

# **Kona Coffee Root-knot Nematodes: Disease Symptoms and Management**

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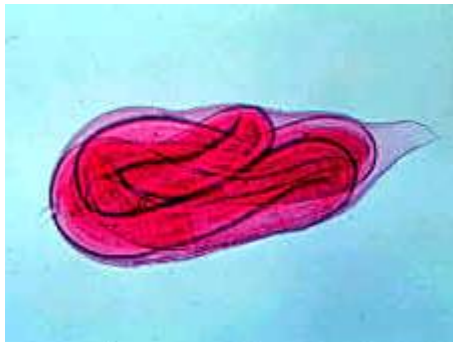
Coffee Talk  
June 13, 2007  
Kainaliu, Hawaii



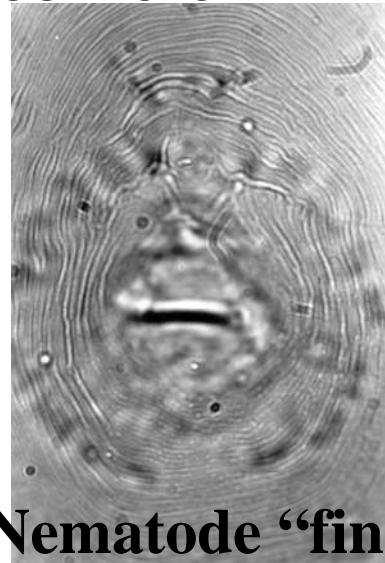
- Coffee trees around the world are attacked by at least 18 species of root-knot nematodes (*Meloidogyne* spp.)
- *Meloidogyne exigua* and *Meloidogyne incognita* are the most common species found in coffee roots.
- In Hawaii there are two species attacking coffee: *Meloidogyne konaensis* (Kona) and *Meloidogyne hapla* (Maui)



- Coffee decline has a fairly long history on Kona, going back probably at least to the 1960's, but the cause was not identified at the time.
- In the 1990's, some large farms had repeated re-planting problems over large acreages, having to replant the same ground every few years due to plant death.
- From 1991-1994, the UH collected a new species of root-knot nematodes from Kona coffee and determined it was most likely cause of coffee decline in Kona. It was *Meloidogyne konaensis*.



- By 2004, 34% of coffee plantations sampled in Kona were infested with *M. konaensis*.
- The pest causes an estimated 20-25% overall reduction in coffee yields and results in many indirect business losses as well (water, fertilizer, labor, re-planting costs, loss of sales).
- We do not know how this nematode came to Kona or how it evolved, but we suspect it came to Hawaii as early as the 19th century when coffees were introduced on a large scale to Kona.



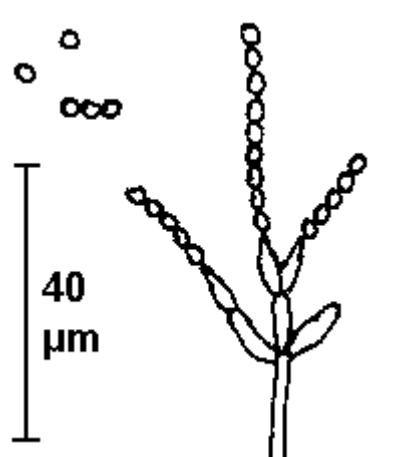
**Nematode “fingerprint”**

# Create and maintain a complex soil ecosystem, which has a number of effects, including:

- Better soil structure, organic matter, and nutrition
- Better soil moisture retention
- More nematode antagonists

## How to do this?

- Composts and mulches (coffee pulp and cherry is good)
- Grow coffee under shade



## Botanical Nematicides

### Beneficial Nematodes

*Steinernema* species

### Biocontrol Bacteria

Deny, Blue Circle (*Burkholderia cepacia*)

Activate (*Bacillus chitinosporus*)

### Biocontrol Fungi

DiTera (*Myrothecium verrucaria*)

MeloCon, BioAct (*Paecilomyces lilacinus*)

### Chitin

ClandoSan

Shrimp Shell meal

### Botanical Nematacide

Nemastop (Organic extracts w/Fatty acids)

Dragonfire (sesame oil)

Ontrol (sesame meal)

Nemagard (ground up sesame plant)

Neem cake

Armorex (sesame oil, garlic,

## Producers or Distributors

[Nitron Industries](#), [Johnny's Seed](#), [BioLogic](#), [Hydro-Gardens](#)

[Stine Microbial Products](#)

[Rincon Vitova](#)

[Valent USA](#), [Peaceful Valley](#),  
[Prophyta](#)

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[Poulenger USA](#)

[Natural Organic Products](#)

[Monsoon](#), [Peaceful Valley](#)

[Soils Technology Corp](#)

**Table 1. Nematode-resistant rootstock for perennial fruit.**

<b>Fruit</b>	<b>Rootstock</b>
Apple	No commonly used rootstock is completely resistant
Pears	Bartlett, Quince (slight resistance)
Asian Pear	Calleryana
Citrus	Poncirus trifoliata, lime, rough lemon, sour orange Forner-Alcaide 5
Grapes	Freedom, Harmony, Dog Ridge, Ramsey
Peach & Nectarines	Nemaguard, Nemared, Citation, Hansen 536
Plums	Myrobalan 29-C, Marianna 2624
Apricots & Almonds	Nemaguard, Nemared, Myrobalan, Marianna 2624
Cherries	Mazzard, Mahaleb

**The main ways that nematodes are controlled on coffee globally are chemical and host resistance.**

- Host resistance is being developed around the world.

Interspecific hybrids

*Coffea canephora* is resistant

Cross with *C. arabica* to get resistant coffee varieties (breeding)

Examples: “Timor Hybrid” and “Nemaya” varieties

Or, *C. canephora* varieties are used as rootstocks themselves, as with the “Apoata” rootstock in Brazil.

In Hawaii we have ‘Fukunaga’

Edward Fukunaga started a collection of coffees at the UH Kona Experiment Station in the 1950’s.

*C. liberica* var. *dewevrei* = Fukunaga

2000 Kona Coffee Festival Cupping Contest won by *C. arabica* Typica ‘Progeny 502’ scion grafted onto ‘Fukunaga’

- Also *C. purpurea*

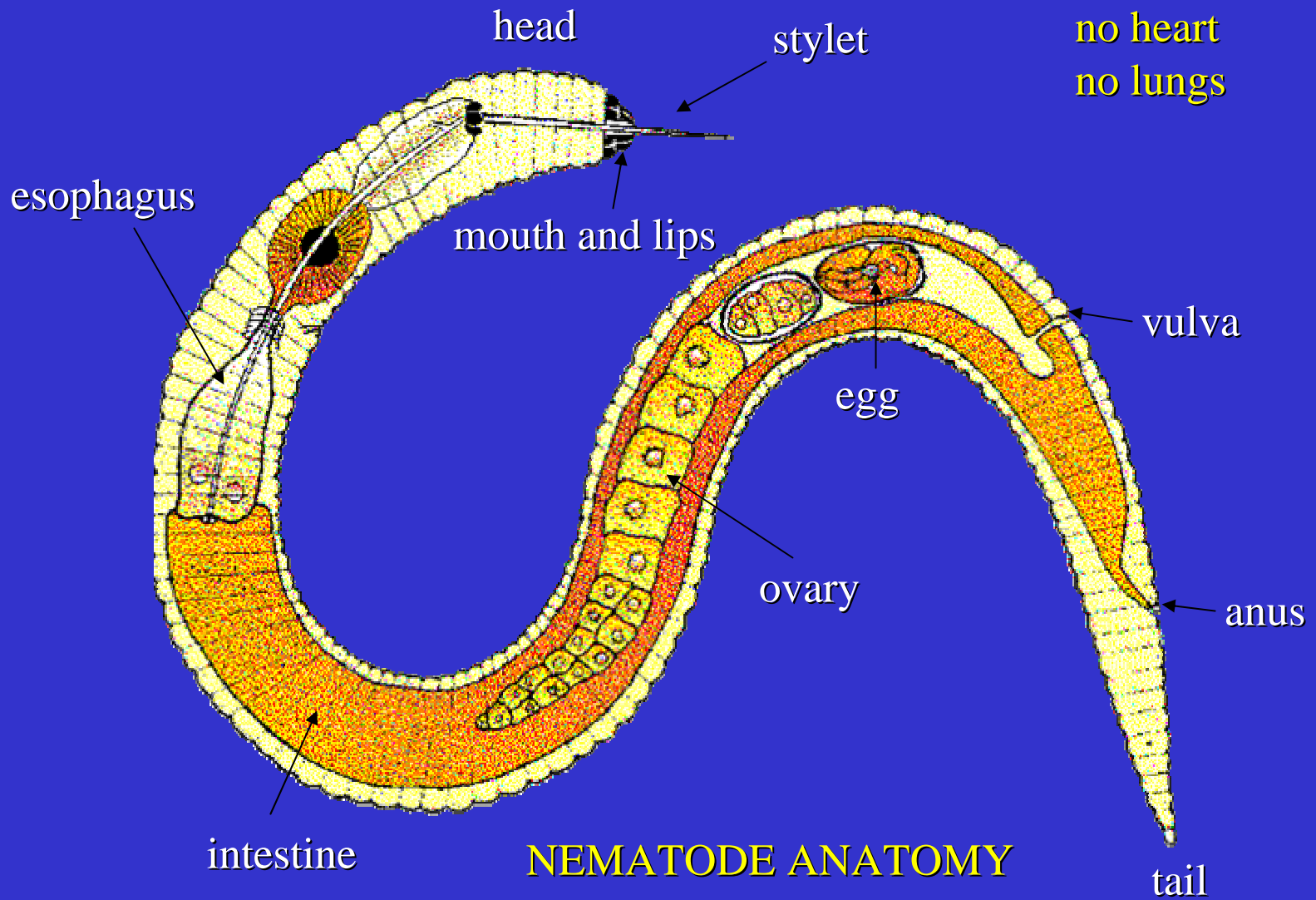
- HARC: doing some breeding.

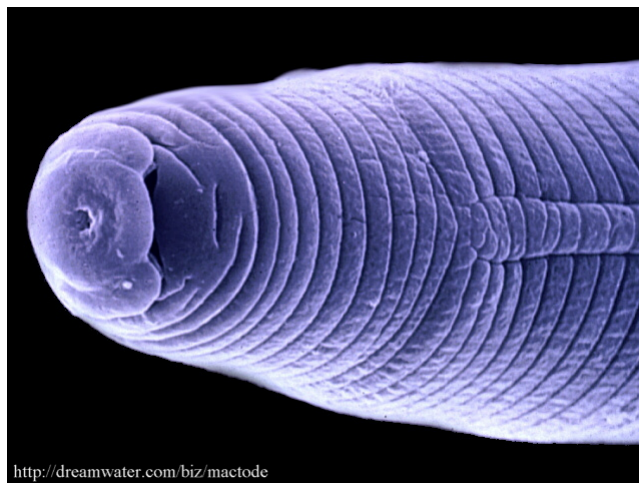
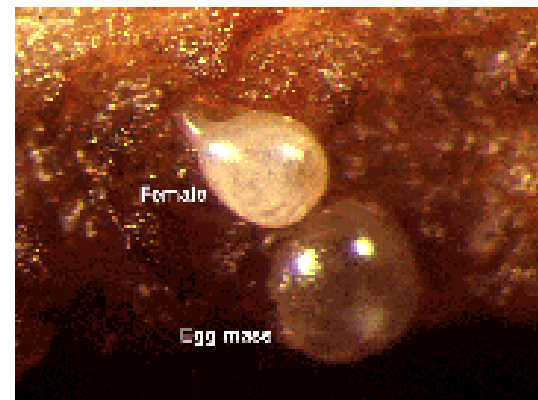
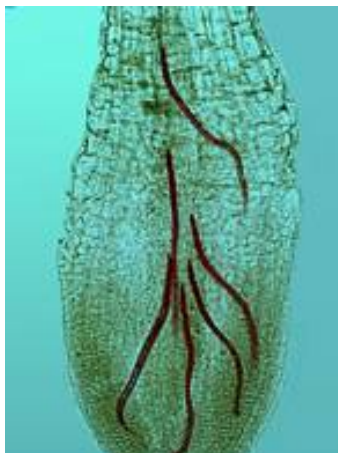




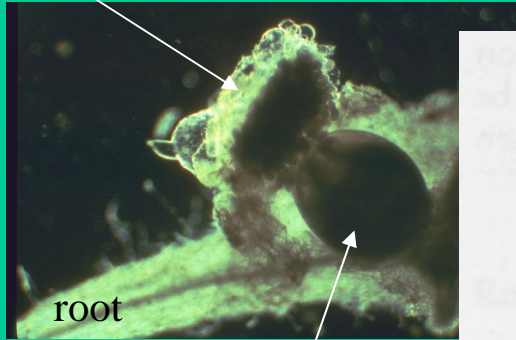
**Nematodes are ancient animals**

no brain  
no heart  
no lungs





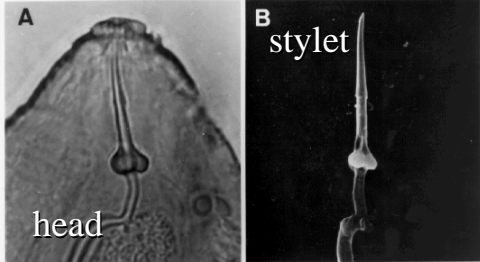
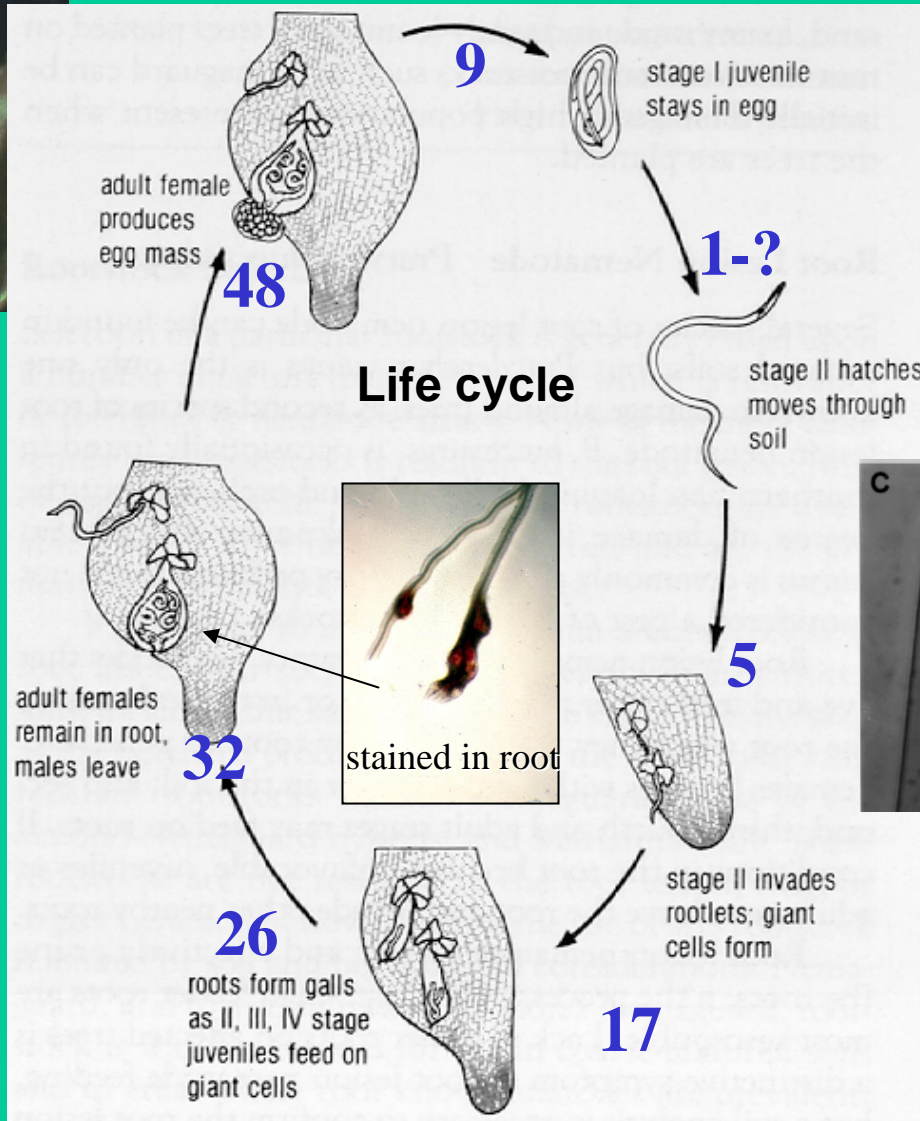
Egg mass



root

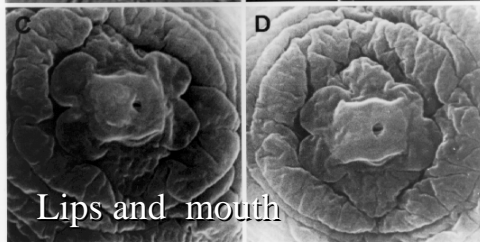
Adult female

adult females

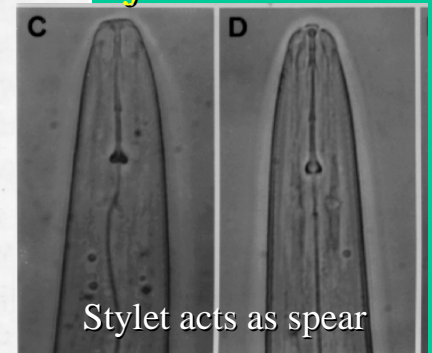


head

stilet



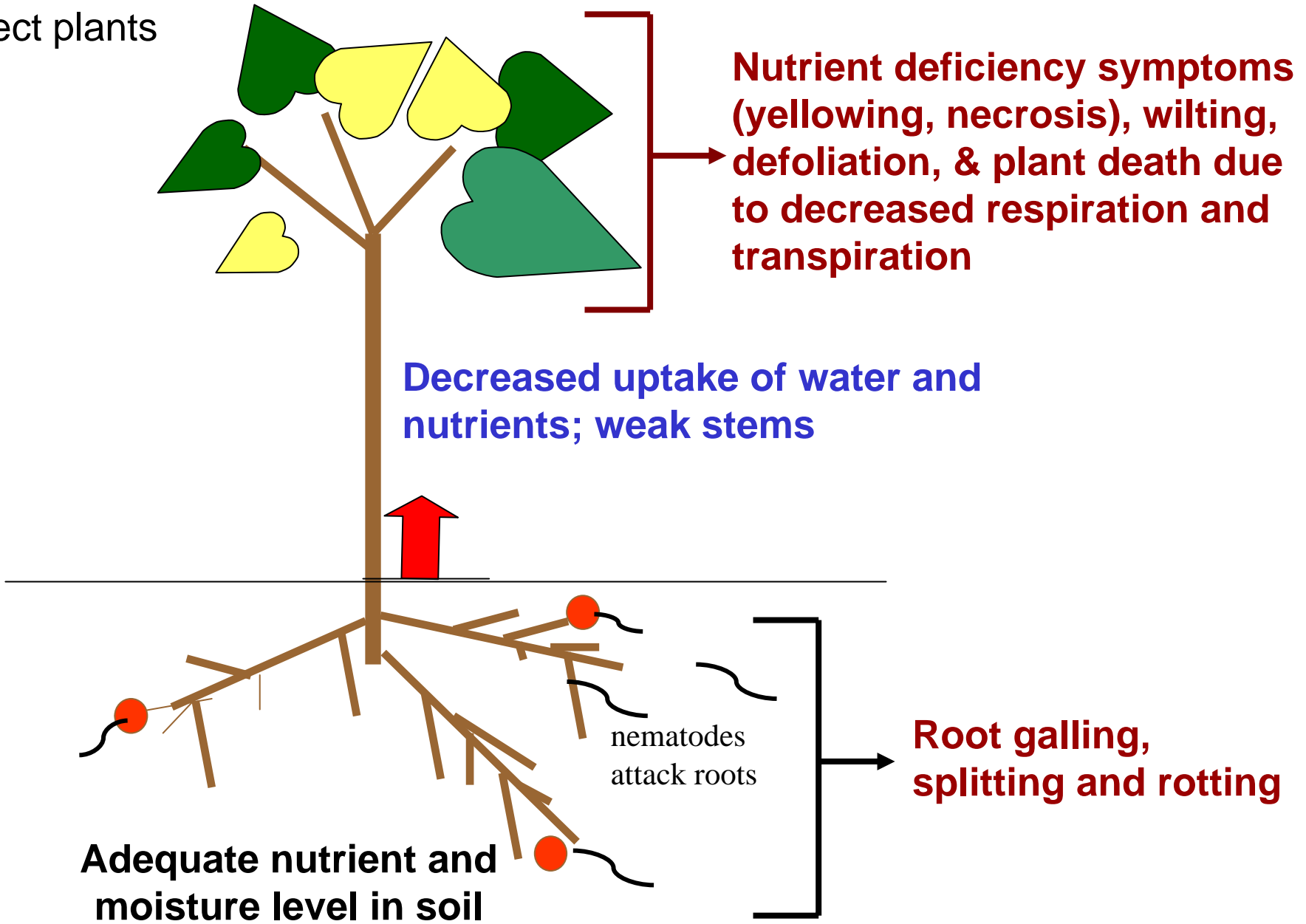
Lips and mouth



Stylet acts as spear

*Meloidogyne konaensis*: the coffee root-knot nematode

How nematodes affect plants



# Information Resources for Coffee Nematode Decline

(1) Online image gallery of symptoms:  
“Coffee Pest & Disease Image Gallery”  
<http://www.ctahr.hawaii.edu/nelsons>

(2) Free Online Publications

[Coffee decline caused by the Kona coffee root-knot nematode](#)

[Managing coffee nematode decline](#)

(3) Video: “The Case of the Nematode Nemesis”



## Coffee Decline Caused by the Kona Coffee Root-Knot Nematode

Coffee growers in Hawaii are able to grow their crop free from many of the world's most serious coffee diseases because our islands are isolated from other coffee-growing areas and the diseases have yet to be introduced here. However, during the past several years a serious disease has been observed in the Kona region of the island of Hawaii. This disease has been referred to in Kona as "transplanting decline," "replant problem," "nutritional stress," and "Kona wilt." It is characterized in coffee plantations by the occurrence of individual or clustered poorly growing or stunted coffee trees.

Visit the UH-CTAHR web page for a free nematode decline publication.



**Infected roots**      **Healthy roots**  
A healthy root system has many fine, white feeder roots.

### Coffee decline caused by the Kona coffee root-knot nematode



**Drooping leaves, thin foliage**

This stunted 3-year-old plant with a poor crop also shows leaf yellowing (chlorosis).



**Yellow leaves**

Nematode-infected coffee trees with good crops can decline rapidly (2-3 months). A heavy crop makes demands on the tree, causing stress that may hasten the decline.



**Dead tree**

<http://www2.ctahr.hawaii.edu/oc/freepubs/>

## A Nematode Decline Symptom Checklist:

### **LEAVES**

- \_\_\_ Leaves drooping
- \_\_\_ Leaves yellowing
- \_\_\_ Leaves brown, falling off tree

### **STEM**

- \_\_\_ Stem narrow or thin
- \_\_\_ Stem wobbly
- \_\_\_ Plant is stunted
- \_\_\_ Plant is easily uprooted by hand

### **BRANCHES**

- \_\_\_ Some branches have thin foliage
- \_\_\_ Some branches dying back

### **ROOTS**

- \_\_\_ Roots are swollen, and galled
- \_\_\_ Roots have a corky appearance
- \_\_\_ Tap root is destroyed or non-functional
- \_\_\_ There are few secondary or feeder roots
- \_\_\_ Roots are discolored,



Leaf flagging



Yellowing, defoliation



Decline, Death



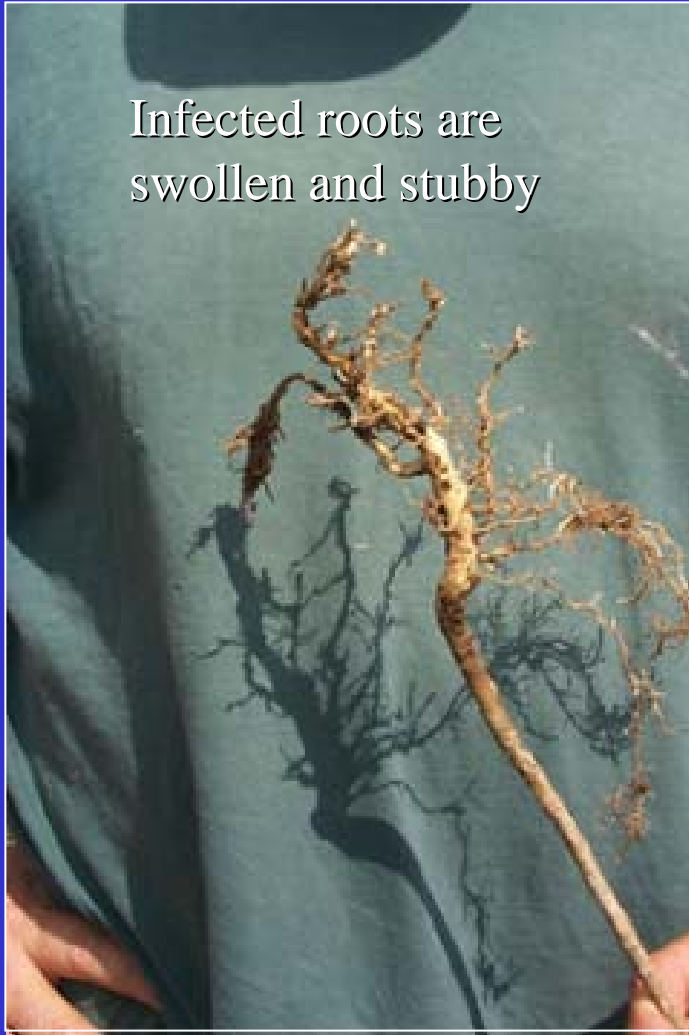
Galled, stubby roots





Flagging of leaves is a symptom caused by damage to roots by the root-knot nematode (*Meloidogyne konaensis*)

Infected roots are swollen and stubby

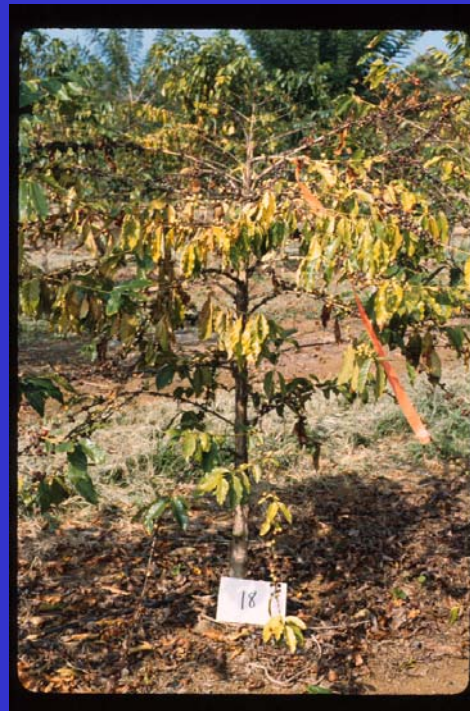


Terminal galling





Poor root systems, plants wobbly, easily uprooted



Sparse foliage, yellow



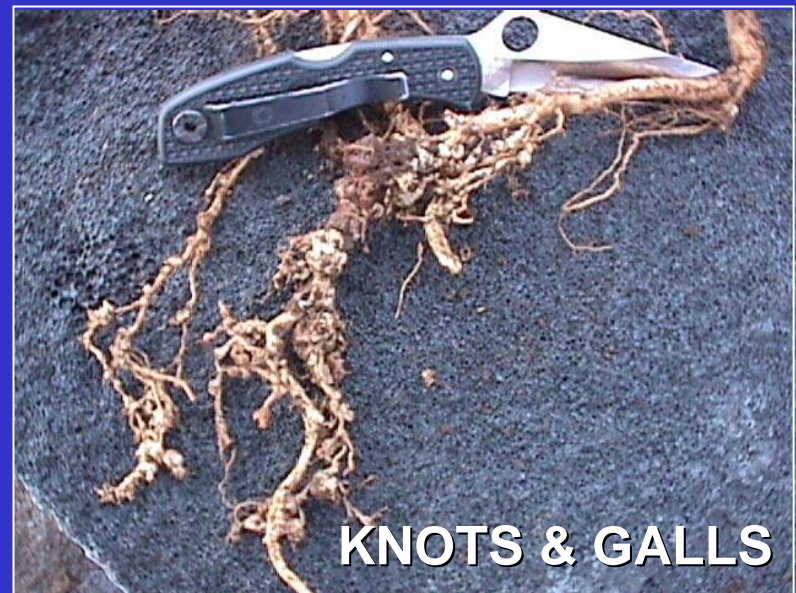
Disease is patchy in the field. 3-4 yr old plants can die

Infected roots are swollen and stubby

Normal roots are not swollen



**ROOT SYMPTOMS caused  
by *M. konaensis***





“Corky” texture to root surface,  
cracking of tissue

Primary roots  
stubby & decayed,  
few feeder roots

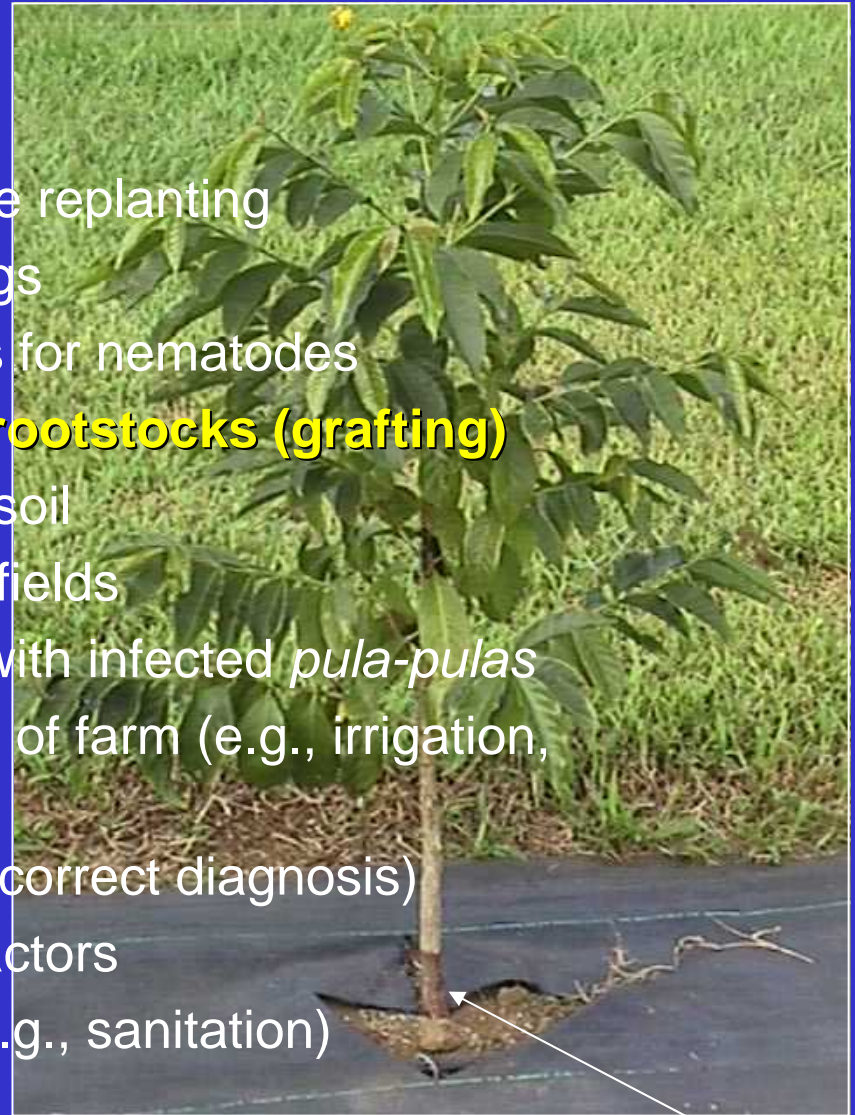


# How severely diseased is my field?

Disease Severity	Foliar Symptoms	Root Symptoms	Notes/Field symptoms
<b>No disease</b>	Leaves dark green, not flagging, no dieback of branches or defoliation, thick stem diameter, plants strongly rooted (hard to wobble)	Extensive feeder root system, healthy tap root and feeder roots, white in color, no galls or terminal swellings visible.	Trees have full canopy, no areas in field are showing decline or stress.
<b>Moderate Disease</b>	Some leaf “flagging”, some leaves yellowing, some leaf necrosis, some defoliation and/or branch die back, some plants have wobbly stems and a relatively thin stem diameter, some plants stunted, flowering sparse or sporadic.	Galling and terminal swellings on feeder roots, some root discoloration is evident, low volume of fine “feeder” roots, there is some galling and swelling on primary roots (tap root).	Localized or patchy areas of declining trees in the field.
<b>Severe Disease</b>	Extensive leaf yellowing and/or severe leaf flagging, much leaf necrosis and leaf drop, branch die back, tree death, very thin stem diameter or very wobbly stems, very poor flowering, and severe plant stunting, plants easily uprooted by hand.	Severe galling and swelling on primary root system, tap roots and secondary roots heavily cracked and “corky” in appearance, extensive root necrosis, missing or heavily damaged tap root, virtually absent feeder root system	Extensive areas of the farm have severely diseased and declining trees, there are localized areas of extensive plant death, almost every tree observed to have drooping, yellow and necrotic leaves

# Management Options for Kona Coffee Decline

- Fallow severely infested fields before replanting
- Replant with nematode-free seedlings
- Eliminate weeds and alternate hosts for nematodes
- **Replant with nematode-resistant rootstocks (grafting)**
- Incorporate/add organic matter into soil
- Avoid spreading nematodes to new fields
- Remove *pula-pulas*, do not replant with infected *pula-pulas*
- Avoid over- and under-management of farm (e.g., irrigation, fertilization)
- Know your farm (conduct sampling, correct diagnosis)
- Minimize plant stress due to other factors
- Educate and train farm personnel (e.g., sanitation)



**Grafted plant ('Fukunaga' rootstock)**



## Grafting with 'Fukunaga' rootstock

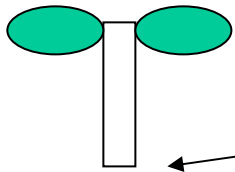


### *Coffea dewevrei* (*C. liberica* cv. *dewevrei*)

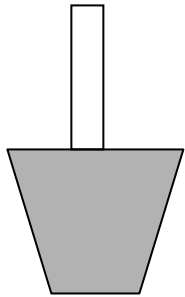
- Resistant to Kona coffee root-knot
- Cupping quality retained



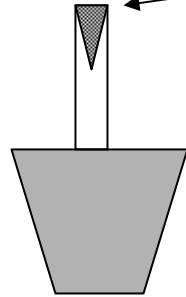
# CLEFT GRAFTING



Prepare ROOTSTOCK with a horizontal cut, discard foliage

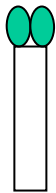


ROOTSTOCK

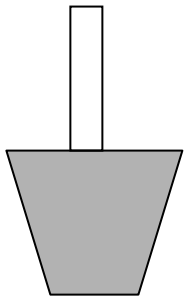


Cut a cleft into the rootstock with an angled slicing motion

ROOTSTOCK



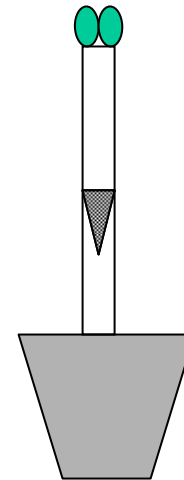
Prepare SCION with a horizontal cut, discard roots



SCION ('FUKUNAGA')



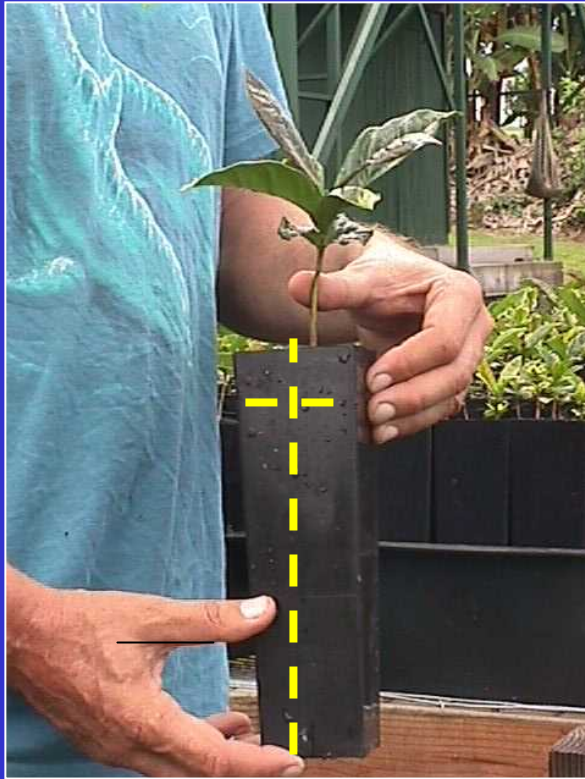
Trim the cut edge of the SCION to form a wedge.



Join the SCION wedge with the ROOTSTOCK cleft and seal with clip or tape.

GRAFTED PLANT





**Tubes 8" long X 2" wide**

**Deep rooting zone is recommended**



Humid chamber for grafted seedlings



Grafted seedlings...don't forget to fertilize!

## GOOD NURSERY PRACTICES FOR COFFEE

- 1) Grow seedlings on an elevated bench and over covered ground to avoid soilborne nematodes that may splash or be carried to seedlings.
- 2) Try to isolate your nursery from your production fields and place the nursery up-slope from nematode-infested fields if possible, and out of the path of water which may drain from nematode-infested fields.

## GOOD NURSERY PRACTICES FOR COFFEE

3) Start and grow coffee seedlings in sterile media when possible, and never in untreated field soil.

4) Grow grafted coffee seedlings in as large a container as is affordable (e.g., paper sleeves, plastic containers), and plant seedlings that are at least 9 months to 1 year of age. Larger, vigorous plants are better able to tolerate nematode infections in the field, so try to plant as large a seedling as you can.

☒ Do not use pula-pula seedlings, avoid their use at all costs, especially if they come from a nematode-infested farm.

☒ Do not use untreated field soil to fill bags or containers for growing coffee seedlings.

☒ Do not introduce nematodes into your nursery on your tools, equipment and boots, etc.

When watering, try to minimize splashing of water from ground to plants. Avoid planting coffee seedlings in nursery beds that contain untreated field soil.



## **Acknowledgements**

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Hawaii Agricultural Research Center

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Dr. Donald Schmitt and Mario Serracin

# Mahalo!



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