UNIVERSITY OF FLORIDA

IFAS

Newer Species of Root-knot Nematodes

Pathogens that rank among the top 5 disease causing agents in world.

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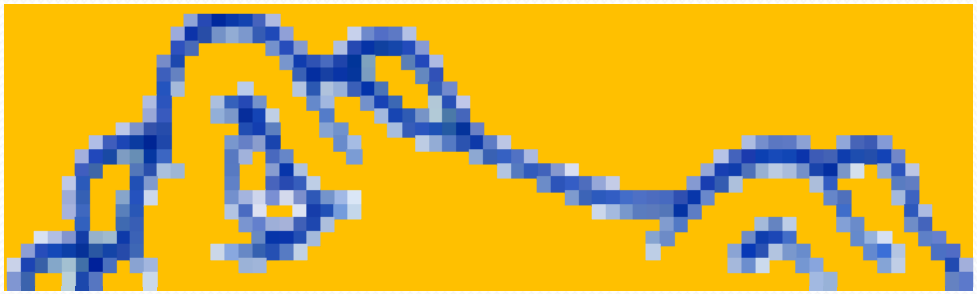


HISTORICAL HIGHLIGHTS OF ROOT-KNOT NEMATODES, *MELOIDOGYNE* SPP.

1855 – Berkeley was first person to report root-knot nematodes. Discovered on cucumber roots, glasshouse in England

History of root-knot nematodes

1) 1887 – Brazilian scientist (Goeldi) observed root-knot nematodes in coffee, coined the name *Meloidogyne* (Gr. = honey + female),

2) Goeldi named nematode as *Meloidogyne exigua,* the coffee root-knot nematode.

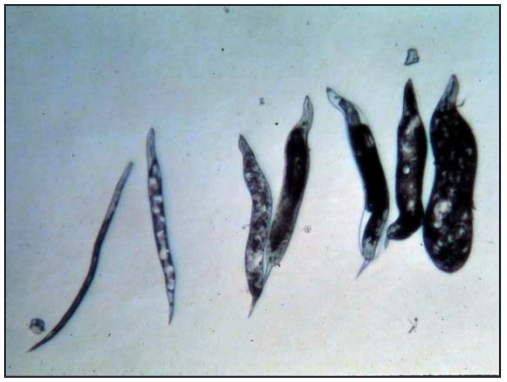
- 1887 – 1949 – Several names applied to these nematodes that induced galls on plant roots:
  - *Ditylenchus*
  - *Anguillula*
  - H*eterodera radicicola*
  - *Heterodera marioni*

- 1889 – Neal and Atkinson were the first scientists to report root-knot nematodes in North America.
- As scientists began to dig deeper into rkn, many variants discovered, referred to as “races”

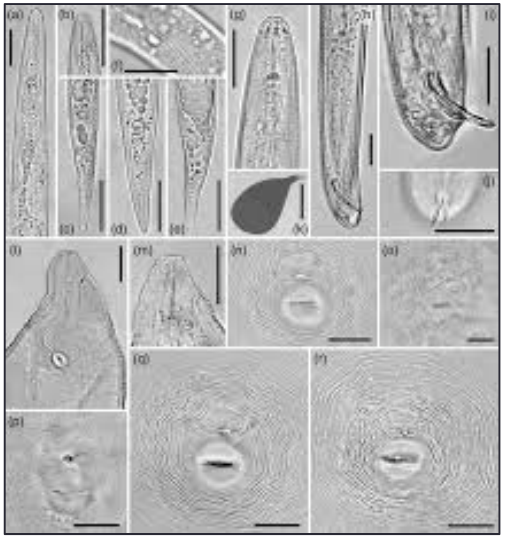
Why identify root-knot nematodes

- ✓ Nonchemical tactics for management, e.g., host resistance or crop rotation are becoming more important in agriculture.
- ✓ Species differ in damage potential, environmental requirements, and host range.
- ✓ Precise identification is often required for effective managment.

There are challenges



- ✓ RKN have conserved morphology
- ✓ Life stages occur in different habitats
- ✓ Indistinct species boundaries, maybe mixed
- ✓ Species have potential for hybridization
- ✓ Polyploidy



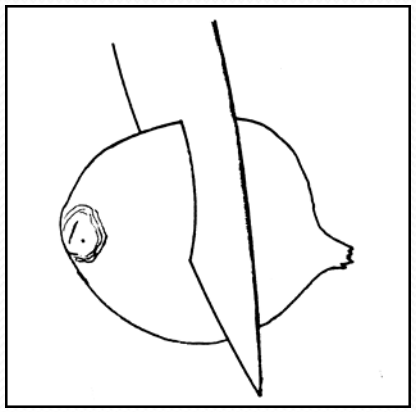
History of root-knot nematodes

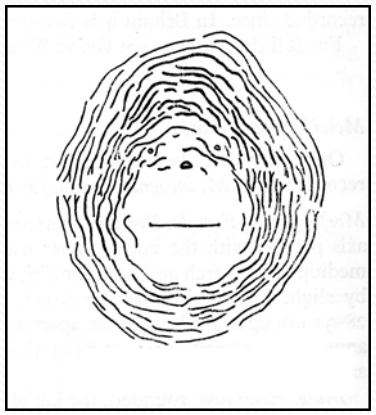
1949 – B. G. Chitwood (USA)

1) Re-established the genus *Meloidogyne.*

2) Based on morphological features described 5 species, and 1 subspecies.

3) Redescribed *M. exigua.*





Root-knot Nematodes

Meloidogyne spp.

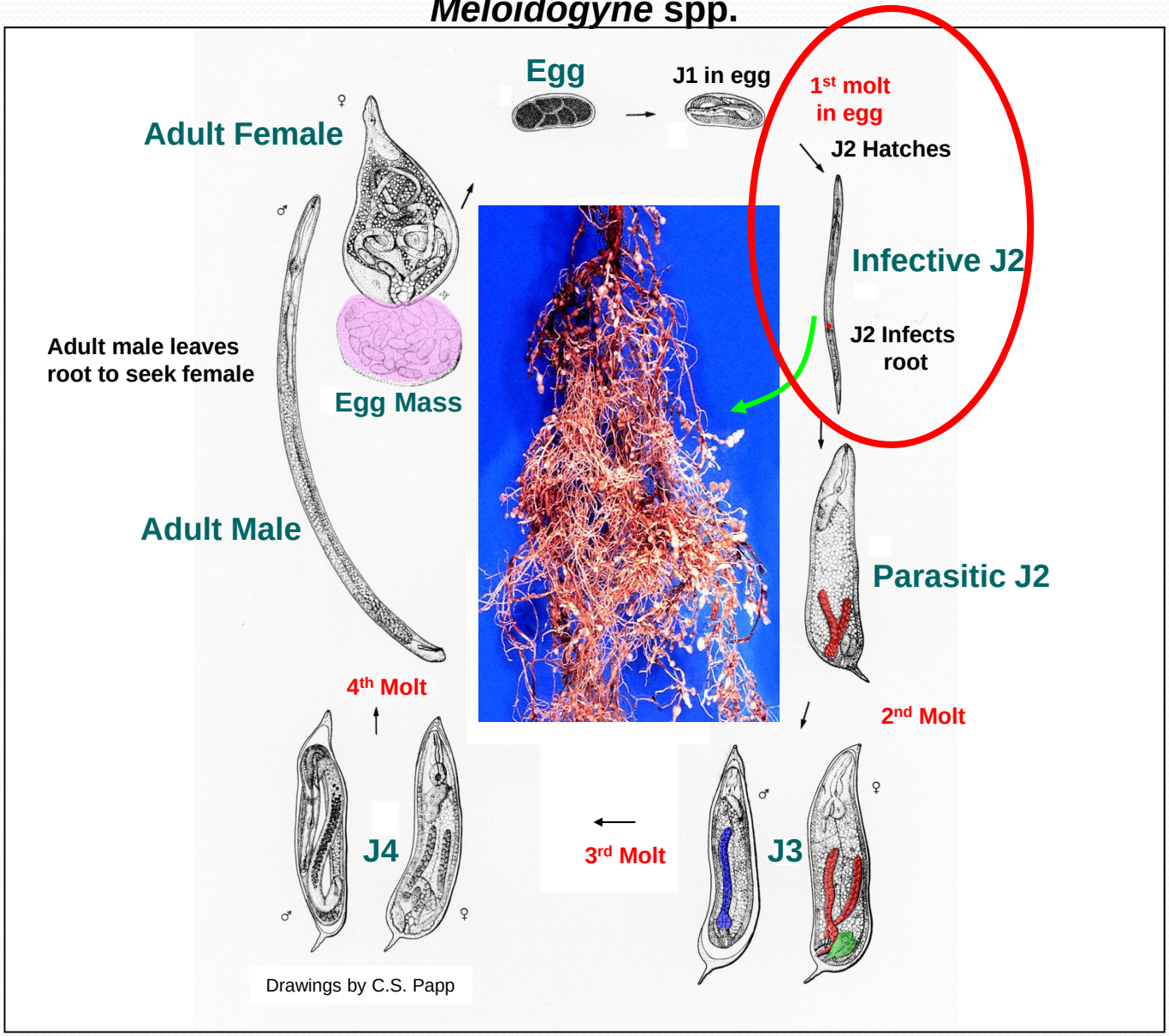
Currently over 100 species described.
Four are most common, occur worldwide.
Infect numerous agricultural crops.

1. ***M. incognita*** **– southern root-knot nematode**
2. ***M. javanica*** **– Javanese root-knot nematode**
3. ***M. arenaria*** **– peanut root-knot nematode**
4. ***M. hapla*** **– northern root-knot nematode**
5. **M. exigua – coffee root-knot nematode**

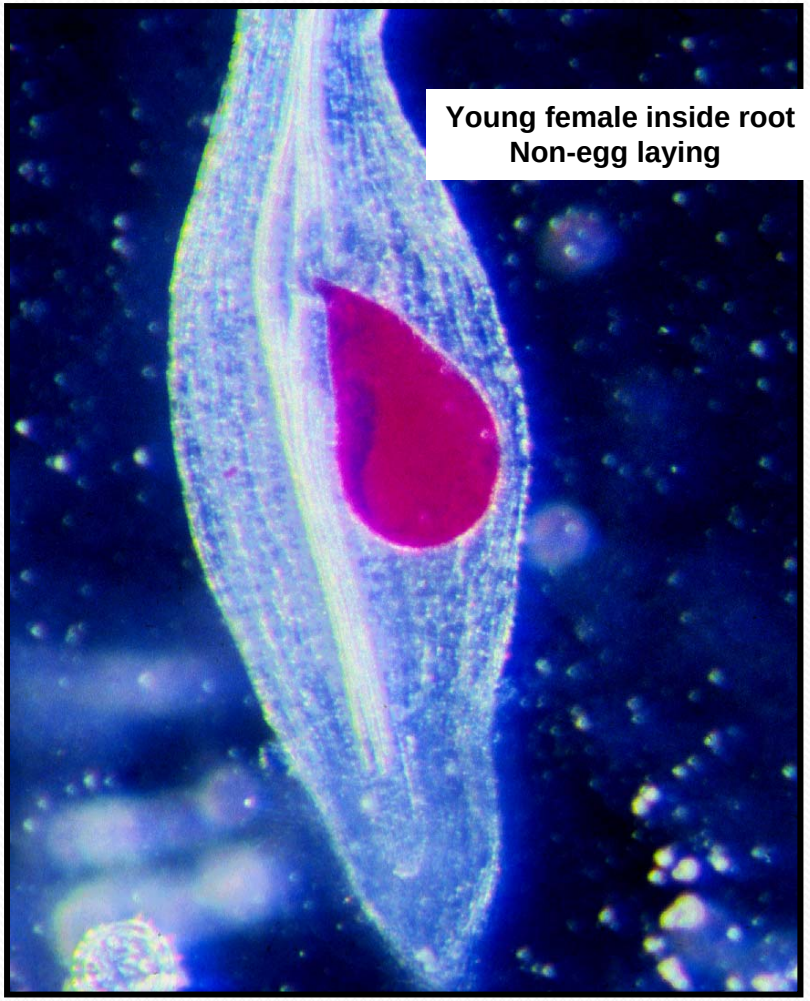
Physiological or host "races" are known for Mi, Mj, and Ma.

Root-knot Nematode Life Cycle

***Meloidogyne* spp.**



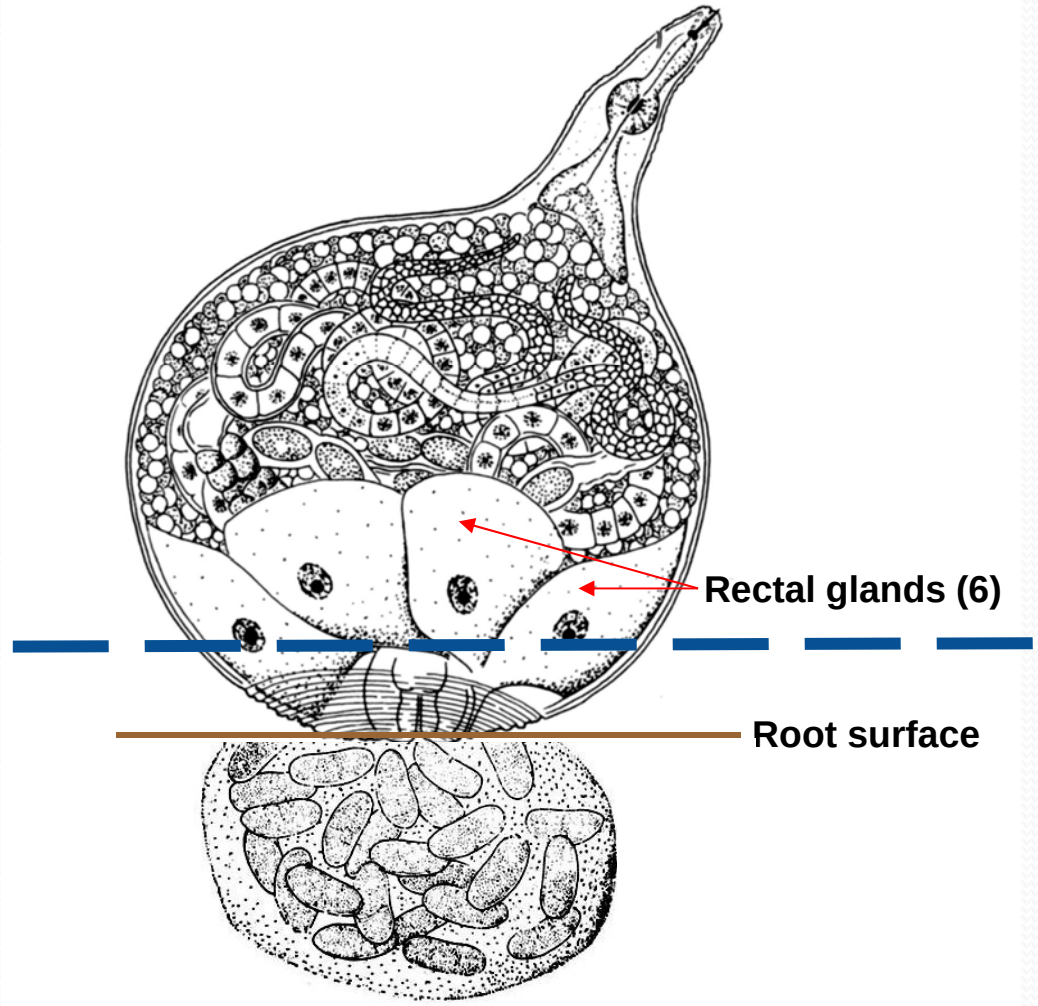

J2 inside roots


Young female inside root
Non-egg laying

Meloidogyne incognita

Egg laying female inside tomato root

Meloidogyne female with egg mass

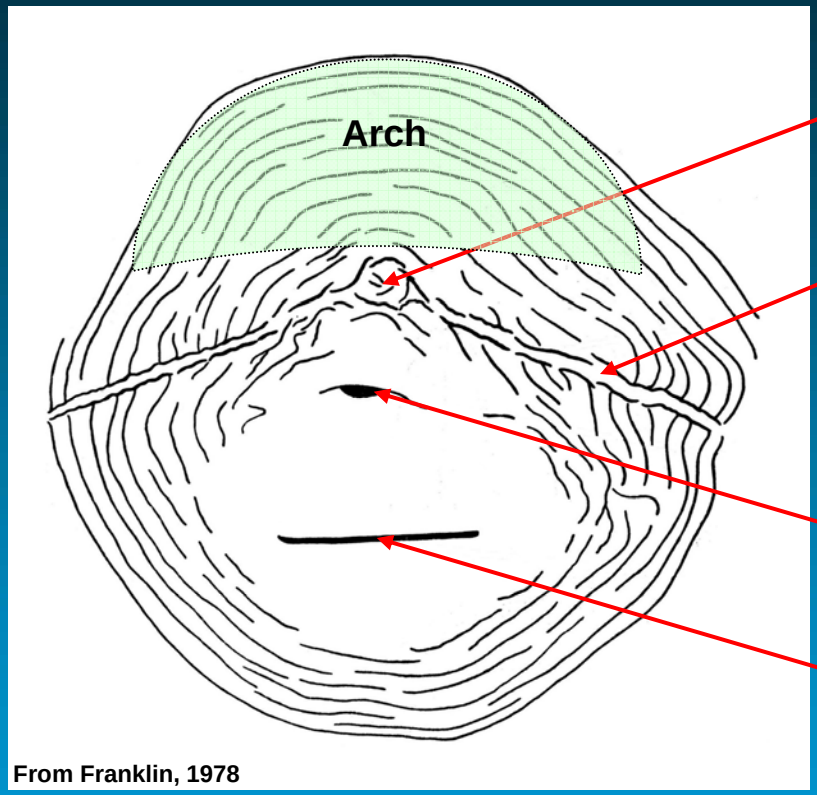


After A. R. Maggenti, 1981

Perineal Pattern of *Meloidogyne* female

Dorsal

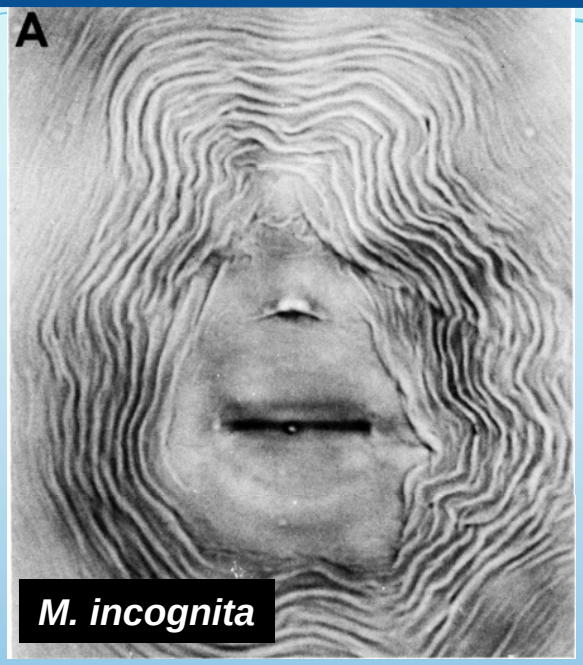
Ventral

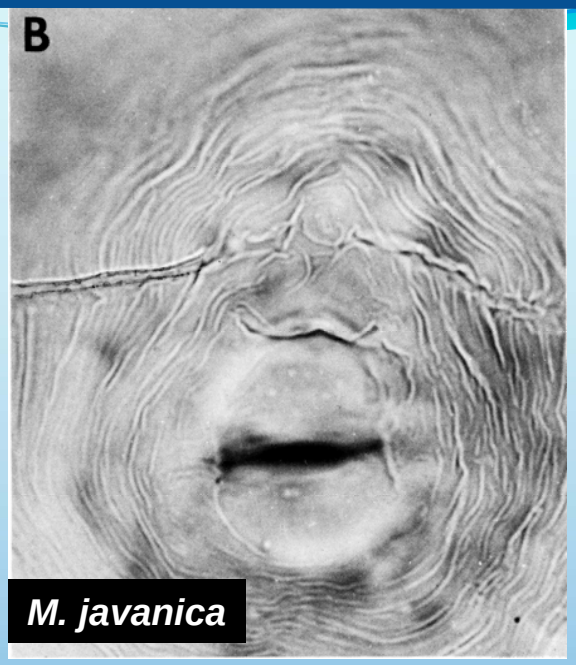


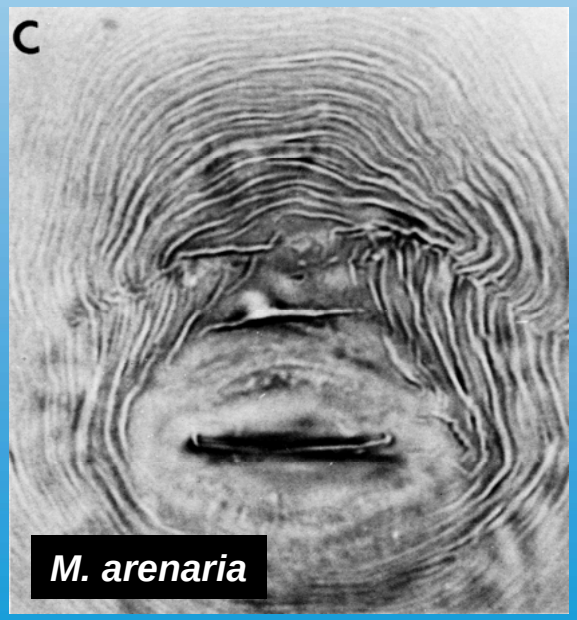
From Franklin, 1978

B. G. Chitwood

Perineal patterns of four common *Meloidogyne* spp.







Photos: J. D. Eisenbach, 1985

Host differentials used for the identification of the most important *Meloidogyne* spp.

(Tomato is a universal susceptible)

1. Will infect peanut …….. 2
   Will not infect peanut …… 3

2. Will infect watermelon ……. *M. arenaria*
   Will not infect watermelon ……. *M. hapla*

3. Will infect pepper ……. *M. incognita*
   Will not infect pepper …… *M. javanica*

*Taylor and Sasser, 1978

Host races of *Meloidogyne arenaria*

Race	Peanut
1	+
2	–

Peanut cultivar Georgia Green, FL 107, or other susceptible peanut cultivar

Host races of *Meloidogyne incognita*

Race	Cotton 'Delta pine'	Tobacco 'NC-95'	% of 298 Populations
1	-	-	67
2	-	+	18
3	+	-	11
4	+	+	4

Taylor and Sasser, 1978

Host races of *Meloidogyne javanica*

Race	Peanut	Pepper
1	–	–
2	–	+
3	+	–
4	+	+

Peanut 'Georgia Green', FL 07, or other susceptible cvs.

Pepper 'California Wonder'

Diagnostic tools for identification of *Meloidogyne* species

1. Morphological characters

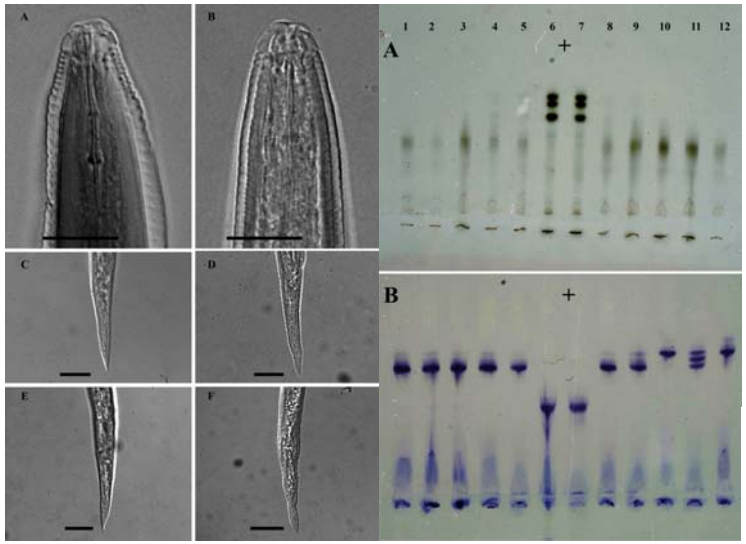
✓ Overlap of morphometric characters

2. Biochemical – isozymes

✓ Occurrence of intraspecific variants

✓ Need of more than one enzyme system to confirm the identity of some isolates

✓ Poor signal intensity in some cases



Ahmed *et al*., 2013

3. Molecular-DNA based

✓ Sensitive detection

✓ Need to use suitable marker that gives reliable resolution between species

When we reference “newer” species of root-knot nematodes!

– What matters?

Identification –

Size matters!

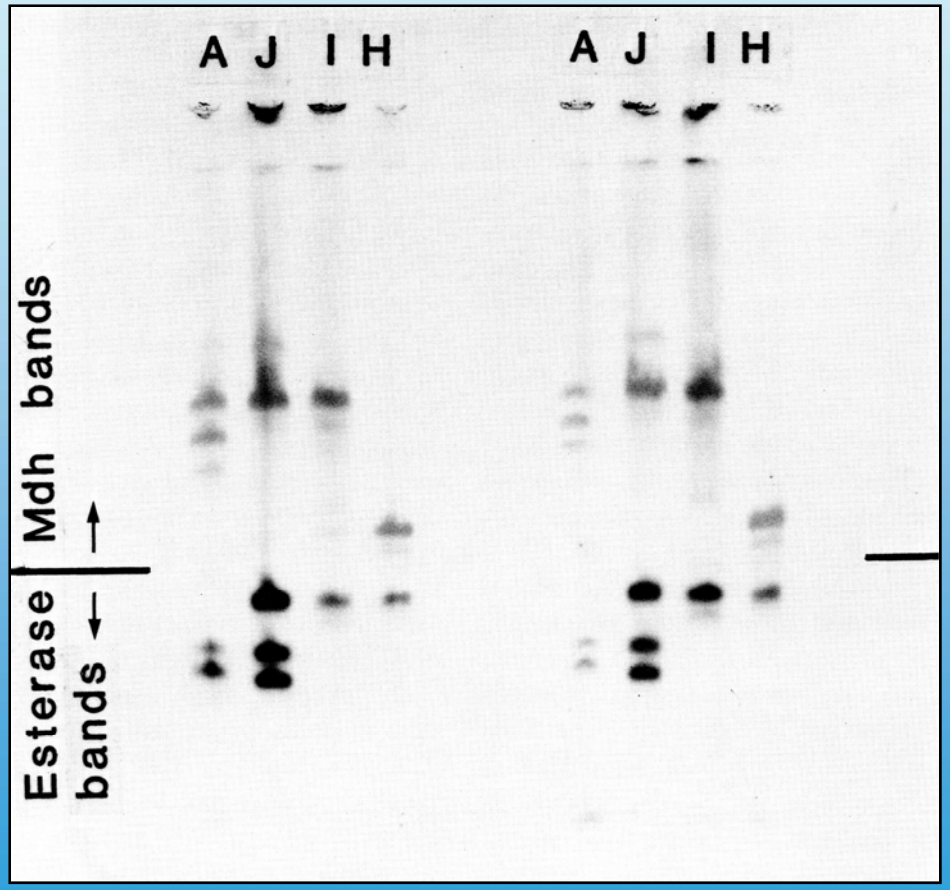
Developmental stage matters!

Expertise matters!

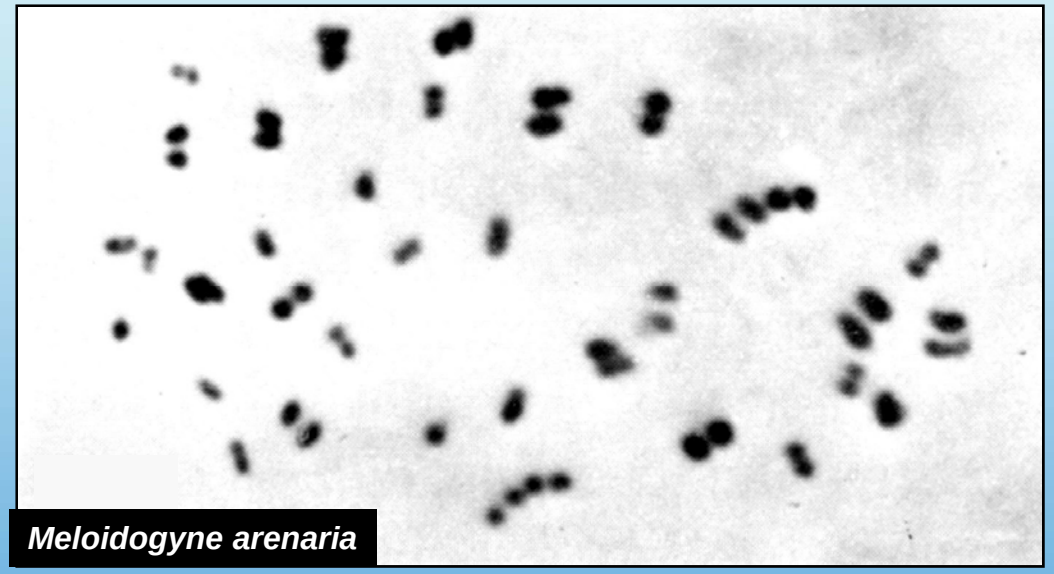
Tools matter!

Isoenzyme electrophoretic profiles of single *Meloidogyne* females

Esbenshade and Triantaphyllou, 1990



Meloidogyne Chromosomes

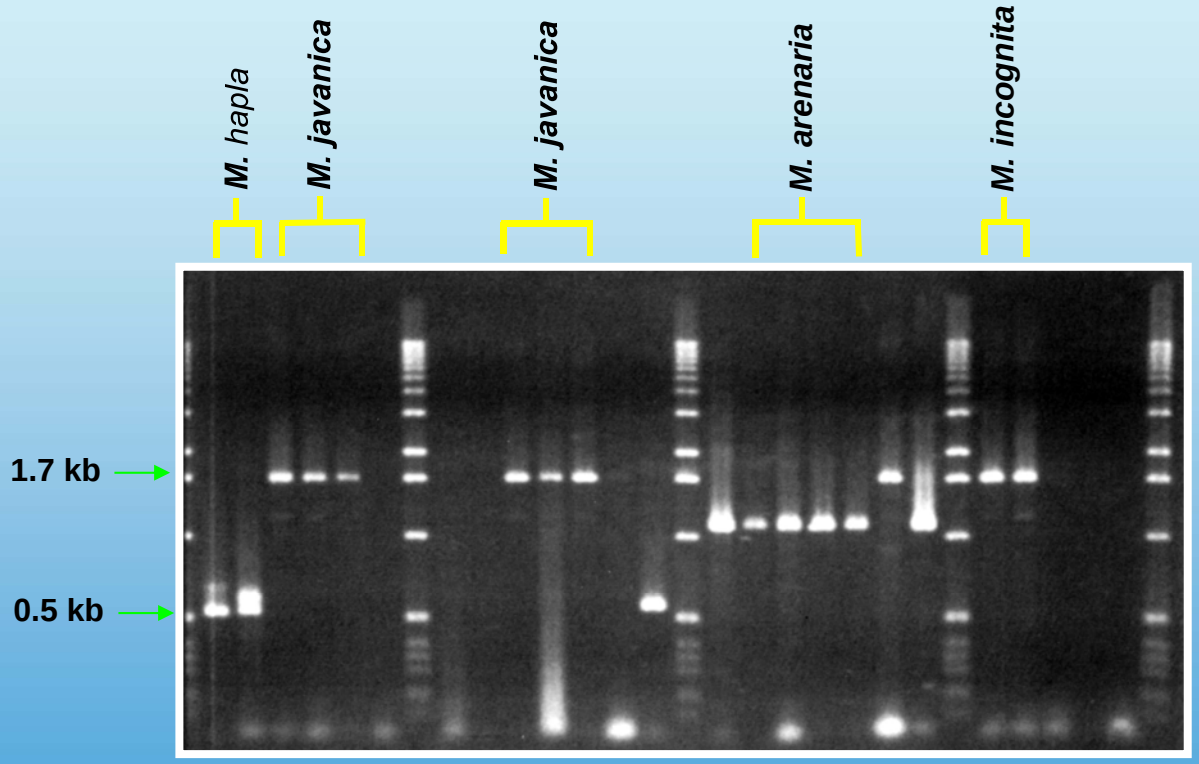


Meloidogyne arenaria

Species	Chromosome number
Meloidogyne arenaria (2n form)	34-37
Meloidogyne arenaria (3n form)	51-54
Meloidogyne hapla (race A)	15-17
Meloidogyne hapla (race B)	45
Meloidogyne incognita	41-44
Meloidogyne javanica	43-48

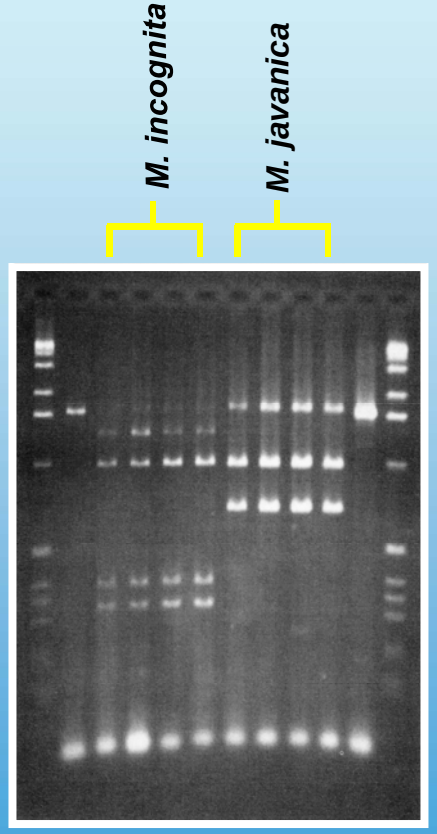
A. C. Triantaphyllou 1971

Meloidogyne spp. – DNA analyses



* Primer annealing sites located in mitochondrial gene coding for cytochrome oxidase subunit II and in the 16S rRNA gene.

Powers and Harris, 1993



Hinf I digestion products of the 1.7 kb fragment from *M. incognita* and *M. javanica*

Worldwide distribution of *Meloidogyne* spp.

558 Populations

Meloidogyne spp.	Number studied	% of Total
M. incognita	298	54
M. javanica	167	30
M. hapla	40	7
M. arenaria	40	7
Others	13	2

Taylor and Sasser, 1978

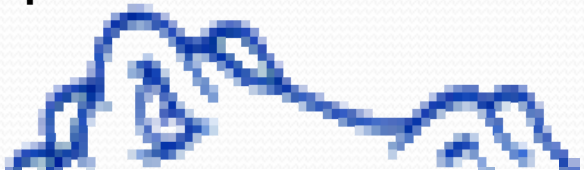
Root-knot nematodes by continents

Continents	Total nu. species	Unique species
North America	35	22
South America	15	9
Europe	28	10
Asia	33	21
Africa	22	7

14 RKN species in Florida, USA

Species	Species
M. incognita	*M. partityla*
M. arenaria	*M. graminis*
M. javanica	*M. graminicola*
M. hapla	*M. marylandi*
M. enterolobii	*M. christiei* #
M. floridensis #	*M. cruciani*
M. haplanaria	*M. thamesi*

Red = important species in vegetable and agronomic crop production.
 # = Currently only reported in Florida.



11 RKN species of concern, consider as invasive

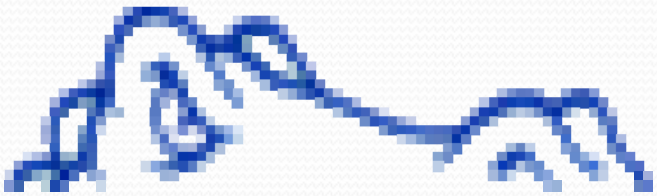
Species	Location	Species	Location
M. enterolobii	FL, NC, Wide	*M. graminicola*	FL, Wide
M. floridensis	FL	*M. hispanica*	NA, Wide
M. minor	WA, Europe	*M. paranaensis*	Hawaii, Brazil
M. fallax	CA, Europe	*M. ethiopica*	Europe, Africa,
M. artiellia	Europe		Brazil, Chile
M. haplanaria	TX, FL	*M. chitwoodi*	NA, Europe

Tomato galled by *Meloidogyne enterolobii*

Okra galled by *Meloidogyne enterolobii*

M*i*-gene tomato – Resistant to RKN

Species where tomato RKN resistant gene becomes nonfunctional	Orgin
Meloidogyne enterolobii	Europe, Asia, Africa, SA, FL, NC
M. floridensis	FL
M. haplanaria	TX, FL
M. hispanica	NA, Europe, Asia, Africa, SA
M. brasilensis	Brazil



7 Root-knot nematode species on peach

Species	Location
M. incognita	Wide
M. arenaria	Wide
M. javanica	Wide
M. floridensis	FL
M. exigua	SA, Europe, Africa
M. hispanica	Wide
M. morocciensis	Africa

7 ROOT-KNOT NEMATODES ON CITRUS -- ASIA

SPECIES	DATE	COUNTRY
M. citri	1990	PRC
M. donghaiensis	1990	PRC
M. fujianensis	1985	PRC
M. indica	1968	India
M. jianyangensis	1990	PRC
M. kongi	1988	PRC
M. mingnanica	1993	PRC

17 species reported from coffee

S. America, Africa, Hawaii

M. exigua	*M. izalcoensis*
M. africana	*M. javanica*
M. arabicida	*M. kikuyensis* ***
M. arenaria	*M. konaensis*
M. coffeicola	*M. enterolobii*
M. decalineata	*M. megadora*
M. hapla	*M. oteifae*
M. incognita	*M. paranaensis*
M. inornata	