AN INTRODUCTION TO PLANT PARASITIC NEMATODES

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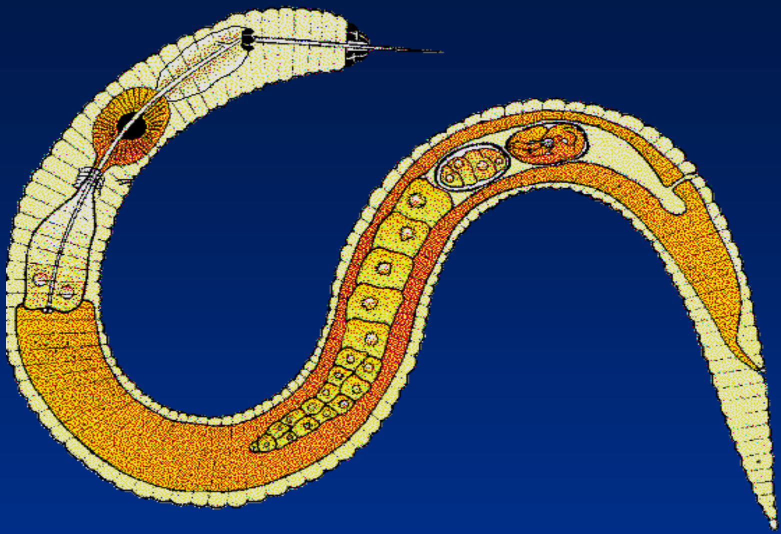
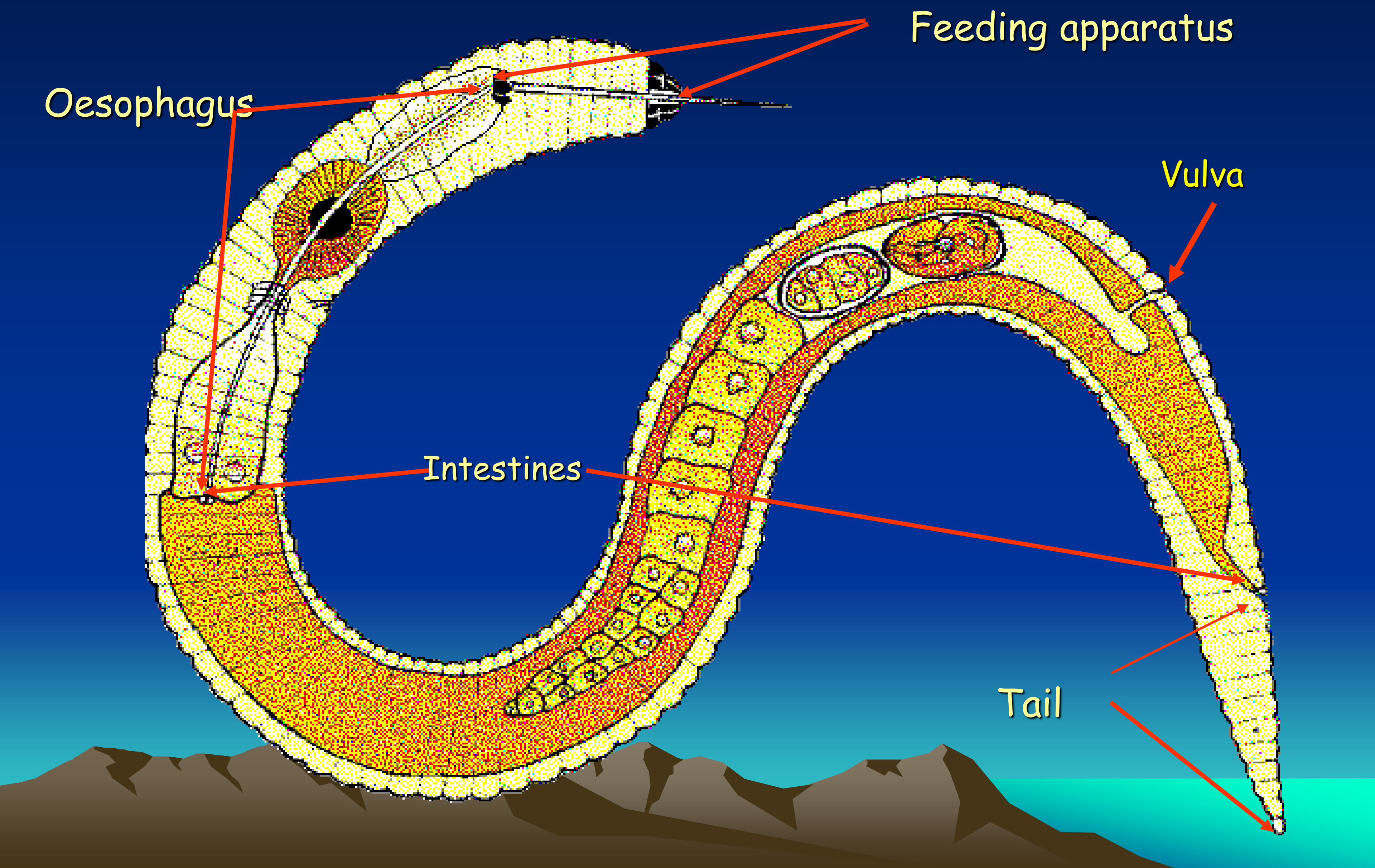
WHAT ARE NEMATODES?

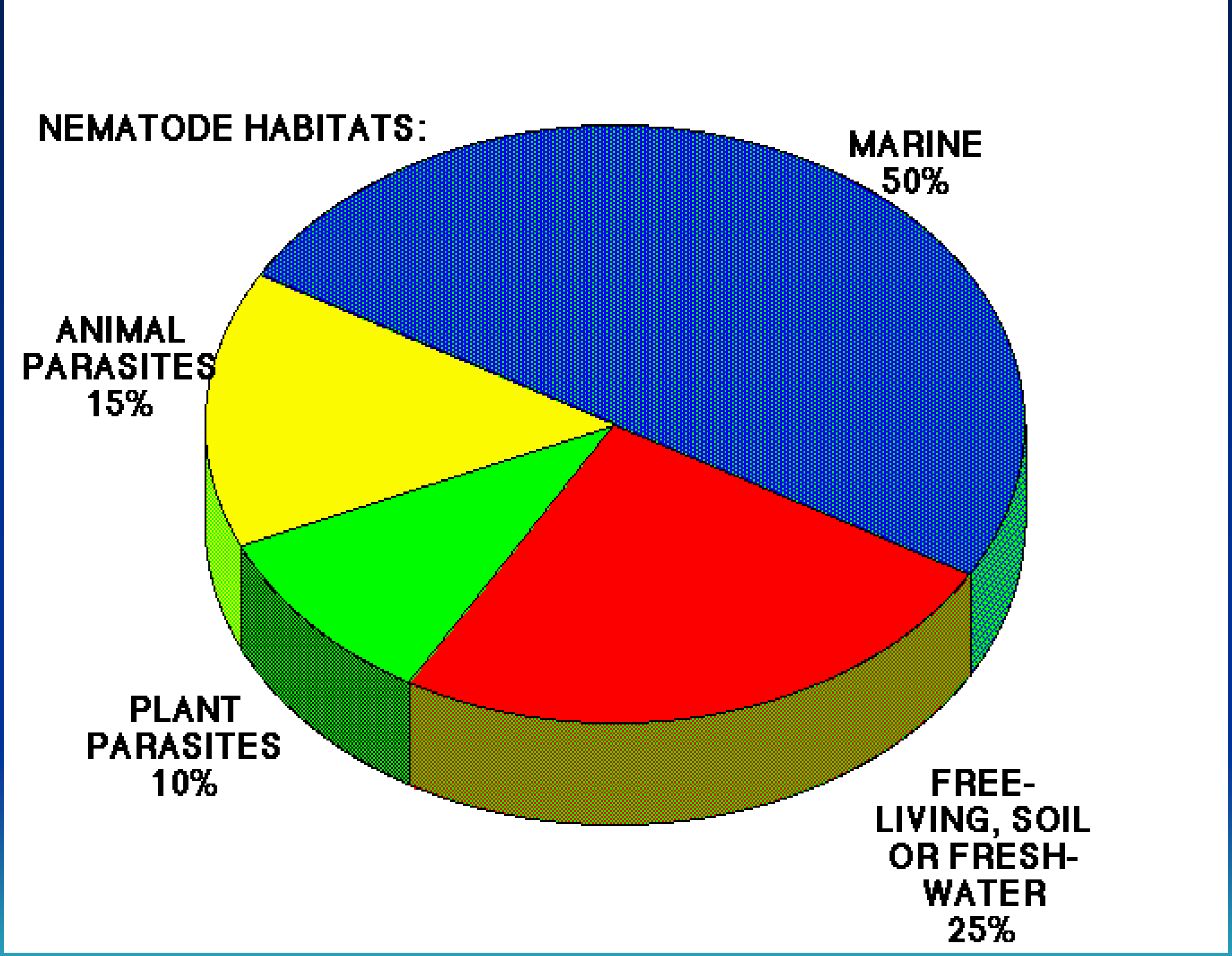


- Minute multicellular organisms (animals)
- Resemble earthworms but not closely related to them
- Habitats include soil, fresh water bodies and marshes

Main body parts

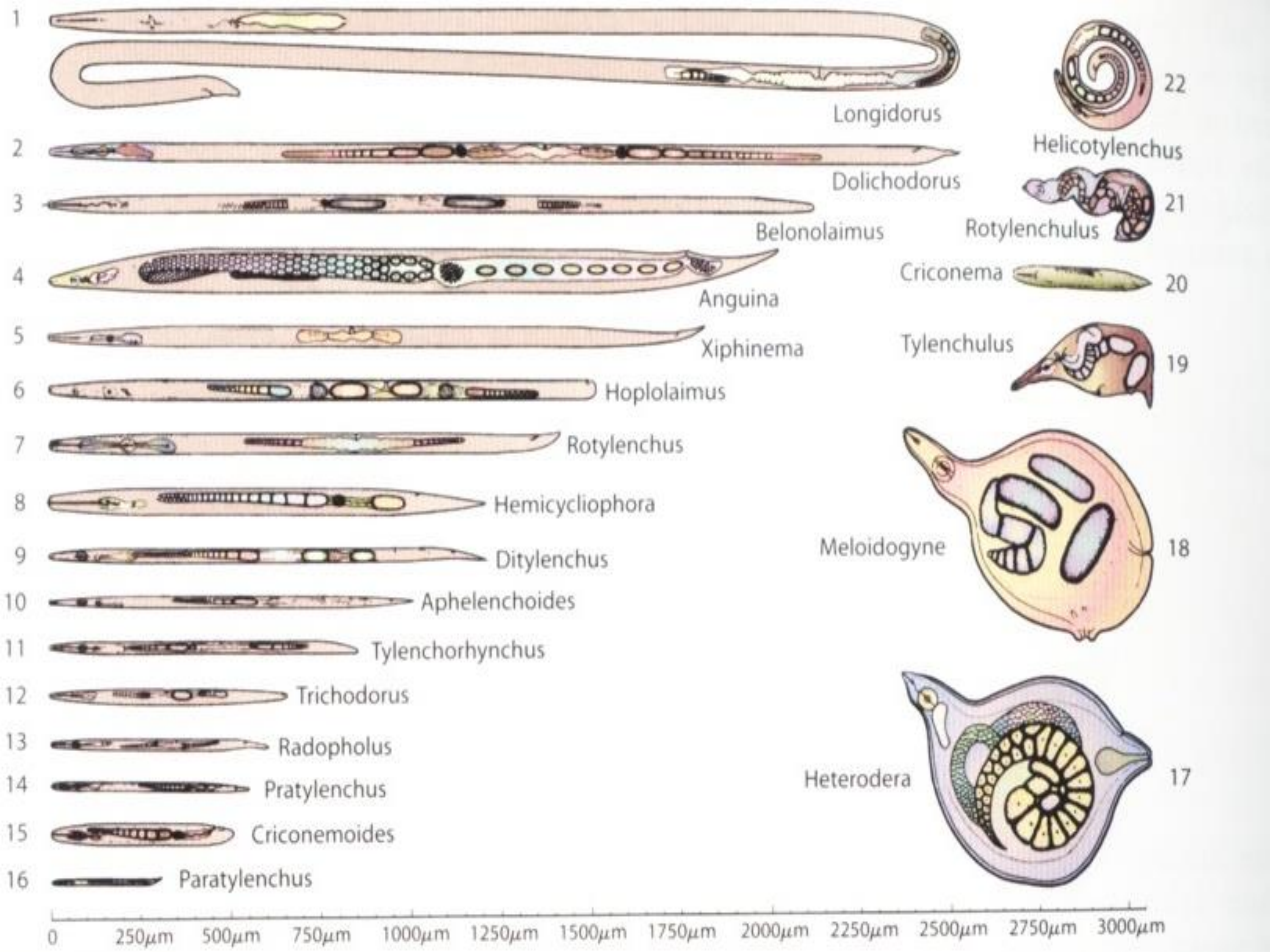


Habitats and relative abundance

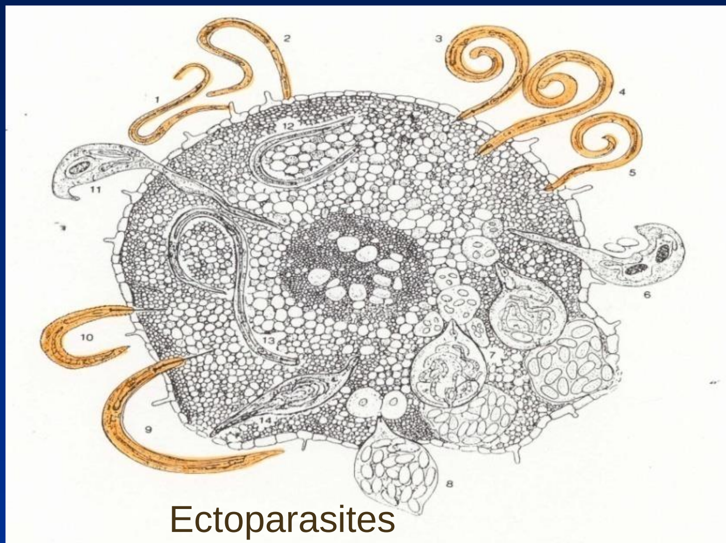


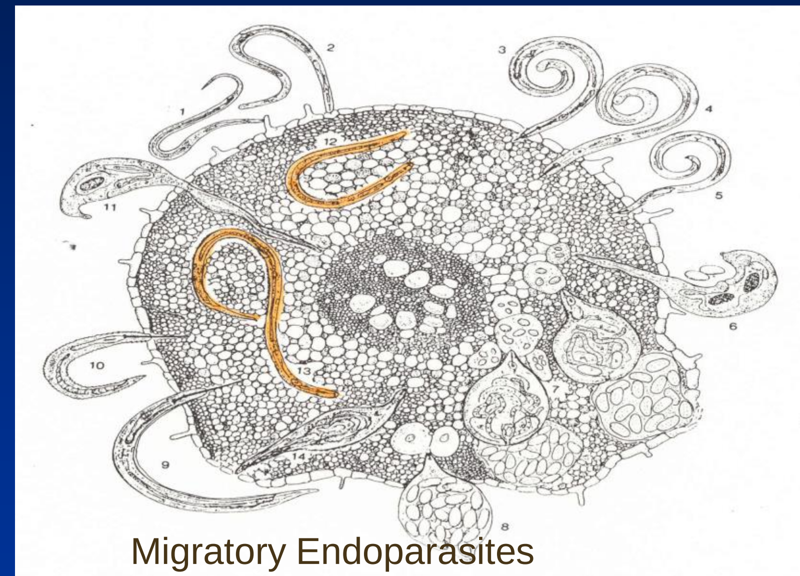
Morphology and relative size

- Majority are eel (serpent) shaped, while mature females of a few species are spherical
- Generally tubular organisms, round in cross section with unsegmented bodies
- Length 300 – 1500um (0.3 – 1.5mm), exceptions of up to 4 mm
- Diameter 15 – 35 um. **NB:** it is their small diameter that makes them invisible to the naked eye

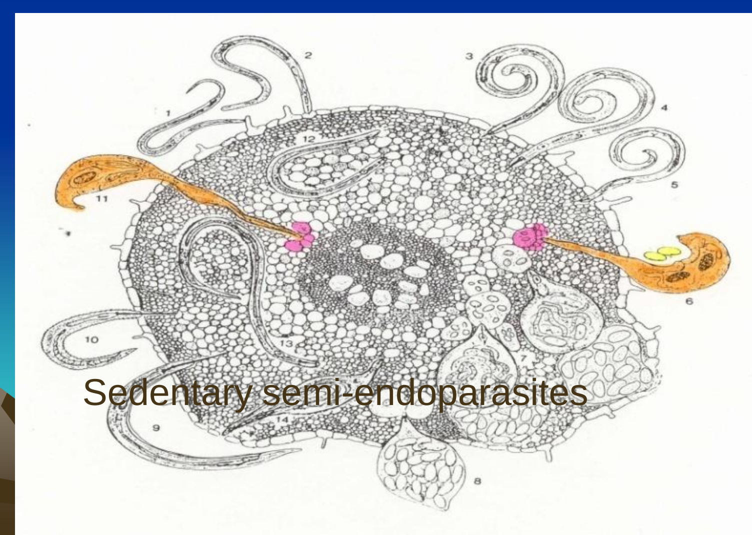

1
Longidorus
2
Dolichodorus
3
Belonolaimus
4
Anguina
5
Xiphinema
6
Hoplolaimus
7
Rotylenchus
8
Hemicycliophora
9
Ditylenchus
10
Aphelenchoides
11
Tylenchorhynchus
12
Trichodorus
13
Radopholus
14
Pratylenchus
15
Criconemoides
16
Paratylenchus
17
Heterodera
18
Meloidogyne
19
Tylenchulus
20
Criconema
21
Rotylenchulus
22
Helicotylenchus
0
250μm
500μm
750μm
1000μm
1250μm
1500μm
1750μm
2000μm
2250μm
2500μm
2750μm
3000μm

Modes of Parasitism

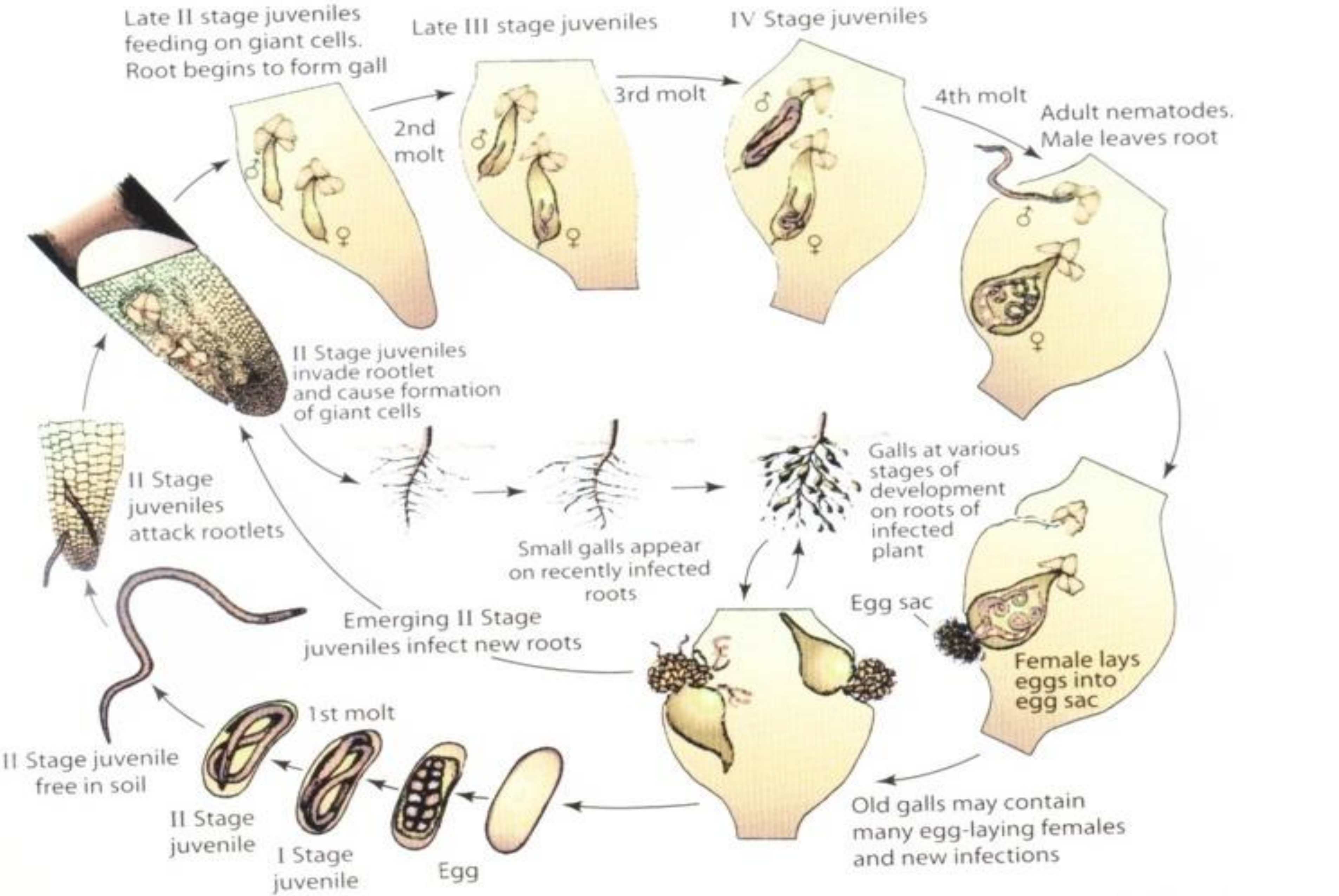

Ectoparasites


Migratory Endoparasites


Sedentary endopararasite


Sedentary semi-endoparasites

Typical Life Cycle: Root-Knot Nematodes



Practices that aggravate nematode problems in agroecosystems

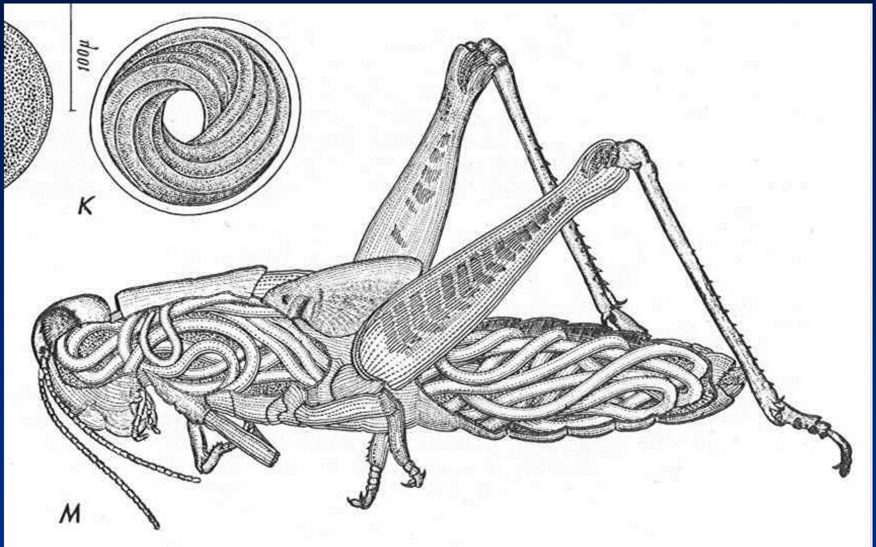
- Intesive cultivation as opposed to shifting cultivation
- Monoculture≡Mixed cropping
- Single genotypes (pure lines)=multiple cropping/varieties
- Recycling of water for fertigation and irrigation

- Free draining and well-aerated substrate cultures
- Excessive tillage which facilitates drainage, spread,aeration and exposure
- Greenhouse-based production system- warmer environment
- Disruption of natural regulatory mechanisms

Spread (dissemination) of PPN

- Active spread- move on their own power – 1m/season
- Passive Spread:-
- Water – Surface run off
  - Irrigation channel
  - Splashing effect
- Wind – In soil and plant debris
  - Nematode stages that are not sensitive to drying
- Man
  – Infected seed
  - Infected seedlings
  - Movement of soil e.g. in wheelbarrows
  - Movement of infected plant residues and fresh compost
  -Soil adhering onto footwear
- Insect vectors – Foliar nematodes
  - Pine wilt nematode - Pine sawyer (beetle)
  - Red ring nematode - Palm weevil

Survival



In infected plants and insect vectors

In egg masses

In cysts

Others

Quiescent state (*Anguina tritici*) 39 years

Dauerlarvae = 18 months.

EFECTS OF NEMATODES ON PLANTS

- Cause diseases due to mechanical and chemical injuries inflicted on plants as well as interference with growth regulation: losses = 12.4%

  Reduced ability to withstand water stress and uptake of nutrients

  Barrier to international trade – Quarantine pests
- Wounds serve as entry points for other disease-causing organisms
- Breakdown of resistance to other disease causing organisms
- Suppress nodulation in leguminous plants
- Increase multiplication of other disease causing organisms
- Agents of spread of other disease causing organisms in the soil e.g. viruses,bacteria and fungi,

Most Important Plant Parasitic Nemaodes in Tropical Soils

- ***Meloidogyne*: root-knot**
- ***Pratylenchus*: lesion**
- ***Ditylenchus*: stem and bulb**
- ***Tylenchulus*: citrus**
- ***Xiphinema*: dagger**
- ***Radopholus*: burrowing**
- ***Belonolaimus*: sting**

Root Knots

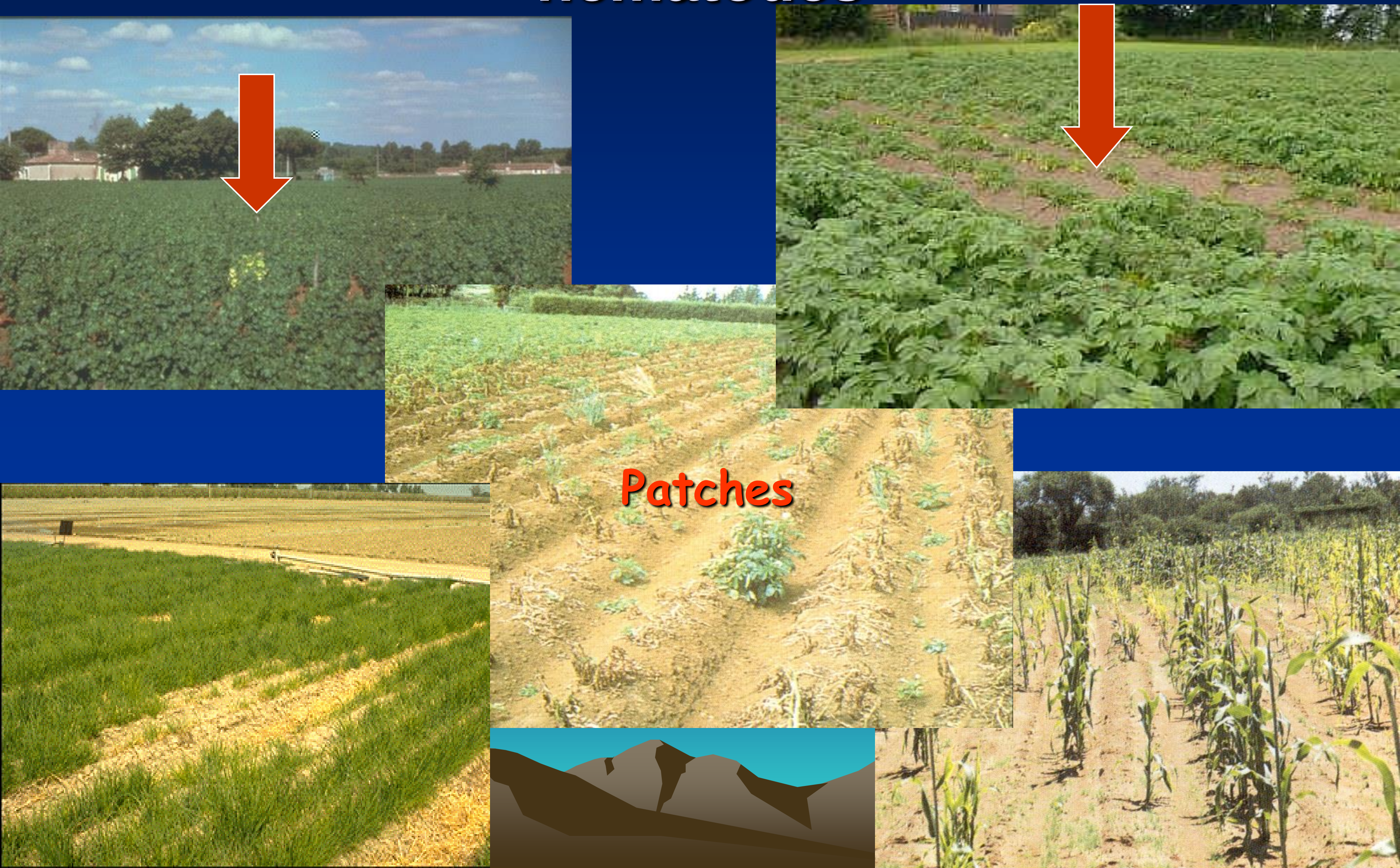
Citrus Nematode

Stem & Bulb

Burrowing/ Lesion

Sting

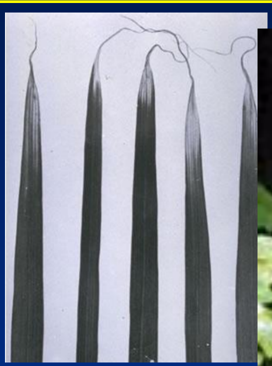
Symptoms associated with damage by nematodes



Stunted growth and patches due to root knot nematodes on *Hypericum* (in Naivasha)

Symptoms of damage by foliar nematodes

Above ground



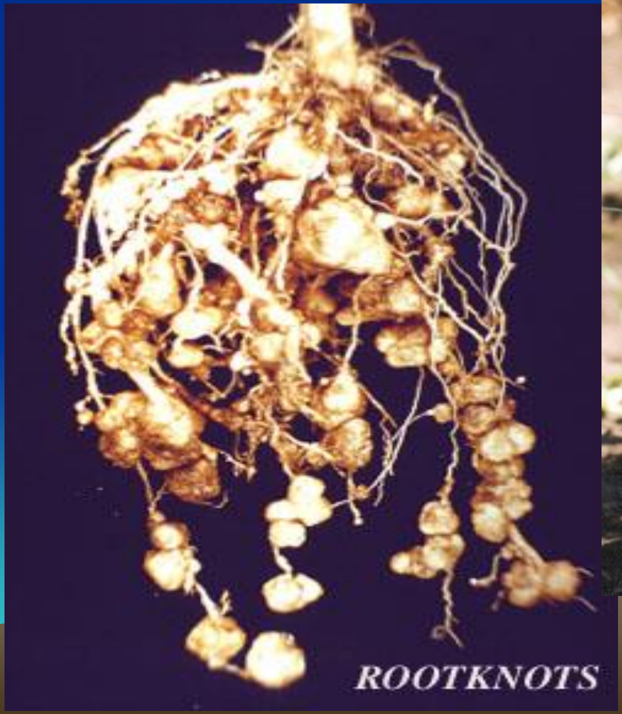
Aphelenchoides besseyi - the causal agent of white tip disease of rice

Bursaphelenchus lignicolus is transmitted by a beetle and causes pine wilt

Aphelenchoides ritzemabosi and A. fragariae

Rhadinaphelenchus cocophilus causes the Red ring disease of coconut and transmitted by the palm weevil, *causes red ring disease*

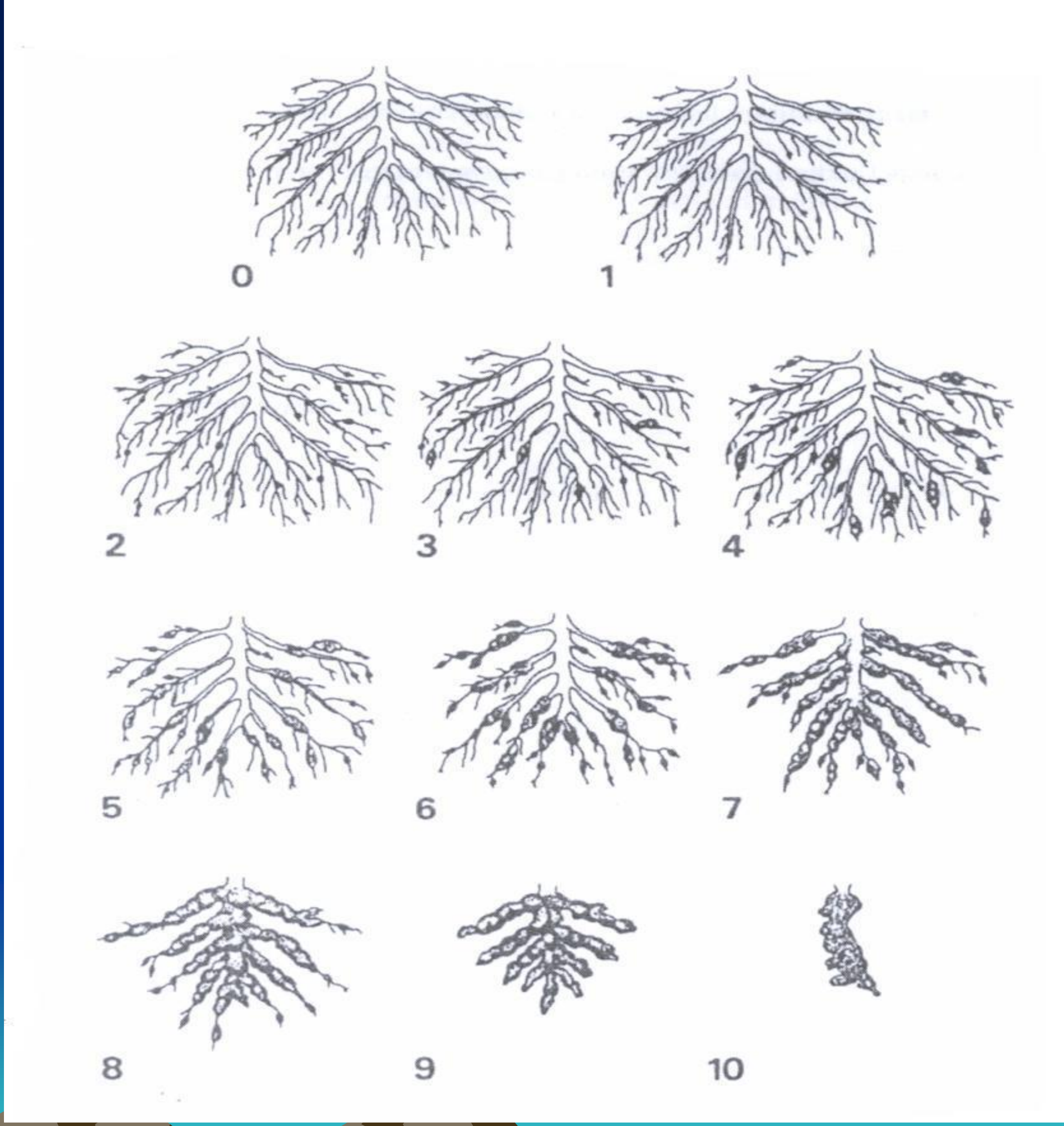
Root-knots/galls




Mature *Meloidogyne* females in roots

Root-knot nematode galling chart

0 = no galls.
5= 50% of roots destroyed.
10= All roots destroyed

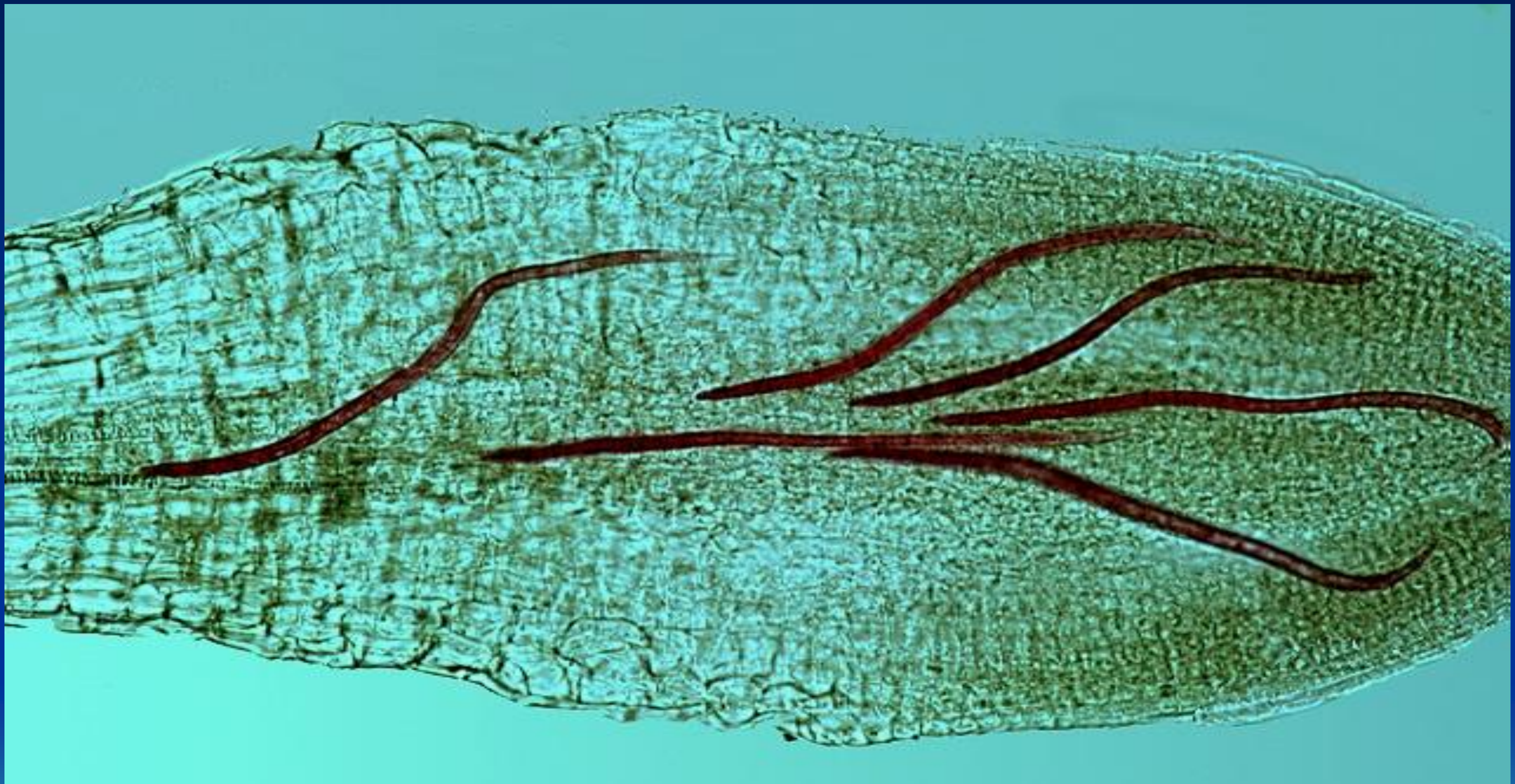


Lesions on bananas

Toppling of bananas

Damage on the corm

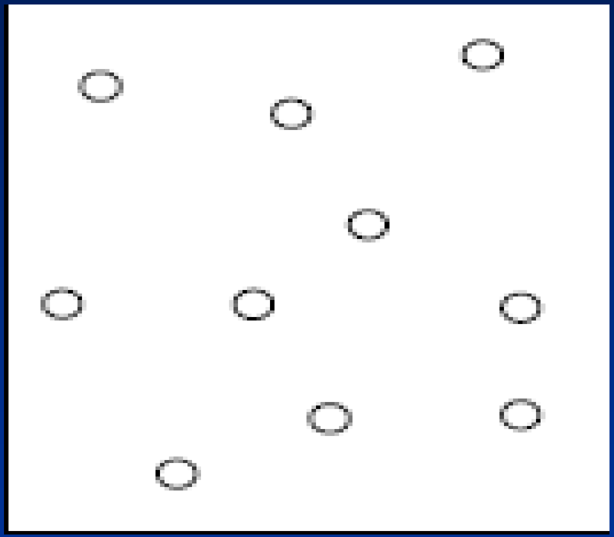
Staining of nematodes in plant tissues

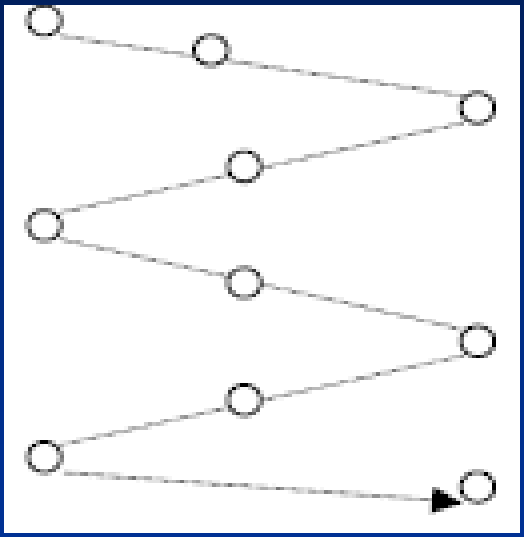


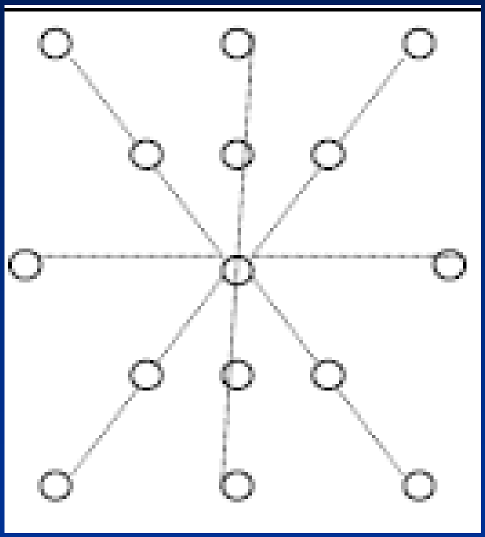
Meloidogyne Juveniles inside root tissue

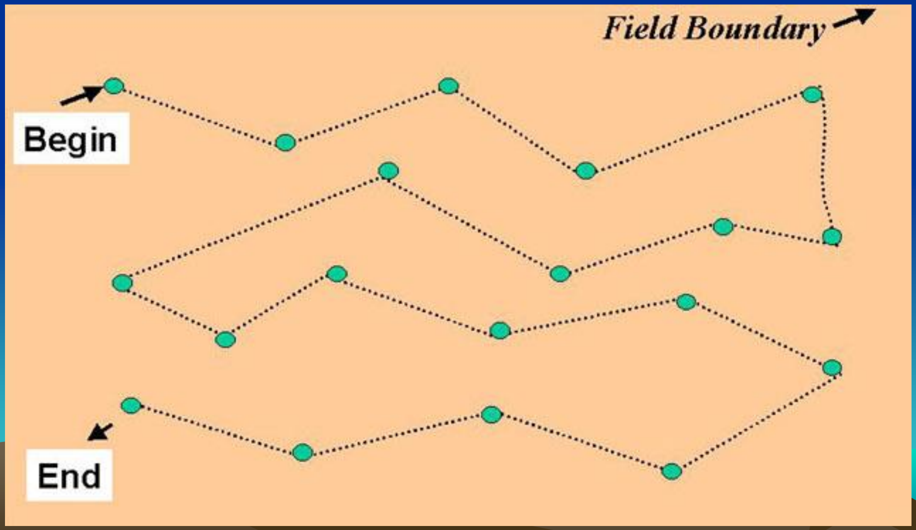
Quantification of Nematodes

Sampling Patterns









Sampling tools

Care of Samples

Transport samples in a cool-box or other insulated containers, preferably with ice packs.

Collect samples in sturdy plastic bags and close the bags firmly

Store samples in a cool place or refrigerate until further processing (most nematodes in the samples will survive storage at 10oC for several weeks)

Do not allow samples to dry as the nematodes will die before the sample arrives in the laboratory. Temperatures above 35^{o}C will also kill many nematodes

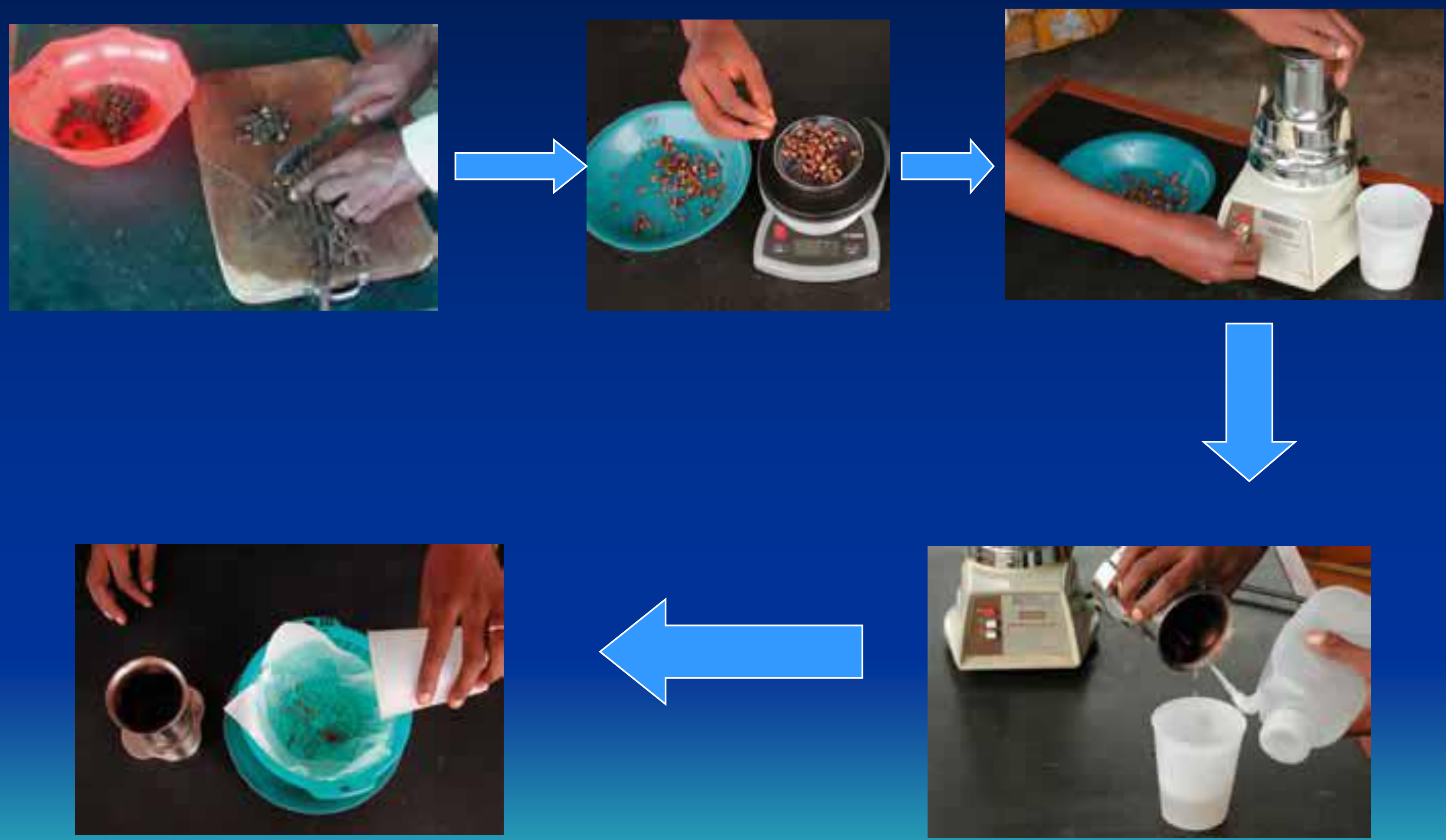
KEEP SOIL AND ROOT SAMPLES SEPARATE BAGS

Nematodes are easy to extract from soil

Extraction of nematodes from soil

Passive Technique (Wet sieving) – Procedure for soil motile nematodes

Extraction of nematodes from plant tissues

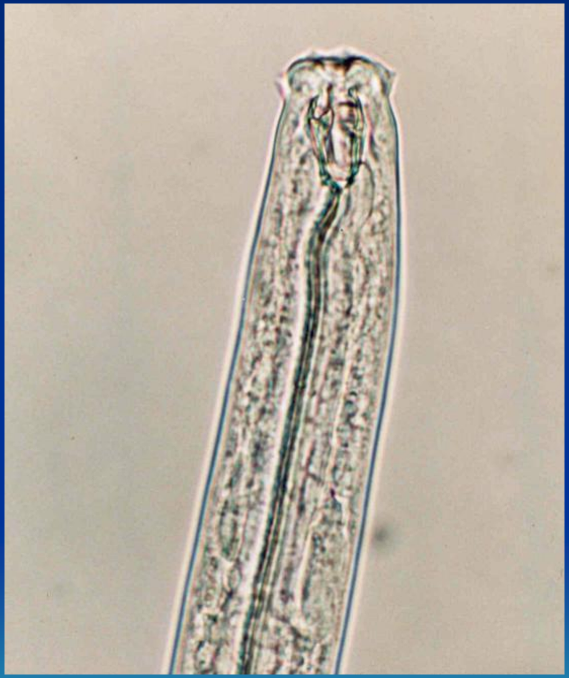


Identification

- Nematode identification requires
  - special techniques to extract nematodes from soil or plant tissues,
  - high-powered microscopes to observe minute morphological features
  - Magnification 400-1000
  - special training in identification procedure.

Diversity of Nematode in Tropical Soils

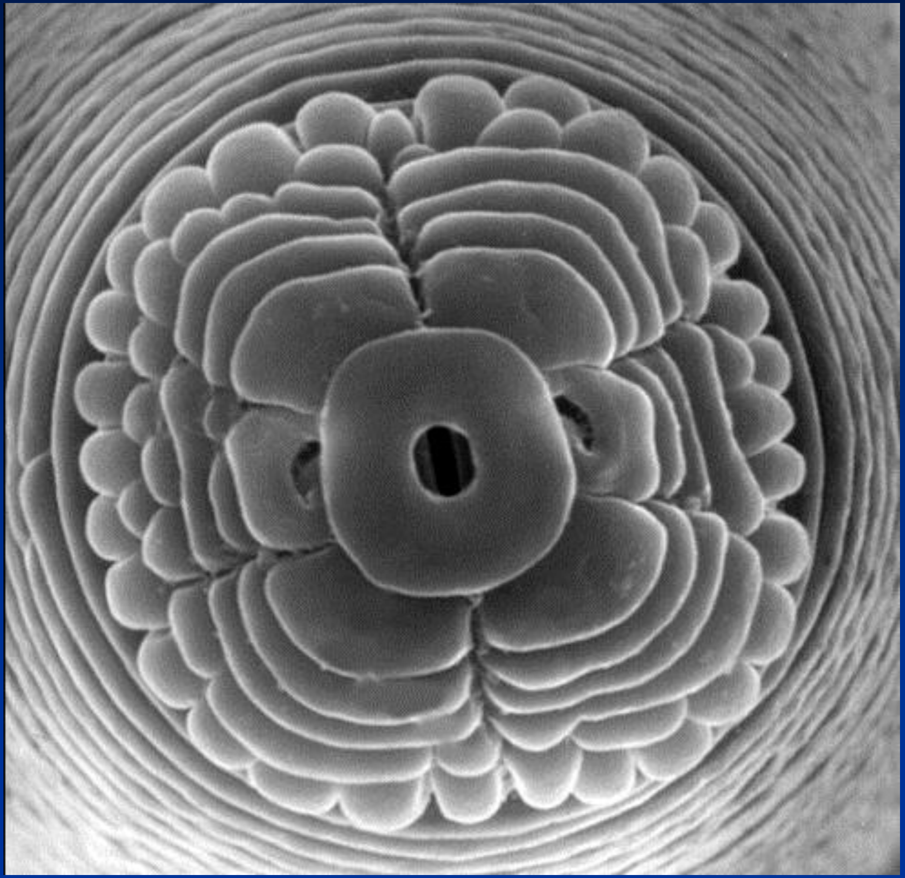
Bacterial Feeder



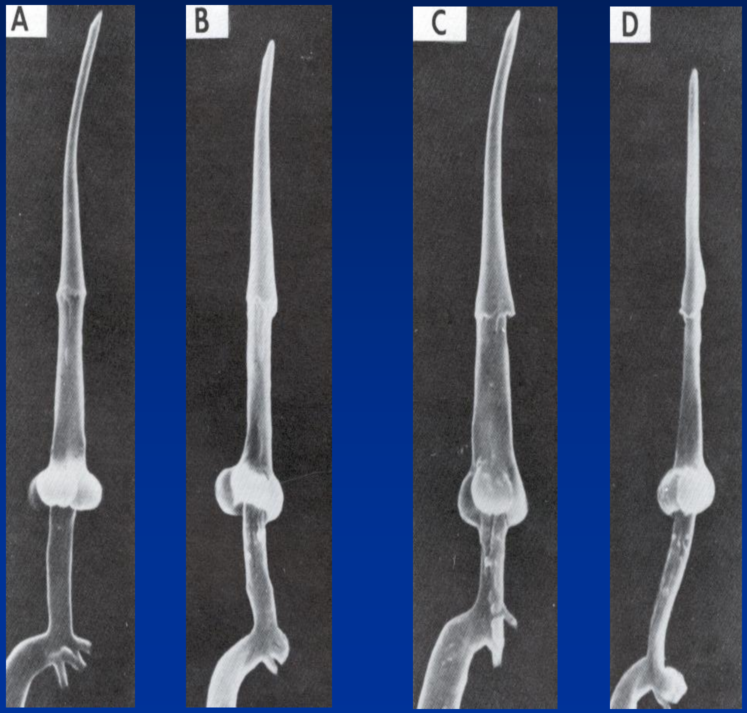
Predator/ carnibal

Plant Parasitic

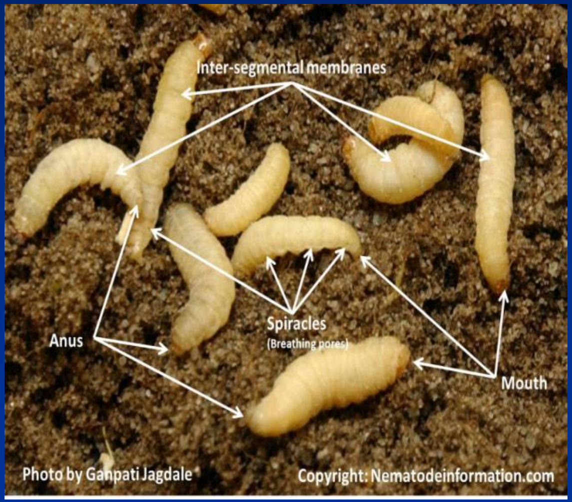
En face view



Types of stylets

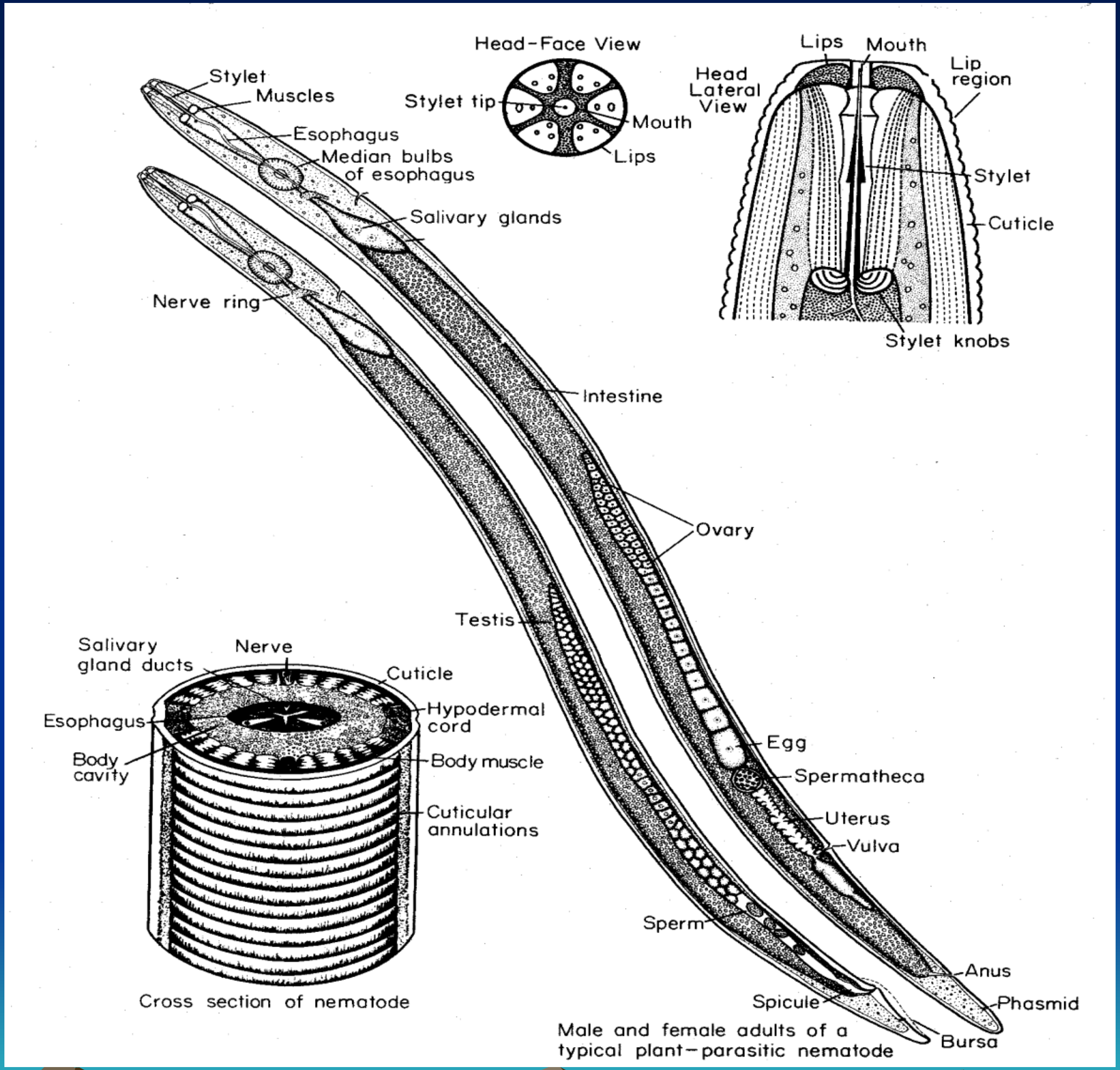


Entomopathogenic Nematodes



Parasite turns host caterpillars red to warn predators

Detailed View of a Nematode



Different Tail Shapes and Lengths

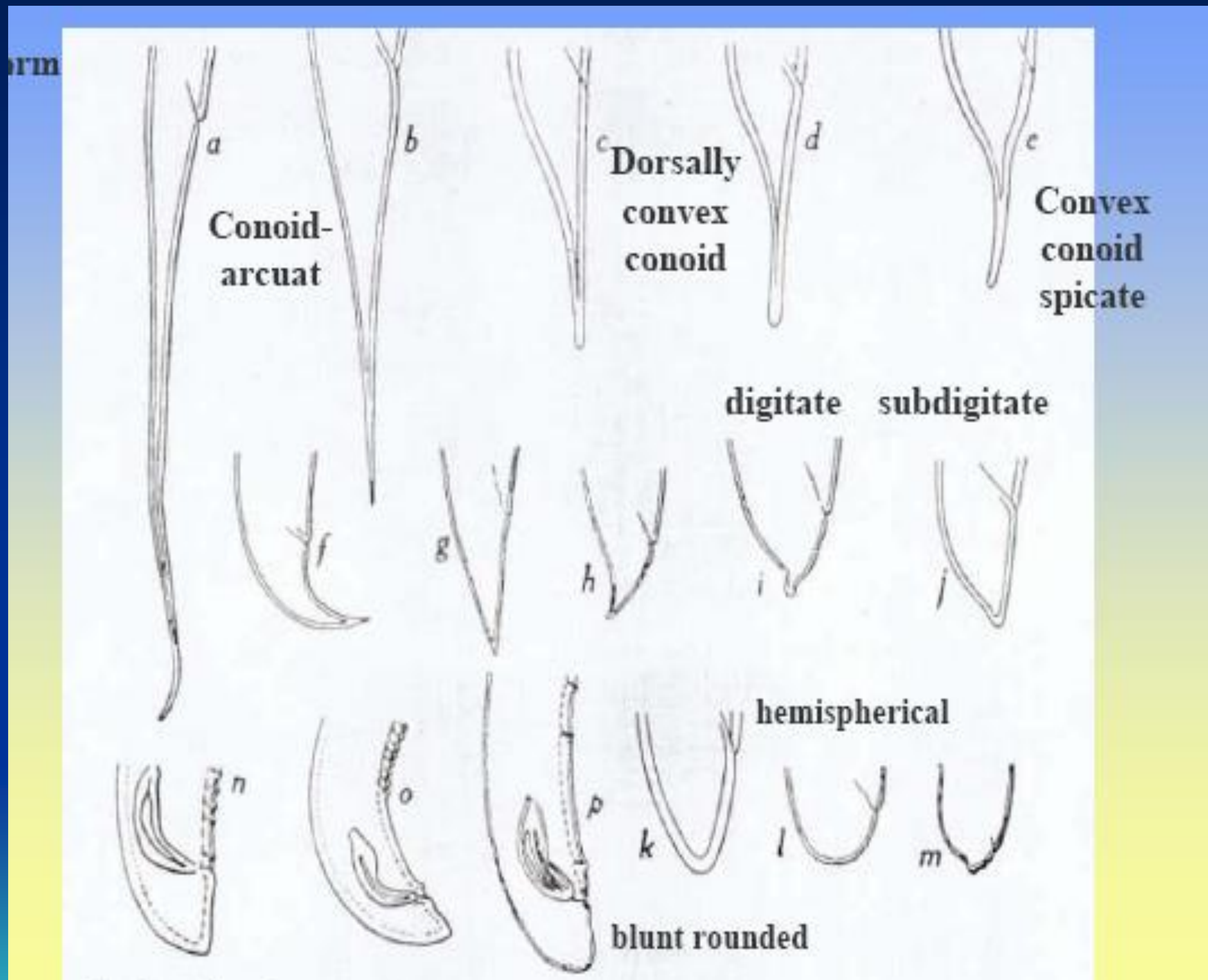


FIG. 56. — Types de queues mâles et femelles chez les Dorylaimides (d'après THORNE et SWANGER).

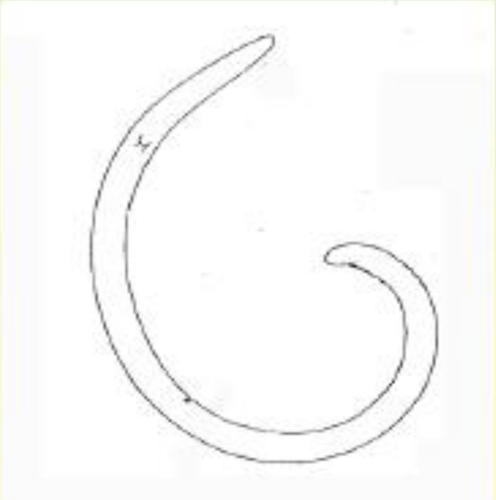
Body habitus

- straight

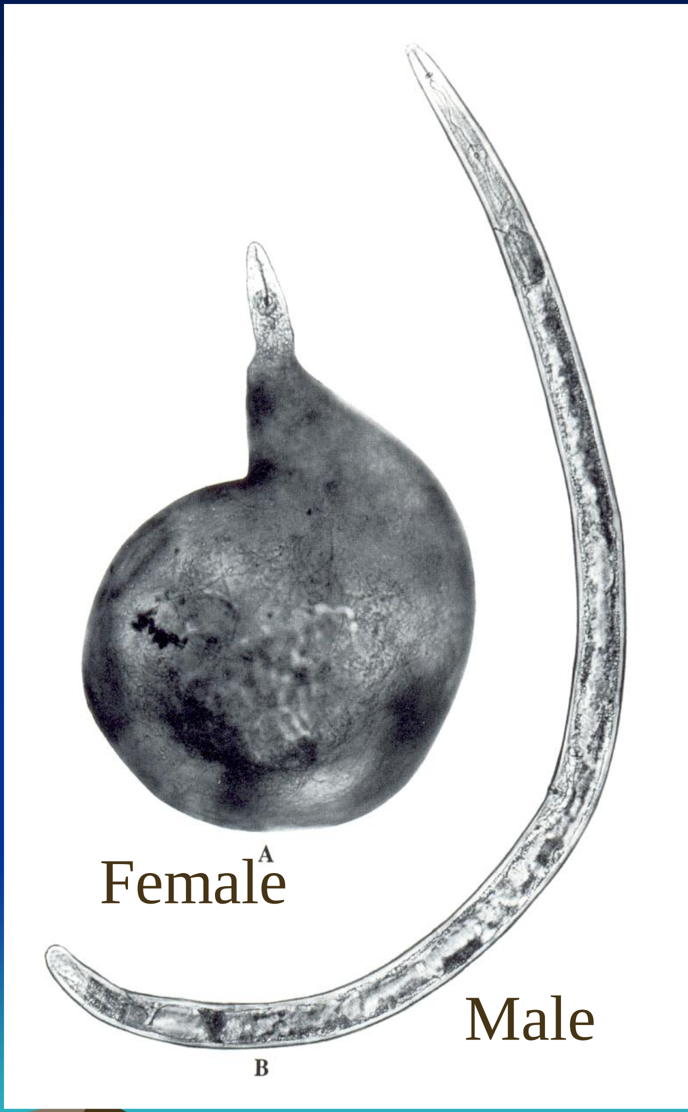
- Ventrally curved

- J-shaped

C-shaped (open, closed C-shape, spiral)



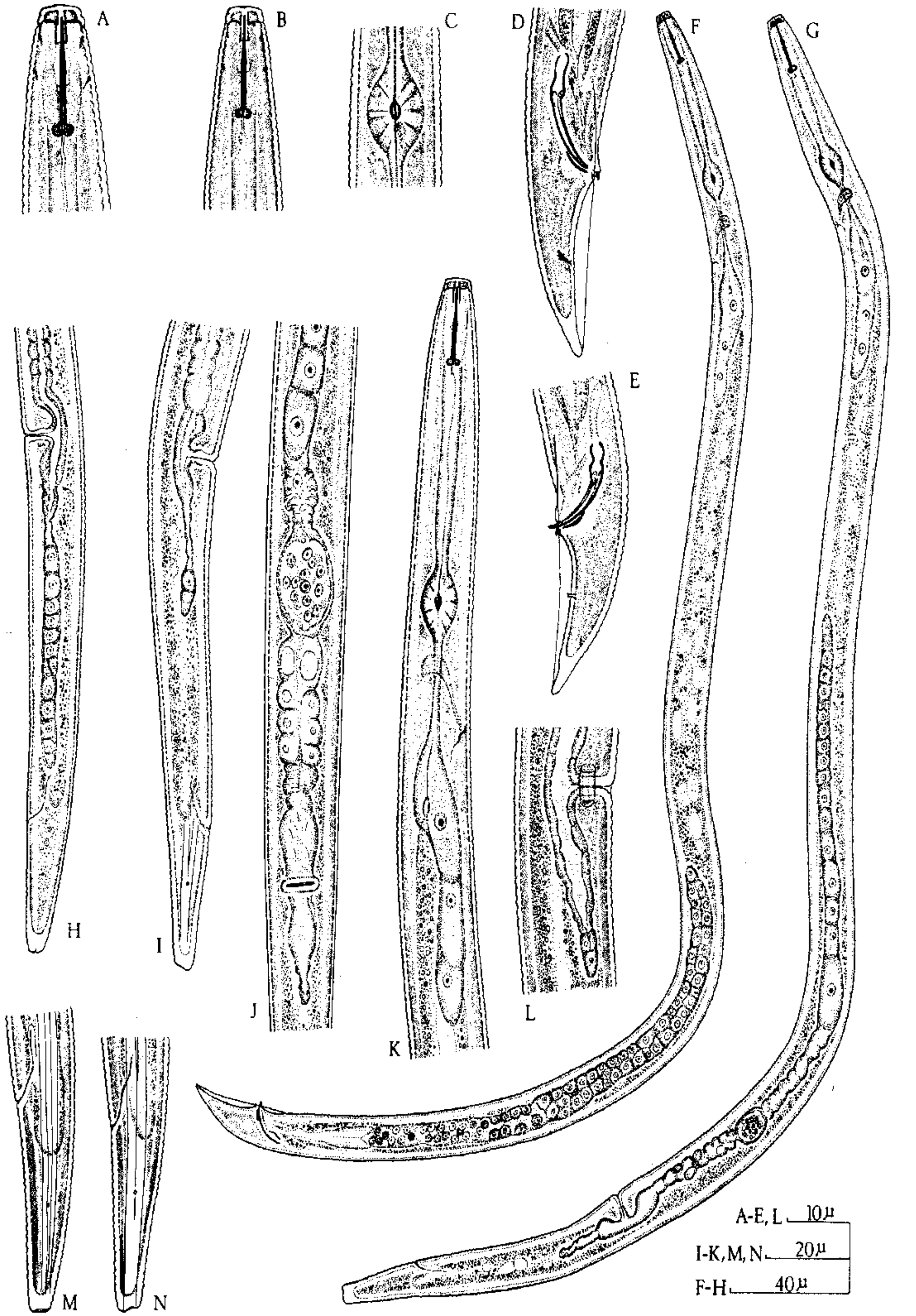
Pronounced sexual dimorphism



Lesions in banana roots

Pratylenchus spp.

- Body length under 1.0 mm
- Lip area low, flattened anteriorly
- Osopahageal glands overlapp the intestine ventrally
- Monodelphic with post-vulval sac
- Vulva position approx 80-90%



Nematode population (100 cm^3 soil) change in 4.5 months

Host		***Meloidogyne incognita***		***Pratylenchus spp.***	
		Pi	Pf	Pi	Pf
Maize		6	273	32	368
Sorgum	Var. 1	15	35	15	140
	Var. 2	3	122	31	60
Soya bean		22	678	49	100

Journal of Nematology; 25: 446 - 453

Thresholds and Expected Yield Loss

***Meloidogyne incognita*, J2/250 cc soil; adjusted for extraction efficiency**

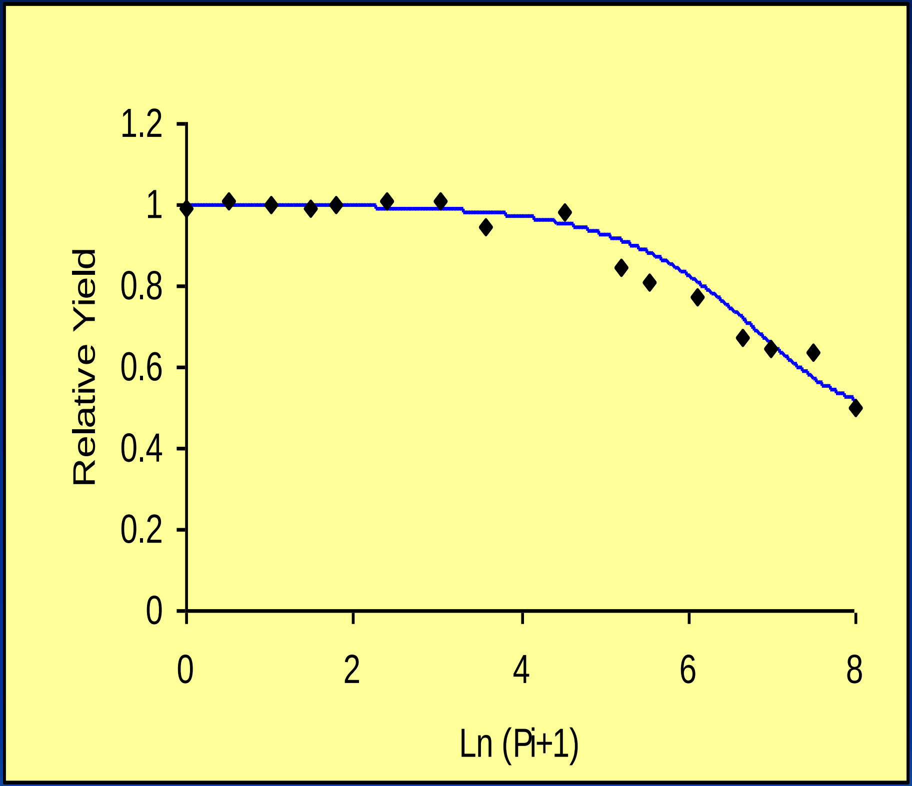
		Expected % yield loss at different preplant nematode densities							
Crop	**Threshold**	**1**	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Bell Pepper	25	0	0	0	0	0	2	5	8
Carrot	0	1	2	5	9	16	29	37	40
Chilli Pepper	15	0	0	0	0	3	14	24	30
Cotton	22	0	0	0	0	0	6	15	27
Cowpea	52	0	0	0	0	0	0	6	8
Snapbean	5	0	0	0	1	3	10	18	29
Sugarbeet	0	0	0	1	1	2	5	8	10
Sweetpotato	0	1	2	4	8	15	30	43	51
Tomato	16	0	0	0	0	0	3	7	14

Nematode thresholds and damage levels

Seinhorst damage function

- $Y=m+(1-m)z^{(Pi-T)}$

- Y=relative yield
- m=minimum yield
- Z=regression parameter
- P_i= pre-plant population level
- T=tolerance level



Nematode Management strategies

Several strategies have been developed which can be put into six major groups

- Preventing introduction and spread
- Cultural practices
- Heat treatment
- Biological
- Chemical
- IPM

Chemical Nematicides

- Nematode management has relied on chemicals for a long time and might continue to do so.

- The increasing concerns regarding toxicity and environmental concern have stimulated a shift to safer pesticides

Evaluation of a nematicide

Laboratory

Greenhouse (small scale)

Greenhouse large scale

Field

IPM for WHAT?

It is important that a pesticide fits well within a an effective IPM stratergy for;

1. Improved food safety
2. Environmental health
3. Sustainable income

Relaxing after a long day with nematodes?

ACKNOWLEDGEMNT

- University of Nairobi
- Syngenta
- Audience

THANK YOU