



Agriculture and
Agri-Food Canada

Agriculture et
Agroalimentaire Canada



Vineland Research Farm

Research on Plant Parasitic Nematodes: Monitoring of high risk plant pathogenic nematodes in Canada

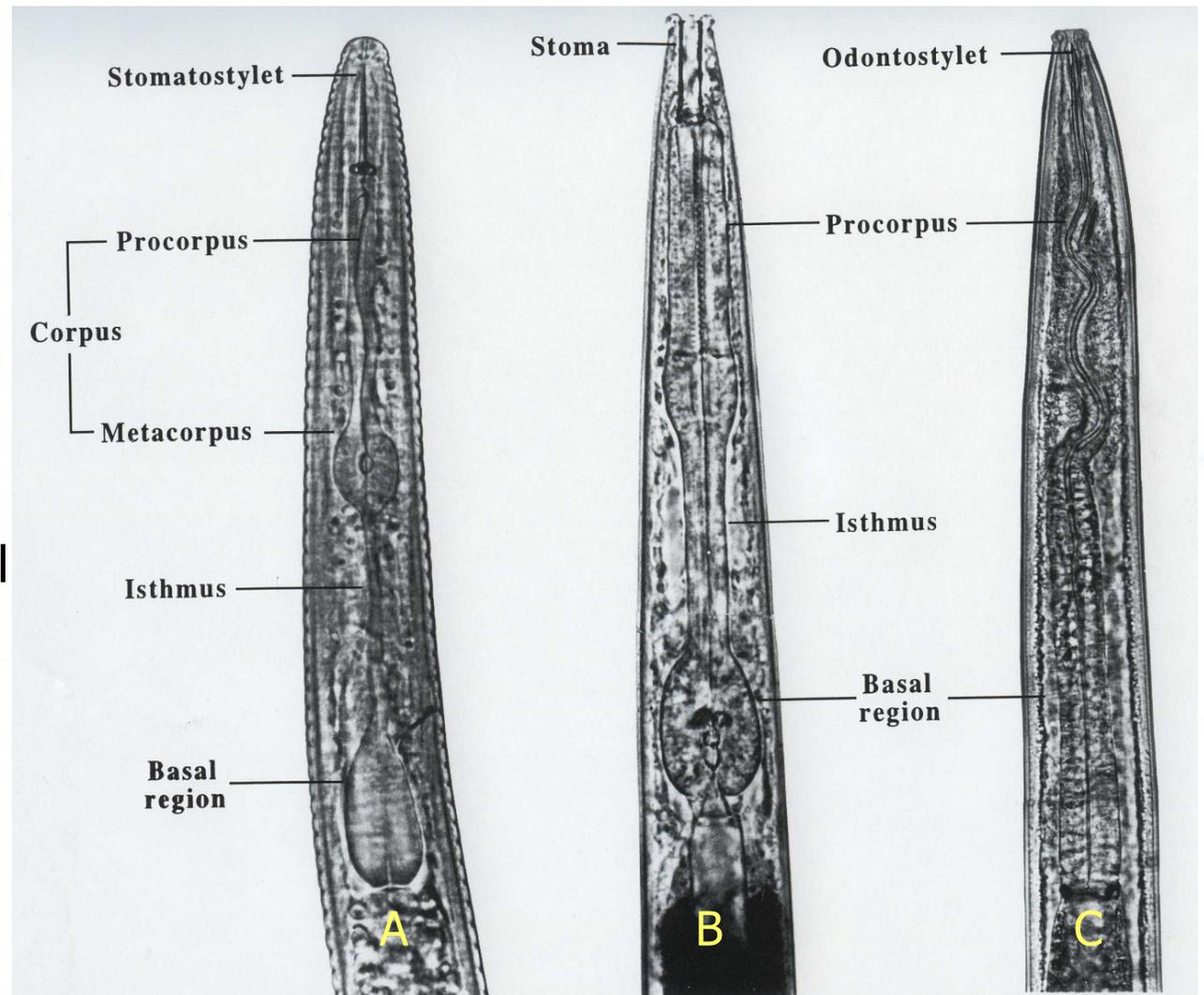


Presented by
TAHERA SULTANA
3rd August, 2019

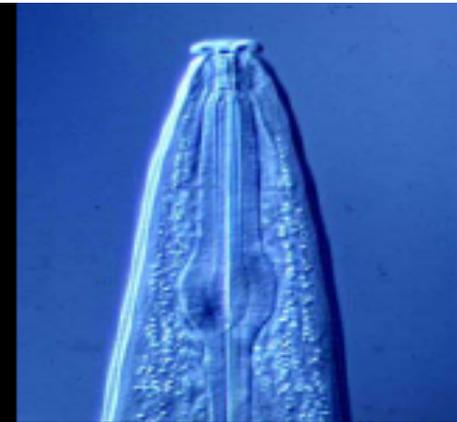
Canada 

Nematode Morphology

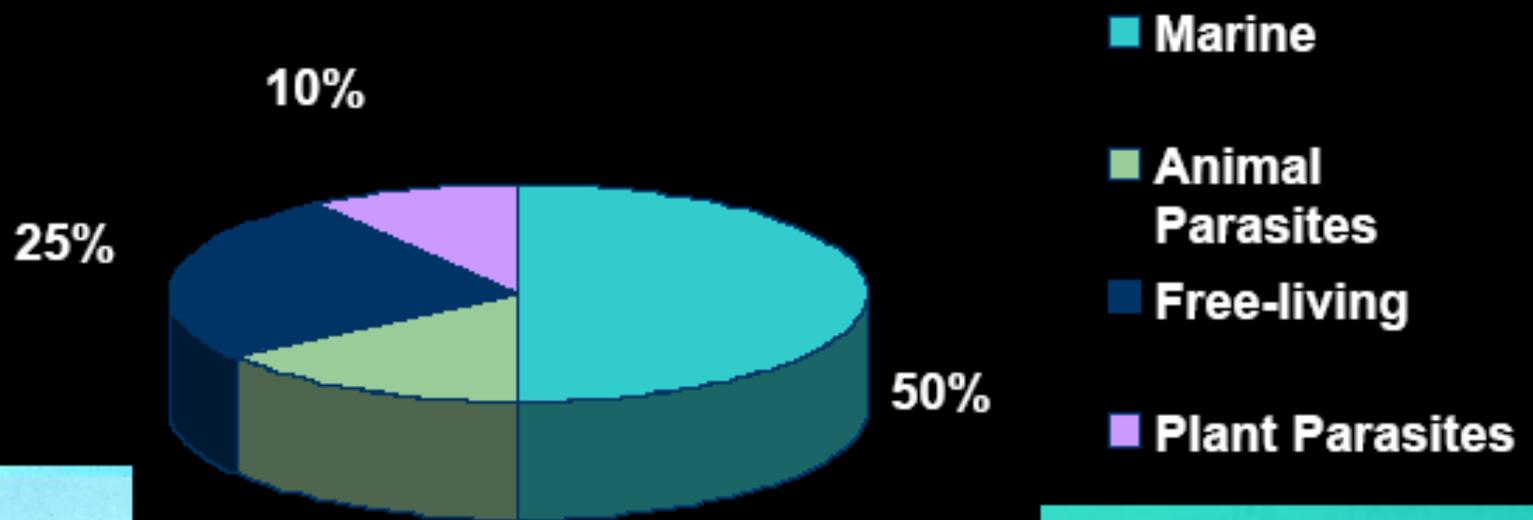
- Nematodes are extremely similar in morphology, plant parasitic ones differ from animal parasites by only the presence of stylet
- Currently accepted classification is based mostly on morphological and ecological traits
- Current identification method is also based on morphological characteristics which needs much expertise



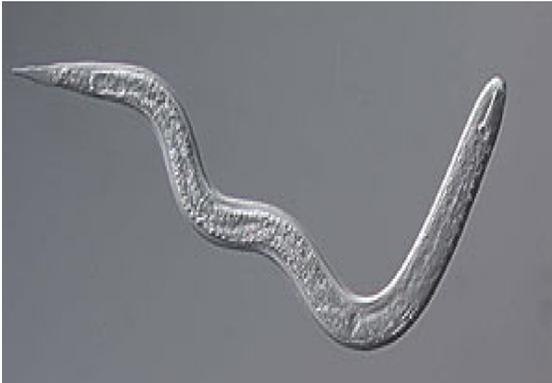
Anterior regions of nematoda; A. Tylenchida B. Rhabditida and C. Dorylaimida



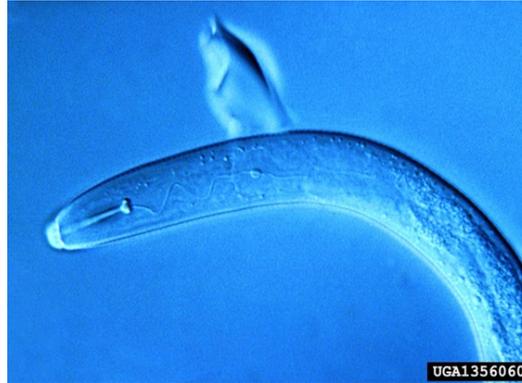
Nematode Diversity



Yield Loss due to Nematode



Soybean cyst nematode



Potato cyst nematode



Stem and bulb nematode

- **Estimated losses to world agriculture: about \$100 billion per year**
- **Estimated losses in USA: > \$5 billion per year**
- **Estimated losses in USA in soybean: > \$1 billion**

Economically Important Nematodes in Canada

- **Potato cyst nematode:** Can reduce yields of potatoes and other host crops such as tomatoes and eggplants by up to 80%
- **Soybean cyst nematode:** Losses to SCN in Ontario have ranged from 5%-100%
- **Stem and bulb nematode:** Significant damage in recent years and some growers have lost whole crops
- **Root-knot nematode in carrot:** 50% grade-out due to crooked, broken or damaged carrots (normal is 20%) lower the total value in market
- **Root-lesion nematode:** Affects most of the major vegetable crops grown in Canada. Yield reductions of 10 to 40%
- **Dagger nematode:** Frequently associated with strawberry, raspberry and grapes rather than with vegetable crops, which tend to be more soft-rooted

Nematode Damage

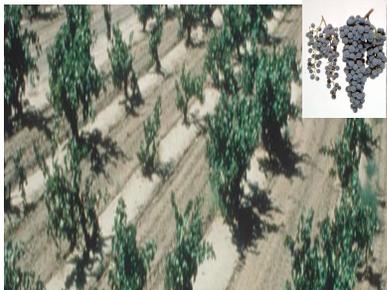


Root-knot nematode infected potatoes, carrot and ginseng



Onion and garlic bulbs infected with stem and bulb nematode

- **Nematodes can cause serious damage to root vegetables such as: potato, carrot, onion, garlic, ginseng etc.**



Nematode affected vineyard



Nematode affected fruit orchard



Nematode affected strawberry plant



Nematode affected cereal field

- **Nematodes also cause severe yield loss in various economically important fruits and cereals**

Nematode as Vector



Ringspot on tomato



Ringspot on blueberry leaf



Declining grapes clusters
due to virus infection

- **Nematodes are vectors of certain plant viruses such as: tobacco ringspot virus (TRSV) and tomato ringspot virus (ToRSV) in blueberry and other plants**

When Should We Consider a Pest as “High Risk”?

- **It causes severe losses to production or market**
- **It is difficult to control or manage once established**
- **It is soil-borne and long survival**
- **It is seed-borne**
- **It is not endemic in the region**

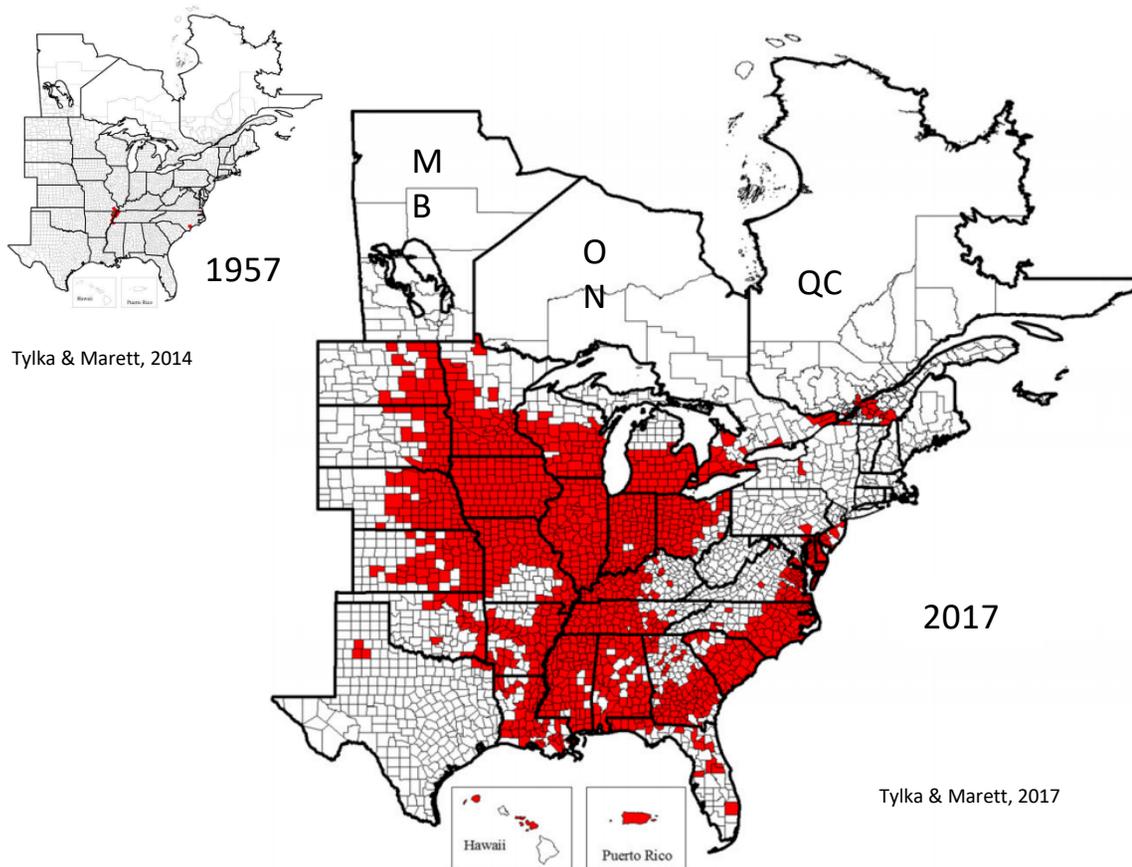
Parasitic Nematodes Regulated by CFIA

Scientific name	Common name
<i>Ditylenchus destructor</i>	Potato rot nematode
<i>Ditylenchus dipsaci</i>	Stem and bulb nematode
<i>Globodera rostochiensis</i>	Golden Nematode
<i>Globodera pallida</i>	Pale Cyst Nematode
<i>Longidorus</i> spp.	Needle nematodes
<i>Meloidogyne chitwoodi</i>	Columbia root-knot nematode
<i>Trichodorus</i> spp.	Stubby root nematodes
<i>Xiphinema</i> spp.	Dagger nematodes

Plant Parasitic Nematodes Challenges

- **No specific symptoms**
 - stunting, wilting, yellowing
- **Chaotic soil distribution**
- **Species identification by standard morphometric requires highly trained people and time**
- **Interpretation of damage thresholds**
- **Very few management tools available**

SCN Distribution in North America

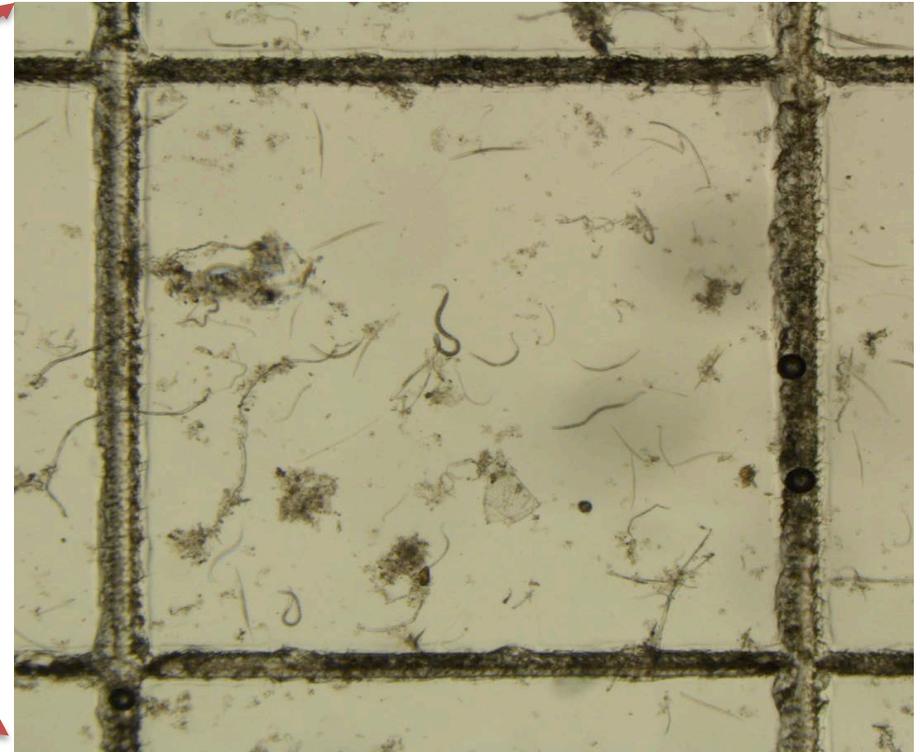
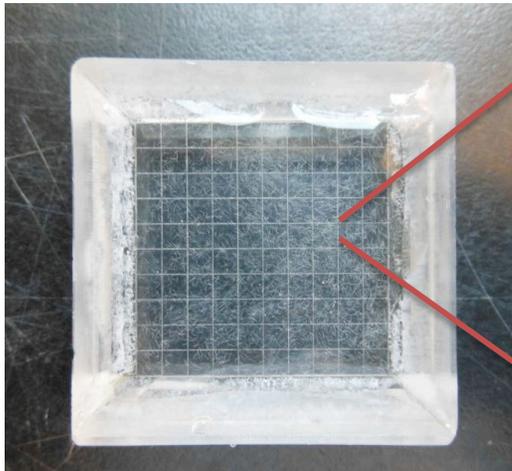


- Nearly all the soybean-producing counties in the U.S.
- First report Canada in 1987
- At the Manitoba-North Dakota border
- MB = highest increase in soybean acreage!

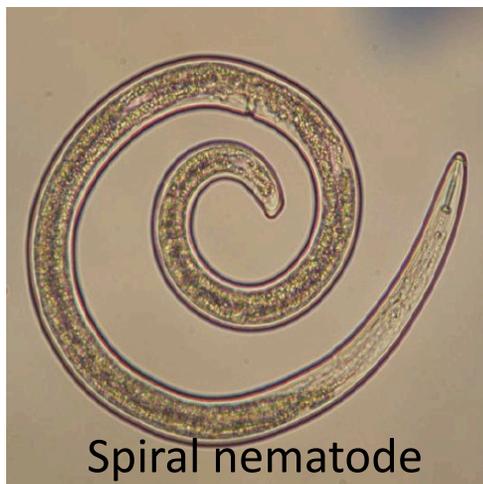
Thanks to:
Benjamin Mimee
Research Scientist, AAFC

Nematode Identification

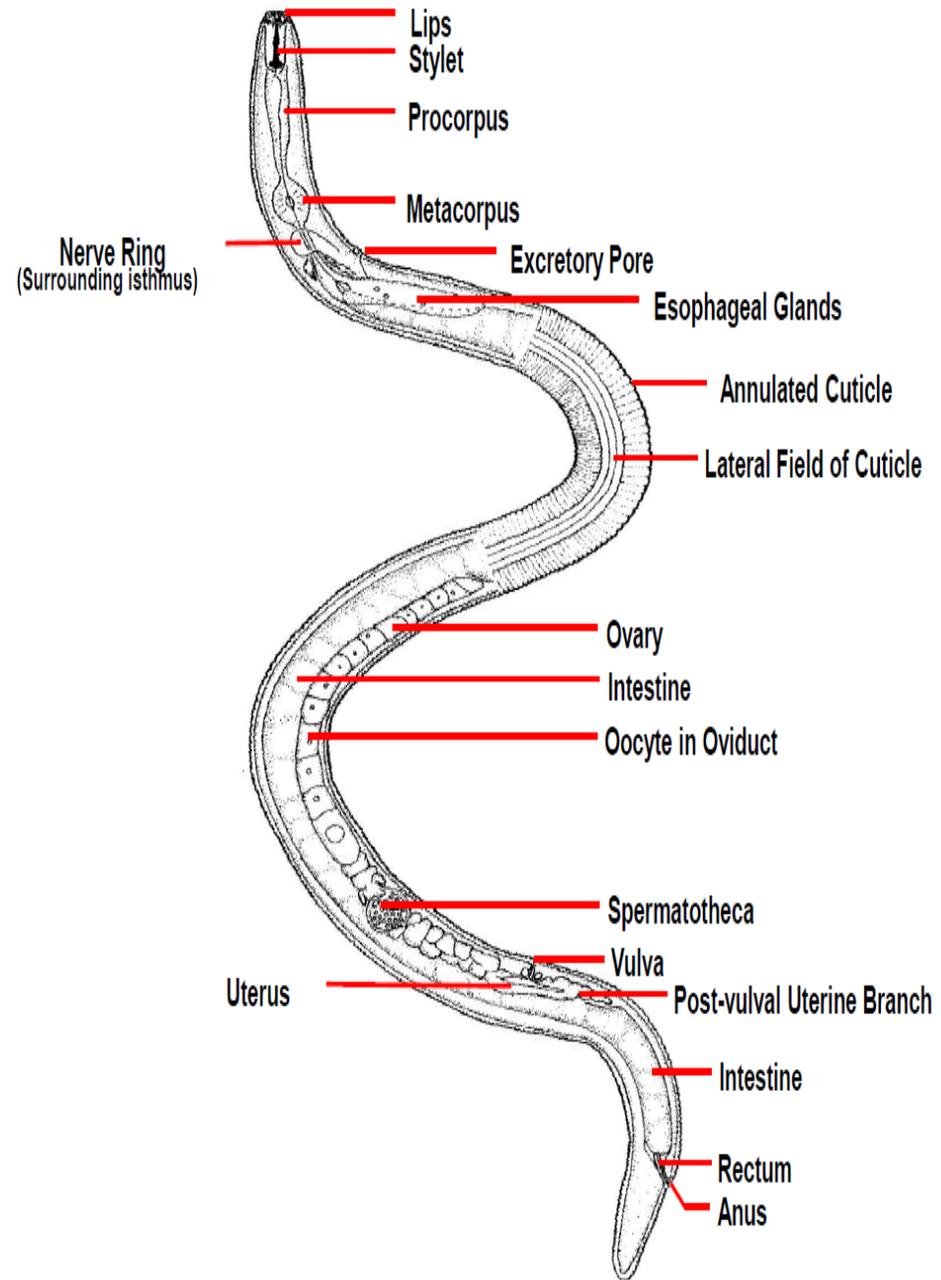
- Nematode extraction from soil by-
Baermann Funnel method
Sucrose centrifugation method



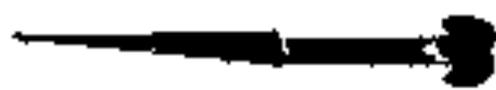
Nematode Identification



Nematode Identification

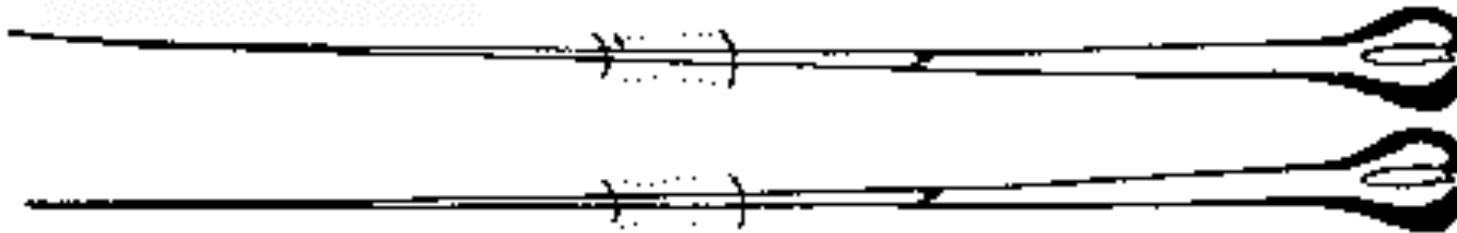
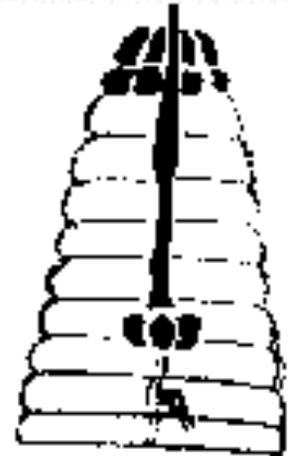


Nematode Identification: Style of Stylets



STOMATOSTYLET

STYLETS

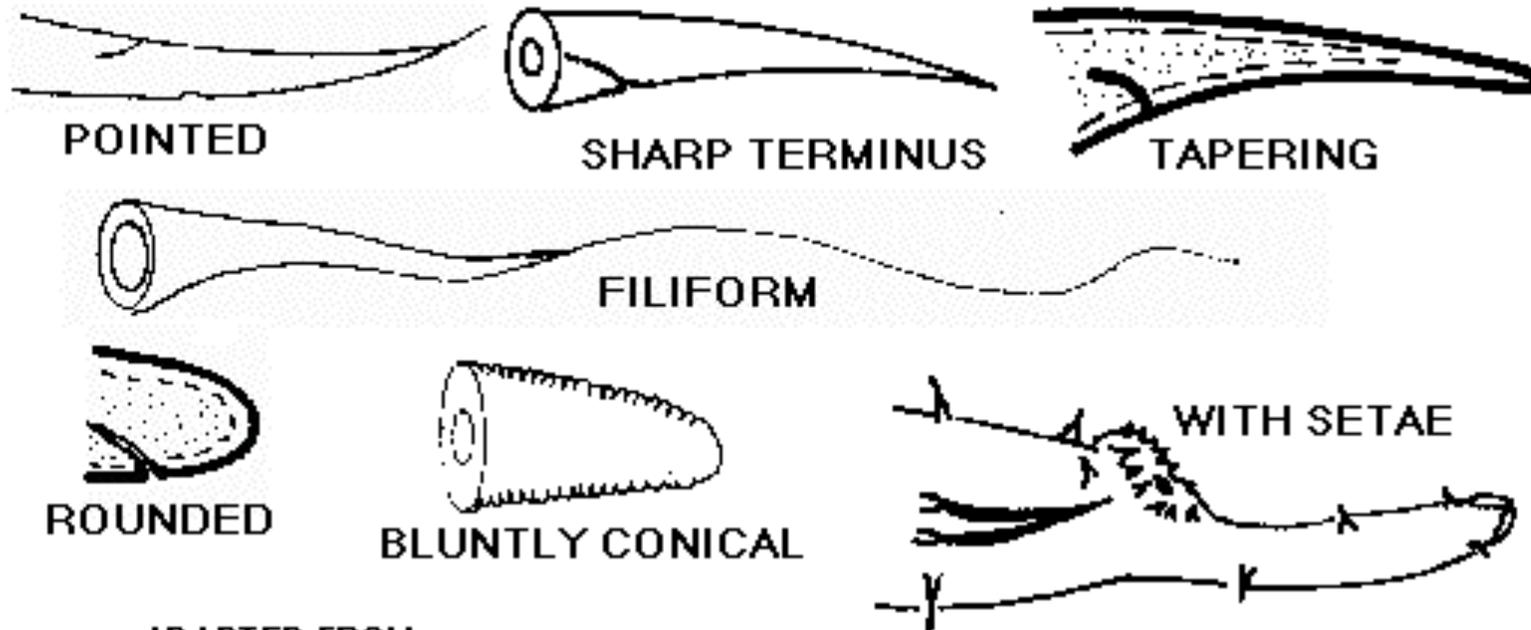


ODONTOSTYLET

ADAPTED FROM: <http://ianrwww.unl.edu/ianr/plntpath/nematode/nemasite.htm>;
(ORIGINALLY FROM - TARJAN, ESSER & CHANG, 1977)

Nematode Identification: Shape of Tail

TAIL SHAPES

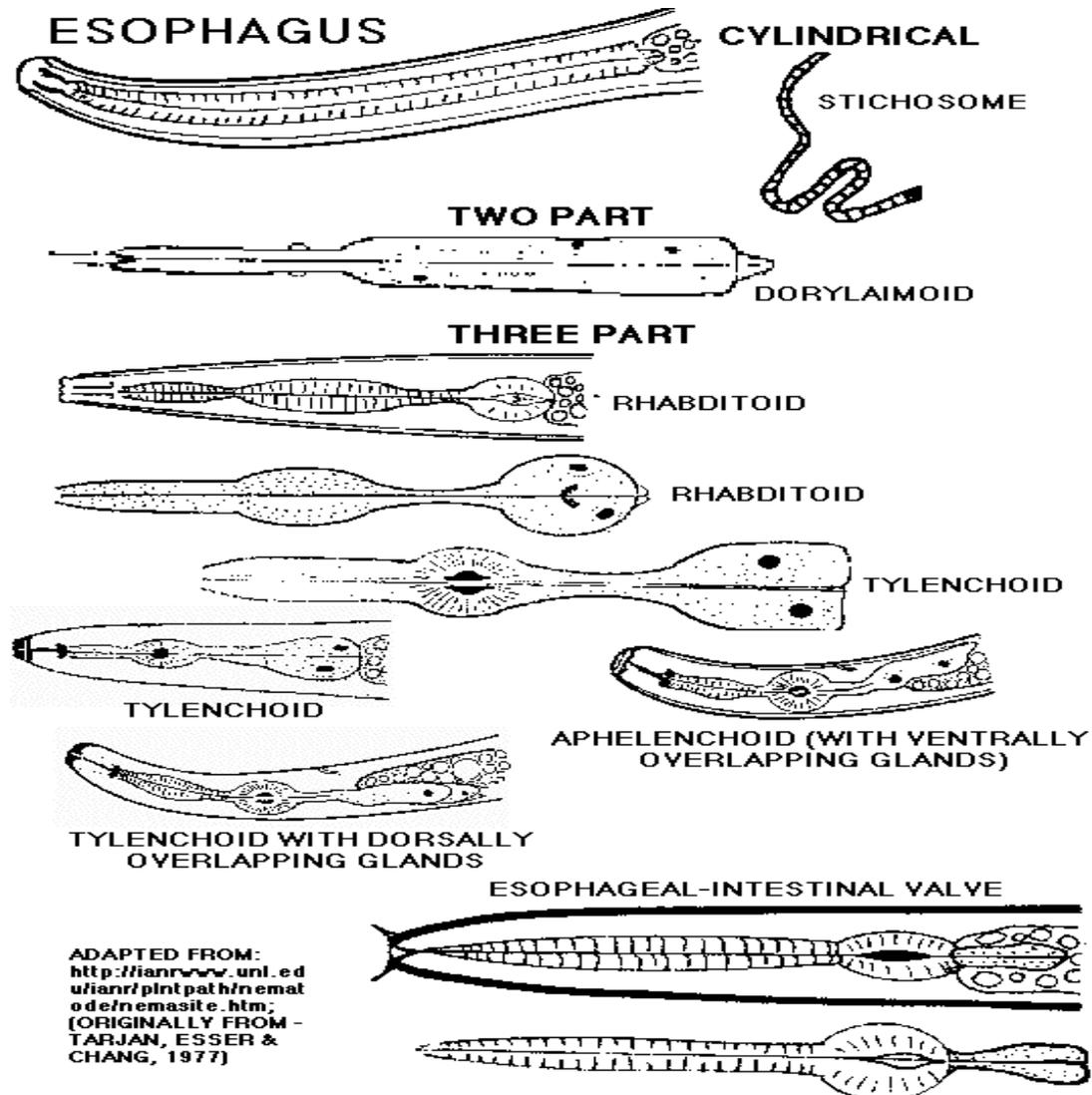


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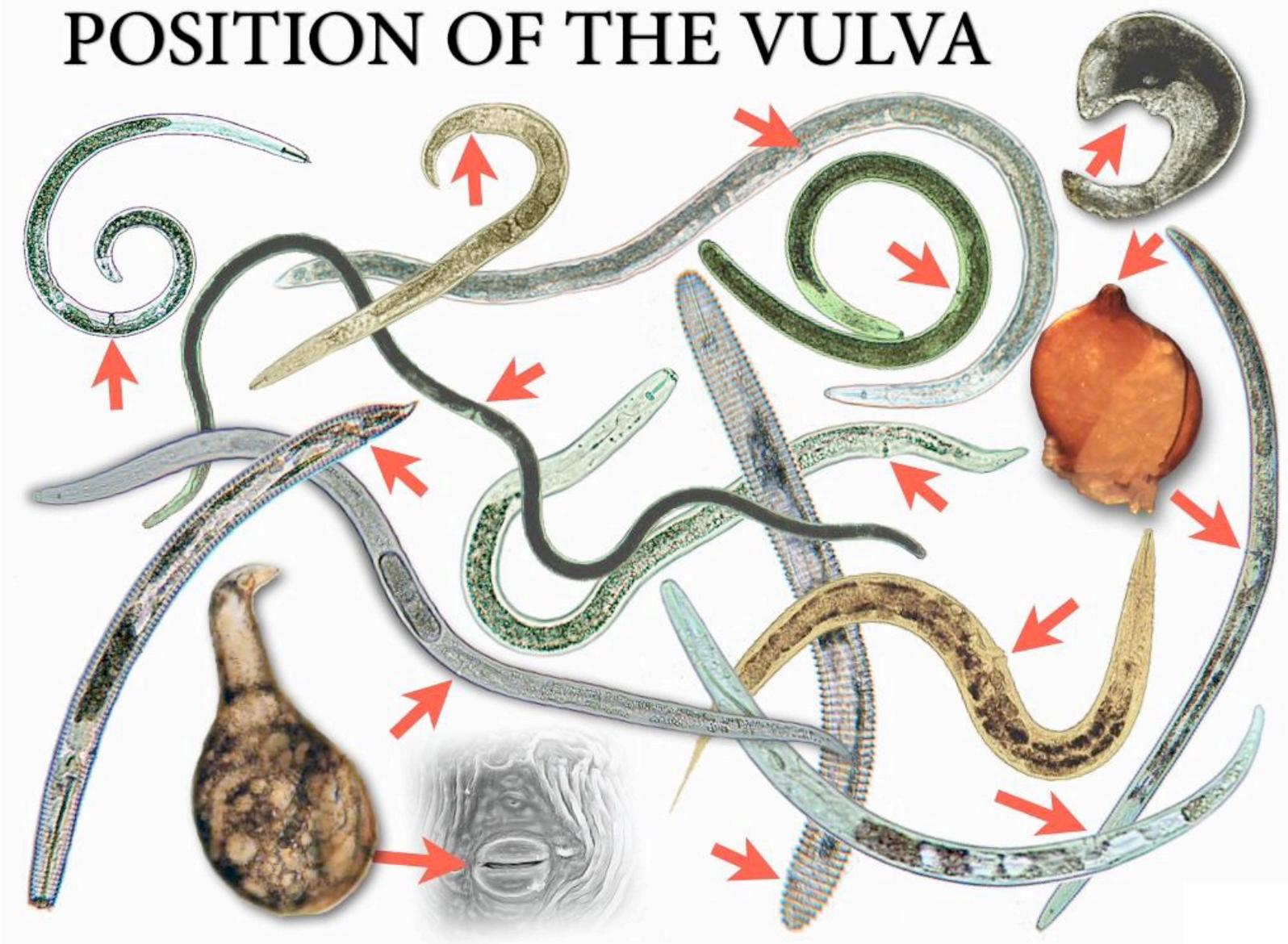
(ORIGINALLY FROM - TARJAN, ESSER & CHANG, 1977)

Nematode Identification: Esophagus Position



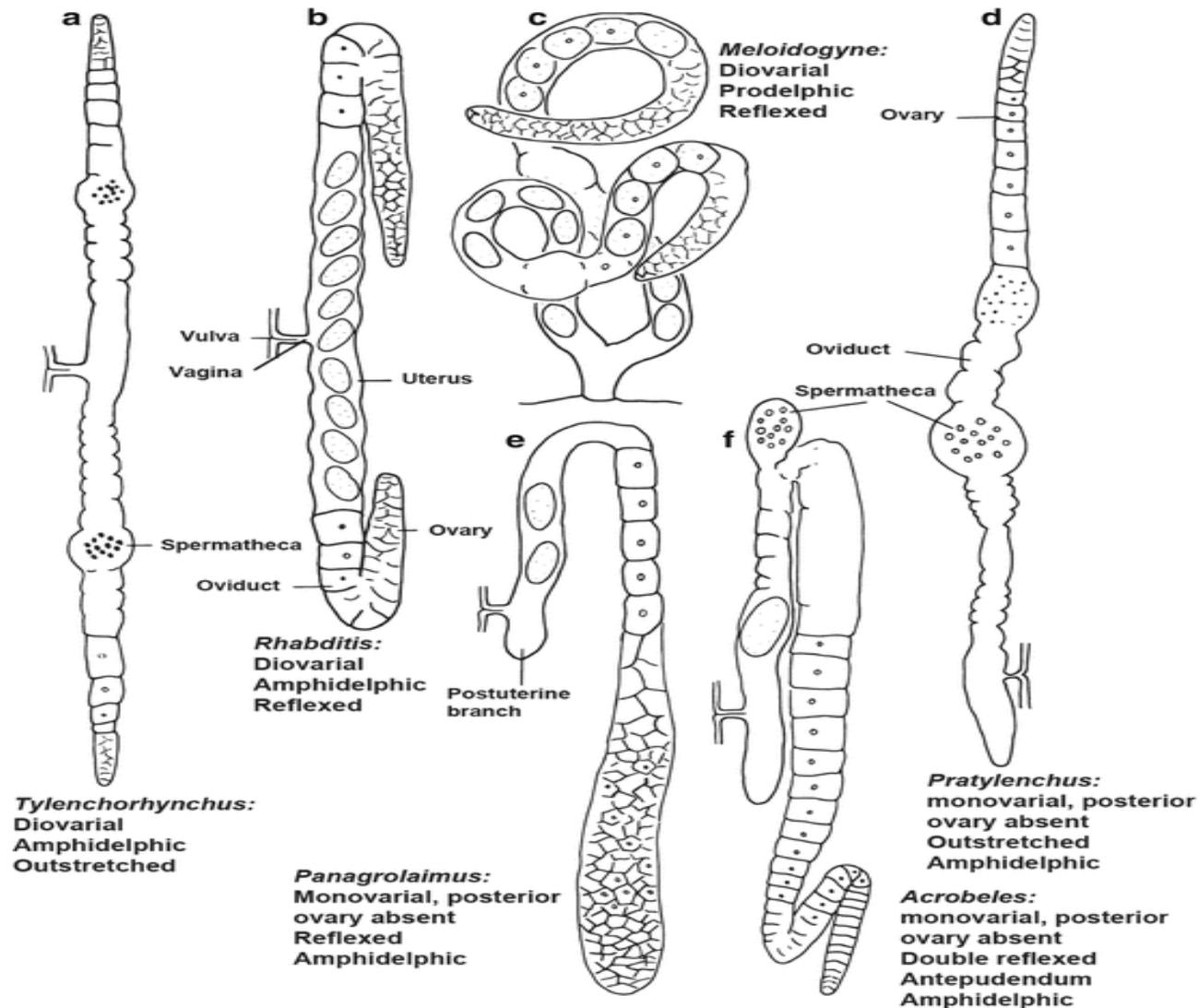
Nematode Identification

POSITION OF THE VULVA



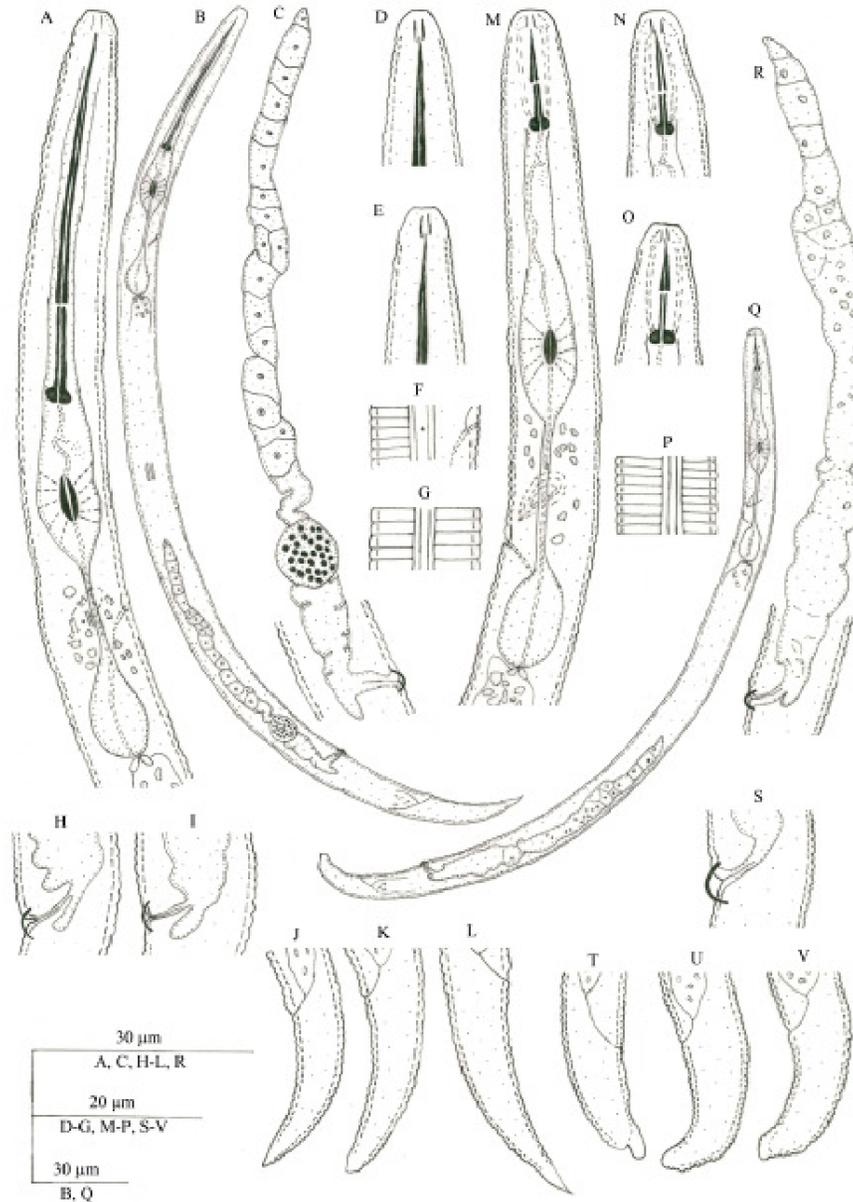
Nematode Identification

Position of Ovary

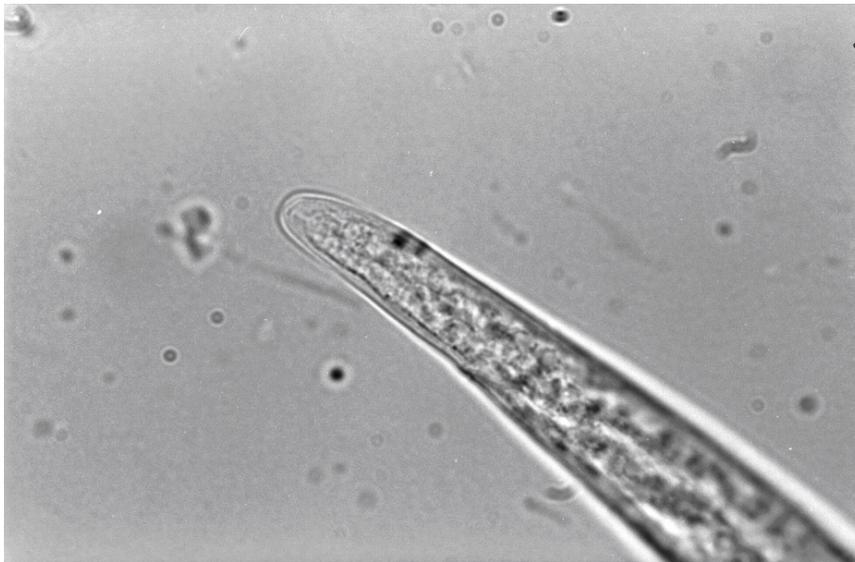


Nematode Identification: Species Level

Example: Paratylenchus spp.



Morphological Based Discrimination of *Bursaphelenchus xylophilus* and *Bursaphelenchus mucronatus* (Presence of mucron in female tail)



Bursaphelenchus xylophilus (♀)

Virulent



Bursaphelenchus mucronatus (♀)

Mostly non-virulent

Nematode Species Identification

- **SCN: Good tool for species ID but marker for pathotypes are still missing. Identification of pathotype is important to control spread**
- **SCN: Virulent population identification**
- ***Xiphinema* sp.: *X. americanum* in present in Canada not *X. index* (?)
X. index is present in northern US states**
- ***Meloidogyne chitwoodi* is regulated by CFIA, could be introduced to Canada**
- ***Pratylenchus crenatus* is widespread in NB not *P. penetrans*: growers use fumigation to prevent potato early dying problem**
- ***Root-knot nematodes (Meloidogyne sp.) used to not occur in the field in Canada, but they can persist in greenhouses when imported from warmer climates***

Thanks to:
Benjamin Mimee
Research Scientist: AAFC

How Laboratory Research Can Help

- **Rapid and accurate diagnosis of nematodes right on time**
- **Avoid false positives which has significant economic consequences**
- **Develop new and improved diagnostic methods**

Nematode Species Identification

- **PPN molecular identification, quantification and characterization**
PCR – qPCR – qRT-PCR
- **Easy identification by anybody**
- **Fast, cheap, precise**
- **Quantification without visual enumeration**
- **Egg viability evaluation (SCN, PCN)**
- **Races/pathotypes identification**
- **In-field diagnostics tools**

Introducing New Technologies

DNA sequencing: Prepare database for nematode sequences

Approaches:

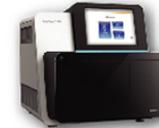
Sanger Sequencing: Barcode, Target enrichment, short length sequencing

Next Generation Sequencing (NGS): Generate millions of sequences per run

Challenges: Data storage and **BIOINFORMATICS**



MiSeq®



NextSeq® 500



HiSeq® 2500



HiSeq® 3000

Next Generation Sequencing platforms from trusted names



Ion Torrent™



PacBio RS II System



HiSeq® 4000



Qing Yu Research Scientist



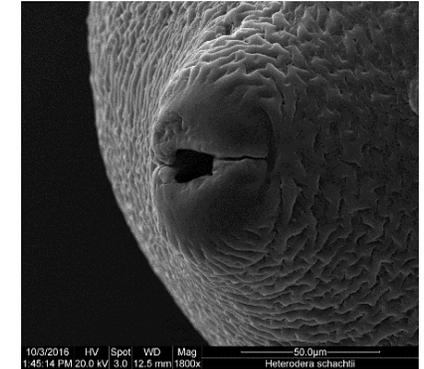
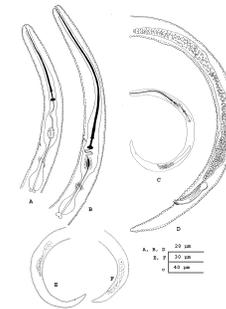
- Taxonomy-Nematoda
- Curator of CNC-Nematode
- NIS-Nematode

Research projects:

- Invertebrate biodiversity and systematics
- Plant Parasitic nematodes on pulse crops

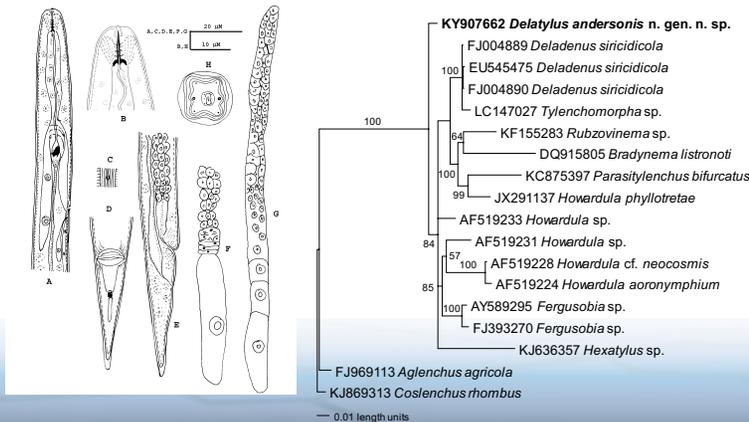
Taxonomy of Plant Parasitic Nematodes

1. Molecular systematics of *Ditylenchus*
2. Taxonomic revision of Criconematidae
3. Molecular diagnostic of cyst nematode in subfamily Heteroderinae



Systematics of Entomophilic Nematodes

1. Taxonomy revision of nematode family Neotylenchidae (Nematoda: Tylenchida)
2. Describing new species of *Deladenus*



Curator CNC-Nematode and NIS-Nematode

1. Curate the Canadian National Collection of Nematodes
2. Provide authoritative identification service (NIS) of nematodes

The Canadian National Collection of Nematodes



Part of CNC in Ottawa
Started in 1945 by Dr. A. Baker
Expanded by Mr. R. Mulvey
Drs. L.Y. Wu
B. Ebsary
R. Anderson

Significantly deposited from Drs. J. Townshend, J. Potter, T. Oshoff (Vineland station, AAFC); from Drs. J. Kimmins (P.E.I.); T. Vrain (BC); and Dr. G. Belski (Quebec), and others.

Depositions from nematode taxonomists around the world.

Donations:



CCMS
GUISCP
RCCCRP

THANK YOU



tahera.sultana@canada.ca