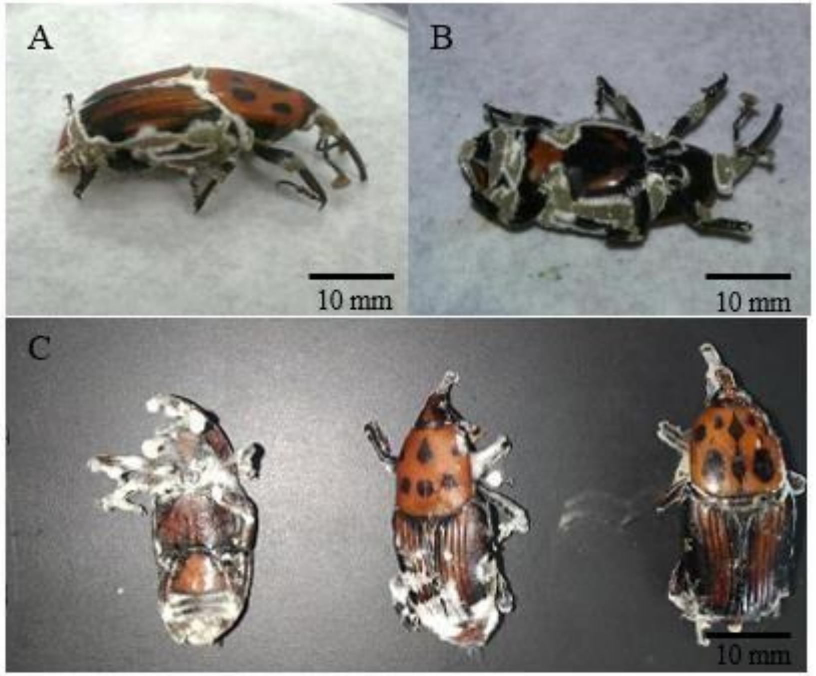
Infected RPW after 14 days exposure , Dorsal View (**A**),Lateral View (**B**).



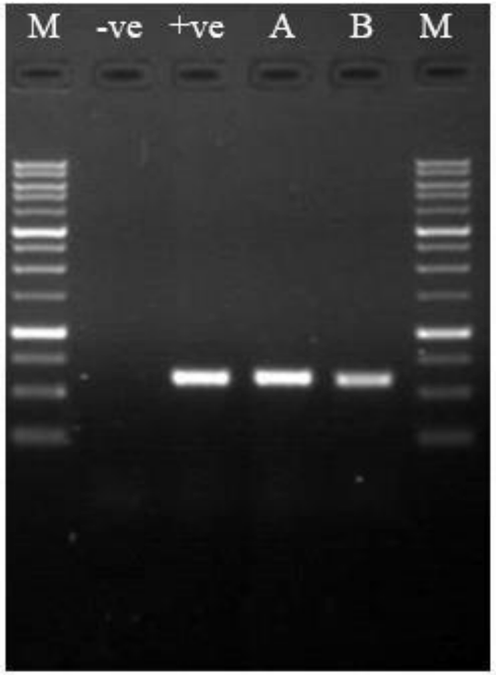
Infected RPW after 7 days exposure, Dorsal view (**C**), Lateral view (**D**).

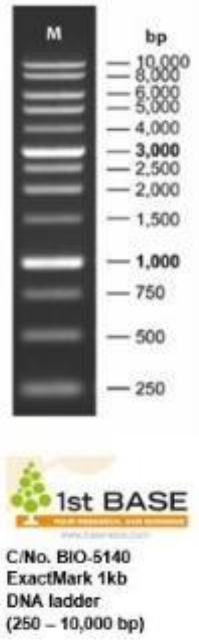
Formulated conidia disperse better than that of the aqueous suspension with a surfactant, ensuring a higher chance of conidia adhering onto insect host, leading to more balanced and repeatable application, which explains the disease spreading ability of formulated conidia.

Confirmation of Met-Gra4 infection



Cadavers of infected RPW treated with, (A and C) conidia-loaded emulsion F25, (B) dry conidia suspension.





PCR product for fungal isolate. M = 1 kb DNA ladder;
-ve = PCR non-template control;
+ve = DNA extracted from *M. anisopliae* pure culture;
A = fungal DNA extracted from RPW treated with conidia suspension (1×10^7 conidia ml^{-1});
B = fungal DNA extracted from RPW treated with conidia-loaded emulsion F25.

- 99.64 – 100 % homolog to *M. anisopliae* with an expected value (E) of zero.
- The actual infection has confirmed, and caused by *M. anisopliae*, not by other fungi.

Conclusion & Potential Future Research

- Making innovations in device development to detect the pest early.
- Developing novel and effective methods for the delivery of chemicals.
- More emphasis on improving the trapping systems.
- Advances in chemical ecology of the insect pest.
- Several bio-control agents have been evaluated over the past and ways should be found to find formulations and dispensing methods.
- Innovation in the research, development, refinement and validation.
- For the sustainability of the RPW management more efforts are required to develop eco-friendly strategies.

Sime Darby

Universiti Malaysia Terengganu

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Supporting IPM Across Southeast Asia

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Communauté du Pacifique

PPPO

COCONUT PEST AND DISEASES
(Pacific-Southeast Asia)

The invasion of Black Headed Caterpillar (*Opisina arenosella*) into Vietnam and its bio-controls

Le Khac Hoang, PhD
Head of Plant Protection Dept.,
Faculty of Agronomy, Nong Lam University
and
Prof. Tran Dang Hoa
Hue University, Vietnam

Ho Chi Minh City, April 2024

Contents

1. Introduction

- Damaged in India, Sri Lanka around **42,82%** (1980-1990), and reinfected in 2010 – 2017 at **62,86%** (Rao et al., 2018)
- In Myanma, Bangladesh damaged approximately **83%** (Cock and Perera, 1987)
- Recently, in Thailand **45%** of coconut yield (Namphueng et al., 2018)
- Damage up to **100%** incase uncontrolled (Seni, 2019)

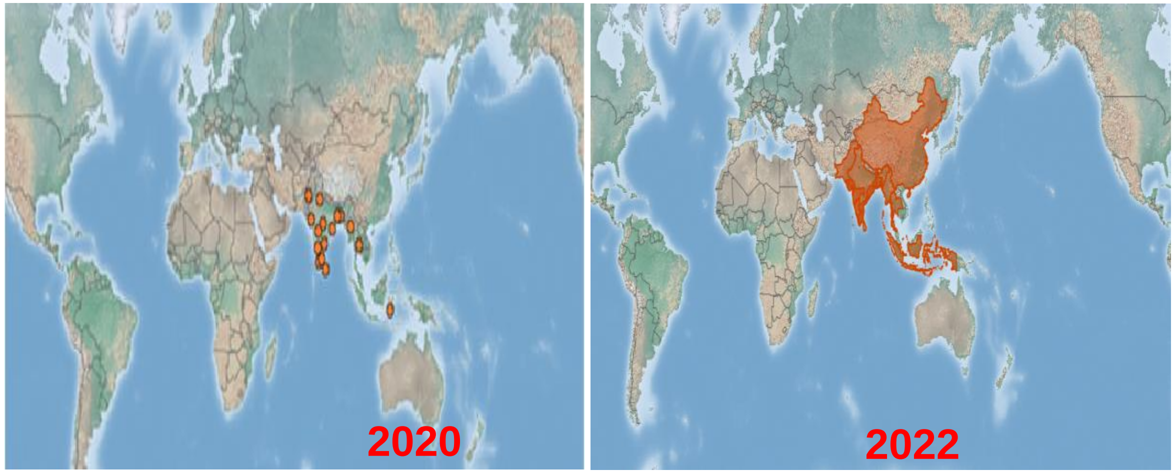


Fig 1. The invasion of the BHC in the World (CABI, 2022)

Fig 2. Damage symptom of the BHC

2. The invasion of the BHC in Mekong Delta

The occurrence and symptoms of the BHC

- First found in Phu Long commune, Binh Dai district, Ben Tre province, Viet Nam on 17th July 2020
- Damage leaflets, and coconut fruit.

Fig 3. Symptoms of the BHC damage on coconut trees

Fig 4. Symptoms of the BHC damage on coconut fruit and leaflets

2. The invasion of the BHC in Mekong Delta (Cont.)

Morphological characteristics of the BHC

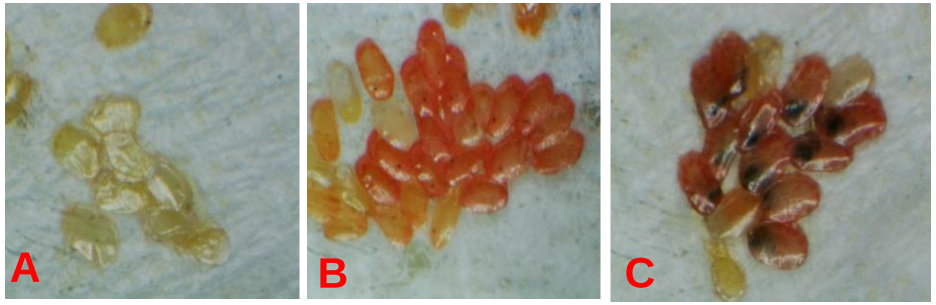


Fig 5. Eggs of the BCH
A: 1 day-old;   B: 3 -5 day-olds; C: 6 – 8 day-olds

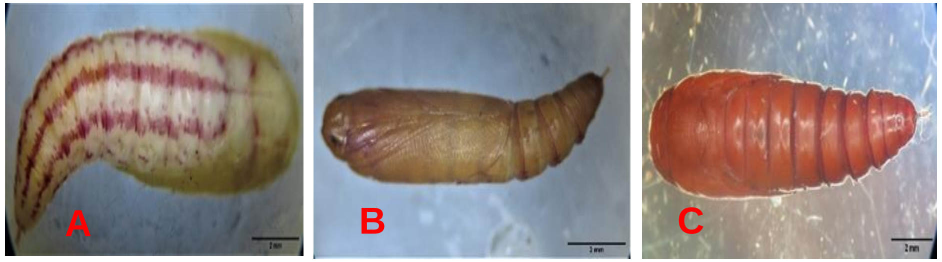


Fig 7. Pupal of the BHC
A: 1 day-old ; B: 2 – 4 1 day-olds;
C: 5 - 8 day-olds

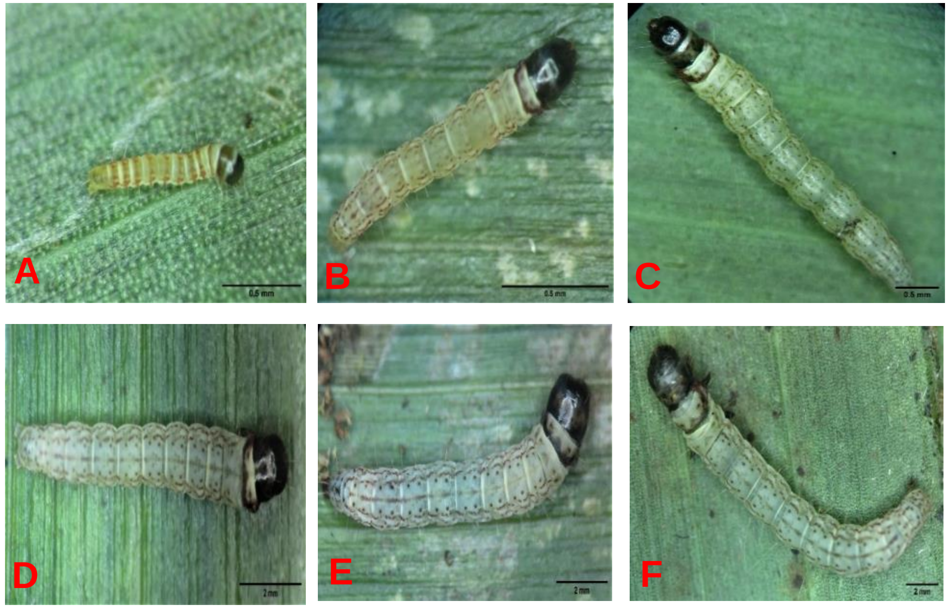


Fig 6. Larval of the BHC
A – F: 1 – 6 instars larval

Fig 8. Adults of the BHC
A. B: Male   C,D: Female

2. The invasion of the BHC in Mekong Delta (Cont.)

The spreads of the BHC in the Mekong Delta

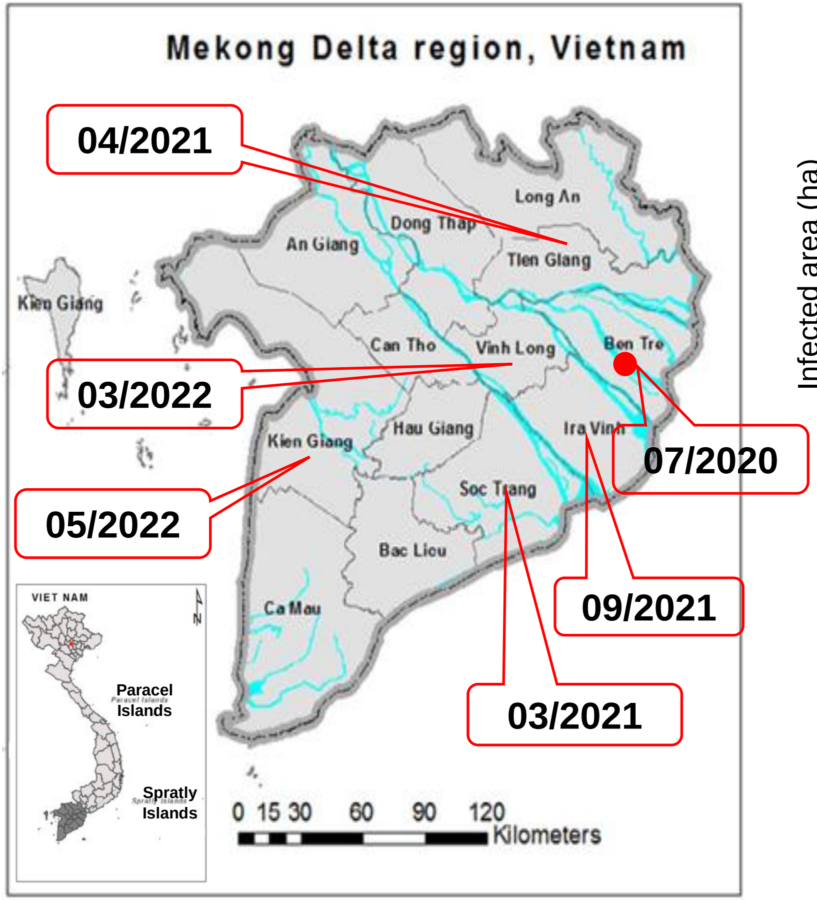


Fig 9. The invasion of the BHC in the Mekong Delta

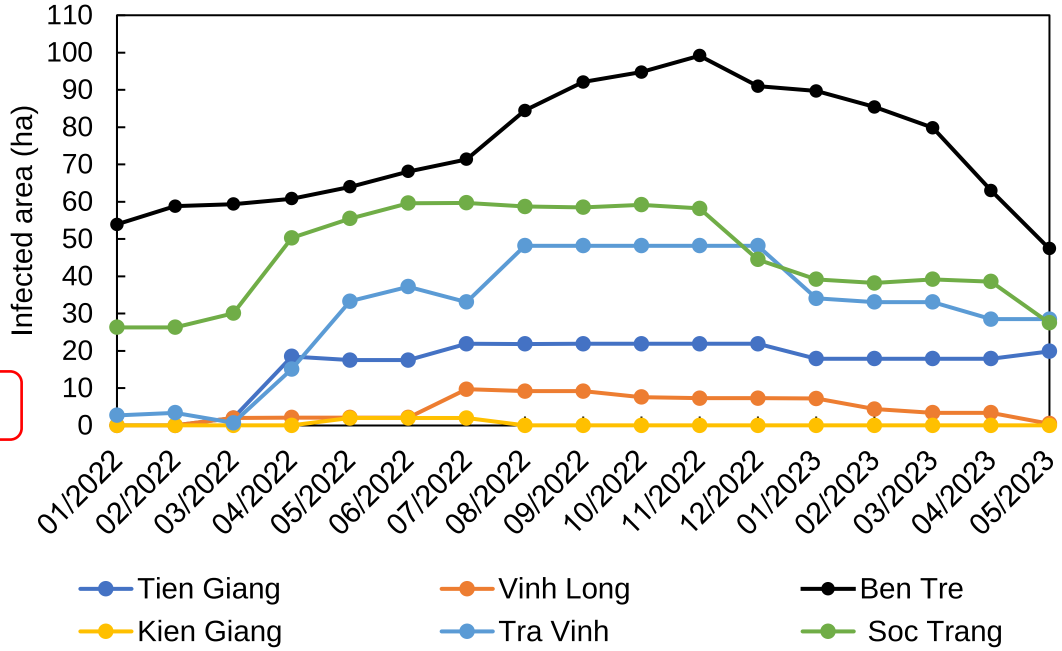


Fig 10. Coconut area were infected by the BHC in the Mekong Delta region from 01/2022 to 05/2023.

2. The invasion of the BHC in Mekong Delta (Cont.)

The spreads of the BHC in the South central coast

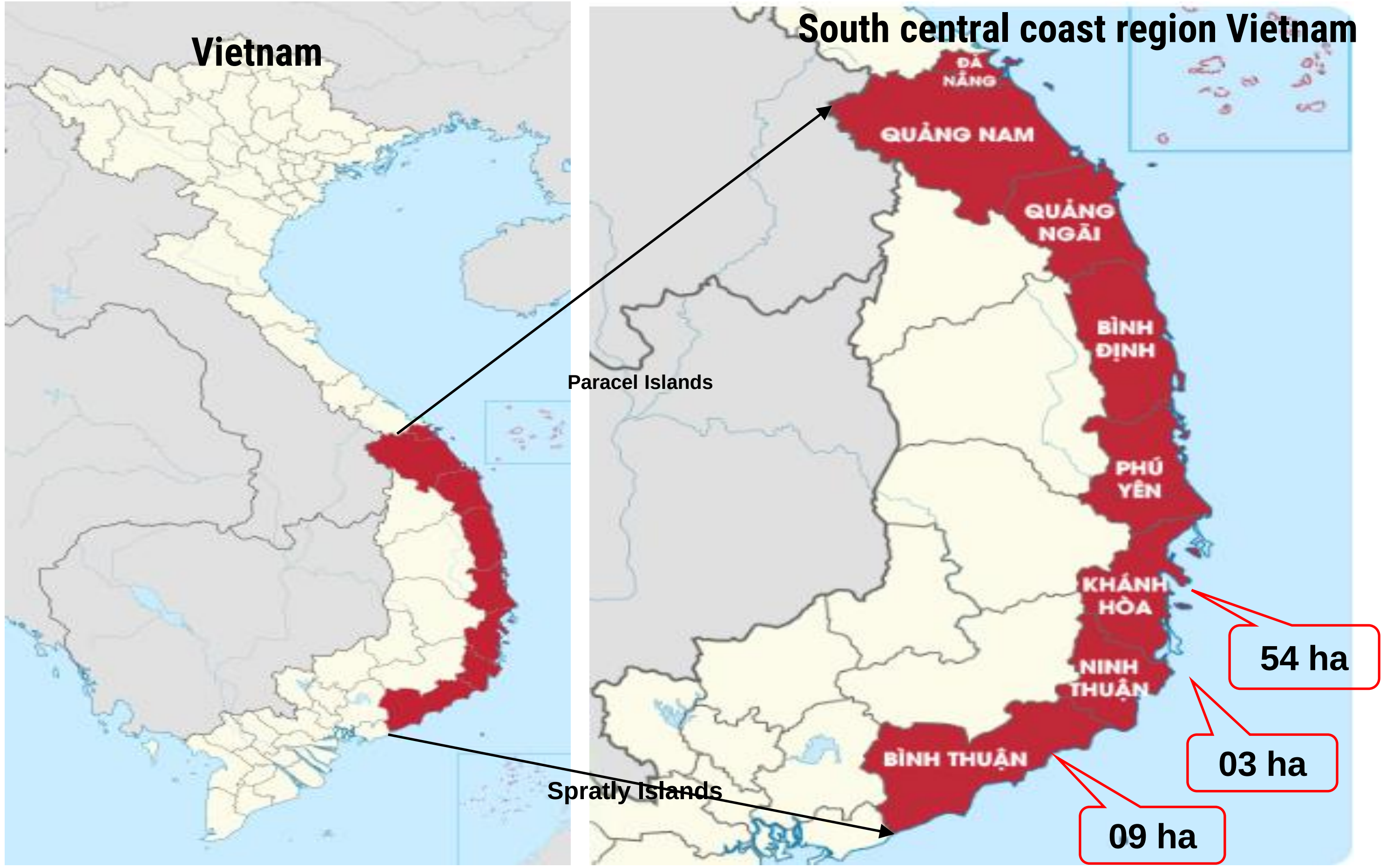


Fig 12. BHC invasion in the South-central coast in 2023- 2024

2. The invasion of the BHC in Mekong Delta (Cont.)

The spreads of the BHC in the South-Central coast

Fig 11. BHC damage on coconut in South central coast region Vietnam

3. Biological control of the BHC

The natural enemies of the BHC in Ben Tre province

Table 2. Natural enemies of the Black Headed Caterpillar in Ben Tre

Scientific name	Order: Family	Stages	Occurrence frequency
Parasitic wasps			
Bracon hebetor	Hymenoptera: Braconidae	Larvae	+
Bracon sp.	Hymenoptera: Braconidae	Larvae	-
Antrocephalus sp.	Hymenoptera: Chalcididae	Pupae	-
Brachymeria euploeae	Hymenoptera: Chalcididae	Pupae	++
Brachymeria kamijoi	Hymenoptera: Chalcididae	Pupae	++
Xanthopimpla punctata	Hymenoptera: Ichneumonidae	Pupae	+
Xanthopimpla nana	Hymenoptera: Ichneumonidae	Pupae	-
Trichospilus pupivorus	Hymenoptera: Eulophidae	Pupae	+
Predators			
Chelisoches sp.	Dermaptera: Chelisochidae	Larvae and Pupae	++
Oecophylla smaragdina	Hymenoptera: Formicidae	Larvae and Pupae	-

-: Occurrence frequency < 5%; +: Occurrence frequency = 5 - 25%; ++: Occurrence frequency = 25 - 50%; +++: Occurrence frequency = 50 - 75%; ++++: Occurrence frequency > 75%.

3. Biological control of the BHC (Cont.)

The natural enemies of the BHC in Ben Tre province (Cont.)

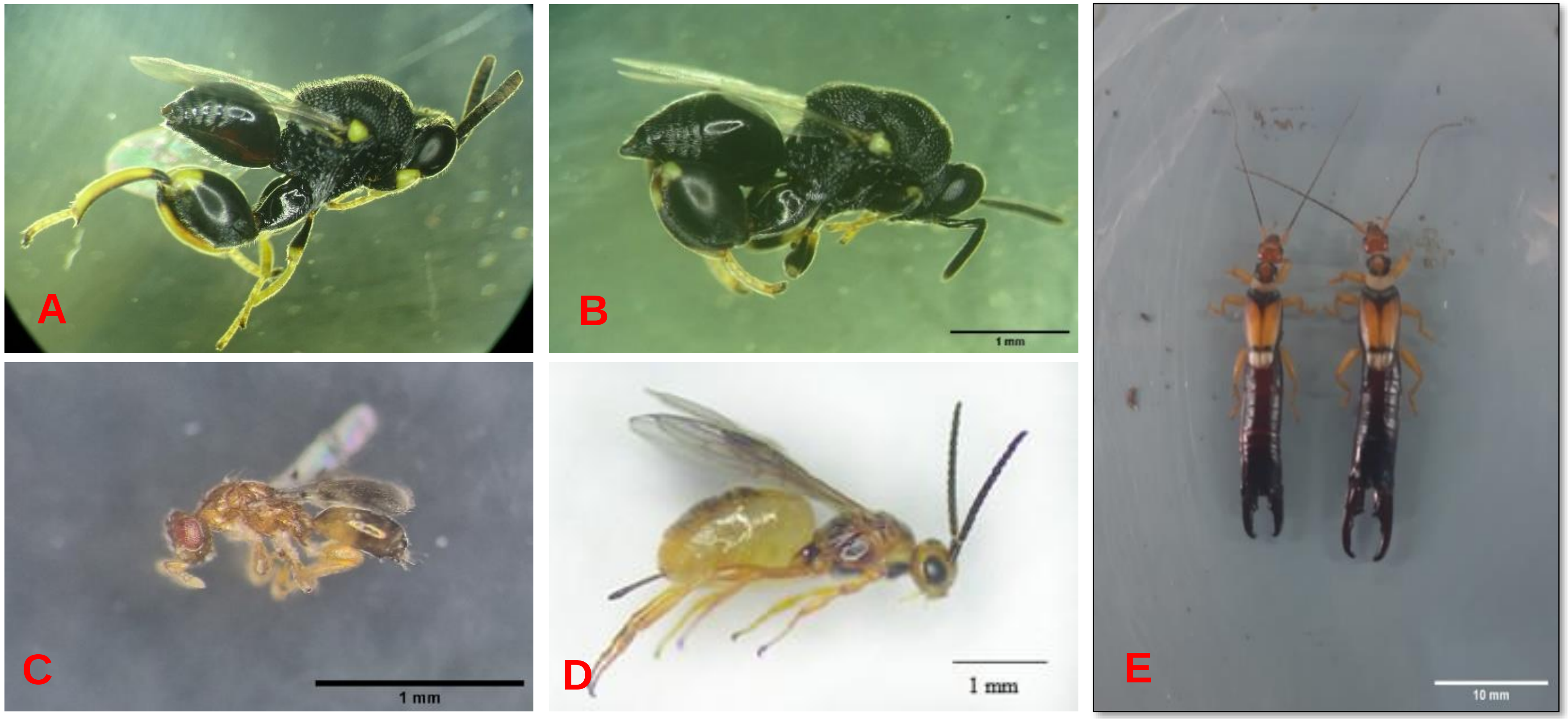


Figure 13. Morphological characteristics of some adults natural enemies the BHC in Ben Tre

A: *B. euploeae*; B: *B. kamijoi;* C: *T. pupivorus;*

D: *B. hebetor;* E: *Chelisoches* sp.

3. Biological control of the BHC (Cont.)

Fig 14. Guiding the technician and farmer to rear the natural enemies of BHC

3. Biological control of the BHC (Cont.)

Fig 15. Guiding the technician and farmer to release the natural enemies of BHC

3. Biological control of the BHC (Cont.)

Accessing the effectiveness of natural enemies in controlling the BHC

3. Biological control of the BHC (Cont.)

Biological control of the BHC on coconut field by using the parasitic wasp T. *pupivorus.*

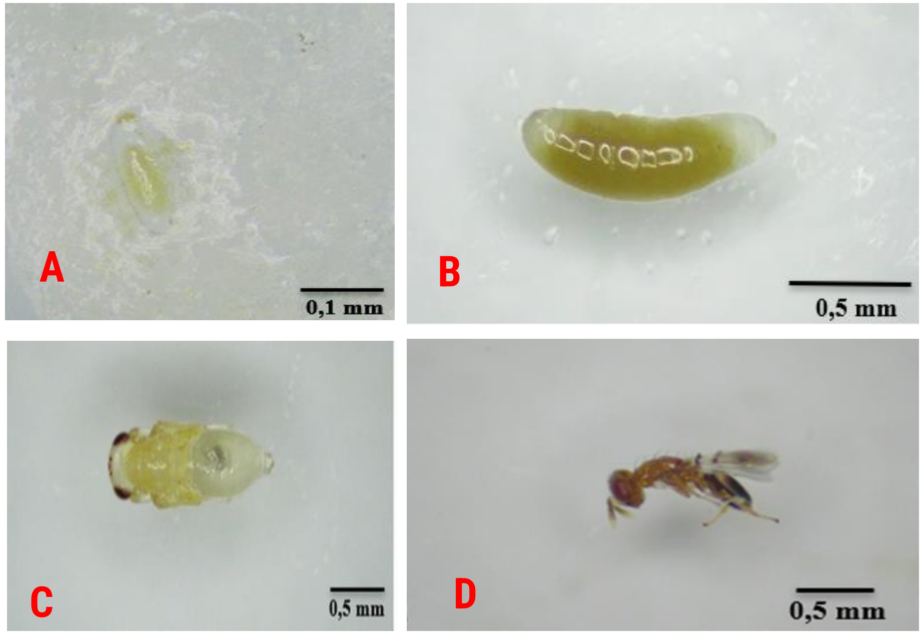


Fig 16. Morphological of *T. pupivorus*

A: egg; B: Larval; E: Pupal; F: Adult

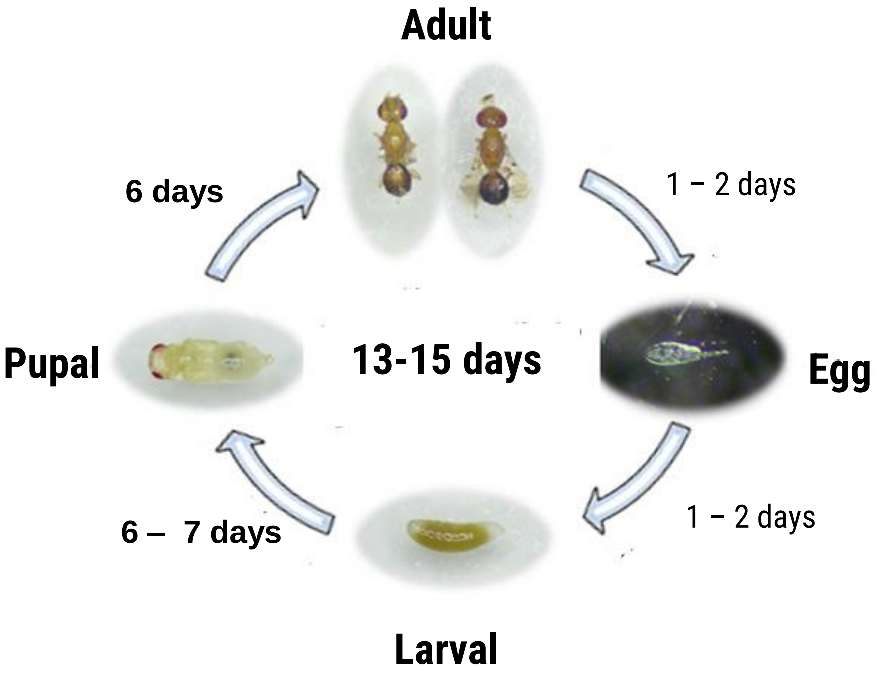


Fig 17. Life cycle of *T. pupivorus*

3. Biological control of the BHC (Cont.)

Biological control of the BHC on coconut field by using the parasitic wasp T*. pupivorus* (Cont.)

Fig 18. Rearing and releasing *T.pupivorus*

3. Biological control of the BHC (Cont.)

Biological control of the BHC on coconut trees by using the parasitic wasp T. *pupivorus* (Cont.)

- Released 5000 wasps/1000 m^2 coconut farm
- Effectiveness was **62.09%** after **120 days** of released); Remadevi et al. (1980) in India, which was about **31.82%**.

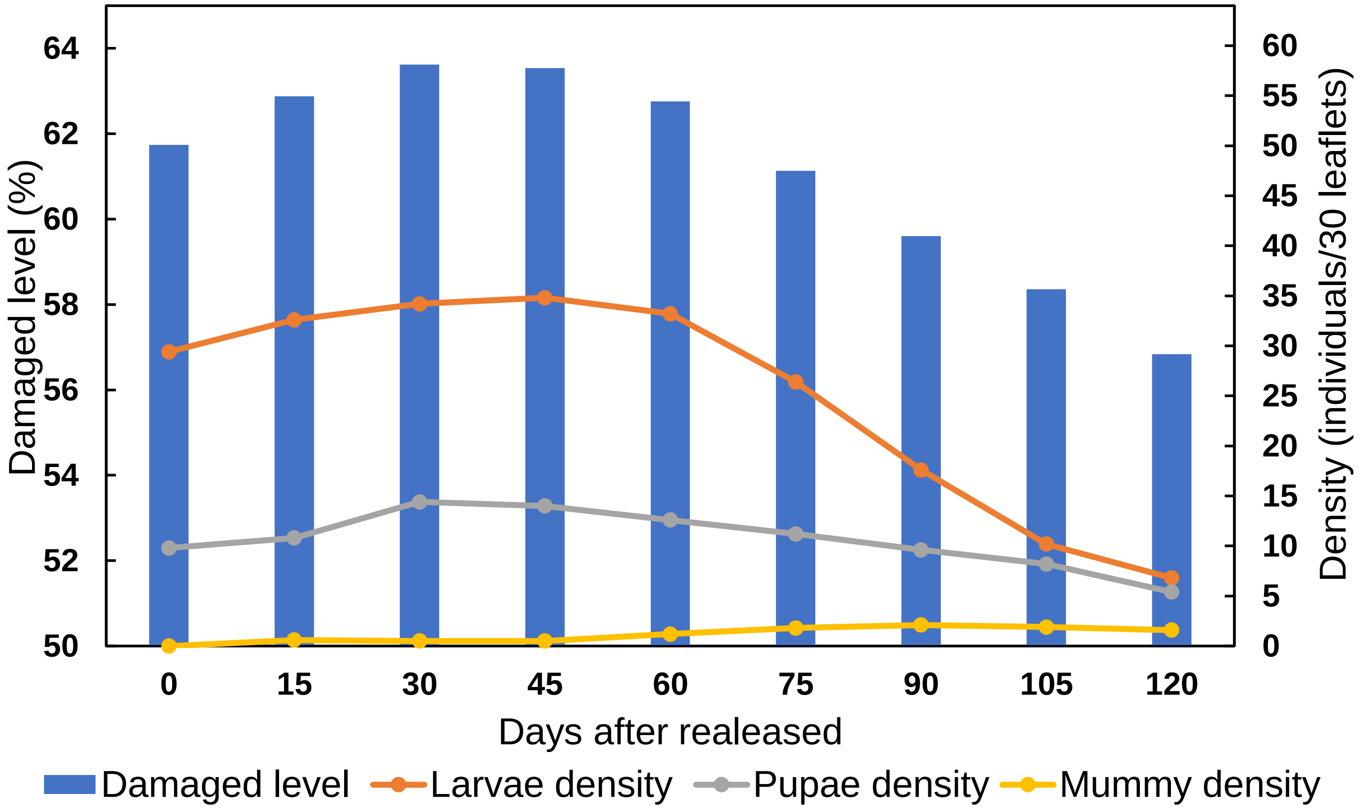


Figure 19. The effectiveness of *T. pupivorus* in controlling the BHC

4. Conclusion and suggestions

- **Conclusion**
  - ➢ **The basic research on controlling the Black Headed Caterpillar has been carried out and has achieved some significant achievements**
  - ➢ **NE*s* show a great potential as a biological control agent**
- **Suggestion**
  - ➢ **Continuing research on the biology of BHC and it’s natural enemies**
  - ➢ **Research to improve NEs rearing by alternative hosts**

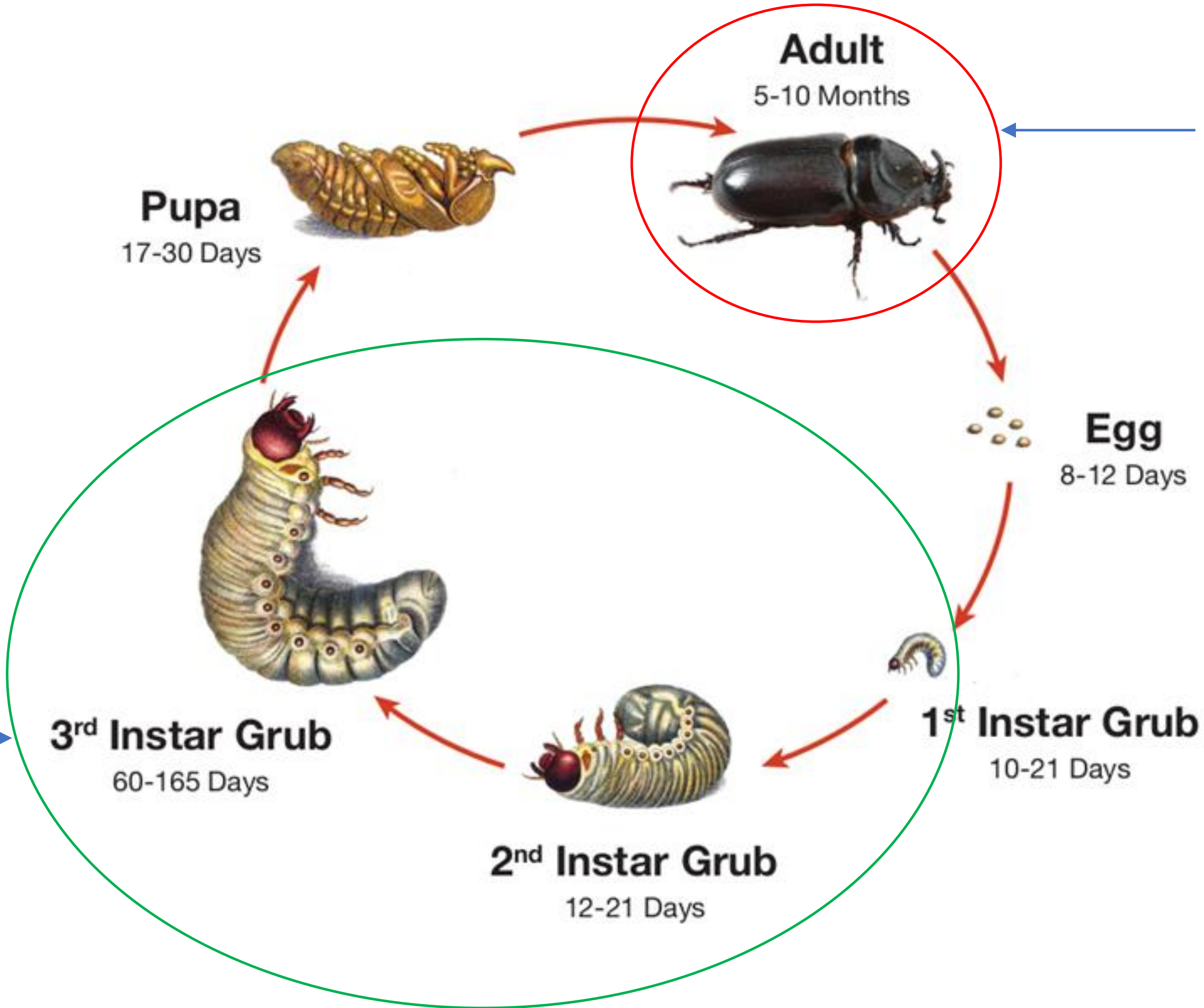

Thank for your attention!

Coconut Rhinoceros Beetle (CRB), *Oryctes rhinoceros* L. establishment and management in the Pacific Region

Mark Ero

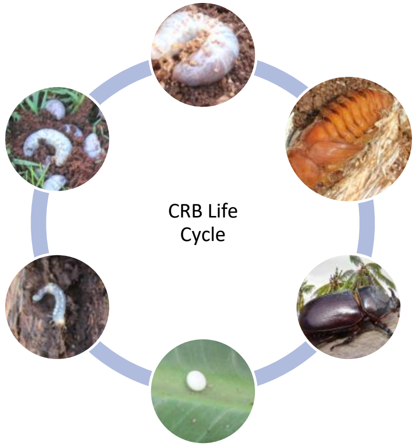
PARC Project, LRD, SPC

CRB life cycle



Responsible for palm damage

Natural decomposers

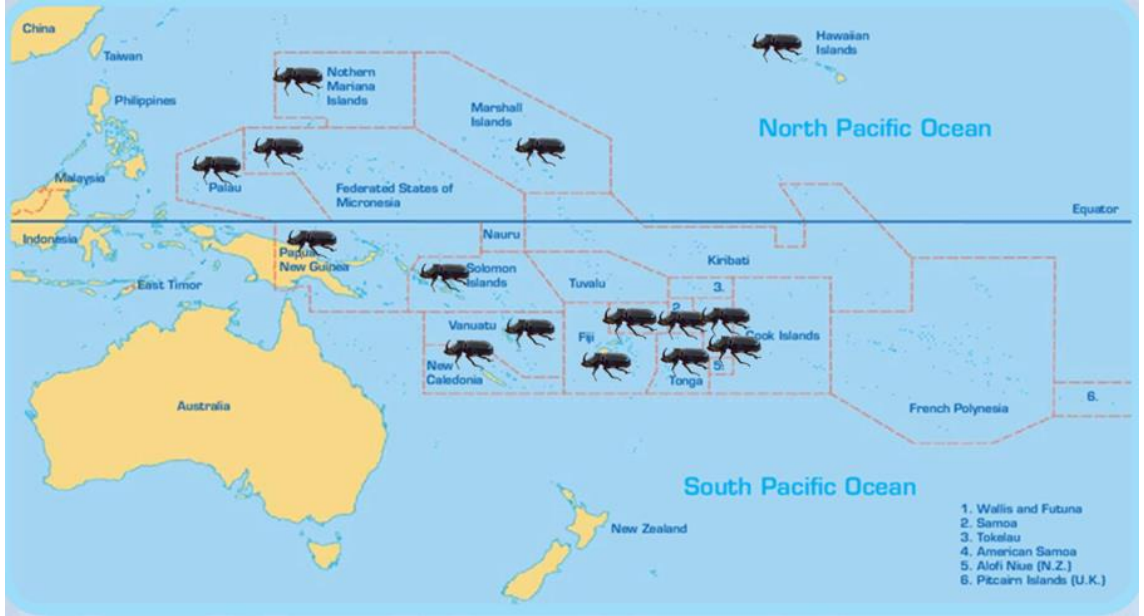


Haplotypes

- There are two haplotype:
  - CRB-G (resistant to Oryctes Nudi Virus- OrNV, used as classical biocontrol agent)
  - CRB-S (Susceptible to Oryctes Nudi Virus- OrNV)
  - Both are morphologically the same, can only be set apart through molecular analysis
  - CRB-G more destructive than CRB-S but the later can become a major issue if escapes the virus and establishes in a new location.

Spread of CRB in the Pacific region

Without CRB (36%)	With CRB (68%)
Cook Islands	CNMI (CRB-G)
Kiribati	Vanuatu (both)
Tuvalu	New Caledonia (CRB-G)
Nauru	Guam (CRB-G)
Niue	Solomon Islands (both)
French Polynesia	PNG (both)
FSM	Palau (both)
Pitcairn Islands	Fiji (CRB-S)
	Tonga (CRB-S)
	Samoa (CRB-S)
	American Samoa (CRB-S)
	Wallis and Futuna (CRB-S)
	Tokelau (CRB-S)
	Hawaii (CRB-G)
	RMI (CRB-G)

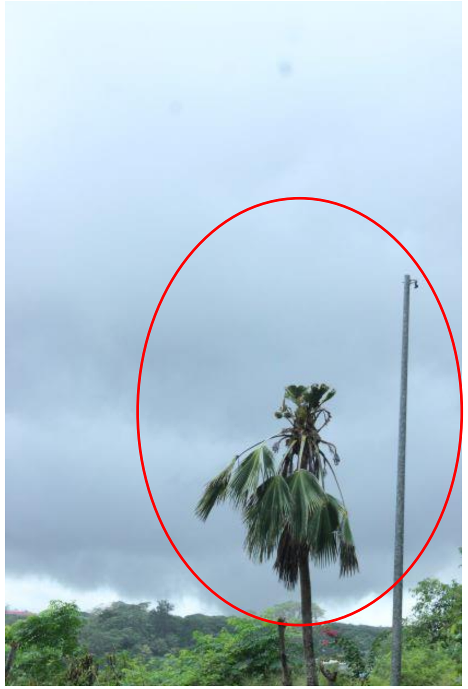


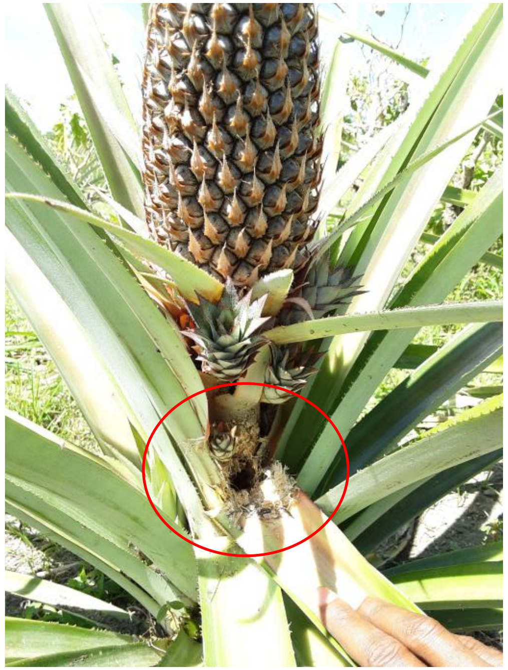
Crops reported attacking

Key pests of coconut and oil palm but can also attack other ornamental palms and food crops.

Coconut crop for the region (income, food security, coastal landscapes, building materials, household items)

Oil palm is an important cash crop for PNG & Solomon Islands





Symptoms CRB damage in coconut

Wedging of leaflets

Frond collapse

Bore hole frass

Frond base bore hole

Palm trunk bore hole

Dead palms

Examples of severe damage caused by CRB

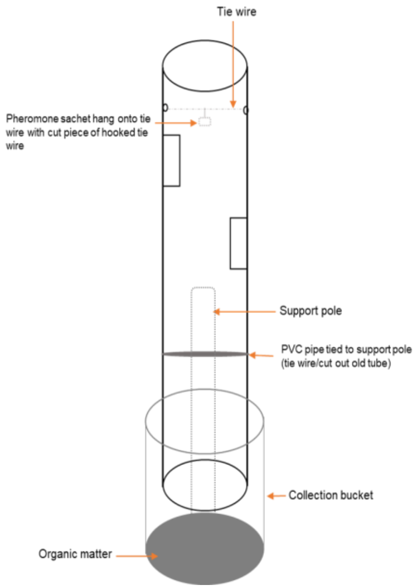
Pacific Community
Communauté du Pacifique

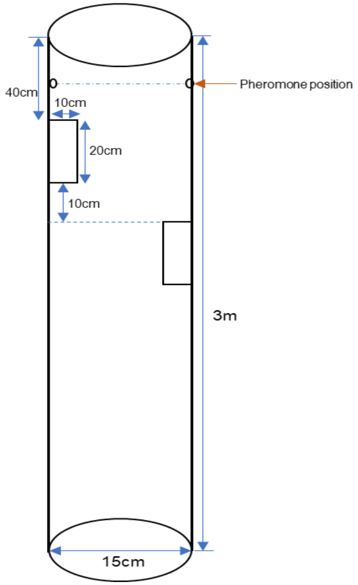
Can lead to the collapse of the coconut industry

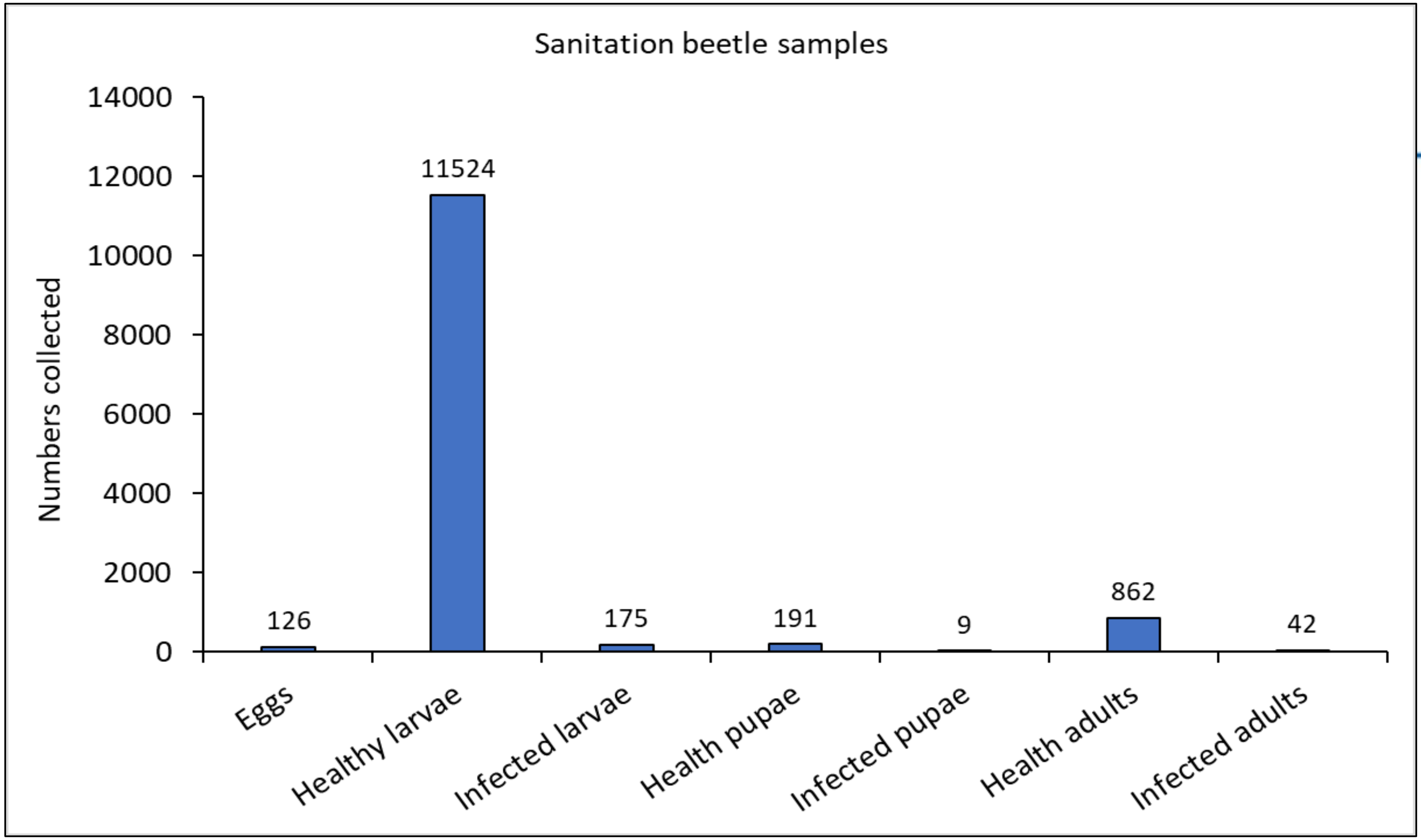
Management options applied (IPM)

IPM options include:

- Sanitation
- Pheromone trapping
- Metarhizium application
- Awareness



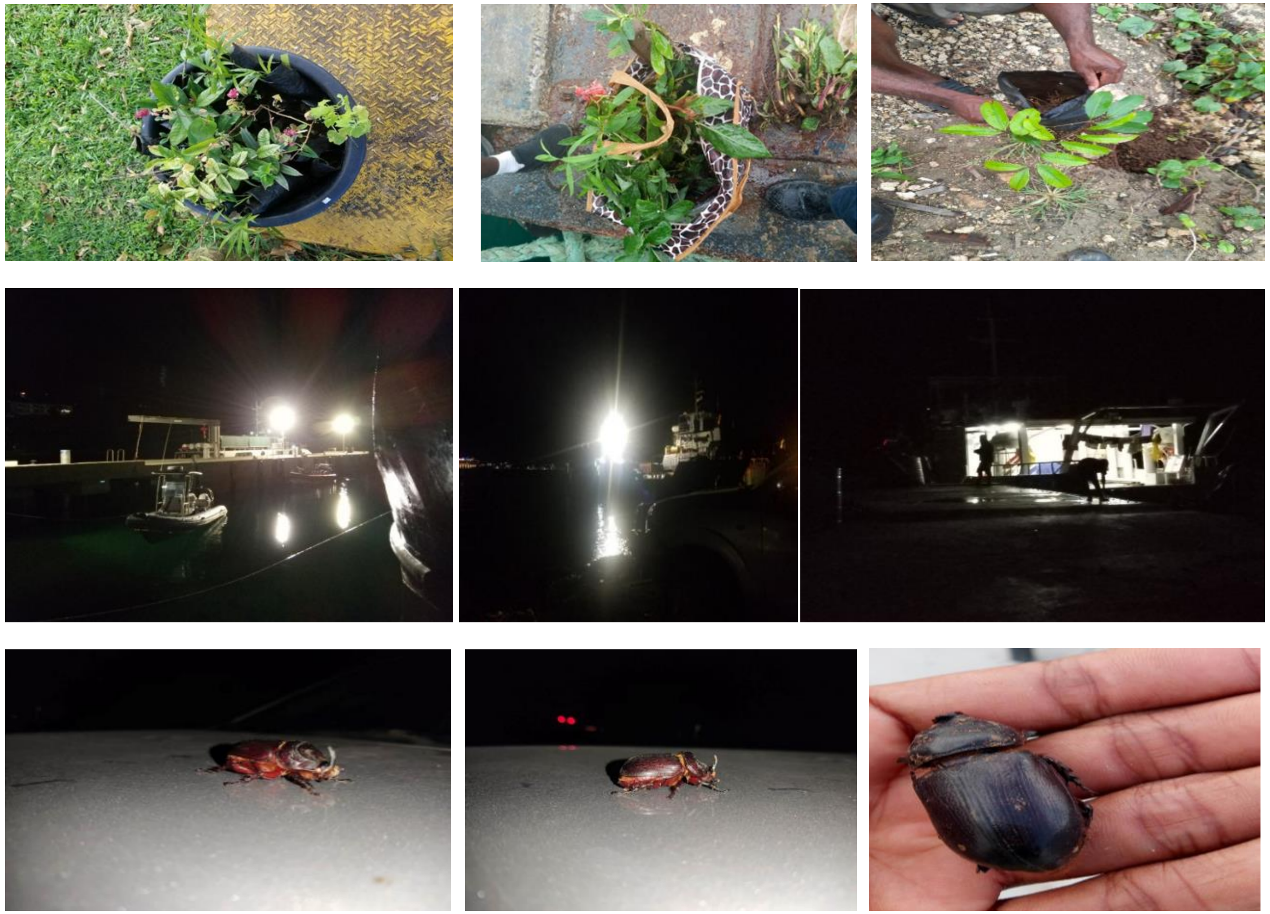




Vanuatu results

Vanuatu vessel inspection program

- Ministerial order (night travel restriction)
- MOA with the Office of Maritime Regulator (OMR)
- SOP (guide operation)
- Operation ongoing



Vanuatu vessel inspection program

- 47 domestic vessels inspected
- 20 CRB (7 males & 13 females) intercepted and destroyed
- Numerous potted plants confiscated
- Main coconut-producing islands (Santo & Malekula) remain free of CRB

Cash for beetle initiative

Months	Adults	Pupae	Larvae	Amount (VT)
May	1,827	2	6,379	218,800vt
June	2,658	0	7,764	318,900vt
July	22	0	54	2,700vt
August	404	0	600	40,100vt
Total	**4,911**	**2**	**14,797**	**580,500vt**

Ca USD5,000.00

Overall total = 19,710

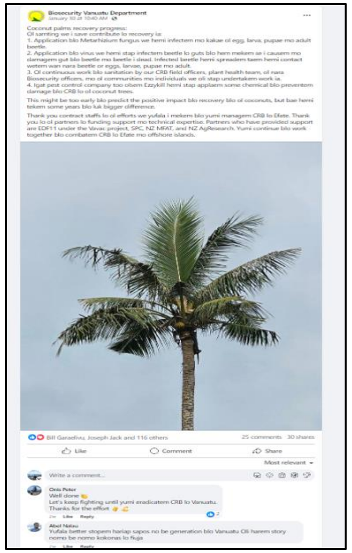
Other management options

Pacific Community
Communauté du Pacifique

- Virus (Oryctes NudiVirus) screening work for CRB-G under way led by our collaborating partner AgResearch, NZ.

- Insecticide treatment can be considered where required (targeted trunk injection (TTI) on mature palms using systemic insecticides and contact insecticide application on young palms but need to be closely monitored).

Still early days but signs of palm recovery noticed in some areas



Key challenges

- COVID 19 travel restrictions and lockdowns (major)
- Natural disasters (e.g cyclones, earthquakes, volcanoes)
- Opposition to biosecurity enforcement programmes (e.g vessel operators in Vanuatu)
- Vandalism/stolen of management materials.

Conclusion

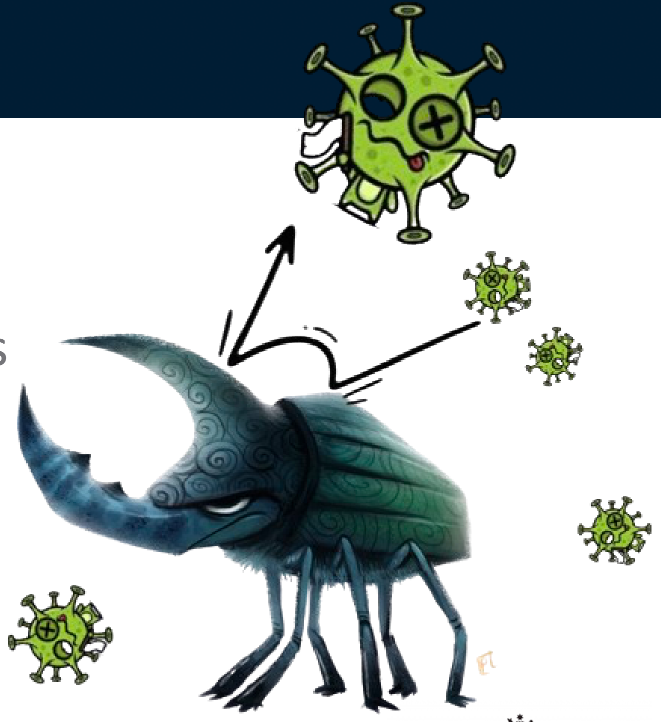
- Sanitation critical element of management to reduce population pressure.
- Consistency in pheromone trap and ABS checks critical.
- Internal quarantine critical for prevention of further inter-island spread

Pacific Community
Communauté du Pacifique

Thanks

Australia's National Science Agency

Coconut pest management options through the lens of genomics - case study of CRB-G



Wee Tek Tay | CSIRO Health & Biosecurity | Pest Genomics

Coconut Pests and Diseases Webinar Series Part I: Introduction to key palm pests with a case study on the Coconut Rhinoceros Beetle

ASEAN FAW Action Plan – SPC – PPPO | 02 April 2024

Australian Government
Department of Foreign Affairs and Trade

Current CRB Distribution

Journal of Invertebrate Pathology 149 (2017) 127–134

Contents lists available at ScienceDirect

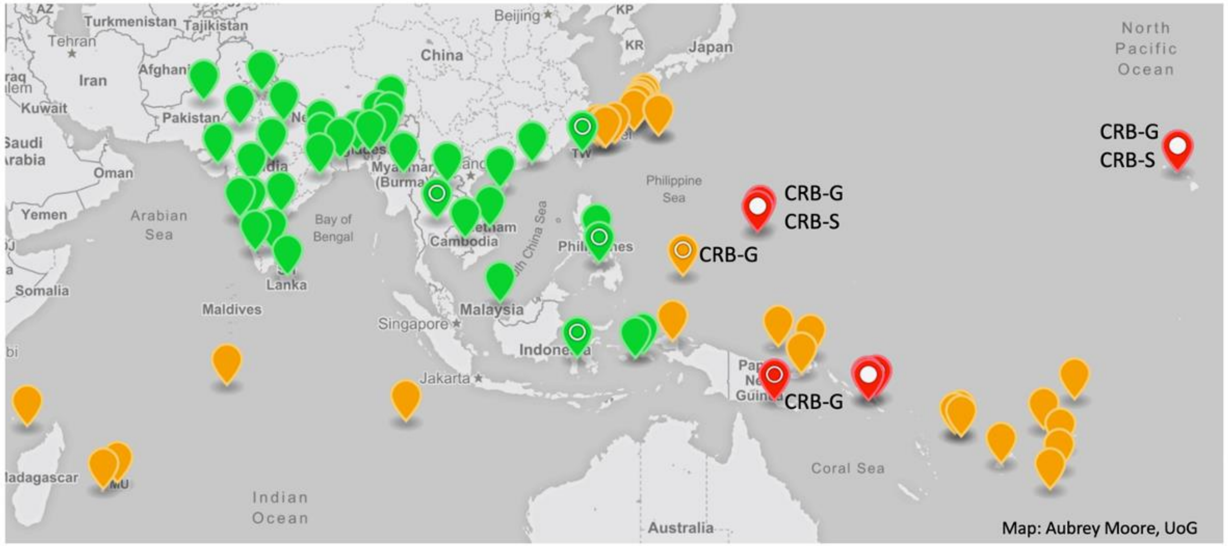
Journal of Invertebrate Pathology

journal homepage: www.elsevier.com/locate/jip

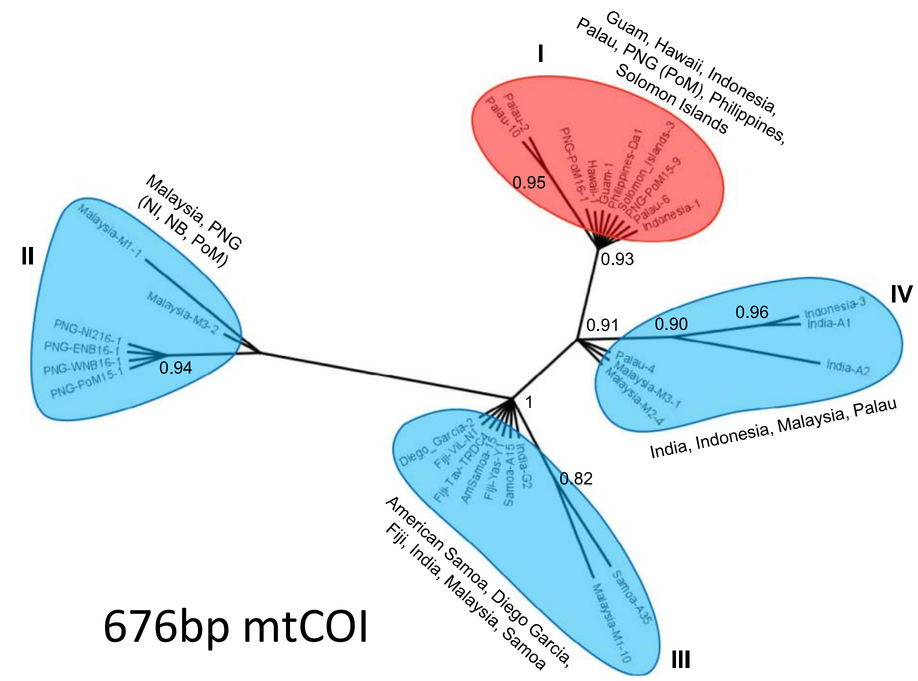
A new haplotype of the coconut rhinoceros beetle, *Oryctes rhinoceros,* has escaped biological control by *Oryctes rhinoceros* nudivirus and is invading Pacific Islands

Sean D.G. Marshall[a,*], Aubrey Moore[b], Maclean Vaqalo[c], Alasdair Noble[a], Trevor A. Jackson[a]

- Unique mtCOI identified from Guam CRB (CRB-G)
- OrNV resistant
- CRB-G COI signature also detected in Hawaii, PNG, Indonesia, Palau, Philippines, Solomon Islands



Native range
20th century
21st century



From Little Things Big Things Grow: 'CRB-G' captivated our imagination

Plant Pathology & Quarantine 10(1): 152–171 (2020) ISSN 2229-2217
www.ppqjournal.org
Doi 10.5943/ppq/10/1/17
Article

Key transboundary plant pests of Coconut [*Cocos nucifera*] in the Pacific Island Countries – a biosecurity perspective

Datt N[1], Gosai RC[1], Ravuiwasa K[2] and Timote V[3]

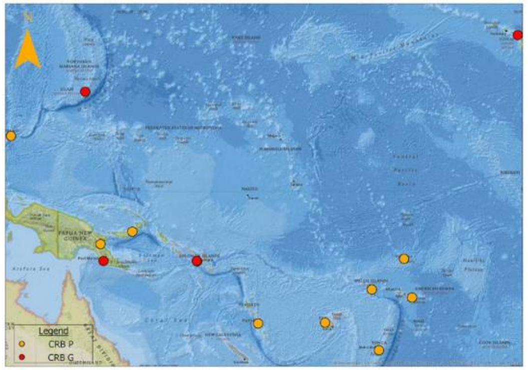


Fig. 1 – Illustration of CRB distribution in the Pacific. The yellow spots indicate the distribution of the Pacific strain while the red spots indicate the presence of the Guam biotype.

Pacific Community Communauté du Pacifique

PEST Alert

Plant Protection - Pacific Community Land Resources Division (SPC-LRD)

No. 52 ISSN 1727-8473 August 2017

A new biotype of Coconut Rhinoceros Beetle discovered in the Pacific

scientific reports

OPEN Confirmation of Oryctes rhinoceros nudivirus infections in G-haplotype coconut rhinoceros beetles (*Oryctes rhinoceros*) from Palauan PCR-positive populations

Shunsuke Tanaka, Robert L. Harrison, Hiroshi Arai, Yukie Katayama, Tetsuya Mizutani, Maki N. Inoue, Joel Miles, Sean D. G. Marshall, Christopher Kitalong & Madoka Nakai

CRB Action Group Meeting, Hyderabad, Nov 13 2019

CRB – Review Hyderabad, 2019

Workshop session. Coconut rhinoceros beetle – the way forward
Wed Nov 13. 2:00 pm. Room 108.

AECOM KALANG
Pacific Horticultural and Agricultural Market Access (PHAMA) Program
Department of Foreign Affairs and Trade

Coconut Rhinoceros Beetle Report (2 parts)

TECHNICAL REPORT
#134

International Association for the PLANT PROTECTION SCIENCES
IAPPS
NEWSLETTER

Number XI September, 2020

XIX International Plant Protection Congress IPPC2019

10-14 November 2019, Hyderabad, Telangana, India

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Hawaii Invasive Species Council - Support Program

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Crop Protection 77 (2015) 181–184

Contents lists available at ScienceDirect

Crop Protection

journal homepage: www.elsevier.com/locate/cropro

International Association for the PLANT PROTECTION SCIENCES
IAPPS
NEWSLETTER

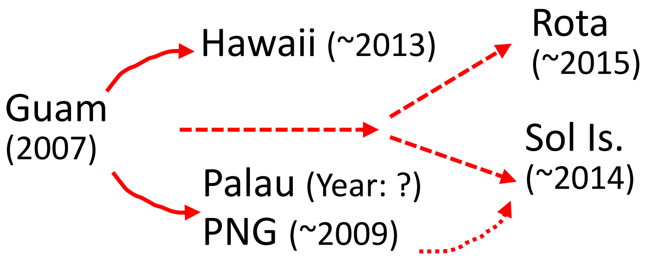
IAPPS Newsletter 77C

scientific reports

OPEN Variants in the mitochondrial genome sequence of *Oryctes rhinoceros* (Coleoptera: Scarabaeidae) infected with *Oryctes rhinoceros nudivirus* in oil palm and coconut plantations

Erise Anggraini, Ganesan Vadamalai, Lih Ling Kong, Mazidah Mat & Wei Hong Lau

Detection & Spread



ABC NEWS

Just In Watch Live Politics World Business Analysis Sport Science Health

Destructive coconut rhinoceros beetle a 'stone's throw' from Australia as it spreads through Pacific

ABC Capricornia / By Inga Stünzner
Posted Thu 17 Jun 2021 at 9:09am

Bulletin OEPP EPPO Bulletin

ORIGINAL ARTICLE Open Access

The coconut rhinoceros beetle (*Oryctes rhinoceros*) outbreak is well established on Efate, Vanuatu

Sulav Paudel, Trevor A. Jackson, Sylvie Boulekouran, Jeffline Tasale, Bill Garae, Patricia Allanson, Mark Ero, Sean D. G. Marshall

First published: 04 July 2023 | https://doi.org/10.1111/epp.12930

and many more …

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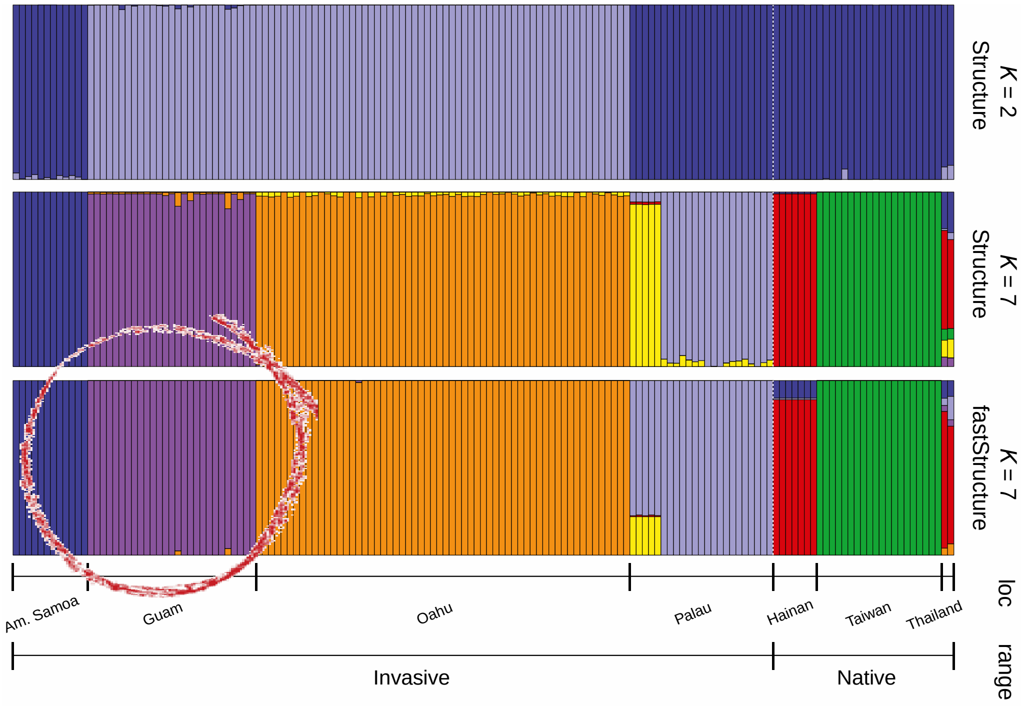
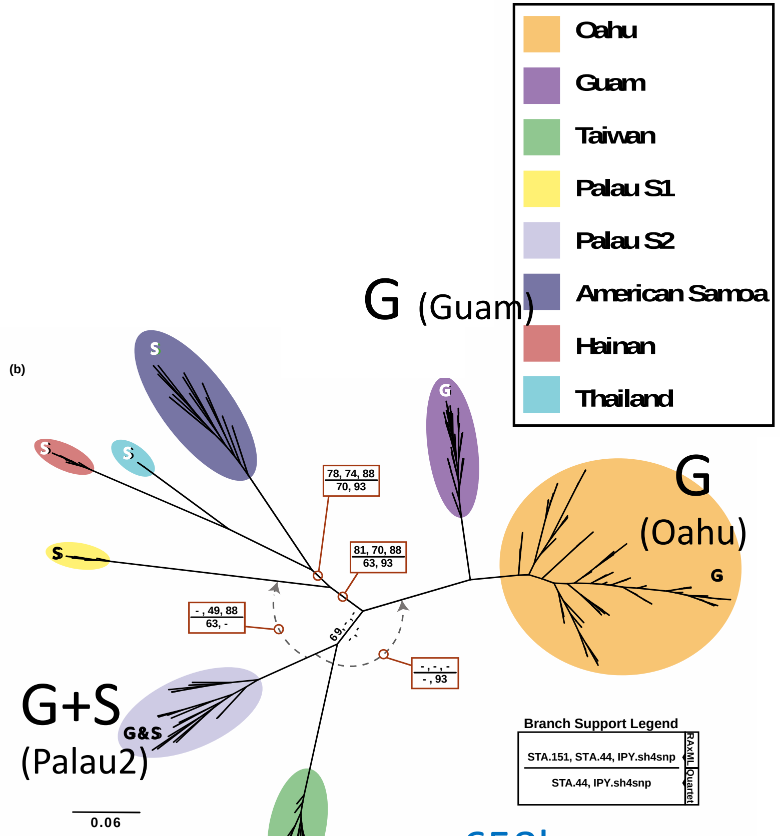
ORIGINAL ARTICLE 2018

WILEY MOLECULAR ECOLOGY

Transpacific coalescent pathways of coconut rhinoceros beetle biotypes: Resistance to biological control catalyses resurgence of an old pest

Jonathan Bradley Reil[1] | Camiel Doorenweerd[1] | Michael San Jose[1] | Sheina B. Sim[1,2] | Scott M. Geib[2] | Daniel Rubinoff[1]





658bp mtCOI

Structure analysis: 7,907SNPs

Guam: Disagreement between nuDNA vs mtCOI markers!!
Population remained on Guam!

Palau:
Two separate populations
Palau S1: Early introduction
Palau S2: Recent introduction

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Current Research in Insect Science 1 (2021) 100015

Contents lists available at ScienceDirect

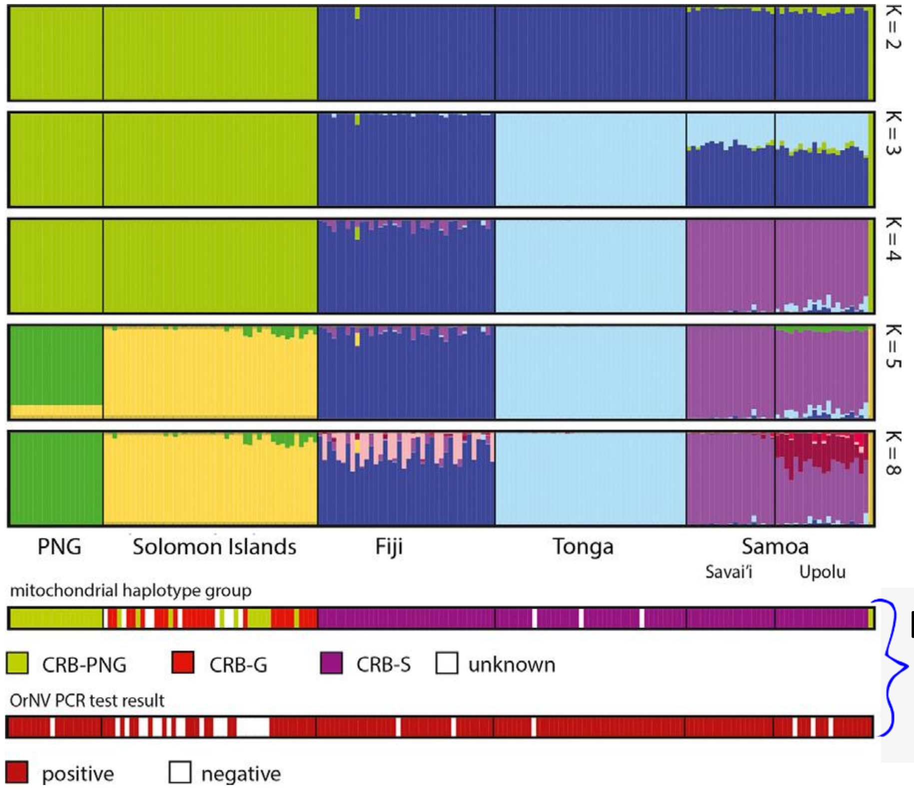
Current Research in Insect Science

journal homepage: www.elsevier.com/locate/cris

Examination of population genetics of the Coconut Rhinoceros Beetle (*Oryctes rhinoceros*) and the incidence of its biocontrol agent (Oryctes rhinoceros nudivirus) in the South Pacific Islands

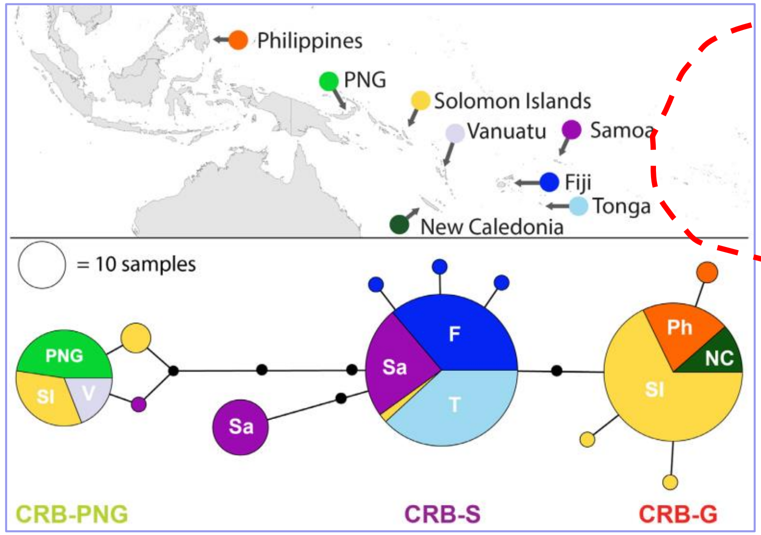
Kayvan Etebari[a,*], James Hereward[a], Apenisa Sailo[b], Emeline M. Ahoafi[c], Robert Tautua[d], Helen Tsatsia[e], Grahame V Jackson[a], Michael J. Furlong[a]

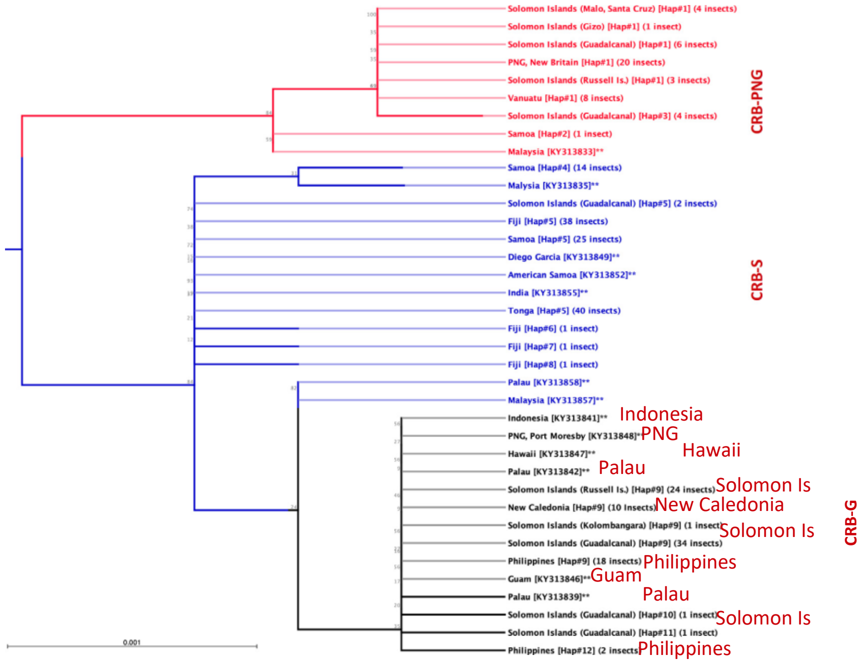
Genotyping by Sequencing (GBS; 1,138 SNPs & 6,561 SNPs)



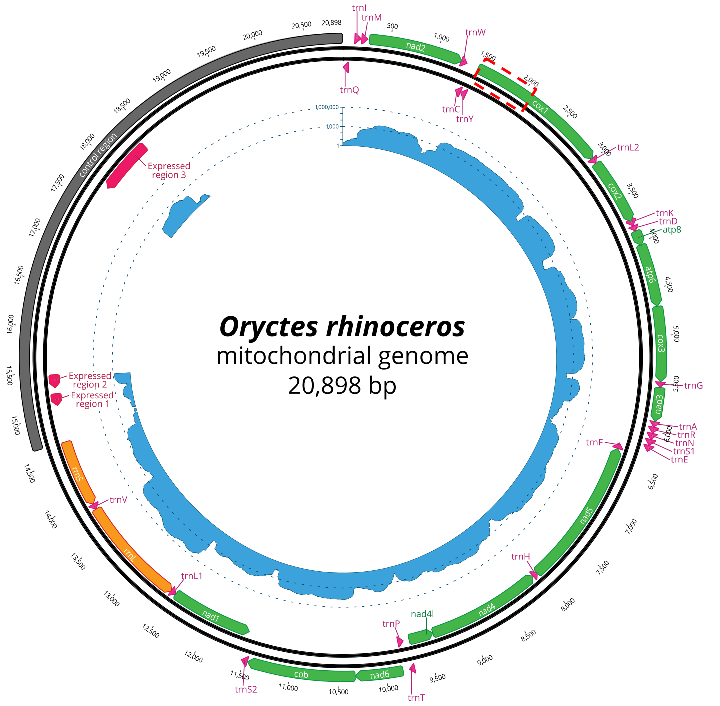
Disagreement between OrNV & mtCOI G- /S- haplotypes

- Lacks appropriate sampling – missing Guam CRB





Mitochondrial genome & the 'barcoding' gene



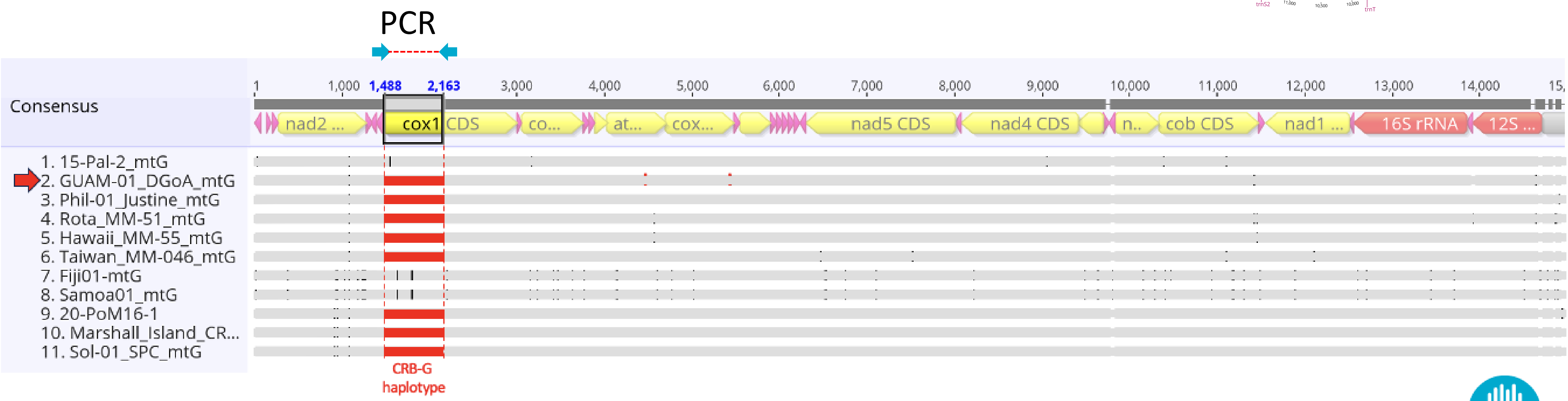
- Inherited from mother
- 2 rRNA genes + control region
- 22 tRNA genes
- 13 protein coding genes
- Inherited as a single genome

- 'Barcoding' mtCOI gene (~670bp)

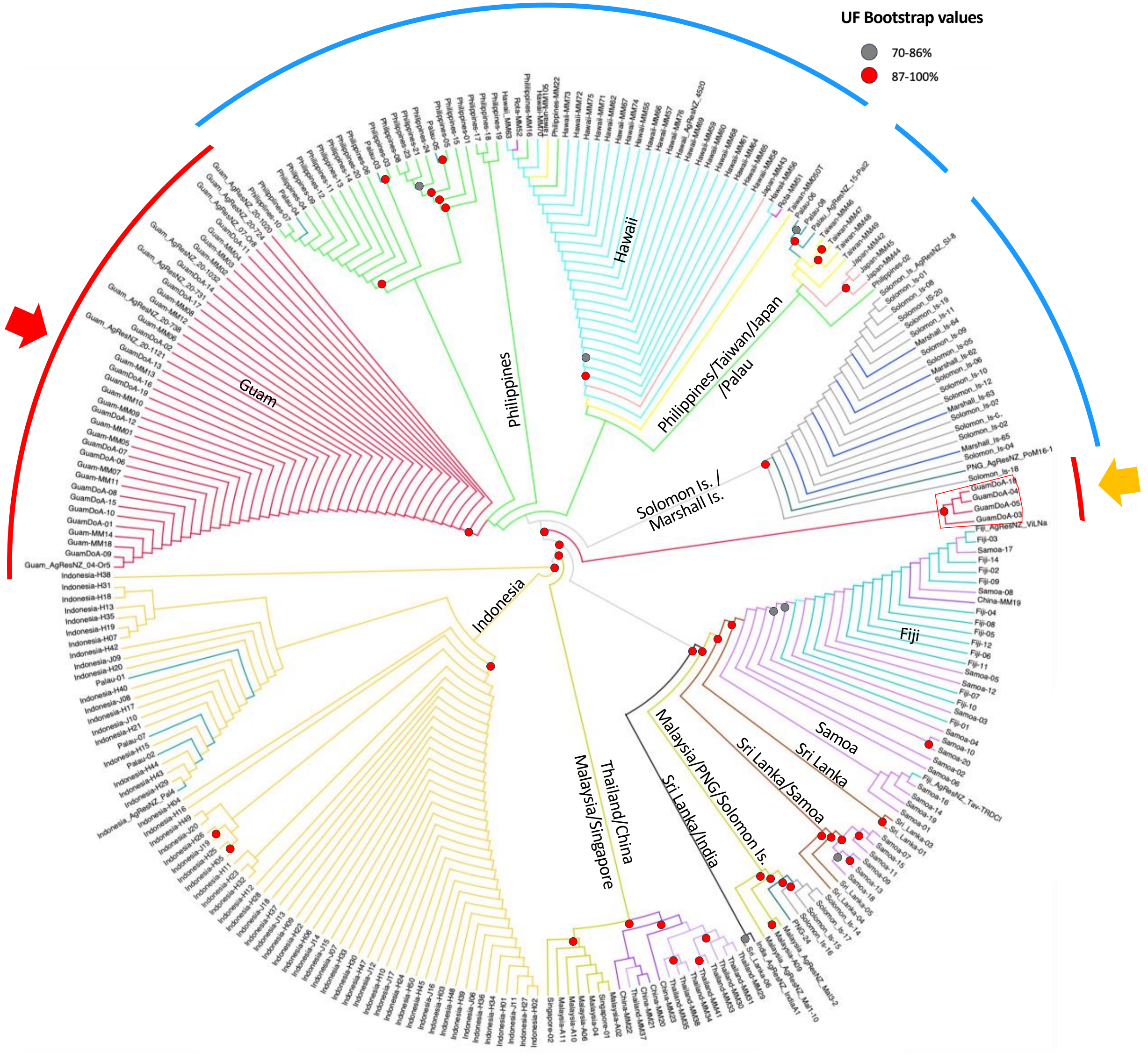
620-670 bp / 20,898 bp ≃ 0.03

~3% of mtDNA to differentiate between G- vs. S-haplotypes!

Assumption: If COI is identical, remaining genome regions also identical

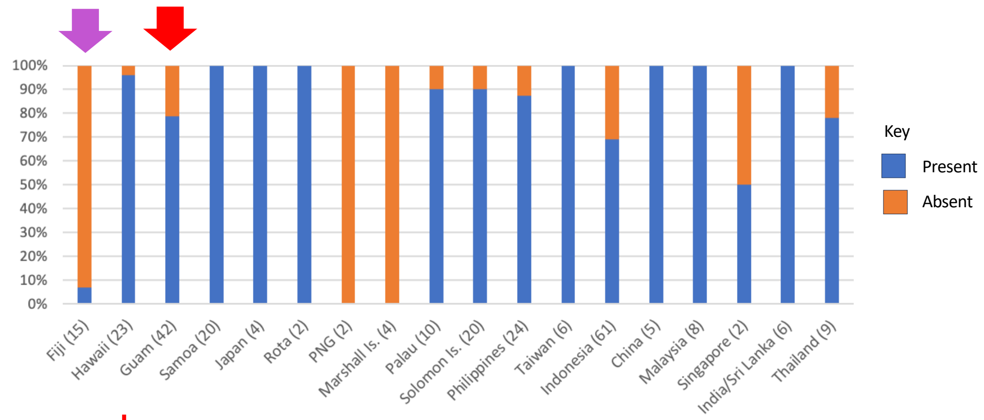


Reassessment of native and invasive CRB phylogeography



- 13 mitogenome PCGs (11,113 bp)
- Guam CRB signature not detected elsewhere
  - COI 'CRB-G' (Philippines, Palau, PNG, Hawaii, Sol Is.)
  - New incursion in Guam detected

OrNV detection by PCR (945 bp)



42 Guam CRB: ~80% OrNV positive

If CRB-G hasn't spread, how to reconcile the widespread severe damage vs. OrNV control failures?

Assessment of *Oryctes rhinoceros* mitochondrial genomes changes the understanding of its invasion and status in the Pacific Tay et al. (In prep.)

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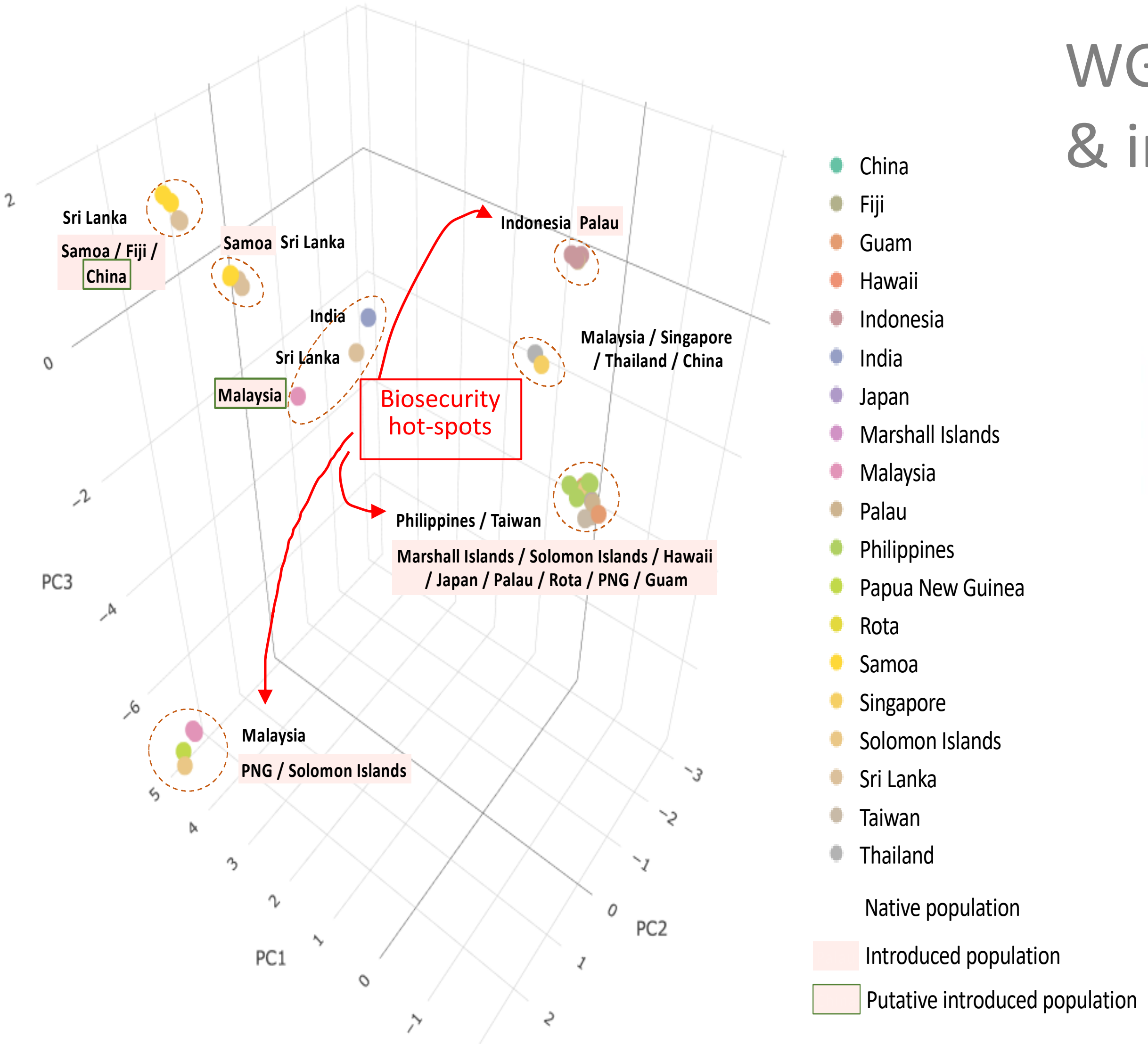
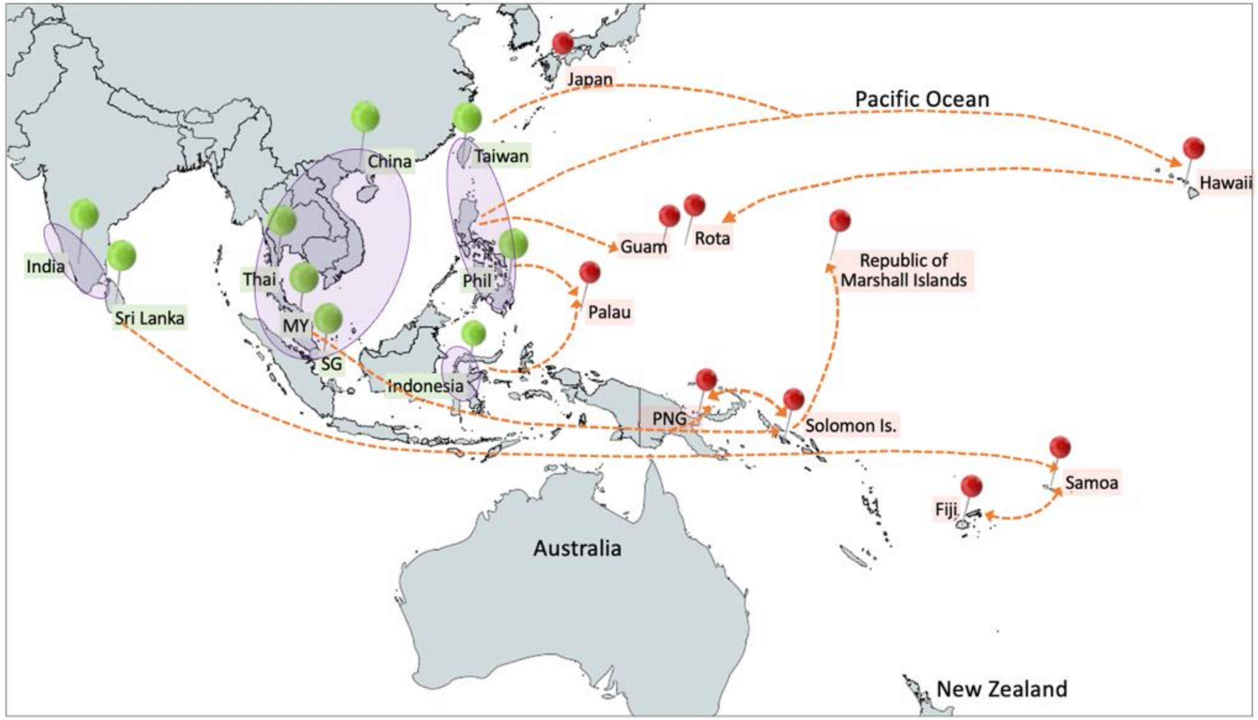
WGS: Biosecurity toolkit to identify 'hot-spots' & introduction pathways/invasion origins





- Identify potential sources for new BCA's

Coconut rhinoceros beetle mitochondrial genomes assessment redefines understanding of its Pacific invasions Tay et al. (In prep.)

Management options

Historical vs. Current Approaches

JOURNAL OF INVERTEBRATE PATHOLOGY 24, 82–92 (1974)

The Epizootiology of Two Pathogens of the Coconut Palm Rhinoceros Beetle

E. C. YOUNG

- Differences in modes of dispersal & infection between EPF vs. OrNV

- *Metarhizium anisopliae*
  - ~ 10-30% as effective as OrNV
  - Synergistic effect with OrNV

Marschall KJ (1970)
Nature 225, 288-9

NATURE VOL. 225 JANUARY 17 1970

Introduction of a New Virus Disease of the Coconut Rhinoceros Beetle in Western Samoa

IN 1963 Huger[1,2] discovered and described a new type of insect virus *Rhabdionvirus oryctes* Huger in populations of the rhinoceros beetle *Oryctes rhinoceros* L. (Dynastinae, Scarab., Col.) in Malaya. This pathogen is at present being tested for its use in the biological control of the rhinoceros beetle, which has become a devastating pest of coconut palm trees since its recent introduction to the islands of the South Pacific[3–5]. The first attempts to introduce *Rhabdionvirus* into populations of *Oryctes* began in 1967 in Western Samoa, where no virus disease had been found during the five years of investigation of the beetle population[6]. Grubs infected with the virus were supplied by the laboratory of the Biologische Bundesanstalt (Institut für Biologische Schädlingsbekämpfung) in Darmstadt, Germany.

The virus was propagated and mass produced in Samoa by feeding healthy grubs with a mixture of macerated carcasses of grubs which had died from *Rhabdionvirus* and rotten sawdust. To introduce the disease into the field a mixture of virus and sawdust was distributed over heaps of rotten coconut logs, in which rhinoceros beetles breed. In this way about 1,500 dead infected grubs were distributed on the island of Manono (March 1967) and in two locations on Savai'i (April 1967). In October 1968 the first *Oryctes* larvae with symptoms of the virus disease were recovered from field collections on Upolu, and after that they were found in increasing numbers on Upolu and in smaller numbers on Savai'i, whereas the beetle had almost disappeared on Manono. Infection experiments and electron microscopy confirmed that the virus collected in the field was *Rhabdionvirus oryctes*.

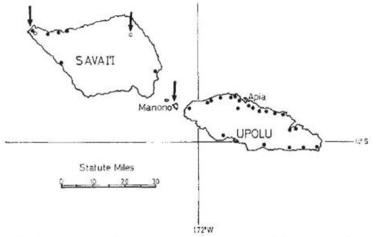


Fig. 1. Map of Western Samoa showing locations of disease caused by *Rhabdionvirus* in October 1969.

The first and largest amounts of infected larvae were found on Upolu in plantations opposite Manono. By the first half of 1969 the disease had spread over almost the whole of Upolu and some parts of Savai'i. The map (Fig. 1) shows the situation of the virus disease in the field in October 1969. Arrows and open circles represent the places where the virus was first introduced, black dots represent places where infected *Oryctes* were collected. Between January 1969 and May 1969, 1,370 out of 3,815 (35·9 per cent) grubs collected in the field died in the laboratory from the entomophagous fungus *Metarrhizium anisopliae* (Metsch.) Sorokin, and 2,185 (57·5 per cent) died from *Rhabdionvirus oryctes*; deaths from both diseases amounted to 93·4 per cent. Between May 1969 and October 1969, 760 out of 3,277 larvae collected in the field (23·2 per cent) died from *Metarrhizium* and 2,389 (73·0 per cent) from *Rhabdionvirus*, 96·2 per cent in all.

At the same time that infected *Oryctes* appeared in the field there was a conspicuous decrease in damage to the palms in certain areas, which indicates that not only had *Rhabdionvirus oryctes* established itself in the local beetle population, but that it already exercised some degree of control. The relatively high incidence of *Metarrhizium* among larvae collected in the field may be either an effect of contamination through handling, or a consequence of some synergistic effect between the two diseases. (The natural mortality of *Oryctes* from this fungus in Samoa averages 10–20 per cent.) Experiments on the host range of *Rhabdionvirus* indicate a high specificity so far, but the tests are not finished.

After this successful introduction of *Rhabdionvirus* into the beetle population in Samoa, field trials are in progress on a more economic basis, involving large scale release of the virus all over Western Samoa in order to achieve effective control of the beetle. Introduction into other islands is also being considered.

K. J. MARSCHALL

UN/SPC Rhinoceros Beetle Project,
Box No. 597,
Apia,
Western Samoa.

Received October 20, 1969.

OrNV Genome Comparisons

Tay et al. (Unpublished Data)

Others / Indonesia

Others: ~99.5% | Indonesia: ~99.6% | Others vs Indonesia: ~94.5%

	69_15-P...	56_01-V...	70-16-P...	71-18-N...	74-23-O...	MT150...	65_10-I...	MN623...	MW298...	68_14-...	67_12-...	66_11-...	MW298...
69_15-Pal-2.R_OrNV		99.0%	99.1%	99.0%	99.0%	98.9%	98.9%	98.9%	98.8%	98.9%	98.9%	98.8%	98.9%
56_01-ViL-Nal1_OrNV	99.0%		99.8%	99.7%	99.7%	99.6%	99.6%	99.6%	99.3%	99.5%	99.5%	99.5%	99.4%
70-16-Pal-4_OrNV	99.1%	99.8%		99.7%	99.7%	99.6%	99.6%	99.6%	99.3%	99.5%	99.6%	99.5%	99.4%
71-18-NI16-21_OrNV	99.0%	99.7%	99.7%		99.7%	99.7%	99.6%	99.6%	99.4%	99.5%	99.6%	99.5%	99.4%
74-23-OrA15_OrNV	99.0%	99.7%	99.7%	99.7%		[illegible]	[illegible]	99.6%	99.3%	99.5%	99.6%	99.5%	99.3%
MT150137	98.9%	99.6%	99.6%	99.7%	[illegible]		[illegible]	99.7%	99.4%	99.5%	99.6%	99.5%	99.4%
65_10-India-A1_OrNV	98.9%	99.6%	99.6%	99.6%	[illegible]	[illegible]		99.6%	99.3%	99.5%	99.5%	99.5%	99.2%
MN623374	98.9%	99.6%	99.6%	99.6%	99.6%	99.7%	99.6%		99.6%	99.5%	99.6%	99.5%	99.4%
MW298153	98.8%	99.3%	99.3%	99.4%	99.3%	99.4%	99.3%	99.6%		99.3%	99.3%	99.2%	99.2%
68_14-Mal3-2_OrNV	98.9%	99.5%	99.5%	99.5%	99.5%	99.5%	99.5%	99.5%	99.3%		99.5%	99.4%	99.2%
67_12-Mal1-10_OrNV	98.9%	99.5%	99.6%	99.6%	99.6%	99.6%	99.5%	99.6%	99.3%	99.5%		99.6%	99.2%
66_11-Mal1-9_OrNV	98.8%	99.5%	99.5%	99.5%	99.5%	99.5%	99.5%	99.5%	99.2%	99.4%	99.6%		99.2%
MW298154	98.9%	99.4%	99.4%	99.4%	99.3%	99.4%	99.2%	99.4%	99.2%	99.2%	99.2%	99.2%	
IND01_virus_Conseq_0...	94.2%	94.6%	94.6%	94.6%	94.6%	94.6%	94.5%	94.5%	94.4%	94.5%	94.5%	94.5%	94.5%
IND02_OrNV	94.2%	94.6%	94.6%	94.6%	94.6%	94.6%	94.5%	94.5%	94.4%	94.5%	94.5%	94.5%	94.5%
IND11_OrNV	94.2%	94.5%	94.5%	94.5%	94.5%	94.6%	94.5%	94.5%	94.3%	94.5%	94.5%	94.5%	94.5%
IND05_OrNV	94.1%	94.5%	94.5%	94.5%	94.5%	94.6%	94.5%	94.5%	94.3%	94.5%	94.5%	94.4%	94.4%
IND06_OrNV	94.1%	94.5%	94.5%	[illegible]	[illegible]	[illegible]	[illegible]	94.5%	94.3%	94.4%	94.4%	94.4%	94.4%
IND08_OrNV	94.1%	94.5%	94.5%	94.5%	[illegible]	[illegible]	[illegible]	94.5%	94.3%	94.4%	94.5%	94.4%	94.4%
IND12_OrNV	94.1%	94.5%	94.5%	94.5%	94.5%	94.6%	94.4%	94.5%	94.3%	94.4%	94.4%	94.4%	94.4%
IND07_OrNV	94.2%	94.5%	94.5%	94.5%	94.5%	94.6%	94.5%	94.5%	94.3%	94.5%	94.5%	94.5%	94.5%
IND10_OrNV	94.1%	94.5%	94.5%	94.5%	94.5%	94.6%	94.5%	94.5%	94.3%	94.5%	94.5%	94.5%	94.5%
IND09_OrNV	94.1%	94.5%	94.5%	94.5%	94.5%	94.6%	94.5%	94.5%	94.3%	94.5%	94.5%	94.5%	94.5%

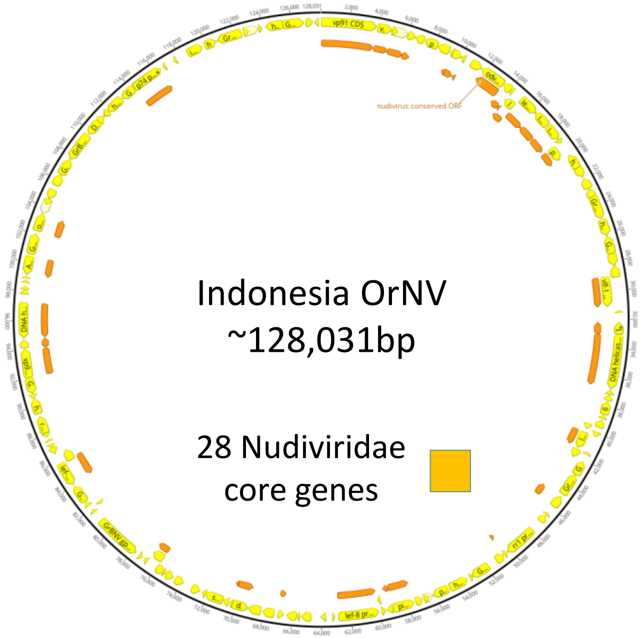
	IND01_...	IND02_...	IND11_...	IND05_...	IND06_...	IND08_...	IND12_...	IND07_...	IND10_...	IND09_...
69_15-Pal-2.R_OrNV	94.2%	94.2%	94.2%	94.1%	94.1%	94.1%	94.1%	94.2%	94.1%	94.1%
56_01-ViL-Nal1_OrNV	94.6%	94.6%	94.5%	94.5%	94.5%	94.5%	94.5%	94.5%	94.5%	94.5%
70-16-Pal-4_OrNV	94.6%	94.6%	94.5%	94.5%	94.5%	94.5%	94.5%	94.5%	94.5%	94.5%
71-18-NI16-21_OrNV	94.6%	94.6%	94.5%	94.5%	94.5%	94.5%	94.5%	94.5%	94.5%	94.5%
74-23-OrA15_OrNV	94.6%	94.6%	94.5%	[illegible]	94.5%	[illegible]	94.5%	94.5%	94.5%	94.5%
MT150137	94.6%	94.6%	94.6%	[illegible]	94.6%	[illegible]	94.6%	94.6%	94.6%	94.6%
65_10-India-A1_OrNV	94.5%	94.5%	94.5%	[illegible]	[illegible]	[illegible]	94.4%	94.5%	94.5%	94.5%
MN623374	94.5%	94.5%	94.5%	94.5%	94.5%	94.5%	94.5%	94.5%	94.5%	94.5%
MW298153	94.4%	94.4%	94.3%	94.3%	94.3%	94.3%	94.3%	94.3%	94.3%	94.3%
68_14-Mal3-2_OrNV	94.5%	94.5%	94.5%	94.5%	94.4%	94.4%	94.4%	94.5%	94.5%	94.5%
67_12-Mal1-10_OrNV	94.5%	94.5%	94.5%	94.5%	94.4%	94.5%	94.4%	94.5%	94.5%	94.5%
66_11-Mal1-9_OrNV	94.5%	94.5%	94.5%	94.4%	94.4%	94.4%	94.4%	94.5%	94.5%	94.5%
MW298154	94.5%	94.5%	94.5%	94.4%	94.4%	94.4%	94.4%	94.5%	94.5%	94.5%
IND01_virus_Conseq_0...		99.9%	99.7%	99.6%	99.6%	99.6%	99.6%	99.6%	99.6%	99.6%
IND02_OrNV	99.9%		99.7%	99.7%	99.7%	99.7%	99.6%	99.7%	99.6%	99.6%
IND11_OrNV	99.7%	99.7%		99.6%	99.6%	99.6%	99.6%	99.6%	99.6%	99.6%
IND05_OrNV	99.6%	99.7%	99.6%		99.6%	[illegible]	99.6%	99.6%	99.6%	99.6%
IND06_OrNV	99.6%	99.7%	99.6%	[illegible]		[illegible]	99.6%	99.6%	99.6%	99.6%
IND08_OrNV	99.6%	99.7%	99.6%	[illegible]	[illegible]		99.6%	99.6%	99.6%	99.6%
IND12_OrNV	99.6%	99.6%	99.6%	99.6%	99.6%	99.6%		99.6%	99.6%	99.6%
IND07_OrNV	99.6%	99.7%	99.6%	99.6%	99.6%	99.6%	99.6%		99.6%	99.6%
IND10_OrNV	99.6%	99.6%	99.6%	99.6%	99.6%	99.6%	99.6%	99.6%		99.6%
IND09_OrNV	99.6%	99.6%	99.6%	99.6%	99.6%	99.6%	99.6%	99.6%	99.6%	

	Historical samples		Current	
Country	N (AgRes NZ)	N ('MM' code)	N (This study)	Distribution
China		5		Native
Thailand		9		Native
Malaysia	2		6	Native
Singapore			2	Native
Indonesia			61	Native
Sri Lanka			5	Native
India	1			Native
Philippines		2	22	Native
Taiwan		6		Native
Palau	2		8	Invasive
Papua New Guinea	1		1	Invasive
Japan		4		Invasive
Solomon Islands	2		18	Invasive
Fiji	2		13	Invasive
Guam	10	15	19	Invasive
Rota		2		Invasive
Marshall Islands			4	Invasive
Samoa			20	Invasive
Hawaii		23		Invasive
Total	20	66	179	

~150 OrNV isolates

Assembly using:	Solomon Is.		Indonesia	
CRB sample origin/sample code	MN623374 (125,917bp)		IND01 OrNV (128,031bp)	
	%HQ	%PI	%HQ	%PI
Indonesia IND01	98.5	98.4	99.9	99
Indonesia IND02	98.2	98.8	99.9	98.9
Indonesia IND05	98.3	98.9	99.9	98.8
Indonesia IND06	97.8	98.7	99.7	98.5
Indonesia IND07	98.1	98.9	99.9	98.8
Indonesia IND08	98.1	98.6	99.8	98.5
Indonesia IND09	97.8	98.8	99.8	98.9
Indonesia IND10	98	98.9	99.8	98.8
Indonesia IND11	98.1	98.7	99.9	98.8
Indonesia IND12	97.4	98.8	99.9	98.7
Fiji 01-ViL-Nal1.R	100	98.3	95.6	98.6
India India-A1.R	100	98.4	96.2	98.7
Malaysia 11-Mal1-9.R	99.9	98.6	93.4	98.9
Mala[illegible] 12-Mal1-10.R	99.9	98.2	96.2	98.5
Malaysia 6[illegible]_1[illegible]-Mal3-2	100	98.5	96.1	98.8
Palau 70_16-Pal-4.R	100	98.3	96.1	98.7
Soliomon Islands 71_18-NI16-21	100	98.5	96	98.7
Samoa 74_23-OrA15	100	97.7	96.4	98.2

Others



Hypervariable/intergenic excluded: 96.2%

Only Nudiviridae core genes: 98.1%

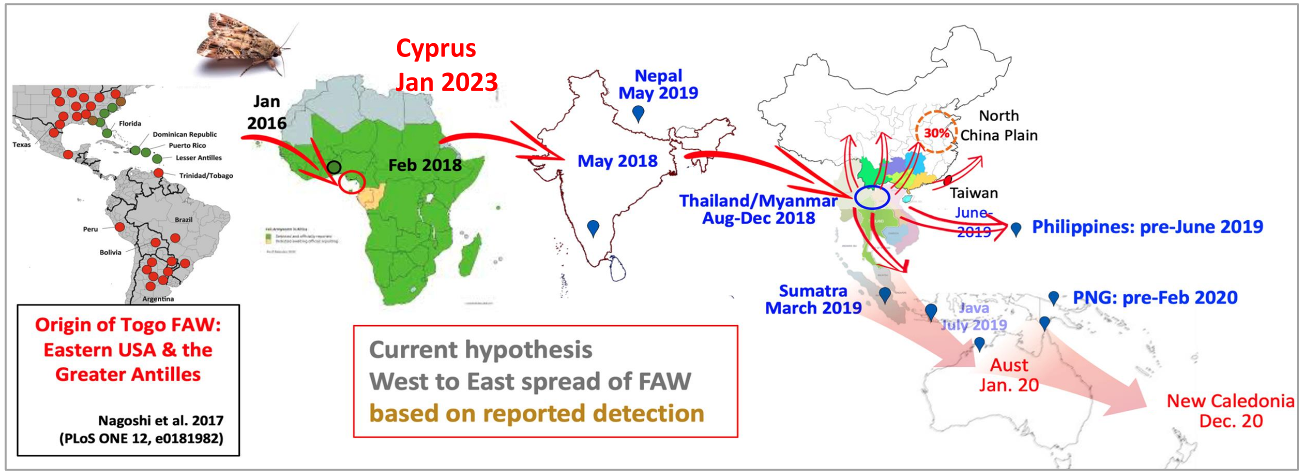
- Distinct variants!
- Distinct phenotypes?

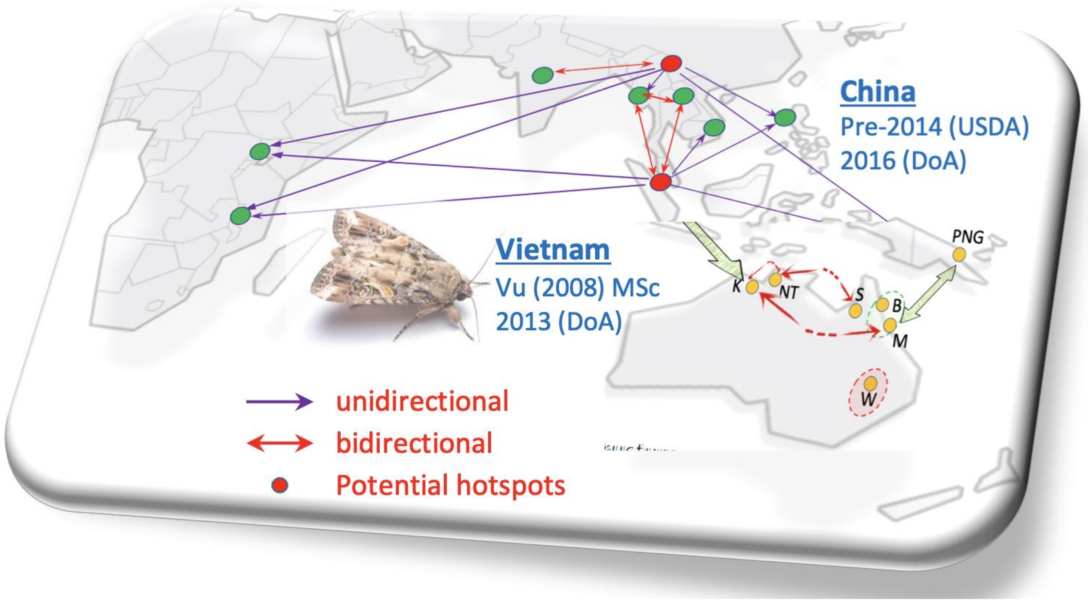
Indonesia OrNV: An alternative biocontrol agent?

Emerging coconut pests (& diseases) for the Pacific …

mtCOI vs. Genomics: Global spread of FAW

The world was caught unprepared!

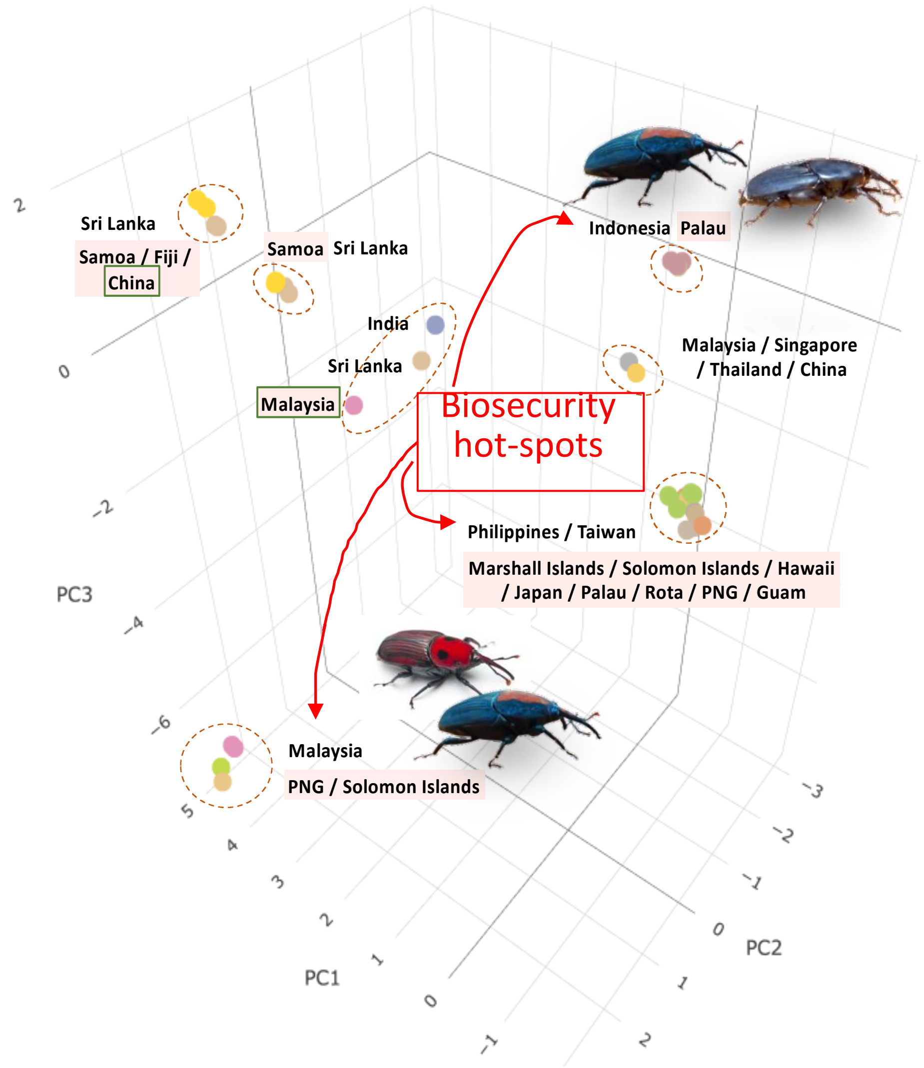




- Rapid spread (natural, unstoppable)
- single founder
- west-to-east

- Multidirectional (Human-assisted, stoppable)
- Multiple founder
- Multiple biosecurity hotspots

Red Palm Weevil (RPW) & other Palm weevil species complex



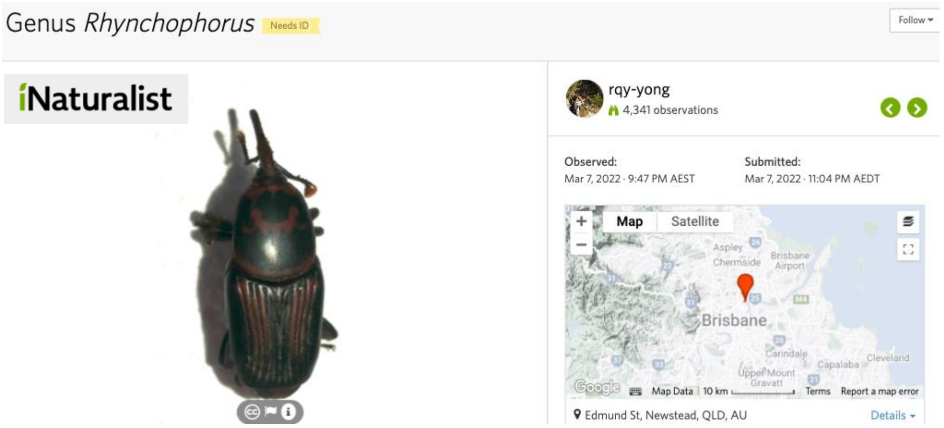
- China
- Fiji
- Guam
- Hawaii
- Indonesia
- India
- Japan
- Marshall Islands
- Malaysia
- Palau
- Philippines
- Papua New Guinea
- Rota
- Samoa
- Singapore
- Solomon Islands
- Sri Lanka
- Taiwan
- Thailand

Native population

Introduced population

Putative introduced population

Coconut rhinoceros beetle mitochondrial genomes assessment redefines understanding of its Pacific invasions
Tay et al. (In prep.)



rqy-yong commented 2y

@borisb Thank you for confirming my suspicions. I have the specimen retained; was already dead when found, my friends brought it to me having found the body in a plant they bought from Bunnings hardware store

reiner commented 2y

@rqy-yong probably send the specimen to your local museum since you still have it.

ausweevil commented 2y

Looks like Rhynchophorus bilineatus to me, rather than R. vulneratus (and certainly not R. ferrugineus), but I would need to see the underside of the rostrum in greater detail (higher resolution) to be sure. Better still check the male genitalia, which provide the only truly diagnostic characters of this species. The specimen is indeed a male; the brush of setae on the rostrum is clear in one of the photos. If species identification is crucial, you can send the specimen to me at the Australian National Insect Collection of CSIRO in Canberra.

R. bilineatus is the southern-most of the 3 Australasian Rhynchophorus species, occurs widely in New Guinea and surrounding islands. It has been intercepted in Australia a few times in the past but is not evidently established here.

Rolf Oberprieler

RPW & threats to coconut palms in Asia-Pacific

Time for a genomics approach?

Australian Government
Australian Centre for International Agricultural Research

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Web edition hosted at https://apps.lucidcentral.org/pppw

Coconut red palm weevil (180) 31/3/2024, 10:17 am

Pacific Pests, Pathogens, Weeds & Pesticides - Online edition

Coconut red palm weevil (180)

Common Name

Red palm weevil; also known as the Asian palm weevil or sago palm weevil.

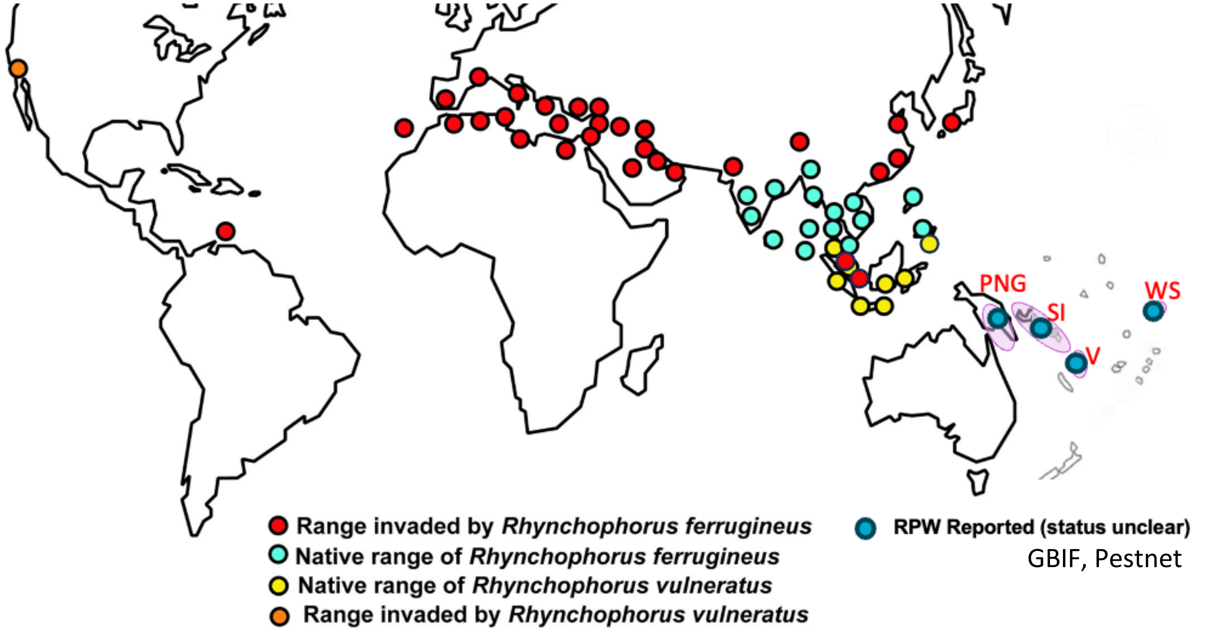
Scientific Name

Rhyncophorus ferrugineus

Distribution

Asia, Middle East, North Africa, the Caribbean, Europe, Oceania. It is recorded from Papua New Guinea, Samoa, Solomon Islands, and Vanuatu. Note, this pest has spread extensively in the Middle East and Europe in the last 30 years.

Photo 1. Adult red palm weevil, *Rhyncophorus ferrugineus*.



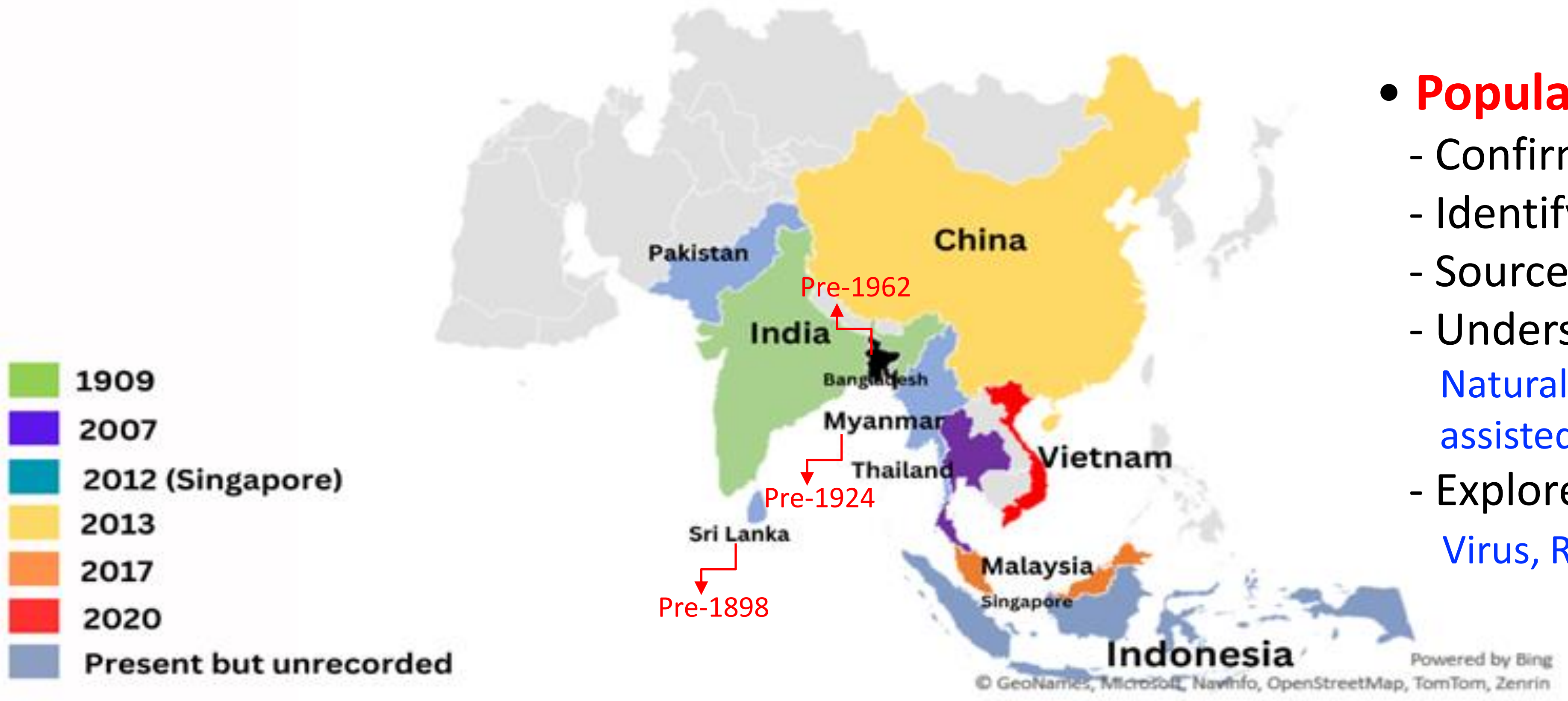
GBIF, Pestnet

Modified from Rugman-Jones (2013)

- Which species, how far have they spread?
- Pathway analysis (genomics)
- BCA options – time to build up our 'biosecurity preparedness tool-kit'?

CSIRO

Black Headed Caterpillar



Note: Sri Lanka outbreaks occur throughout the country from 1965 to 1985 (Perera *et al*, 2009)

- **Population genomic**
  - Confirm native population
  - Identify biosecurity hotspots
  - Source BCAs
  - Understand pathways

    Natural (unstoppable) vs. Human-assisted (behavioural)
  - Explore novel control options

    Virus, RNAi

Burma (see Ghosh C.C. (1924) Oryctes rhinoceros and other important palm pests in Burma. - pp. 99-103 in Report of the Proceedings of the 5th Entomology Meeting, Pusa, February 1923. - Calcutta.)

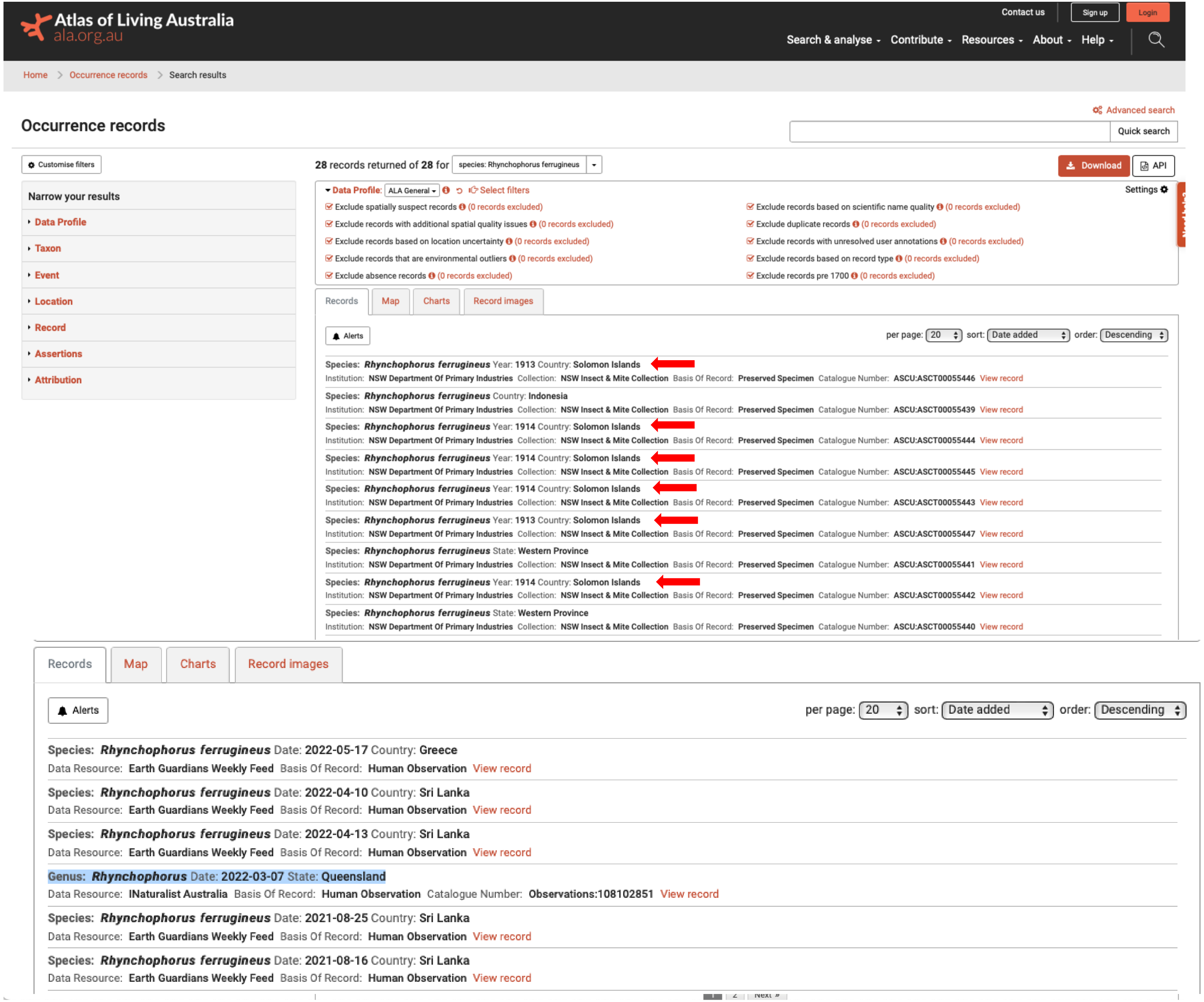
Bangladesh (see Alam, M. Z. (1962). A list of insects and mites of Eastern Pakistan. — 107 pp. Dacca, East Pakistan, Dep. Agric.)

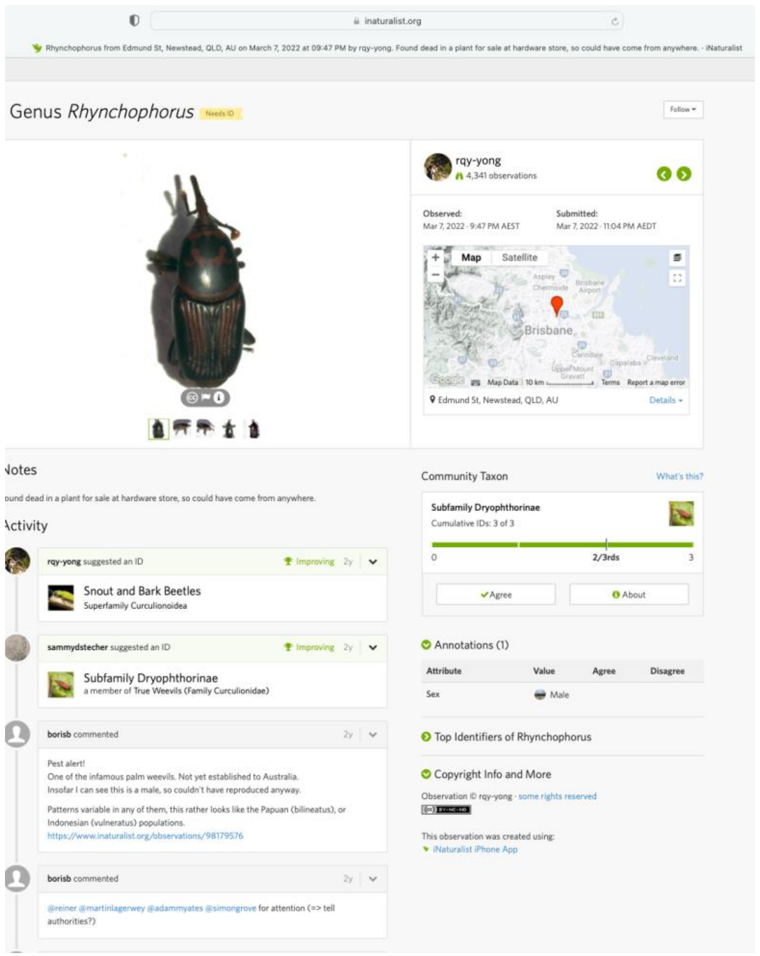
Sri Lanka (see Green, E. E. (1898). A coconut palm caterpillar. - Trop. Agriculturist Ceylon 26, 298-308.) cited in Perera et al. 1989

Thank You!

Health & Biosecurity
Wee Tek Tay, PhD
Team Leader (Pest Genomics)

+61 2 6246 4286
weetek.tay@csiro.au
https://people.csiro.au/T/T/Weetek-Tay


Atlas of Living Australia
ala.org.au
Contact us
Sign up
Login
Search & analyse
Contribute
Resources
About
Help
Home
Occurrence records
Search results
Occurrence records
Advanced search
Quick search
Customise filters
28 records returned of 28 for species: Rhynchophorus ferrugineus
Download
API
Narrow your results
Data Profile
Taxon
Event
Location
Record
Assertions
Attribution
Data Profile: ALA General
Select filters
Settings
Exclude spatially suspect records (0 records excluded)
Exclude records with additional spatial quality issues (0 records excluded)
Exclude records based on location uncertainty (0 records excluded)
Exclude records that are environmental outliers (0 records excluded)
Exclude absence records (0 records excluded)
Exclude records based on scientific name quality (0 records excluded)
Exclude duplicate records (0 records excluded)
Exclude records with unresolved user annotations (0 records excluded)
Exclude records based on record type (0 records excluded)
Exclude records pre 1700 (0 records excluded)
Records
Map
Charts
Record images
Alerts
per page: 20 sort: Date added order: Descending
Species: Rhynchophorus ferrugineus Year: 1913 Country: Solomon Islands
Institution: NSW Department Of Primary Industries Collection: NSW Insect & Mite Collection Basis Of Record: Preserved Specimen Catalogue Number: ASCU:ASCT00055446 View record
Species: Rhynchophorus ferrugineus Country: Indonesia
Institution: NSW Department Of Primary Industries Collection: NSW Insect & Mite Collection Basis Of Record: Preserved Specimen Catalogue Number: ASCU:ASCT00055439 View record
Species: Rhynchophorus ferrugineus Year: 1914 Country: Solomon Islands
Institution: NSW Department Of Primary Industries Collection: NSW Insect & Mite Collection Basis Of Record: Preserved Specimen Catalogue Number: ASCU:ASCT00055444 View record
Species: Rhynchophorus ferrugineus Year: 1914 Country: Solomon Islands
Institution: NSW Department Of Primary Industries Collection: NSW Insect & Mite Collection Basis Of Record: Preserved Specimen Catalogue Number: ASCU:ASCT00055445 View record
Species: Rhynchophorus ferrugineus Year: 1914 Country: Solomon Islands
Institution: NSW Department Of Primary Industries Collection: NSW Insect & Mite Collection Basis Of Record: Preserved Specimen Catalogue Number: ASCU:ASCT00055443 View record
Species: Rhynchophorus ferrugineus Year: 1913 Country: Solomon Islands
Institution: NSW Department Of Primary Industries Collection: NSW Insect & Mite Collection Basis Of Record: Preserved Specimen Catalogue Number: ASCU:ASCT00055447 View record
Species: Rhynchophorus ferrugineus State: Western Province
Institution: NSW Department Of Primary Industries Collection: NSW Insect & Mite Collection Basis Of Record: Preserved Specimen Catalogue Number: ASCU:ASCT00055441 View record
Species: Rhynchophorus ferrugineus Year: 1914 Country: Solomon Islands
Institution: NSW Department Of Primary Industries Collection: NSW Insect & Mite Collection Basis Of Record: Preserved Specimen Catalogue Number: ASCU:ASCT00055442 View record
Species: Rhynchophorus ferrugineus State: Western Province
Institution: NSW Department Of Primary Industries Collection: NSW Insect & Mite Collection Basis Of Record: Preserved Specimen Catalogue Number: ASCU:ASCT00055440 View record
Records
Map
Charts
Record images
Alerts
per page: 20 sort: Date added order: Descending
Species: Rhynchophorus ferrugineus Date: 2022-05-17 Country: Greece
Data Resource: Earth Guardians Weekly Feed Basis Of Record: Human Observation View record
Species: Rhynchophorus ferrugineus Date: 2022-04-10 Country: Sri Lanka
Data Resource: Earth Guardians Weekly Feed Basis Of Record: Human Observation View record
Species: Rhynchophorus ferrugineus Date: 2022-04-13 Country: Sri Lanka
Data Resource: Earth Guardians Weekly Feed Basis Of Record: Human Observation View record
Genus: Rhynchophorus Date: 2022-03-07 State: Queensland
Data Resource: INaturalist Australia Basis Of Record: Human Observation Catalogue Number: Observations:108102851 View record
Species: Rhynchophorus ferrugineus Date: 2021-08-25 Country: Sri Lanka
Data Resource: Earth Guardians Weekly Feed Basis Of Record: Human Observation View record
Species: Rhynchophorus ferrugineus Date: 2021-08-16 Country: Sri Lanka
Data Resource: Earth Guardians Weekly Feed Basis Of Record: Human Observation View record


inaturalist.org
Rhynchophorus from Edmund St, Newstead, QLD, AU on March 7, 2022 at 09:47 PM by rqy-yong. Found dead in a plant for sale at hardware store, so could have come from anywhere. · iNaturalist
Genus Rhynchophorus
rqy-yong
4,341 observations
Observed: Mar 7, 2022 · 9:47 PM AEST
Submitted: Mar 7, 2022 · 11:04 PM AEDT
Map
Satellite
Brisbane
Edmund St, Newstead, QLD, AU
Details
Notes
Found dead in a plant for sale at hardware store, so could have come from anywhere.
Activity
rqy-yong suggested an ID
Improving
Snout and Bark Beetles
Superfamily Curculionoidea
sammydstecher suggested an ID
Improving
Subfamily Dryophthorinae
a member of True Weevils (Family Curculionidae)
borisb commented
Pest alert!
One of the infamous palm weevils. Not yet established to Australia.
Insofar I can see this is a male, so couldn't have reproduced anyway.
Patterns variable in any of them, this rather looks like the Papuan (bilineatus), or Indonesian (vulneratus) populations.
https://www.inaturalist.org/observations/98179576
borisb commented
for attention (=> tell authorities?)
Community Taxon
What's this?
Subfamily Dryophthorinae
Cumulative IDs: 3 of 3
Agree
About
Annotations (1)
Attribute Value Agree Disagree
Sex Male
Top Identifiers of Rhynchophorus
Copyright Info and More
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This observation was created using:
iNaturalist iPhone App

Department for Environment Food & Rural Affairs

Plant Pest Factsheet

Red palm weevil

Rhynchophorus ferrugineus

Figure 1. Red palm weevil adult intercepted in the UK on a gourd imported from Sri Lanka © Fera

Geographical Distribution

Rhynchophorus ferrugineus is present in the following regions and countries: **Europe and Mediterranean**: Albania, Algeria, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Jordan, Libya, Malta, Morocco, Palestinian Authority Territories, Portugal, Slovenia, Spain, Tunisia and Turkey. It may also be more widespread in North Africa. **Asia**: Bahrain, Bangladesh, Cambodia, China, Georgia, India, Indonesia, Iran, Iraq, Japan, Jordan, Kuwait, Laos, Lebanon, Malaysia, Myanmar, Oman, Pakistan, Philippines, Qatar, Saudi Arabia, Sri Lanka, Syria, Taiwan, Thailand, United Arab Emirates, Vietnam and Yemen. **Caribbean**: Aruba, Curaçao and Netherlands Antilles. **Oceania**: Australia, Papua New Guinea, Solomon Islands, Vanuatu, Western Samoa.

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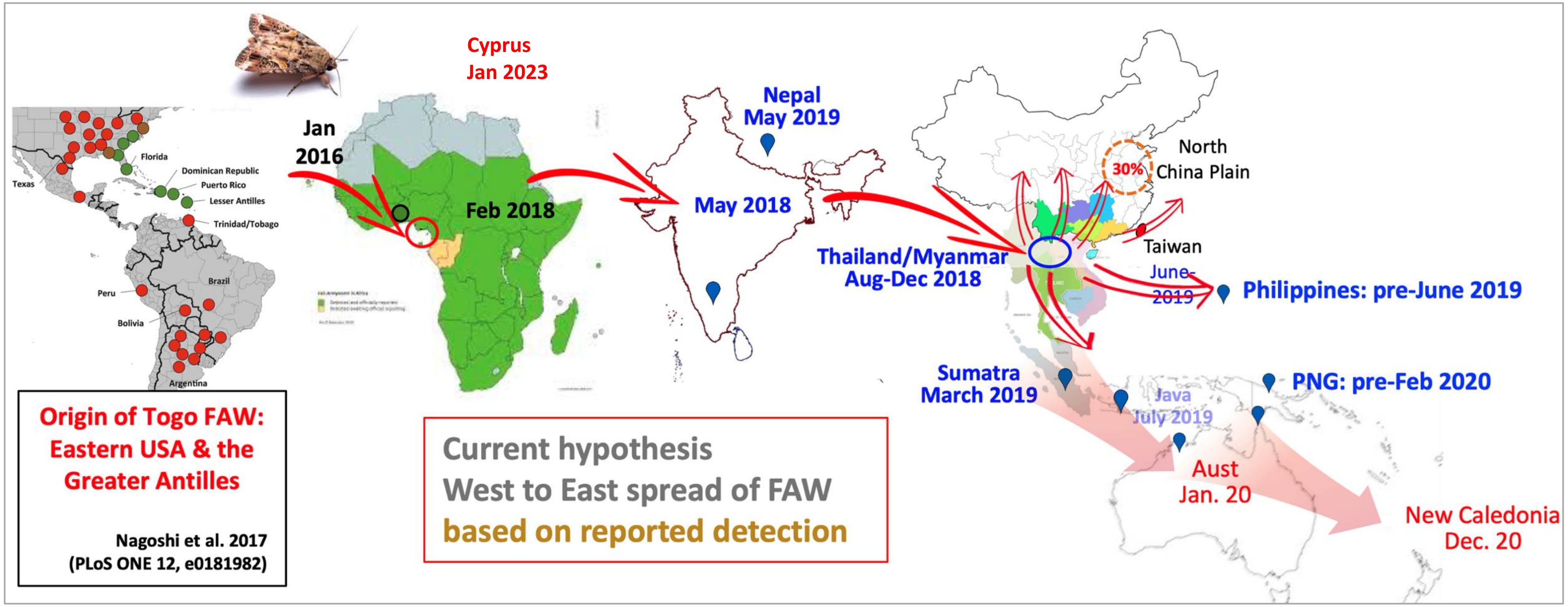
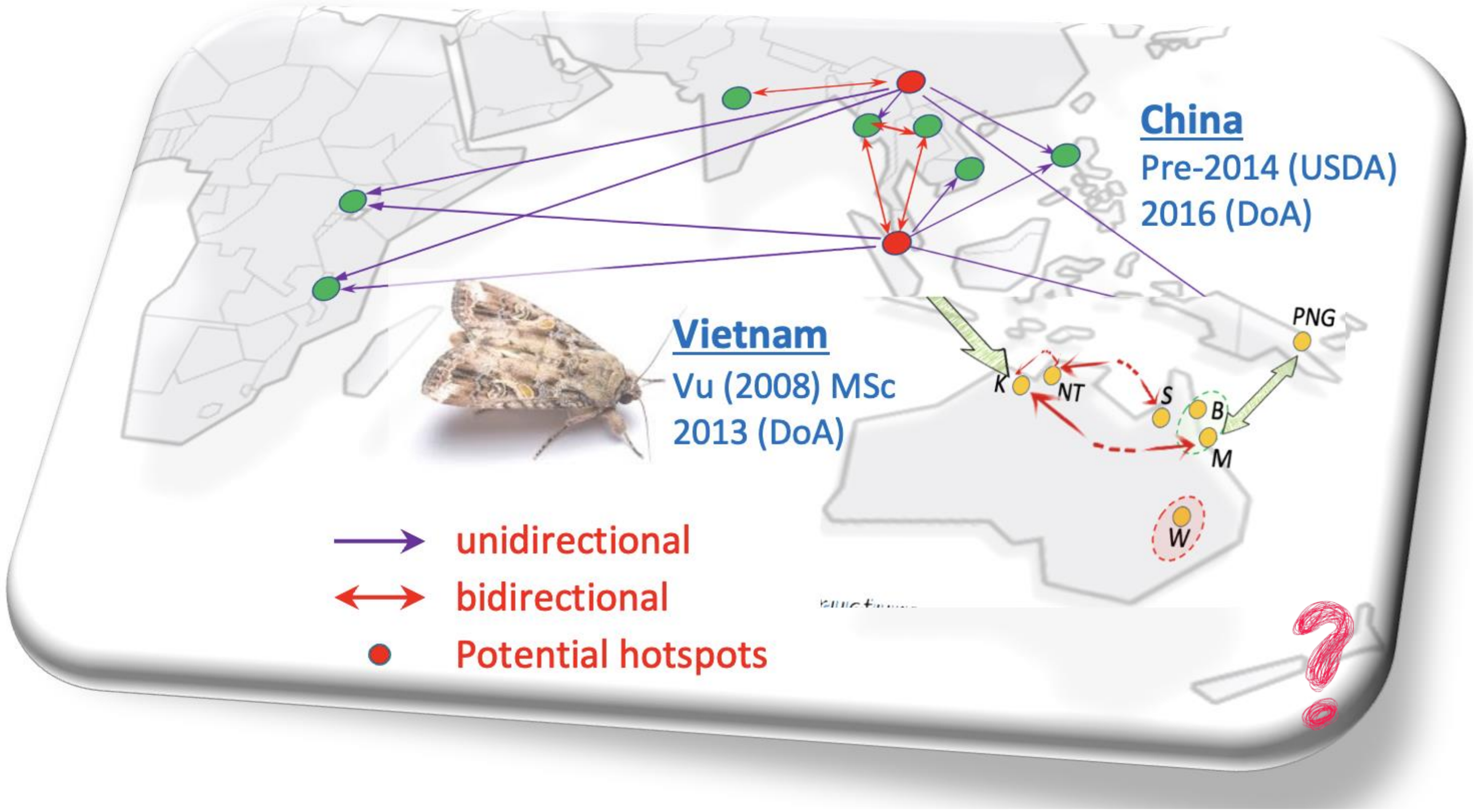
The global spread of FAW

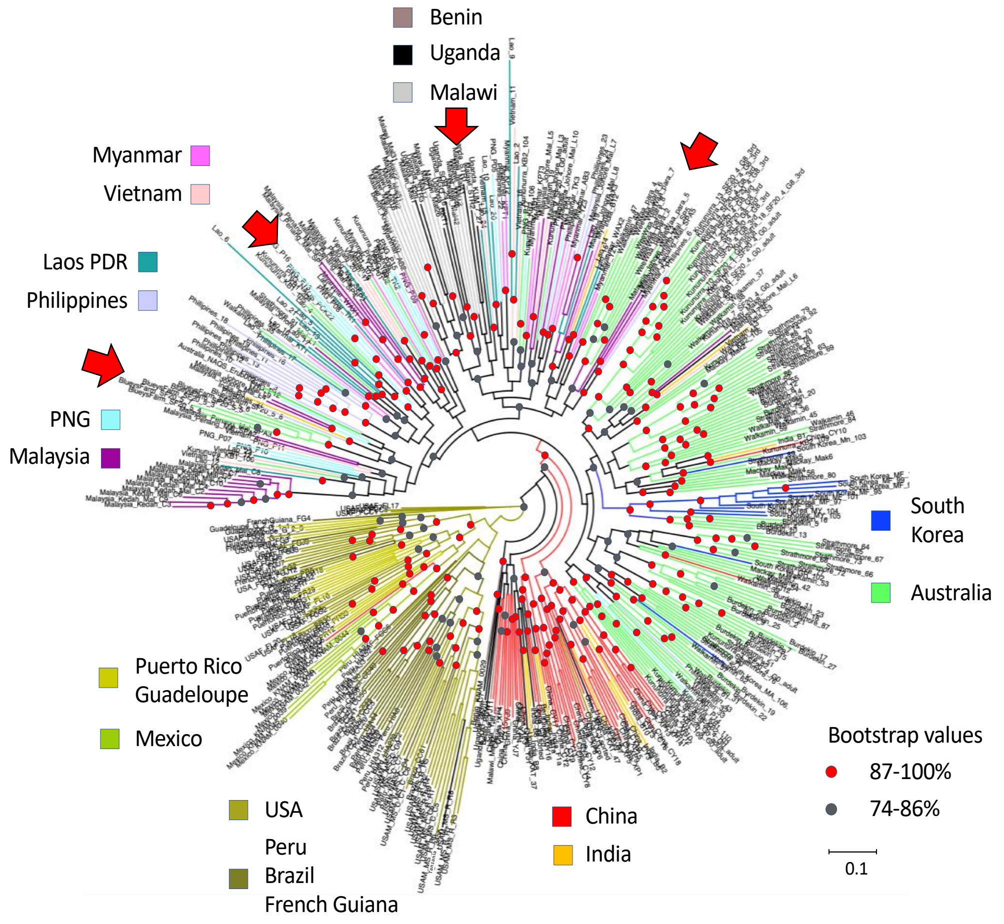
Single gene markers approach via DNA barcoding

- Low genetic diversity in pest pop/s
- Single introduction (west Africa)
- Recent & rapid (West-to-East) spread via wind & natural ability
- **Natural spread (unstoppable) vs. Human-assisted (trade; risks can be reduced)**



Pathways & gene flow in East Africa, Asia & Australia





- Two potential geographic hotspots
- Keep in mind that there are other potential regions not surveyed (e.g., Thailand, Indonesia)

- Current assumption: Single pathway into Australia

- Multiple introductions in Asia/SEA
- Multiple pathways into Australia
  - Significant structures western ≠ eastern populations

Complex multiple introductions drive fall armyworm invasions into Asia and Australia
Rane et al. (2023)

CSIRO

FAW IN SEA

Bulletin of Entomological Research

cambridge.org/ber

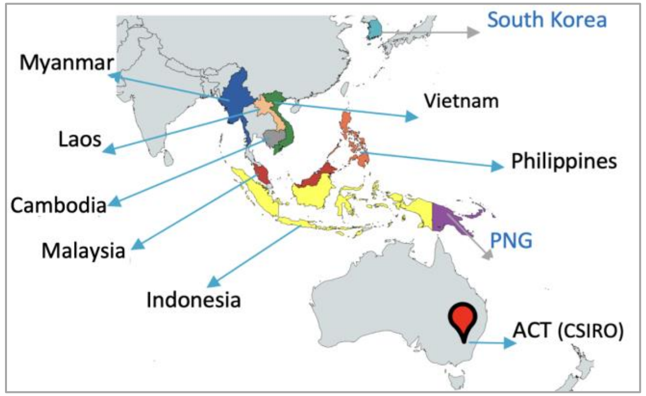
Population genetics reveal multiple independent invasions of *Spodoptera frugiperda* (Lepidoptera: Noctuidae) in China

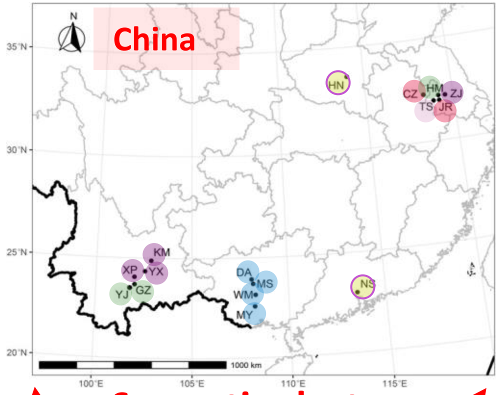
Yun-Yuan Jiang, Yi-Yin Zhang, Xin-Yu Zhou, Xiao-Yue Hong and Lei Chen

Multiple introductions
- Asia
- SE Asia

467 FAWs, 890 SNPs
- 36 invasive populations
- 13 countries
- Africa, Asia, SEA, Oceania

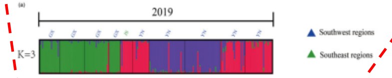
- 9 native populations
- 7 countries
- North, Central, South Americas, Caribbean

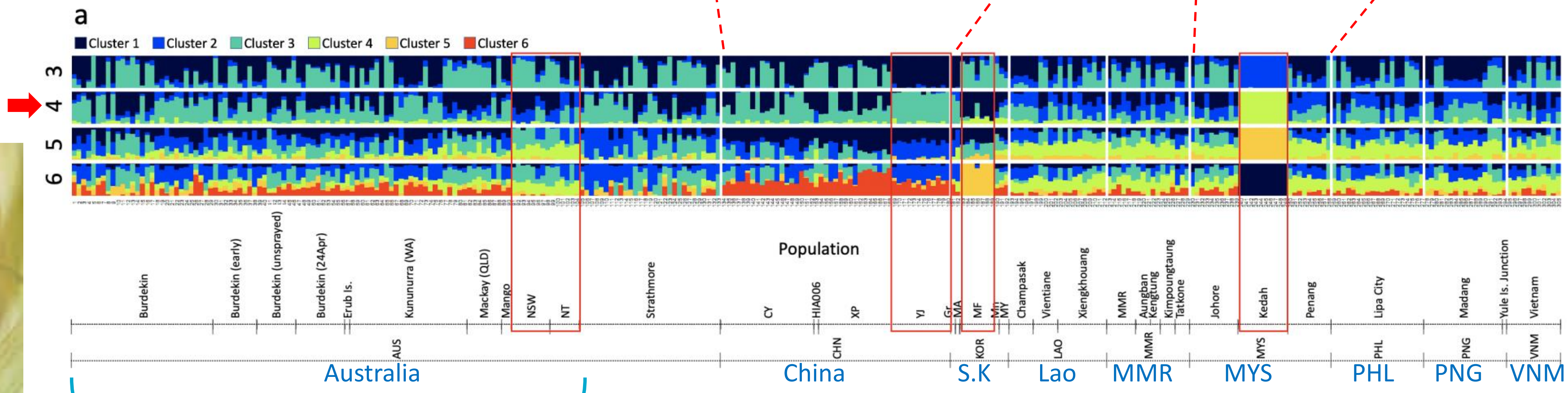




6 genetic clusters

3 clusters





What are the scenarios in Australia?

Complex multiple introductions drive fall armyworm invasions into Asia and Australia
Rane et al. (2023)

Palm Pests and Diseases + Biosecurity
2024 webinar schedule

Part 1 — 2 April — Pests

Part 2 — 23 April — Diseases

Part 3 — 21 May — Future Strategies & Activities

Pacific Conference — 2-5 July — Pacific Conference

ASEAN FAW ACTION PLAN
Supporting IPM Across Southeast Asia

Pacific Conference

"Minimising the economic impact of the Coconut Rhinoceros Beetle and other major pests of coconut through innovative and participatory research outreach actions."

Second notice and call for abstracts

Towards an action plan to minimise the impacts of Coconut Rhinoceros Beetle and other major insect pests of coconut in the Pacific Islands:

Global status, genetics, distribution and control.

Deadline: 31st May 2024

See https://www.spc.int/updates/news/media-release/2024/01/second-notice-and-call-for-abstracts-towards-an-action-plan-to

Information for delegates and participants

1- Dates and venue

The Coconut Pest conference will be held from **2nd -5th July 2024 at the Solomon Islands National University, Honiara, Solomon Islands.**

2- Sponsors of the event

The major sponsor of the event is the Ministry of Foreign Affairs and Trade (New Zealand). The other sponsors include the Crawford Fund, ASEAN FAW Action Plan, the International Coconut Genetic Resources Network (COGENT) and the Solomon Islands National University (SINU).

3- Organisation of the meeting

The conference is hosted by the Pacific Community (SPC) and Solomon Islands National University (SINU) in collaboration with the International Coconut Genetic Resources Network (COGENT).

ASEAN FAW ACTION PLAN
Supporting IPM Across Southeast Asia

Pacific Community
Communauté du Pacifique

PPPO
PACIFIC PLANT PROTECTION ORGANIZATION (PPPO)

Palm Pests and Diseases + Biosecurity

Webinar Series

Part 1: 2 April 2024

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