Pest diagnostics in phytosanitary systems

Natural Enemies and Potential Classical Biological Control of Invasive Scale Insects (*Hemiptera: Coccomorpha*) in Sub-Saharan Africa

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Introduction

Sap-sucking scale insects (Hemiptera: Sternorrhyncha: Coccomorpha)

- Are some of the most overlooked agricultural pests
- They extract plant sap, interfering with photosynthesis, weakening the plant and reducing yield
- Some scale insects transmit viruses, albeit on a much smaller scale than other Sternorrhyncha
- Many scale insects expel copious sugary honeydew, resulting in sooty mould growth

Photo: P.A.C.Ooi, ex-CABI

Introduction cont'd

Scale insects are:

Frequently protected by a waxy and/or powdery covering;

A hard shell-like covering (Diaspididae "armoured scales")

Both of these aspects of morphology protect scales from contact insecticides and detergent spraying

Scale insects are:

Often cryptic, and therefore often overlooked during quarantine inspection, especially eggs or early developmental stages. This contributes to their invasiness.

Introduction cont'd

- Insecticides have been shown to increase populations of scale insects (e.g. on oranges in California) because of their effect on natural enemies, in particular parasitoid wasps (Hymenoptera).
- Parasitoid wasps can be extremely effective in regulating scale insect pest populations.
- Parasitoids have been particularly effective against invasive scale insect pests, which by definition have "escaped" into enemy-free space. This is Classical Biological Control.
- Parasitoids are often extremely host-specific making them highly appropriate for introductions.

Microterys nietneri **(Encyrtidae)**
Female attacking *Coccus hesperidum*.

Photo & © Mike Rose

Introduction cont'd

Cassava (*Manihot esculenta*) is native to South America, but widely introduced in the Old World tropics where it is a major staple food.

Cassava mealybug (*Phenacoccus manihoti*) originates in S. America and was introduced accidentally into Africa in the early 70's causing widespread damage, and seriously affecting the livelihoods of millions.

P. manihoti arrived in Africa leaving its principal natural enemy *Anagyrus lopezi* (Encyrtidae) behind in South America, the main reason for the huge outbreaks and rapid spread of the mealybug.

Introduction cont'd

Anagyrus lopezi (Encyrtidae) was first introduced into Central Africa in the mid 1980s in a project headed by IITA. It spread rapidly and effectively, controlling the cassava mealybug.

Despite being among the most well-studied biocontrol agents *A. lopezi* is currently known to attack only 3 mealybug species, all in the genus *Phenacoccus.*

Estimates of the overall financial benefit of releasing *A. lopezi* into Africa vary greatly depending on the parameters used, but are at least US$8 billion, and could be as high as US$20 billion projected over 40 years (Zeddies *et al*., 2001).

Introduction cont'd

For the present study we selected the seven most important invasive mealybugs in sub-Saharan Africa:

Phenacoccus solenopsis (cotton mealybug) 1

Rastrococcus invadens (fruit tree mealybug) 2

Paracoccus marginatus (papaya mealybug) 3

Pseudococcus cryptus (citriculus mealybug) 4

Aonidiella comperei (false yellow scale) 5

Fiorinia proboscidaria (snout scale) 6

Parlatoria ziziphi (black parlatoria scale) 7

1 2 3 4

5 6 7

Photo credits: https://apps.lucidcentral.org/ppp/text/web_mini/entities/cotton_mealybug_373.htm (1); T. Kondo, Agrosavia, Colombia (2); A. Winotai, Thailand (3); F. Makale, CABI (4); : https://www.agrolink.com.br/problemas/cochonilha_3013.html (5); L. de Roffignac, Cirad (6); https://www.facebook.com (7)

Introduction cont'd

The aim of this presentation is to raise awareness of the importance and potential of native and introduced parasitoids of the most important invasive scale insects in sub-Saharan Africa.

Photo credits: https://apps.lucidcentral.org/ppp/text/web_mini/entities/cotton_mealybug_373.htm (1); T. Kondo, Agrosavia, Colombia (2); A. Winotai, Thailand (3); F. Makale, CABI (4); : https://www.agrolink.com.br/problemas/cochonilha_3013.html (5); L. de Roffignac, Cirad (6); https://www.facebook.com (7)

Methodology

U.K. Darwin Initiative-funded project on scale insects in Kenya, 2018 -

- Field surveys in coastal Kenya during the project's duration (2018-2021) yielded several species of Hymenopterous primary parasitoid wasps.
- Many specimens contained immature parasitoid stages, often impossible to identify even to family-level using conventional methods. Where possible, DNA extraction was undertaken and both nuclear (28SD2-D3) and mitochondrial (CO1 "barcode") sequences were obtained for further identification.

"K78" Kwale Co., Tiwi, Farm 1
ex *Paracoccus marginatus*

Results

***Phenacoccus solenopsis* (solenopsis mealybug)** origin: southwestern North America

26 primary parasitoid species recorded worldwide (J.S. Noyes, Universal Chalcoidoidea Database; accessed Sept 2021).

10 species known from sub-Saharan Africa, including *Aenasius arizonensis* newly recorded during this study.

16 species as potential classical biological control agents.

Photo: https://apps.lucidcentral.org/ppp/text/web_mini/entities/cotton_mealybug_373.htm

Results cont'd

***Rastrococcus invadens* (fruit tree mealybug)**

13 species of parasitoids known worldwide

8 known from sub-Saharan Africa

5 potential species for classical biological control

Photo: T. Kondo, Agrosavia, Colombia

Results cont'd

***Paracoccus marginatus* (papaya mealybug)**
(origin: northern South America)

3 parasitoids recorded: Encyrtidae

Acerophagus papayae	Mexico
Anagyrus loecki	Costa Rica
Pseudleptomastix mexicana	Mexico

Photo: F. Makale, CABI

Results cont'd

***Paracoccus marginatus* (papaya mealybug)**
(origin: northern South America)

Aenasius arizonensis newly recorded for Africa
Reared ex *P. marginatus* Kwale Feb. 2020

Photo: F. Makale, CABI

Results cont'd

***Pseudococcus cryptus* (citriculus mealybug)**
(origin: South America)

13 parasitoid species known worldwide

4 known from sub-Sharan Africa

9 parasitoid species as potential biological control agents

Photo: F. Makale, CABI

Results cont'd

Introduced armoured scales in Eastern Africa

***Aonidiella comperei* (false yellow scale)**
possibly from Australasia

No parasitoid wasps for potential classical biological control known.

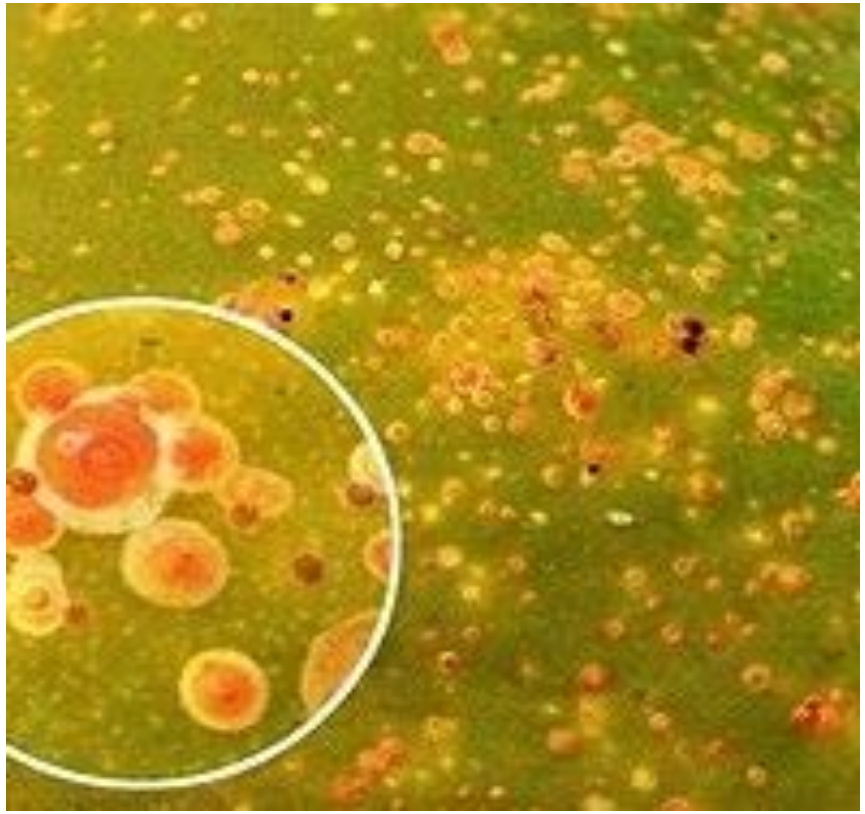

Photo: https://www.agrolink.com.br/problemas/cochonilha_3013.html

Results cont'd

Introduced armoured scales in Eastern Africa cont'd

***Fiorinia proboscidaria* (snout scale)** from Southern Asia

- No parasitoid wasps used for biological control known. An undescribed species of *Encarsia* reared at Kwale during the present study.

Photo: https://www.growingproduce.com/crop-protection/watch-out-for-snout-scale-in-florida-citrus/

***Parlatoria ziziphi* (black parlatoria scale)** from Southern Asia

13 parasitoid species known worldwide

12 known from sub-Saharan Africa, but several species recorded only from South Africa

Photo: https://www.facebook.com

Discussion

Most of these invasive scale insect pests show great potential for Classical Biological Control using parasitoid wasps in sub-Saharan Africa

Photo: Darwin Initiative project

Recommendations

- **Field surveys for indigenous parasitoids (and other natural enemies) urgently needed.**
  - Baseline data need to be gathered before considering Classical Biological Control introductions
  - Famers and extension workers learn to recognise parasitoid presence and activity
  - Regional, National and International pest management authorities need capacity for the identification of pests and parasitoids
  - Eventual incorporation of DNA-based identification will be essential
  - Simple, local mass-rearing methods for indigenous and exotic parasitoids can be developed
  - Potential Classical Biological Control candidates are assessed carefully before release

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WHERE HERITAGE LIVES ON

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CABI

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Theme: *"Enhancing Phytosanitary Systems for Healthy Plants, Safe & Sustainable Trade"*
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