Plant Health and Nematode Pest on the Prairies: Should We Care?

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NSERC Senior Industrial Research Chair

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University of Saskatchewan
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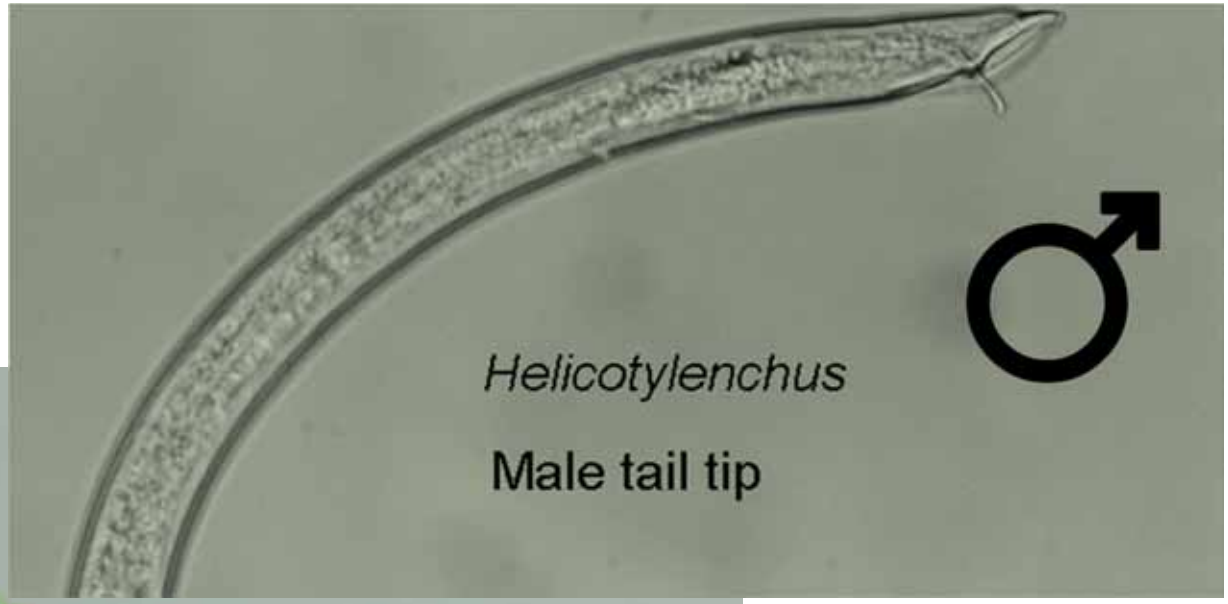
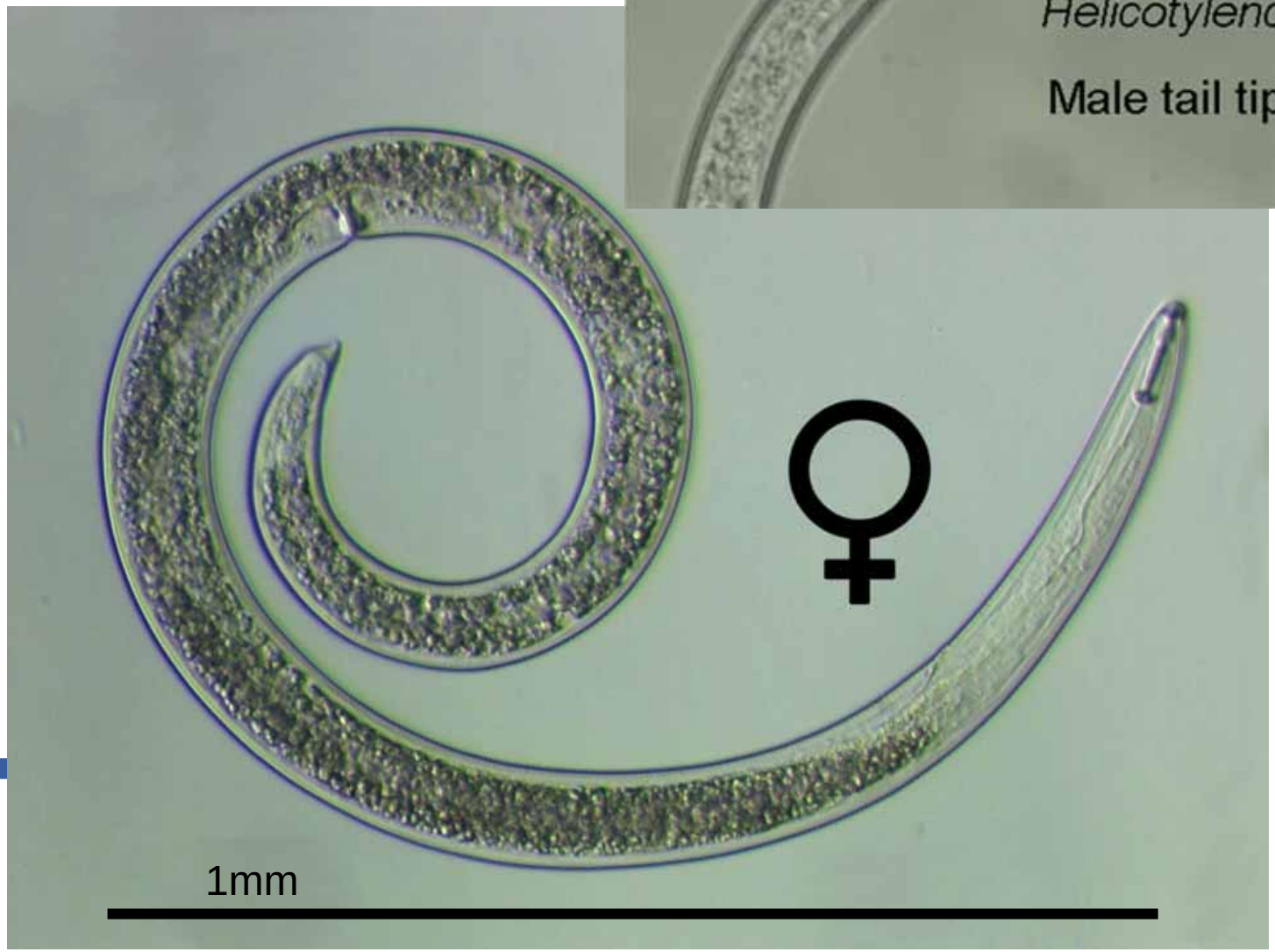
INTERNATIONAL YEAR OF PLANT HEALTH 2020

University of Manitoba

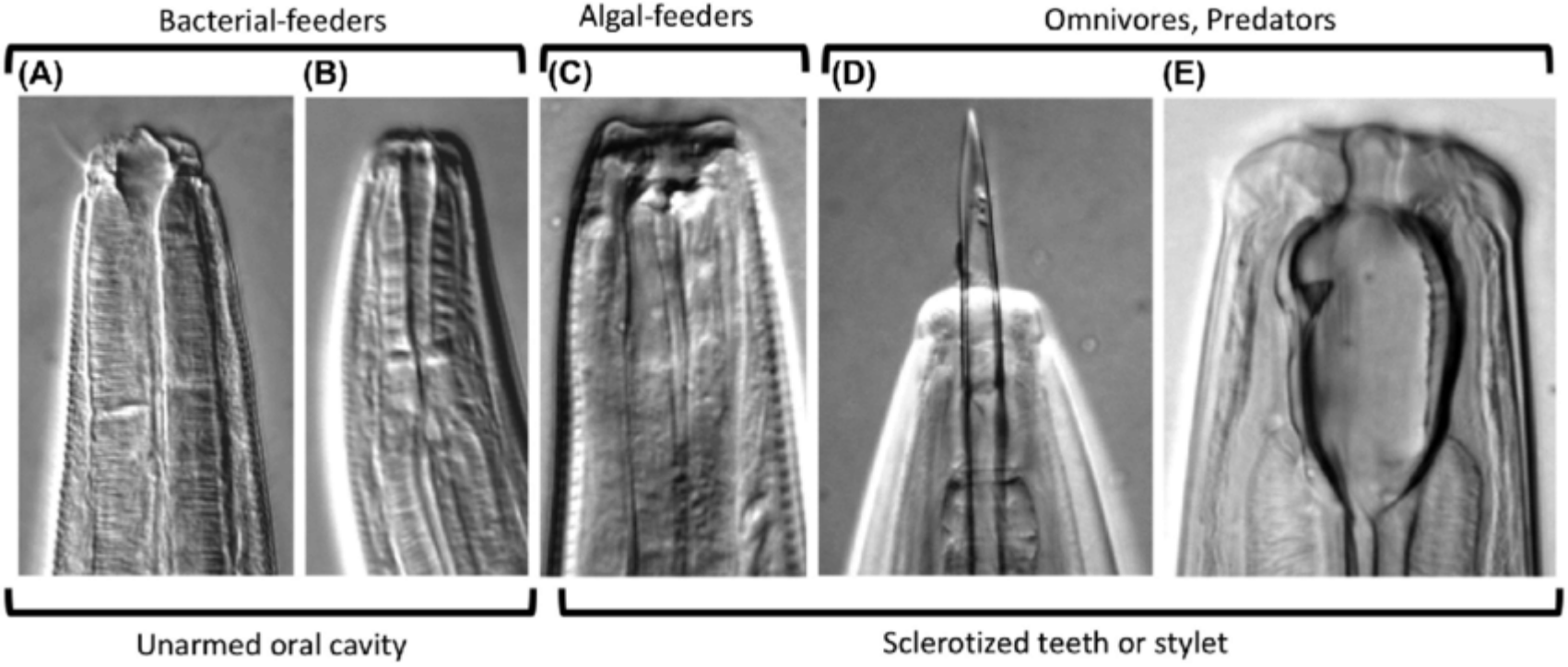




Placentonema gigantissima
8.5 m

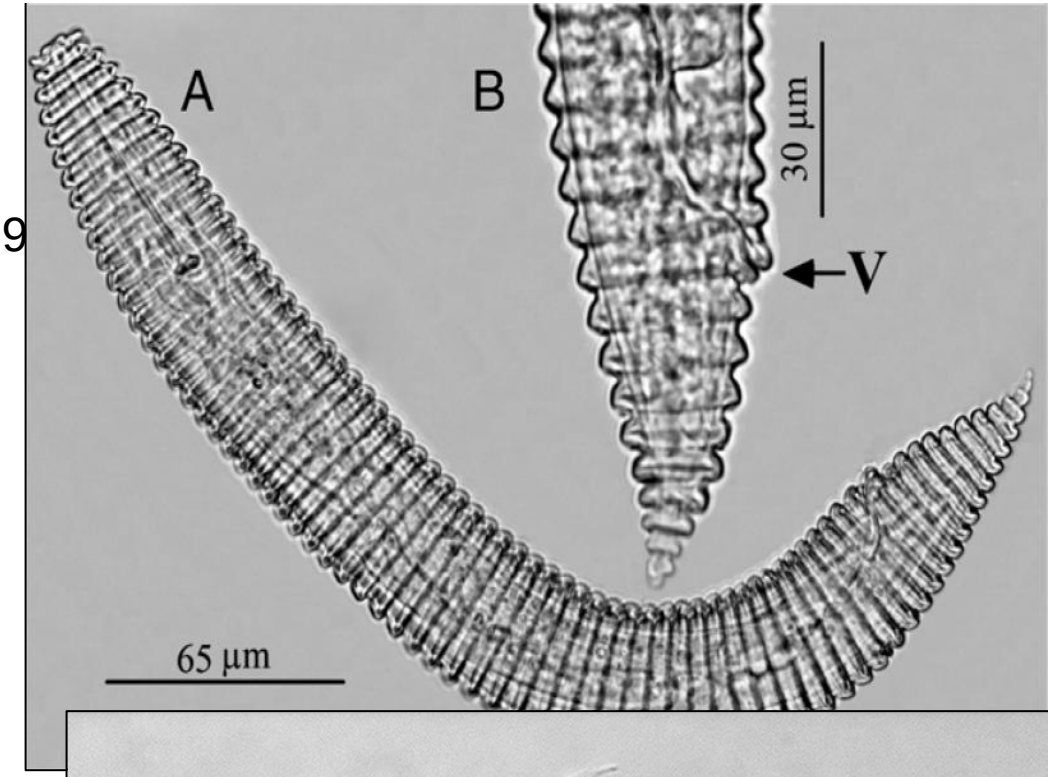
Feeding

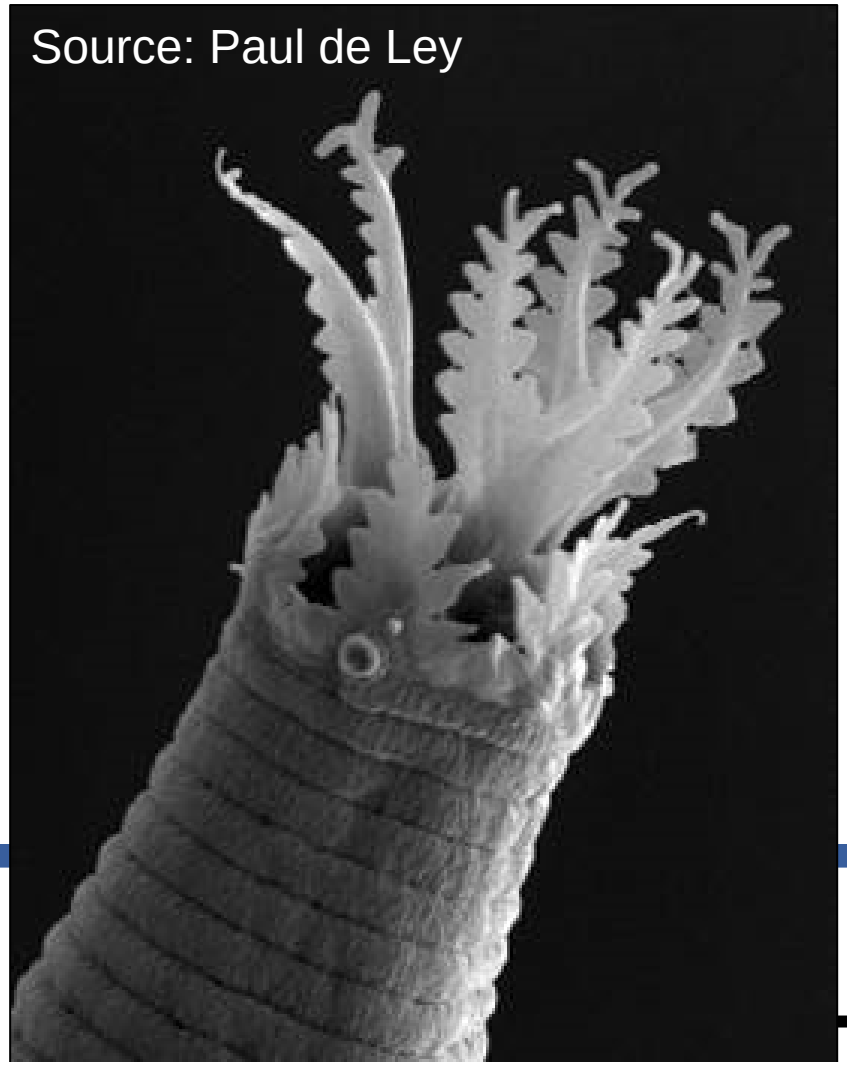
Source: Majdi and Traunspurger 2015

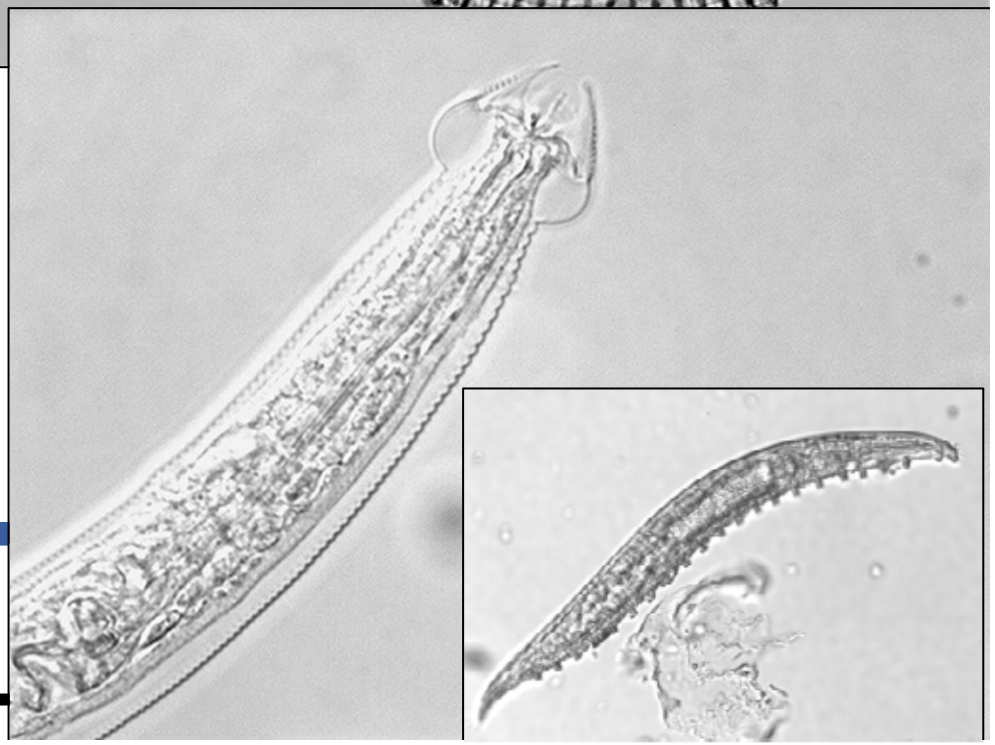


Beautiful

Source:Tabolin and Markina 2019





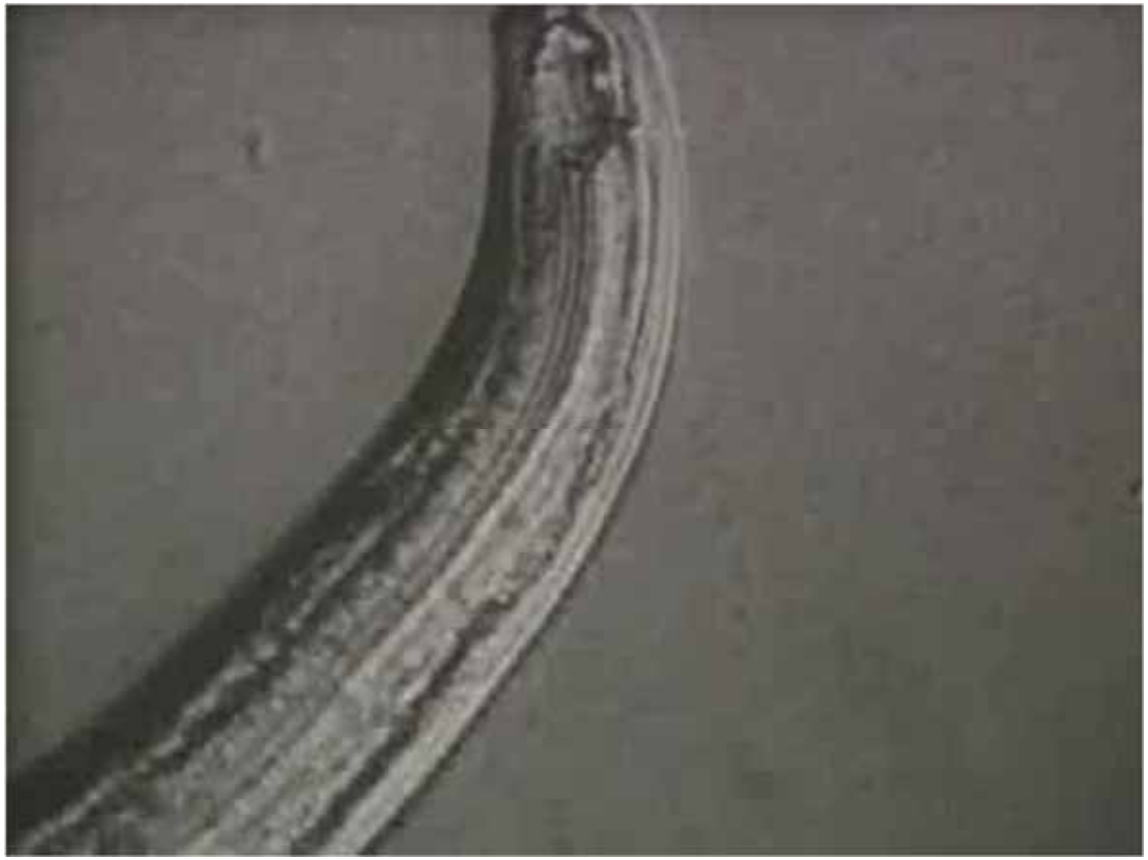


Everywhere

"In short, if all the matter in the universe except the nematodes were swept away, our world would still be dimly recognizable, and if, as disembodied spirits, we could then investigate it, we should find its mountains, hills, vales, rivers, lakes, and oceans represented by a film of nematodes. "

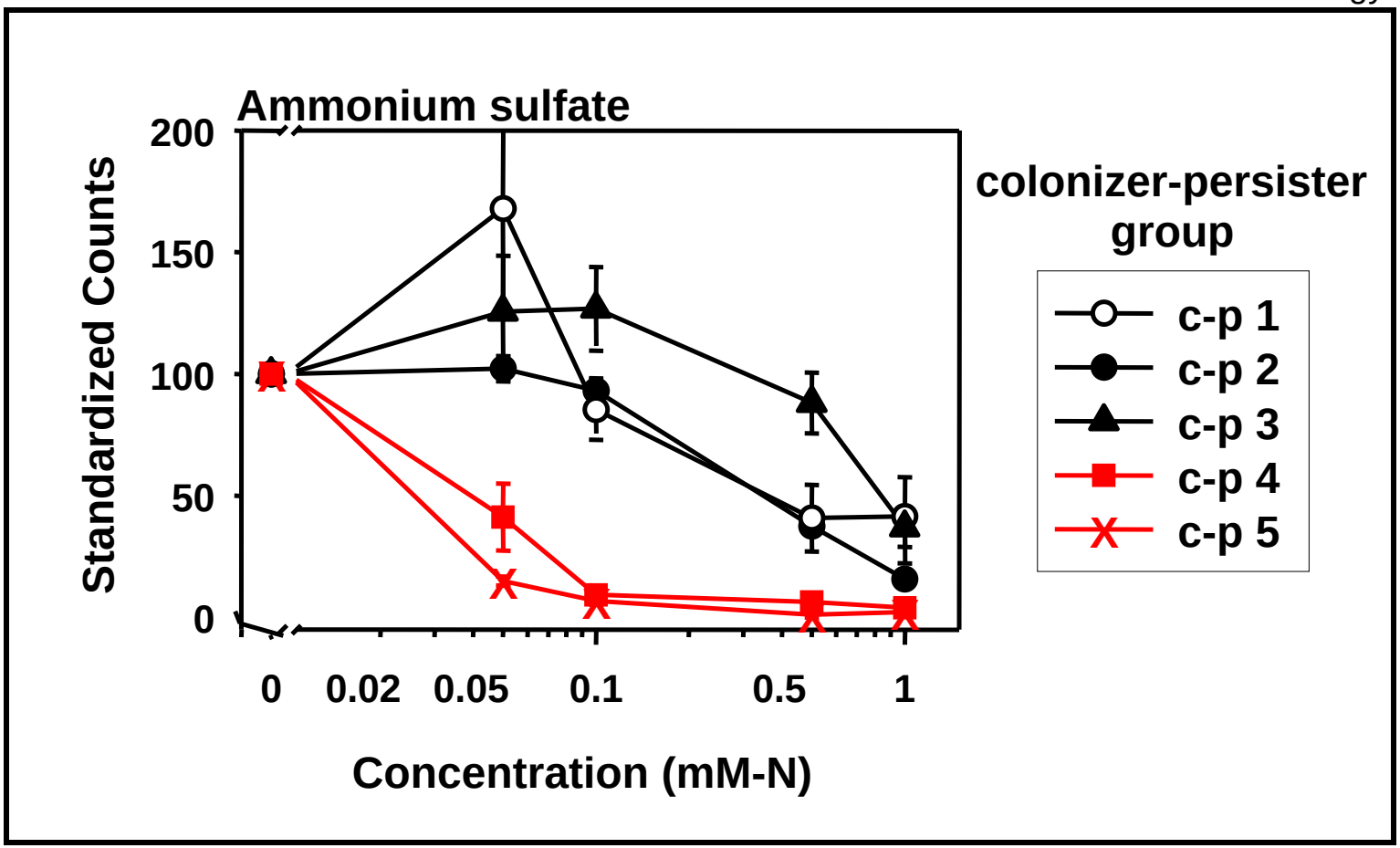
Nathan Augustus Cobb, from "Nematodes and Their Relationships", 1915

Beneficial



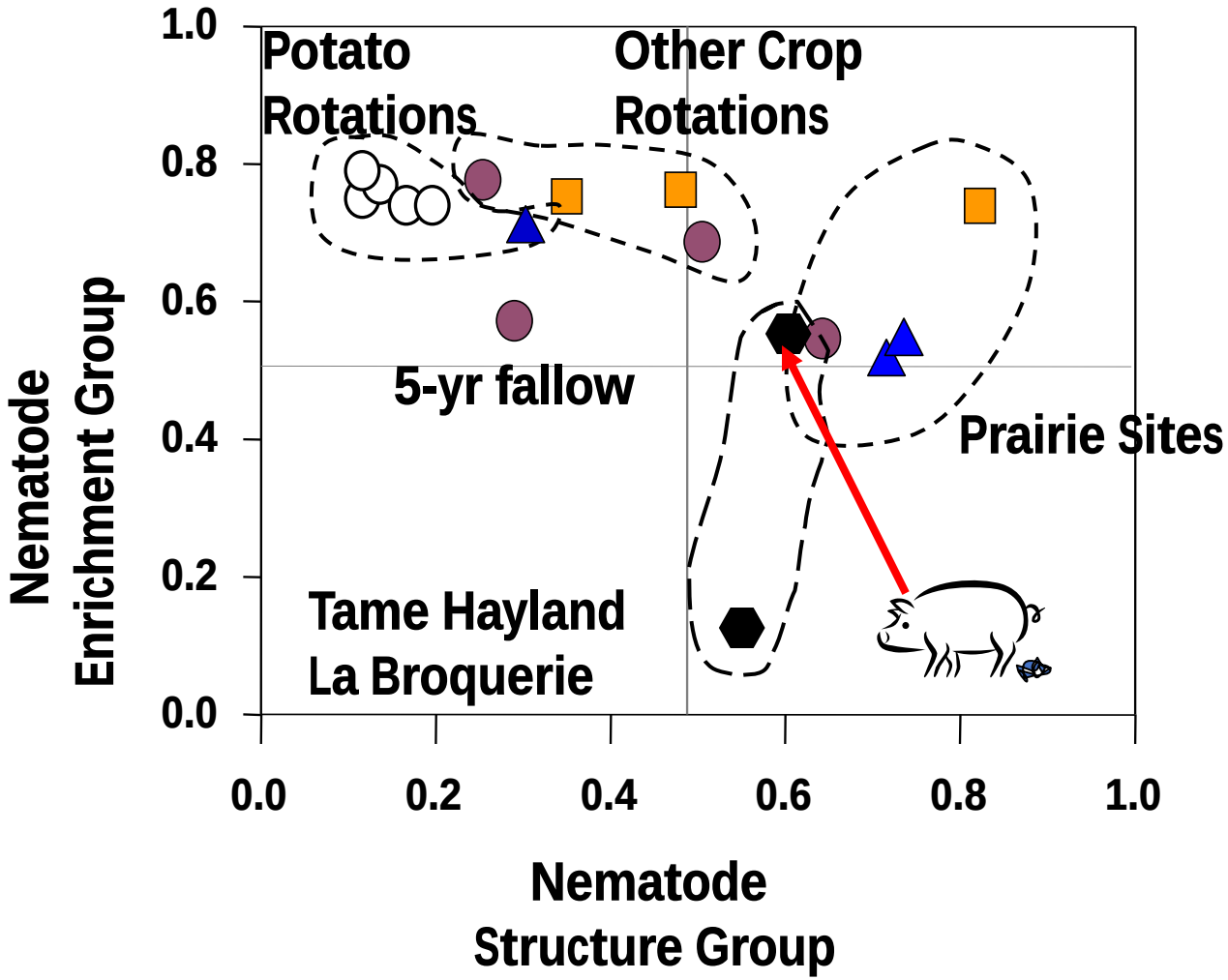
Nematodes: Sensitive Creatures

Tenuta and Ferris 2004 J. Nematology

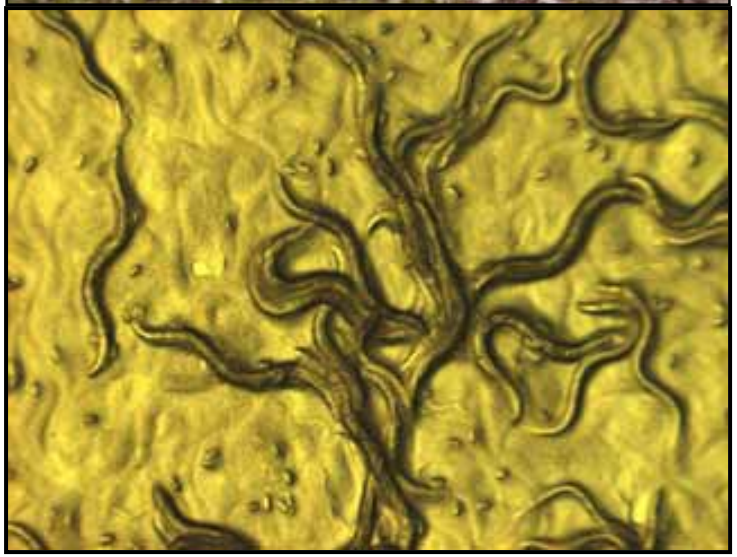


Nematodes: Respond to Agricultural Management

Summary Manitoba Nematode Community Studies

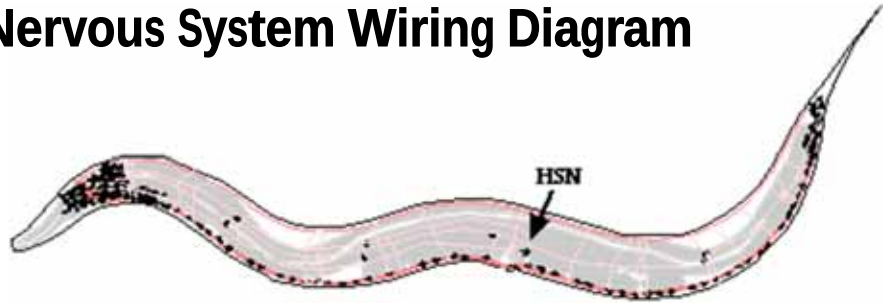


Nematodes: Model Organisms
Caenorhabditis elegans



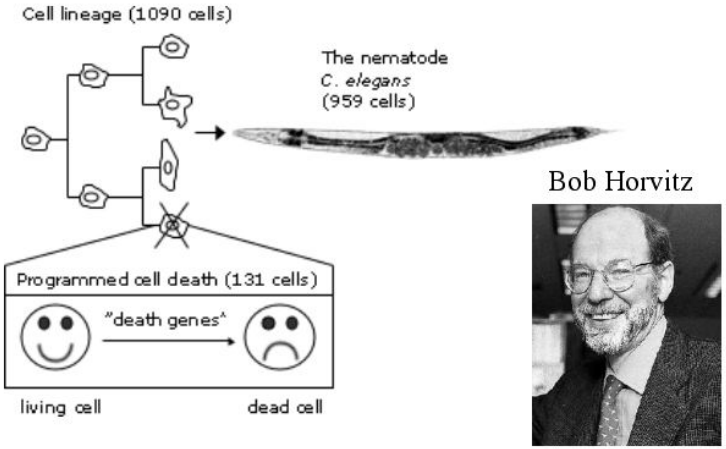
C. elegans As a Model

Nervous System Wiring Diagram



302 neurons

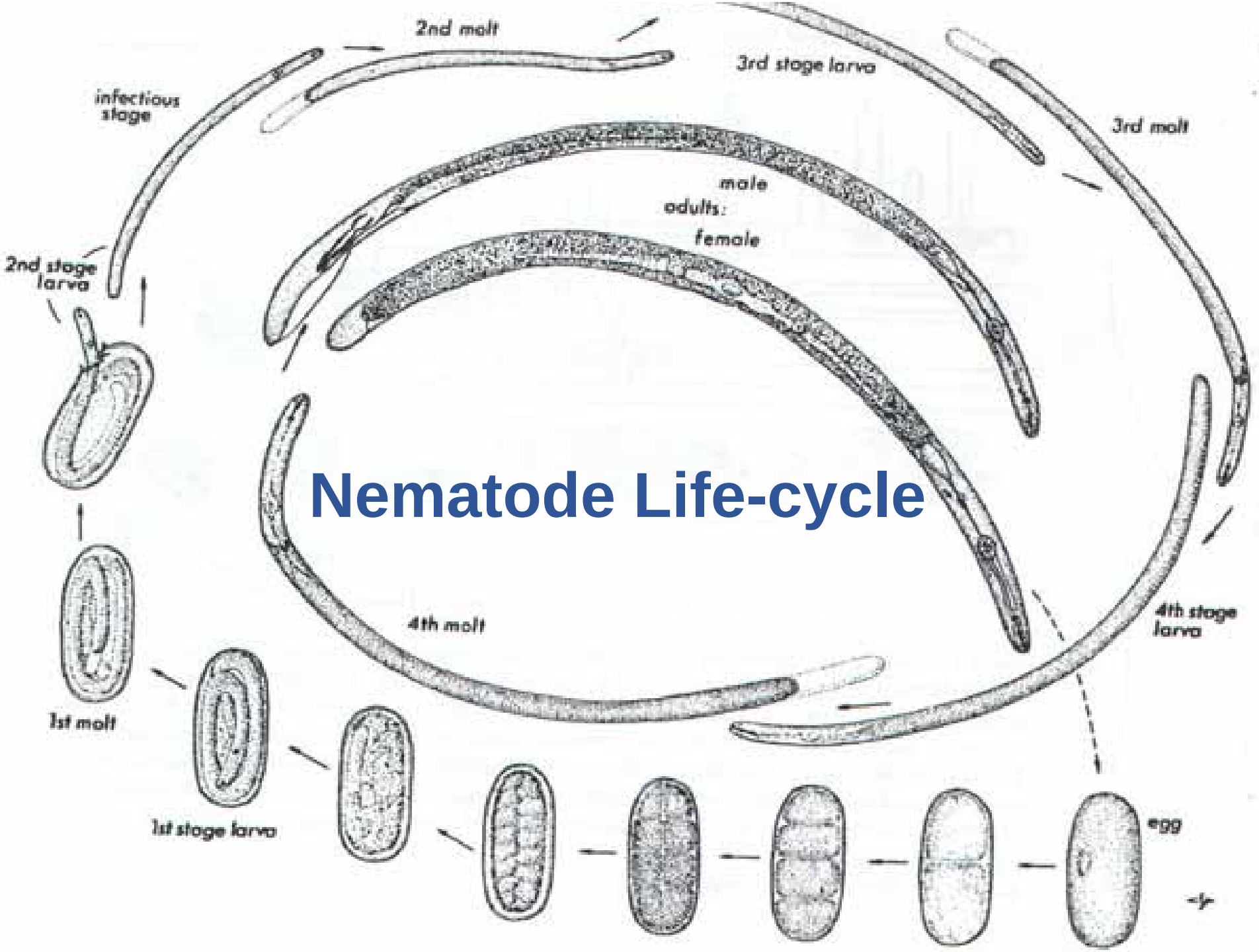
Apoptosis genes discovered in *C. elegans*



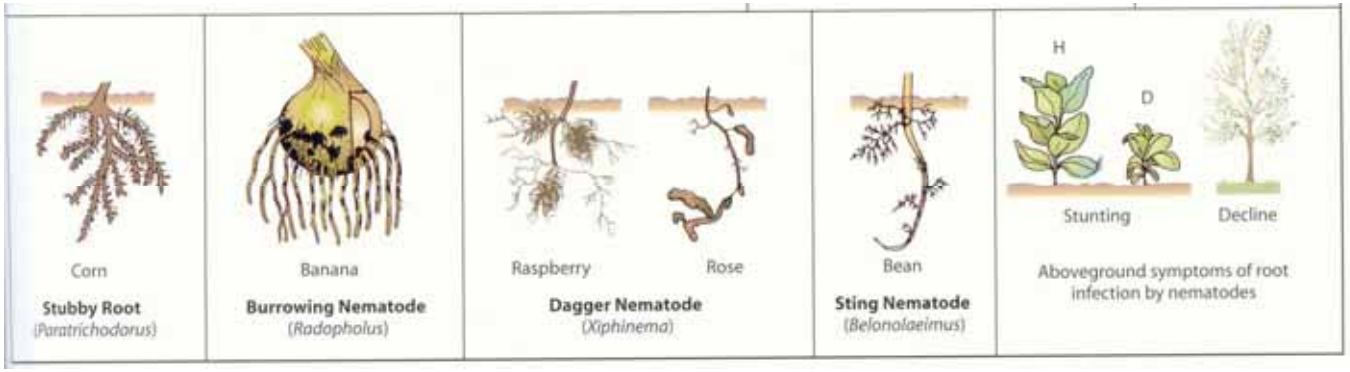
Bob Horvitz

Worms in Space

Nematode Life-cycle

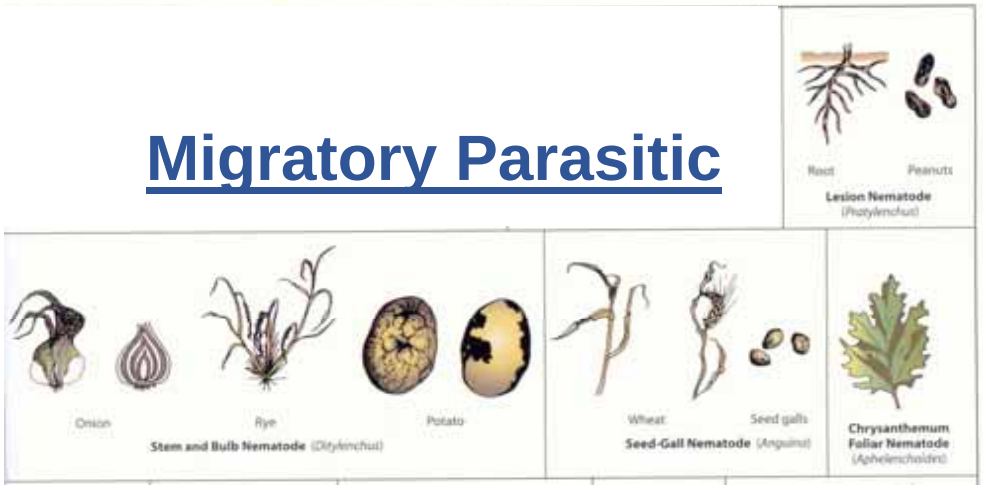


Types of Plant Nematodes



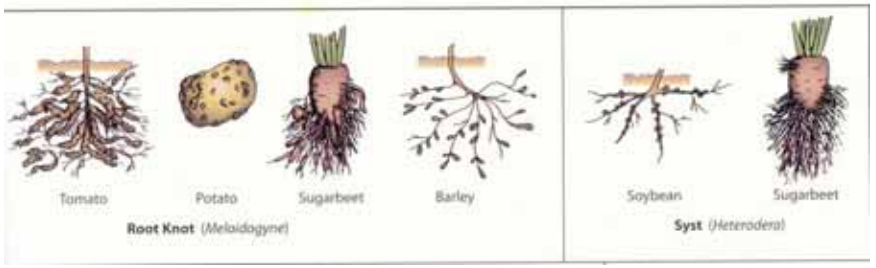
Ectoparasitic

Migratory Parasitic



Endoparasitic

Gall formers **Cyst formers**



Morphology and Size of Important Plant Nematodes

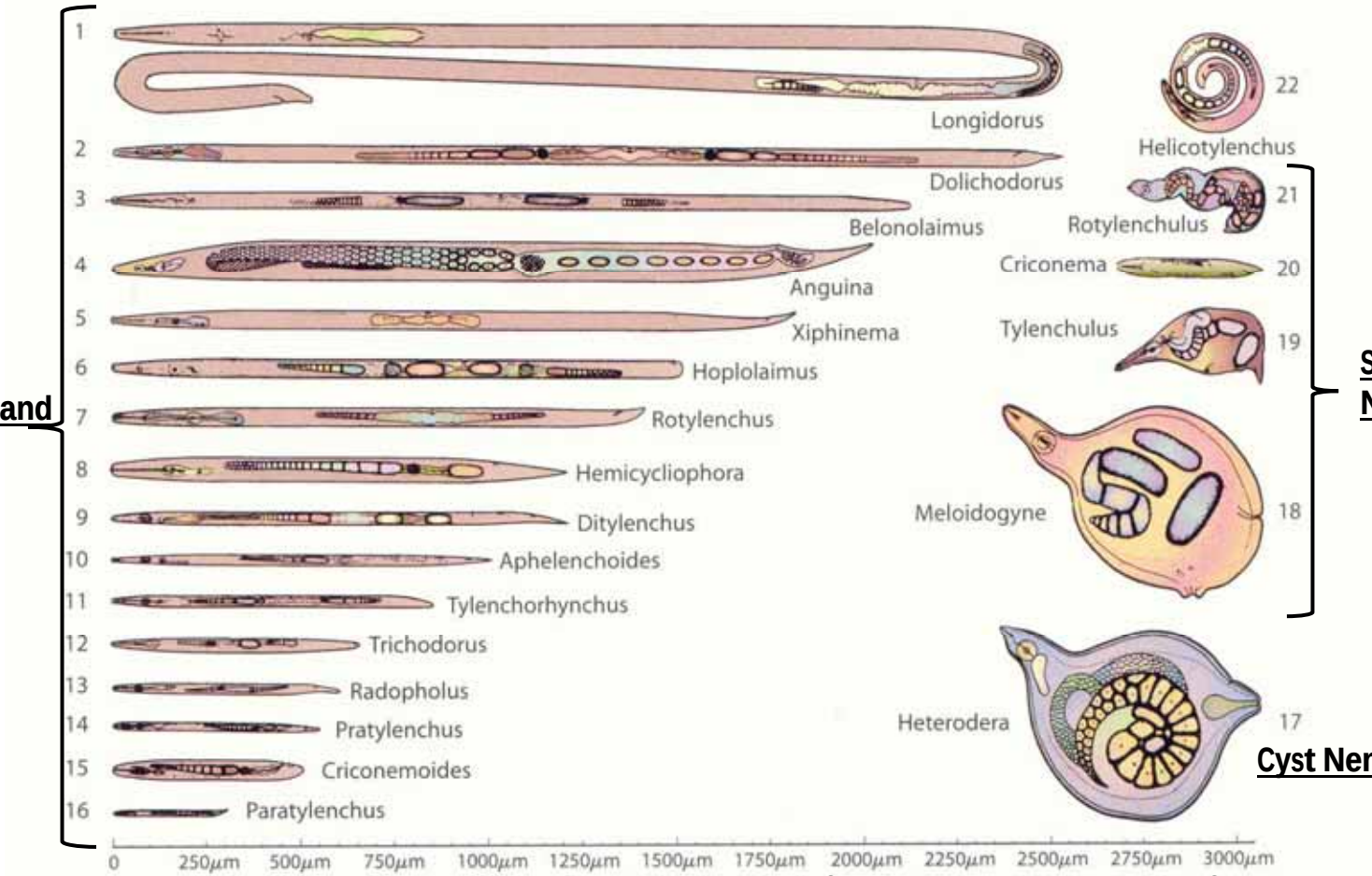


FIGURE 15-3 Morphology and related sizes of some of the most important plant parasitic nematodes.

Ectoparasitic and Migratory Parasitic

Sedentary Nematodes

Cyst Nematode

How Do Nematodes Reduce Yields?

- Siphon root and stem contents (energy robbing)
- Compromise root function
  - Galls and lesions reduced water and nutrient uptake
  - Nematode rob root energy
- Disease by secondary pathogens
  - Allow pathogens to enter root
  - Weakens plant preventing defense against pathogens
- Some nematodes vector plant viruses

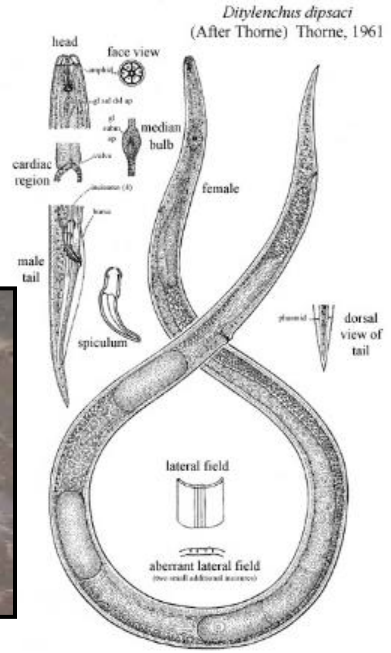
Symptoms of Nematode Diseases?

- Next to viruses probably most difficult disease to diagnose
- Symptoms can include:
  - Dwarfing/stunting
  - Chlorosis
  - Root galls
  - Root rots
  - Lesions on roots
  - Lack of fine roots
  - Stem swelling
  - Stem twisting

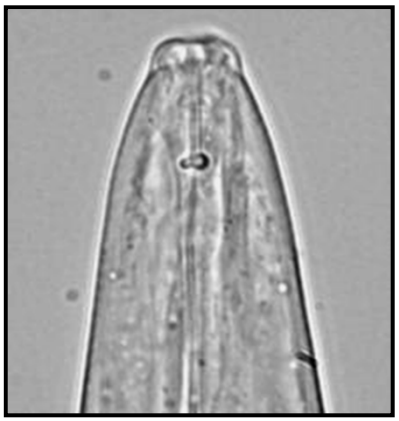
Canadian Quarantine Nematodes?

- Cyst Nematodes of Potato
  - *Globodera rostochiensis – golden nematode* (Victoria Island, Quebec, NFLD)
  - *Globodera pallida* –pale cyst nematode (NFLD)
- Potato Rot Nematode
  - *Ditylenchus destructor* (Ontario)
- Stem and Bulb Nematode
  - *Ditylenchus dipsaci* (localized bulb crops many provinces)
- Needle Nematode
  - *Longidorus* spp. (localized Hort crops)
- Columbia Root-knot Nematode of Potato
  - *Meloidogyne chitwoodi* (localized Columbia basin in US, not Canada)
- Stubby Root Nematode
  - *Trichodorus/Paratrichodorus spp.* (localized Hort and corn crops)
- Dagger Nematode
  - *Xiphinema* spp. (localized Hort crops)

Story of the Stem and Bulb Nematode and Yellow Pea



- *Ditylenchus dipsaci*
- A quarantinable migratory endoparasitic nematode
- Parasitizes >500 plant species
- >30 crop host races identified but really a messy pot - race concept not used
- Species understanding changing: new species broken out: *D. gigas* and *D. weischeri*



The Pea Issue

- Yellow p
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- Vessels
  before c

The nematode was infrequently found by CFIA in grain shipments and there were no disease reports, we thus went to the Pulse Grower Groups with the suspicion that it was not *D. dipsaci*

The Pulse Industry welcomed the invitation for research because for more than 10 years there wasn't research being done on the issue. We undertook:

- grower pea grain survey
- field weed survey
- molecular identification studies
- host screening studies

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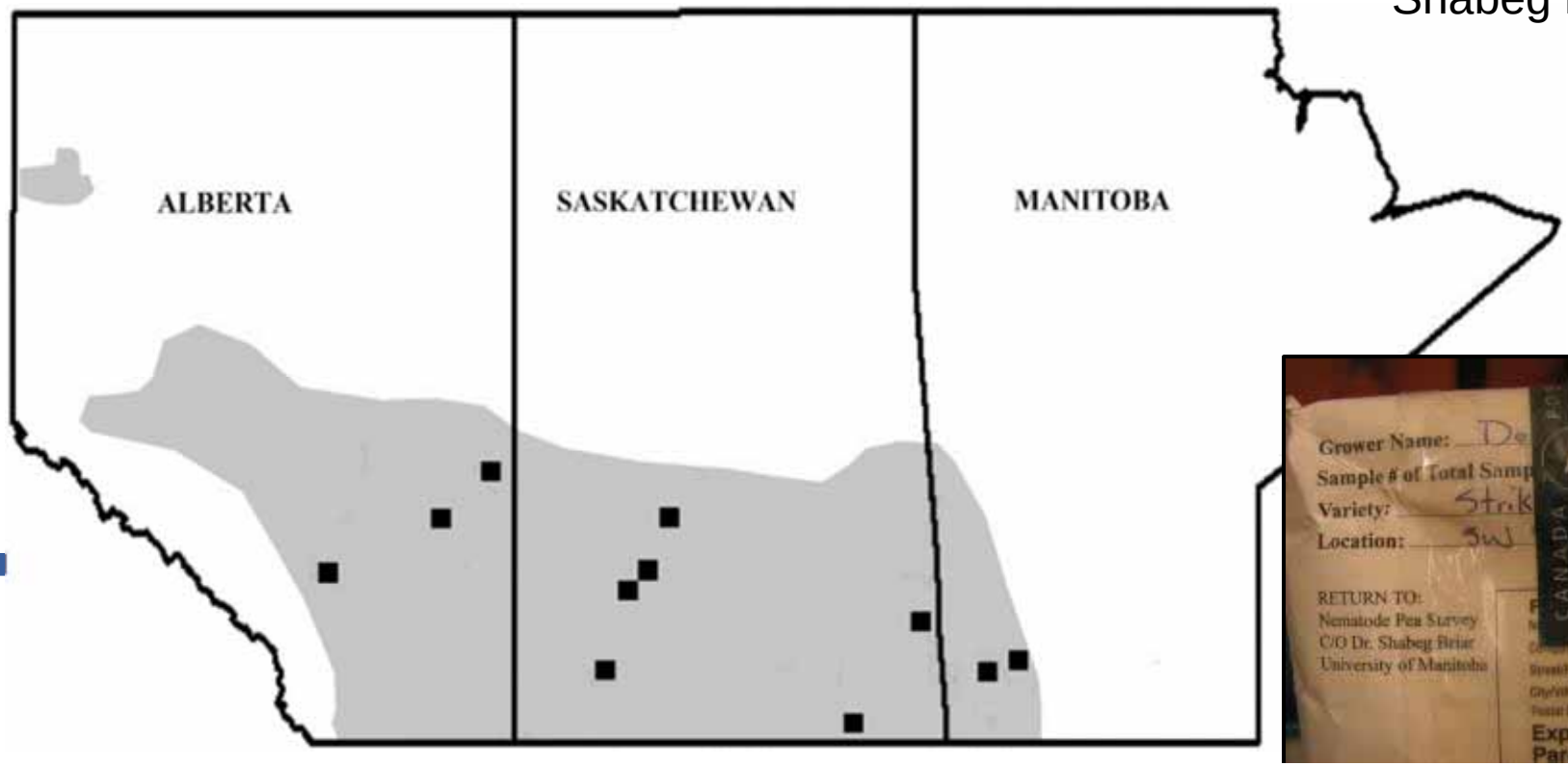
Occurrence of Pea Submission Positive for *Ditylenchus*

- Samples of pea grain from 538 farmer fields
- Only 11 field positive for *Ditylenchus*
- Abundances ranged 4 to 1,500/kg grain

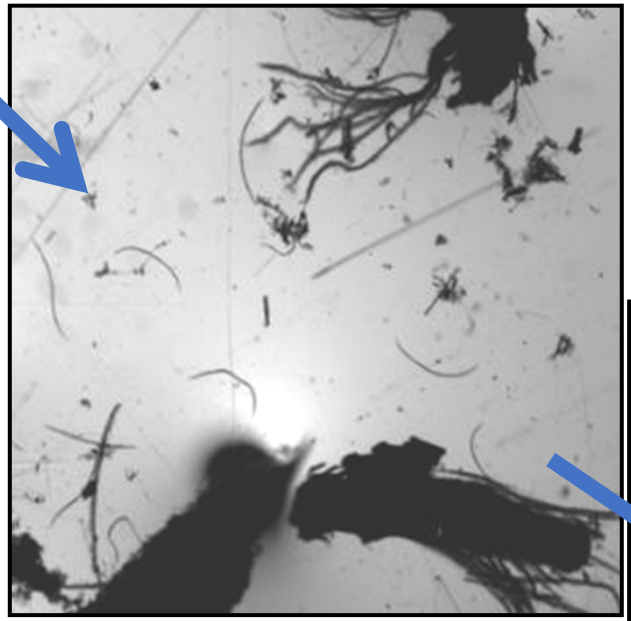
Shabeg Briar, PDF

Tenuta et al. 2014, J. Nematol



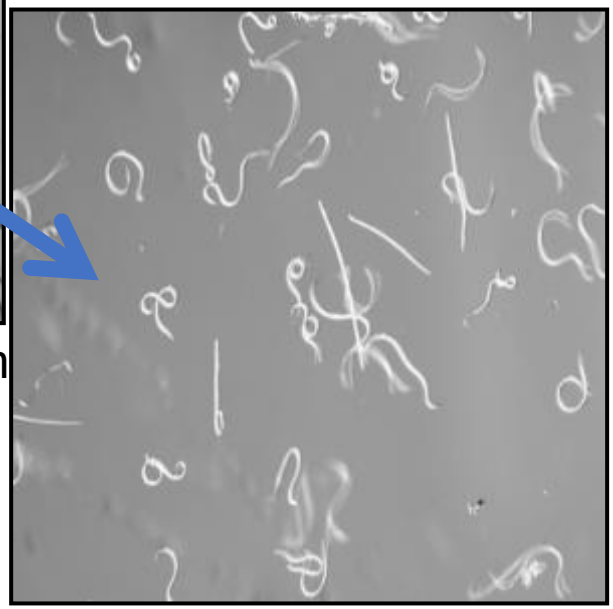
Eureka Moment! Ditylenchus Nematodes Were Emanating from Weed Seeds

13% of farmer grain samples contained Creeping Thistle seeds

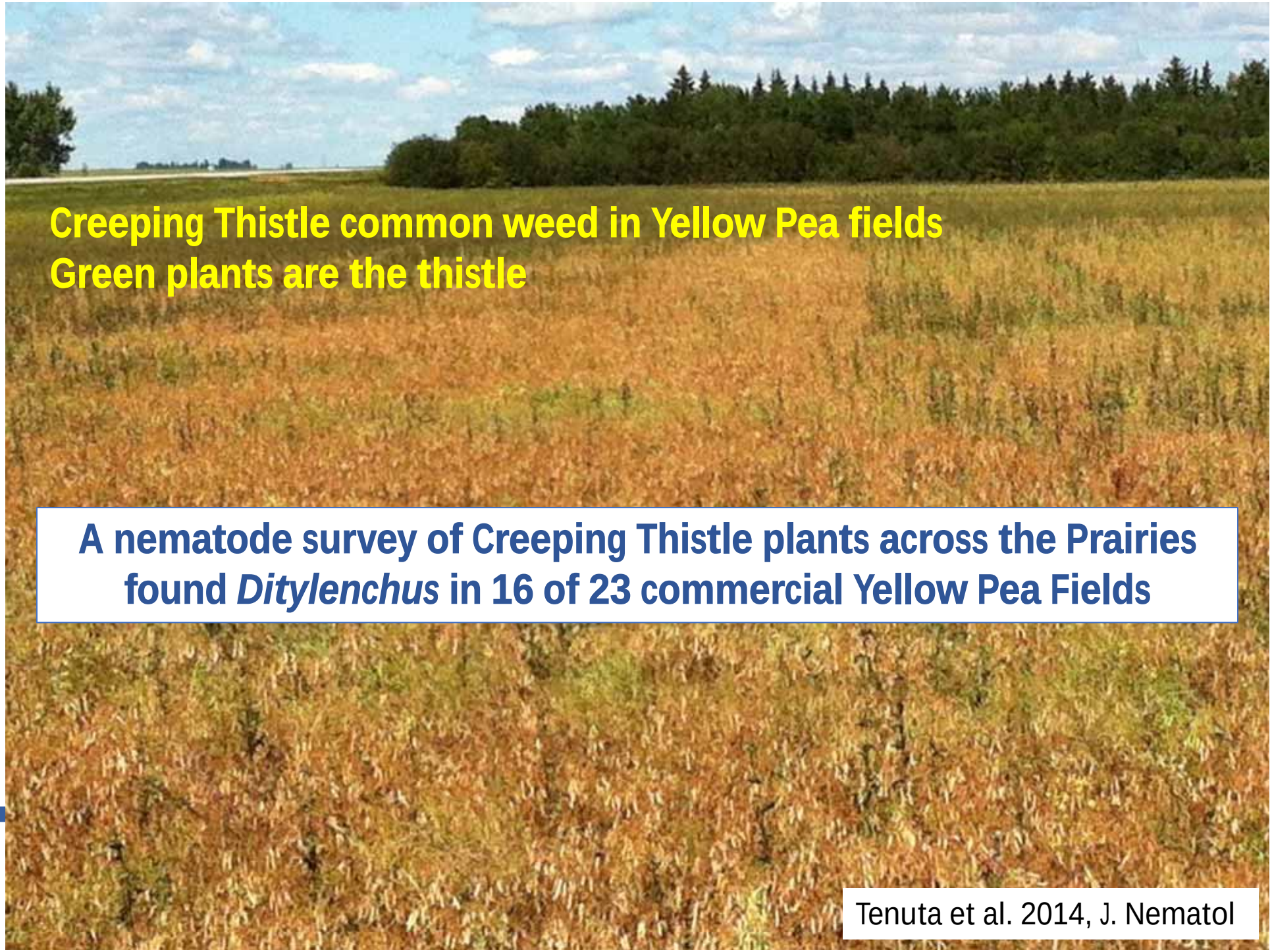


Creeping Thistle flowers with nematodes emanating

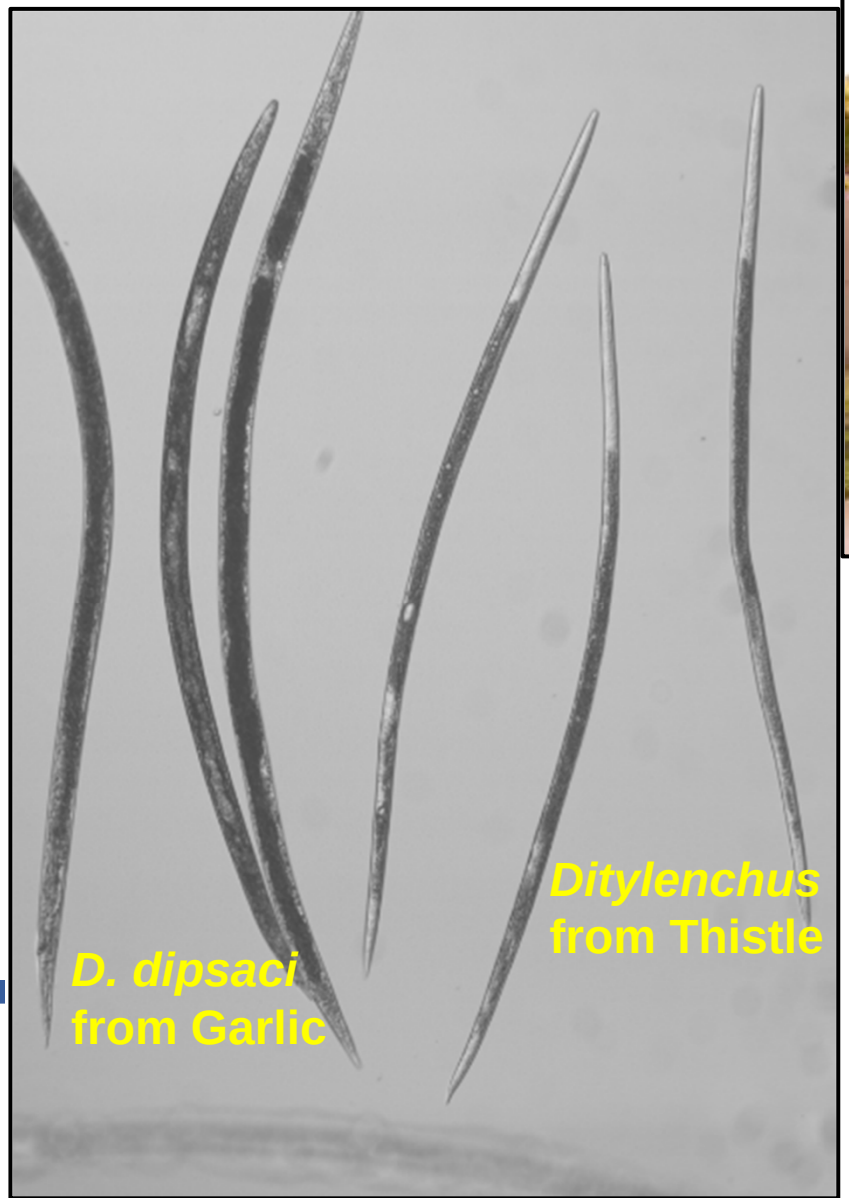
Ditylenchus from Thistle flowers



Tenuta et al. 2014, J. Nematol


Creeping Thistle common weed in Yellow Pea fields
Green plants are the thistle
A nematode survey of Creeping Thistle plants across the Prairies found *Ditylenchus* in 16 of 23 commercial Yellow Pea Fields
Tenuta et al. 2014, J. Nematol

Slight Morphology Difference in Thistle Nematode and *D. dipsaci*



Molecular Analysis

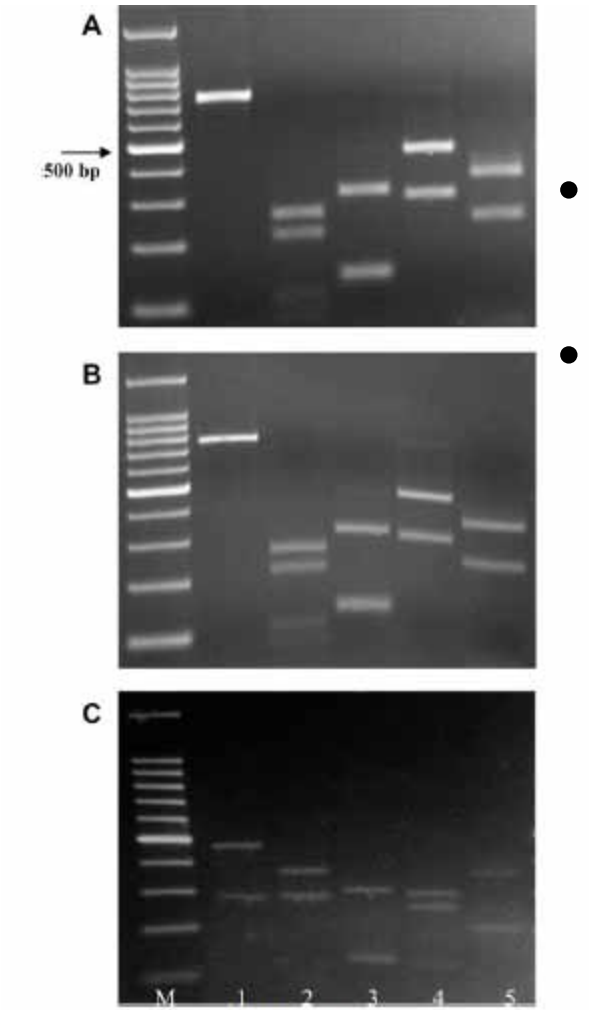
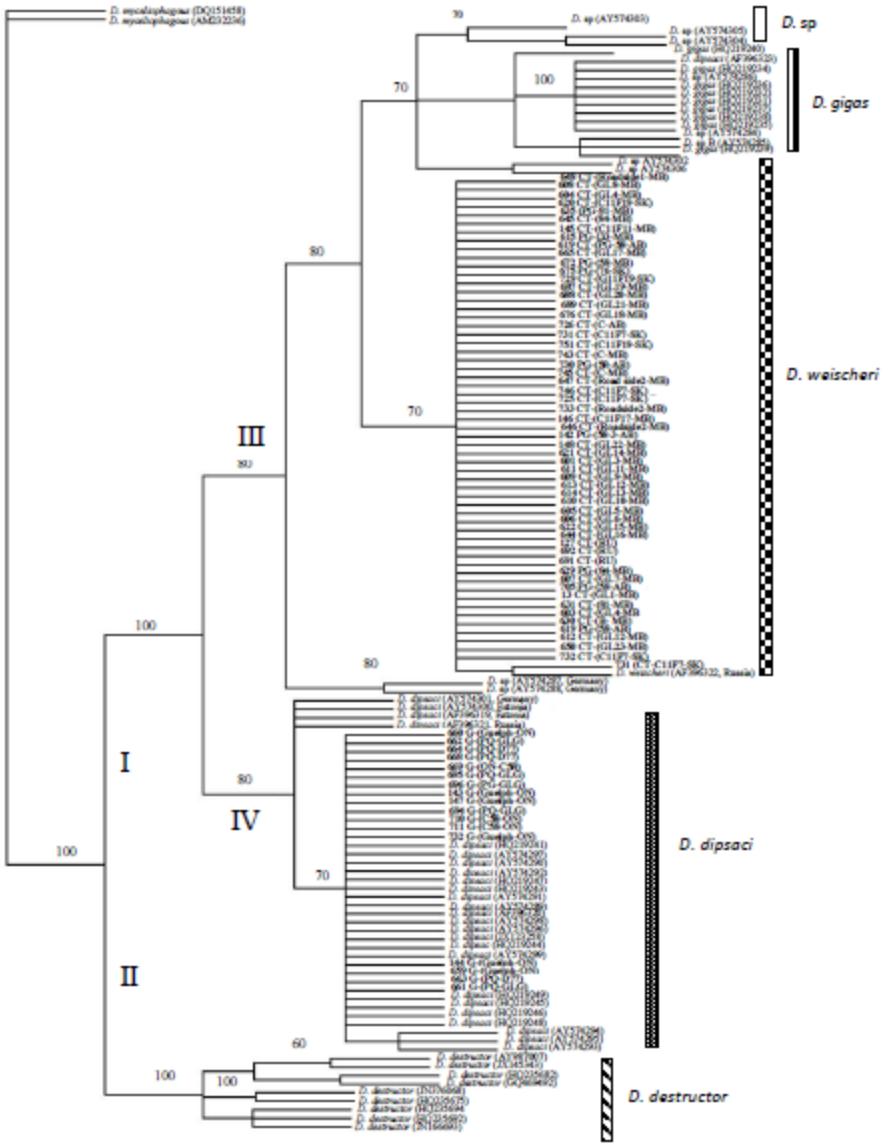


FIG. 3. Representative ITS-PCR-RFLP diagnostics pattern for *Ditylenchus* (A) from *C. arvense* obtained from Russia and consistent with being *D. weischeri*; (B) obtained from pea grain harvest samples 58-3 and 76-5, and *C. arvense* from samples 84, C11F11, C11F18, and RS2, and also consistent with being *D. weischeri*, and (C) pattern obtained for samples of garlic from Ontario (*D. dipsaci*^{CDA}) and Quebec (*D. dipsaci*^{PQ}) and consistent with being *D. dipsaci*. Lanes are M, 100 bp DNA marker ladder (Promega, Madison, WI) and restriction digests: 1, *Bsh*1236I; 2, *Hinf*I; 3, *Msp*I; 4, *Hae*I; and 5, *Taq*I. Example patterns shown are for analysis of a single nematode.

- The nematode is *D. weischeri*
- Easily differentiated by molecular methods



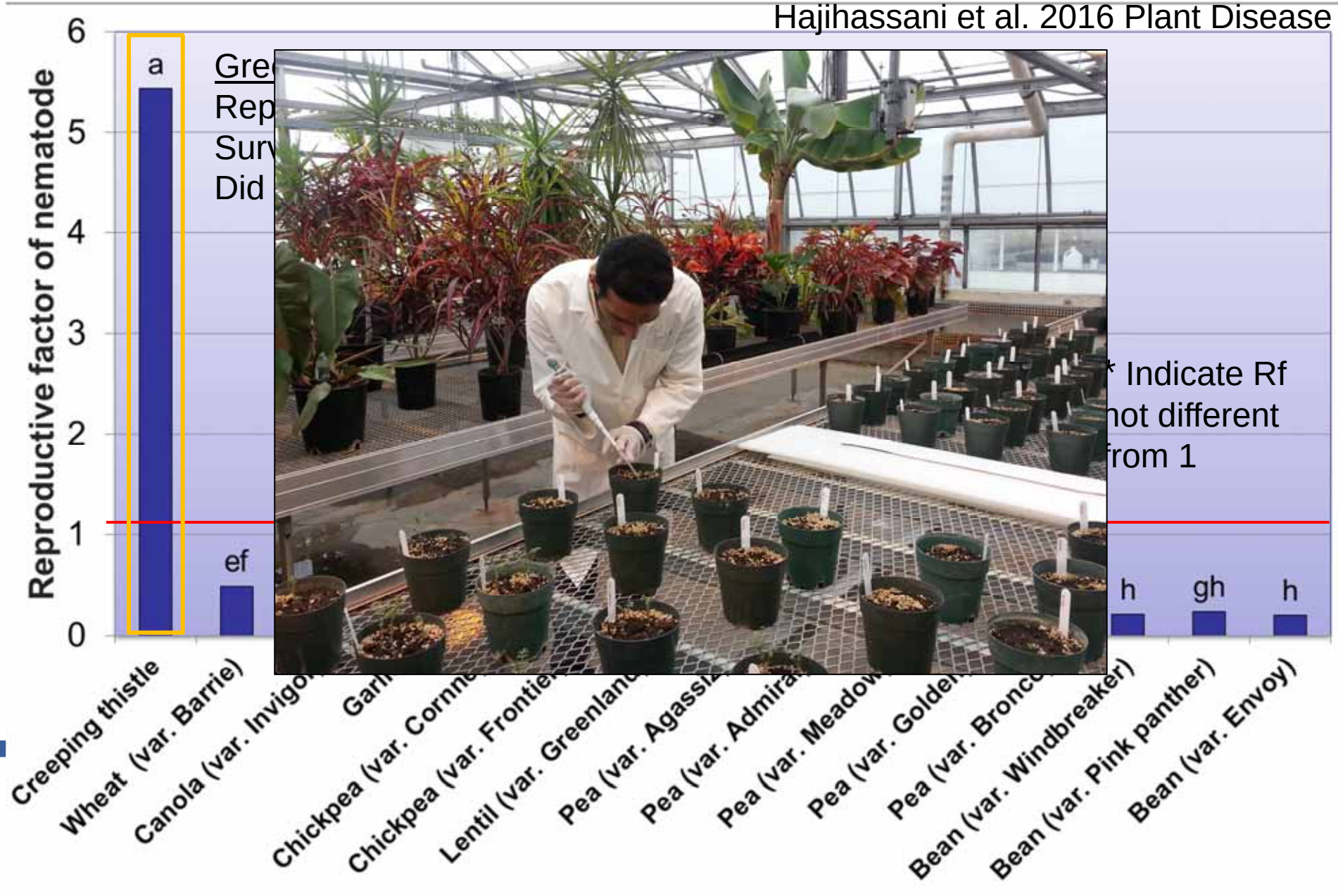
Madani and Tenuta 2017, J. Nematol

Identity Confirmation and Diagnostics

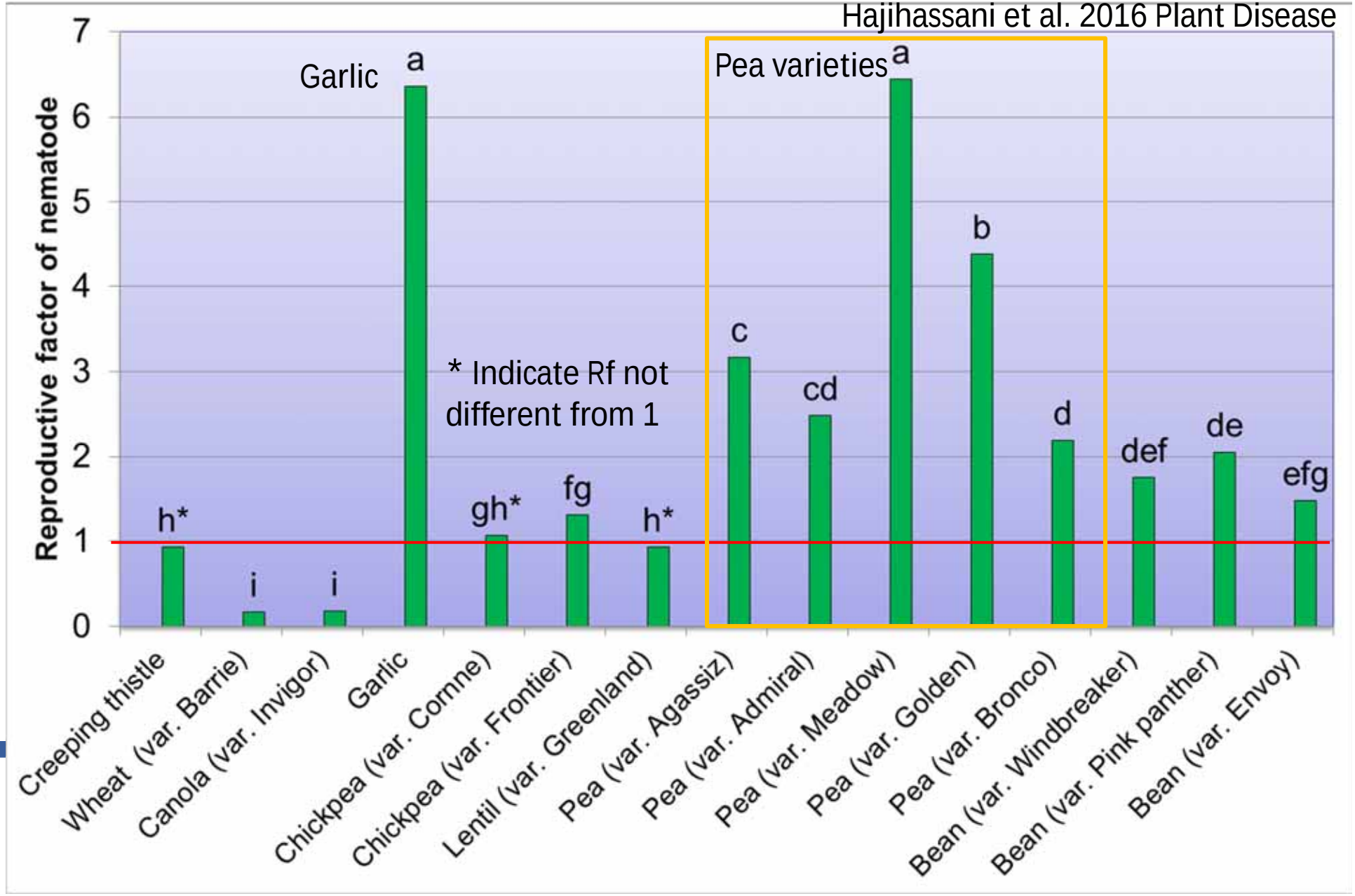
- Confirmed species differentiation *D. weischeri* & *D. dipsaci* by sequencing ITS, CoxI, D2-D3/ 28s, & Hsp90 genes (Madani et al., 2017)
- Developed diagnostic conventional and real-time PCR for *D. weischeri* and *D. dipsaci* (Madani et al. 2015, CJPP)
- Passed all protocols to CFIA that confirmed past *Ditylenchus* finds in pea were *D. weischeri*
- Confirmed *D. weischeri* not present in pods and seeds of pea
- **Win! No longer fumigating pea for *Ditylenchus***

D. weischeri Really Likes Creeping Thistle

Hajihassani et al. 2016 Plant Disease



D. Dipsaci Really Likes Garlic and Yellow Pea



Life-cycle in Yellow Pea

Plant Disease • 2017 • 101:297-305 • http://dx.doi.org/10.1094/PDIS-04-16-0479-RE

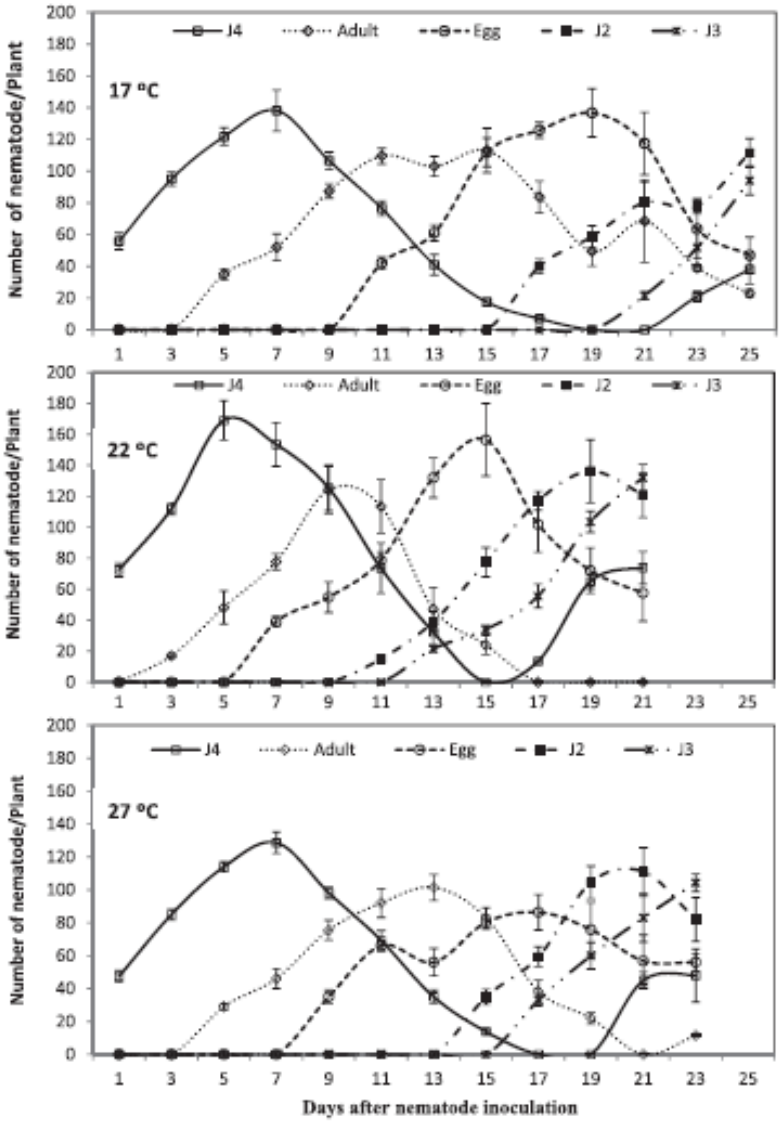
Influence of Temperature on Development and Reproduction of *Ditylenchus weischeri* and *D. dipsaci* on Yellow Pea

den, Department of Plant Science, University of

17ºC

22ºC

27ºC



to reproduce **on**
al temperatures,
ry high constant

Fig. 3. Mean number of *Ditylenchus dipsaci* recovered over 25 days in Agassiz yellow pea. J2, J3, and J4 = second-, third-, and fourth-stage juvenile, respectively. Values are the mean ± one standard error ($n = 6$) of the mean of temperature treatments and life stage.

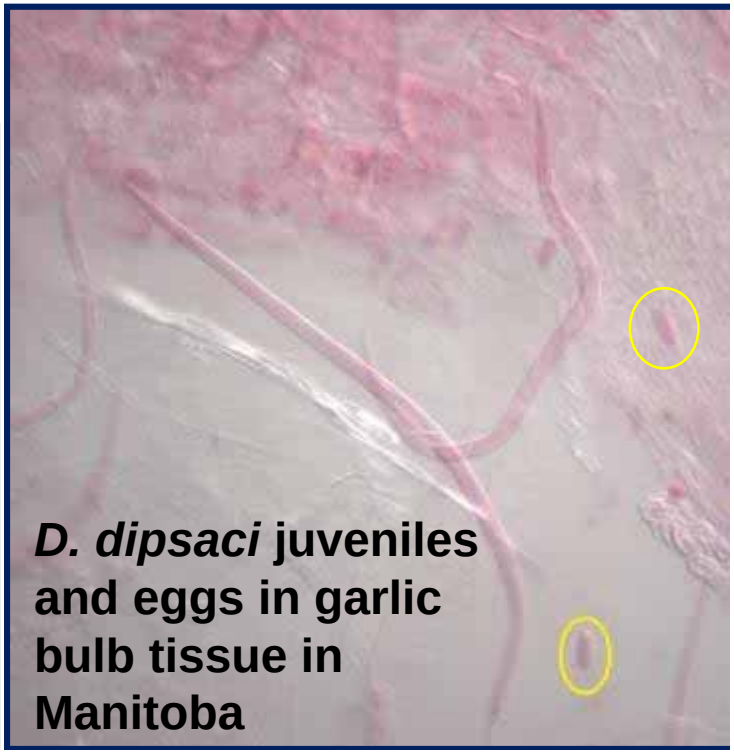
Fig. 1. Mean number of *Dit*
respectively. Values are mea

Risk to Pulses Because of Garlic!

Hajihassani and Tenuta 2017 Can. Plant Dis. Survey

Commercial garlic infested with *D. dipsaci* in Manitoba in 2015

- Grower imported garlic bulbs from Ontario and planted fall 2014
- Rampant problem of *D. dipsaci* in garlic throughout ON, QC and North East U.S.
- Extension efforts to garlic growers to protect pea and dry bean fields across Prairies

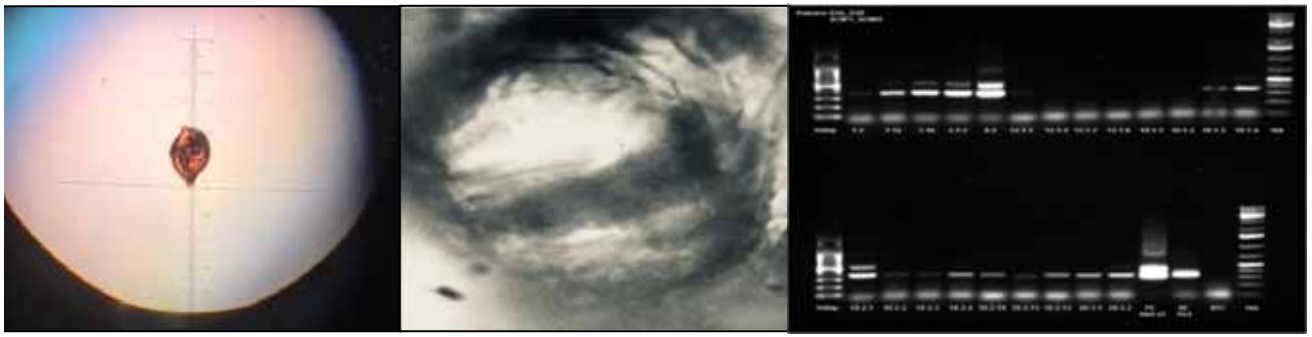


***D. dipsaci* juveniles and eggs in garlic bulb tissue in Manitoba**

Soybean Cyst Nematode: *Heterodera glycines* The Quick March North

Lightning Summary of SCN Work

Extracting cysts from field soil



SCN Cyst

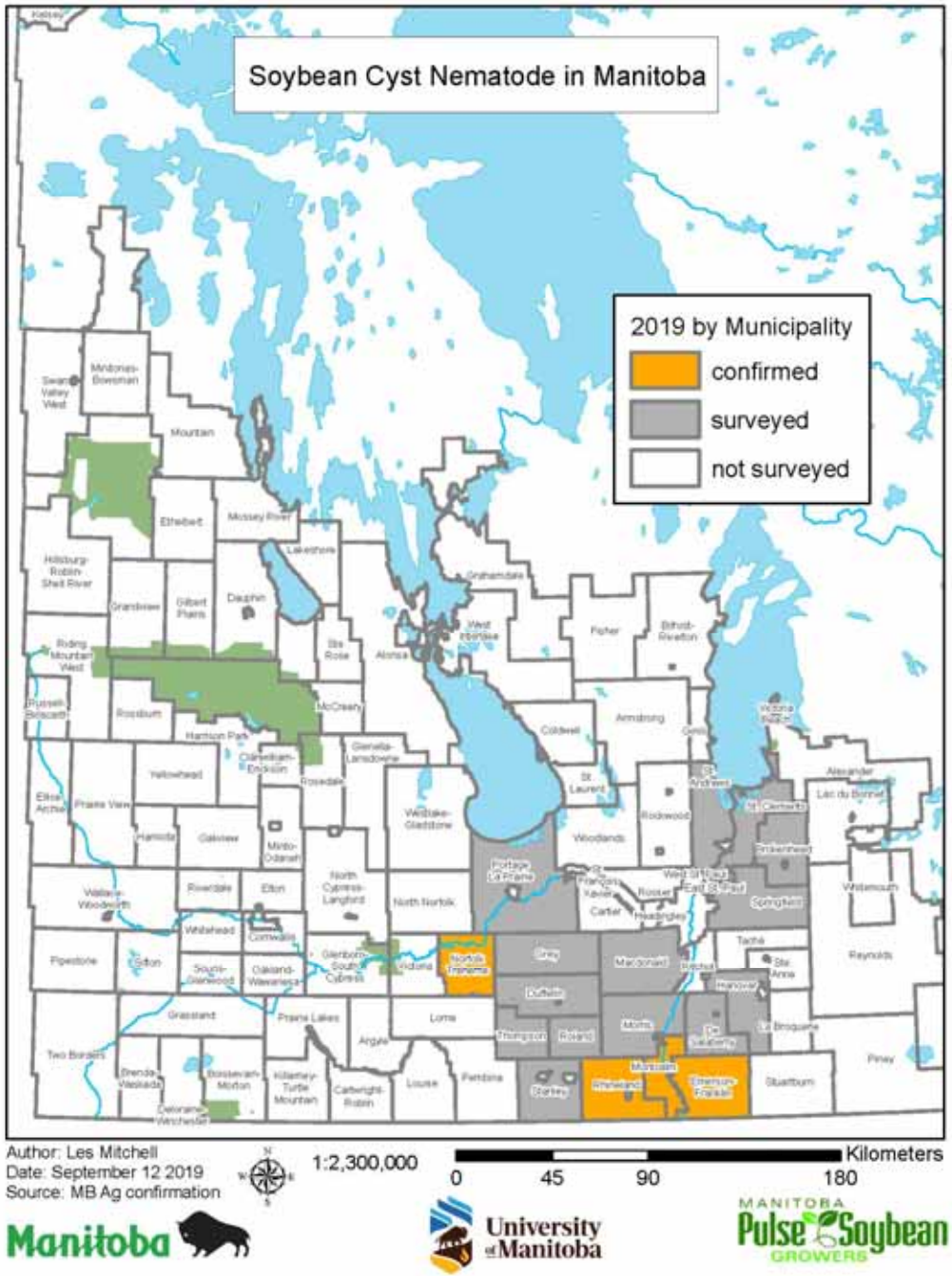
Vulva Pattern for SCN

DNA of SCN

Found Cyst on Soybean in Norfolk Treherne Field in 2019

Now Trying to Raise Population From Manitoba in the Laboratory

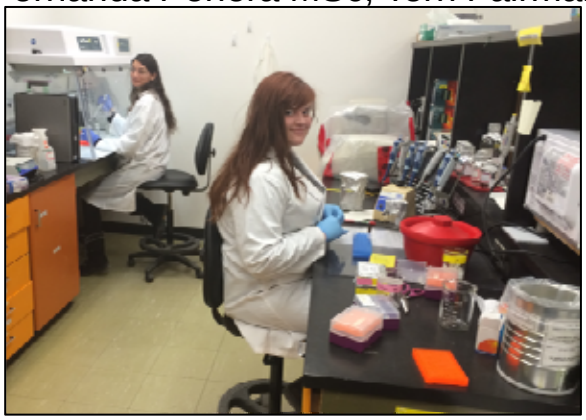
SCN Distribution Map for Manitoba from our Surveys



Other Pulse Nematodes in the Prairies?

- Conducted survey of pulse fields (pea, lentil, chickpea, fababean) across AB, SK and ON
- Pulse and weed above-ground and soil samples taken
- 93 fields so far

Fernanda Periera MSc, Terri Fairman

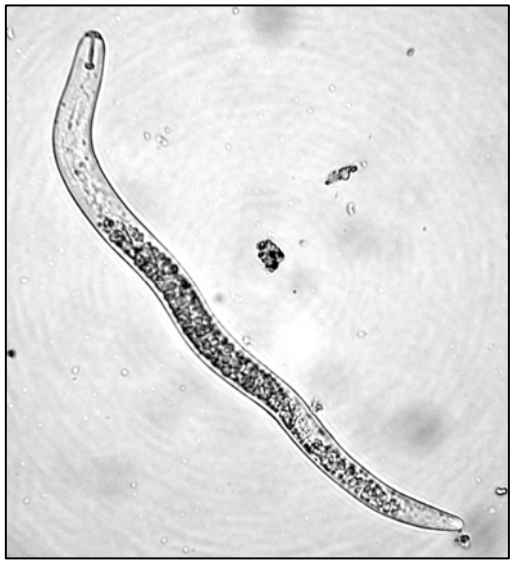


Pratylenchus genera of most interest: 19% of fields

Presence of plant parasitic nematode genera in pulse fields sampled across the Prairies in 2014 and 2015 (Pereira MSc. Thesis)

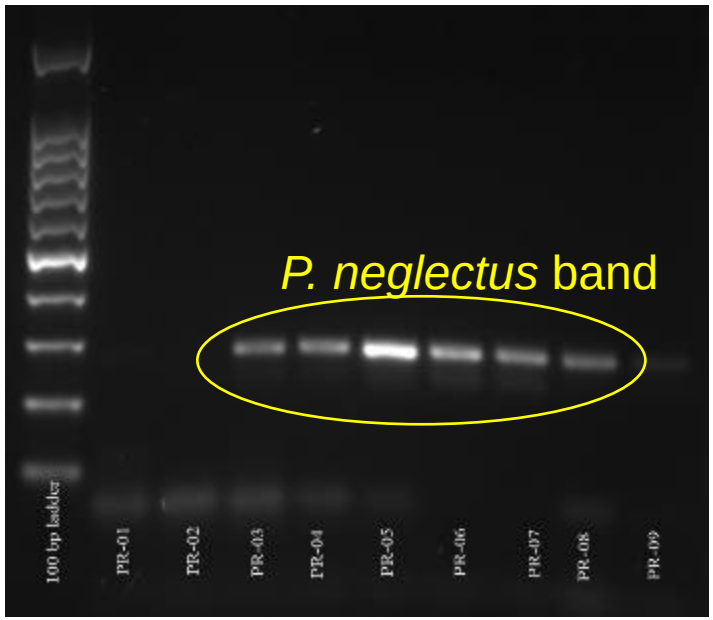
Taxa	Positive fields	Positive sample types: Above Ground Crop	Above Ground Weed	Soil Crop	Soil Weed
Anguina	3	3	–	–	–
Aphelenchoides	65	38	15	55	52
Aphelenchidae	54	24	5	18	11
Ditylenchus	37	13	25	18	15
Helicotylenchus	18	–	–	19	14
Hoplolaimus	2	–	–	1	1
Longidorus	1	–	–	–	1
Merlinius	1	–	–	1	–
Paratylenchus	44	–	–	41	38
Pratylenchus	**18**	**–**	**–**	**15**	**8**
Subanguina	6	3	3	2	–
Trichodorus	1	1	–	–	–
Tylenchorhynchus	60	1	–	60	59
Xiphinema	6	–	–	3	3
Samples analysed	93	178	125	93	69

P. neglectus is the Species on the Prairies

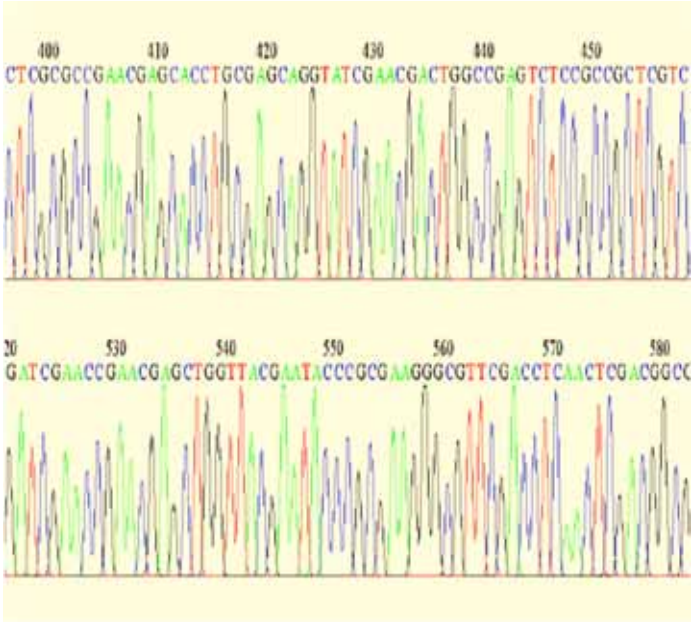


- *P. neglectus* identified by

  Species Specific PCR (using Albanna et al. 2004 D3B

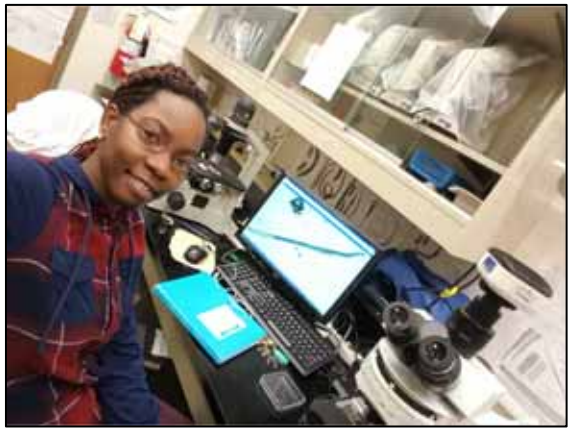


Sequencing D3B Region



P. neglectus Importance?

- Potato not primary host in Manitoba (Mahran et al. 2010 CJPP)
- Reports of yield reductions to spring peas and lentils
- Pest of canola and wheat as well
- Host preference MSc of **Priscillar Wenyika**



plant disease

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June 2008, Volume 92, Number 6
Page 979
https://doi.org/10.1094/PDIS-92-6-0979B

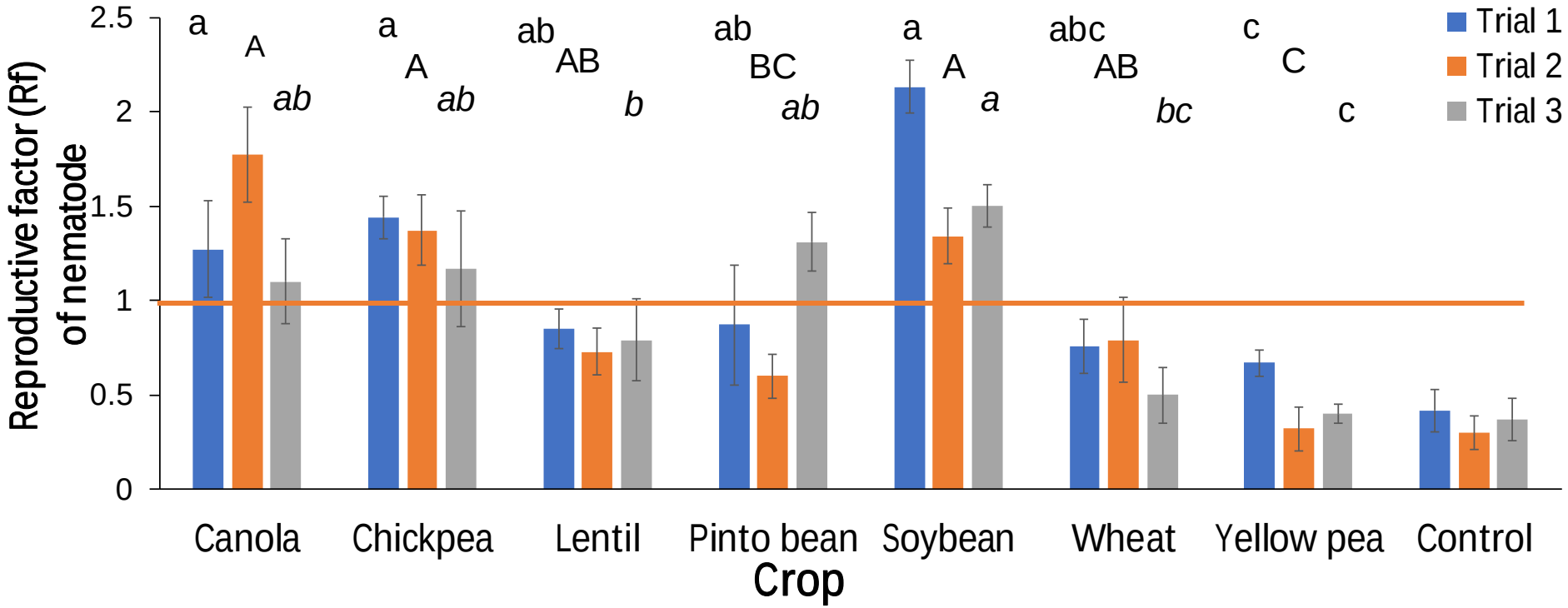
Disease Notes

Pratylenchus neglectus, *P. thornei*, and *Paratylenchus hamatus* Nematodes Causing Yield Reduction to Dryland Peas and Lentils in Idaho

E. Riga, Washington State University, IAREC, 24106 N. Bunn Road, Prosser 99350; **L. D. Porter** and **H. Mojtahedi**, USDA-ARS, 24106 N. Bunn Rd., Prosser, WA; and **D. Erickson**, George F. Brocke and Sons Inc, Kendrick, ID

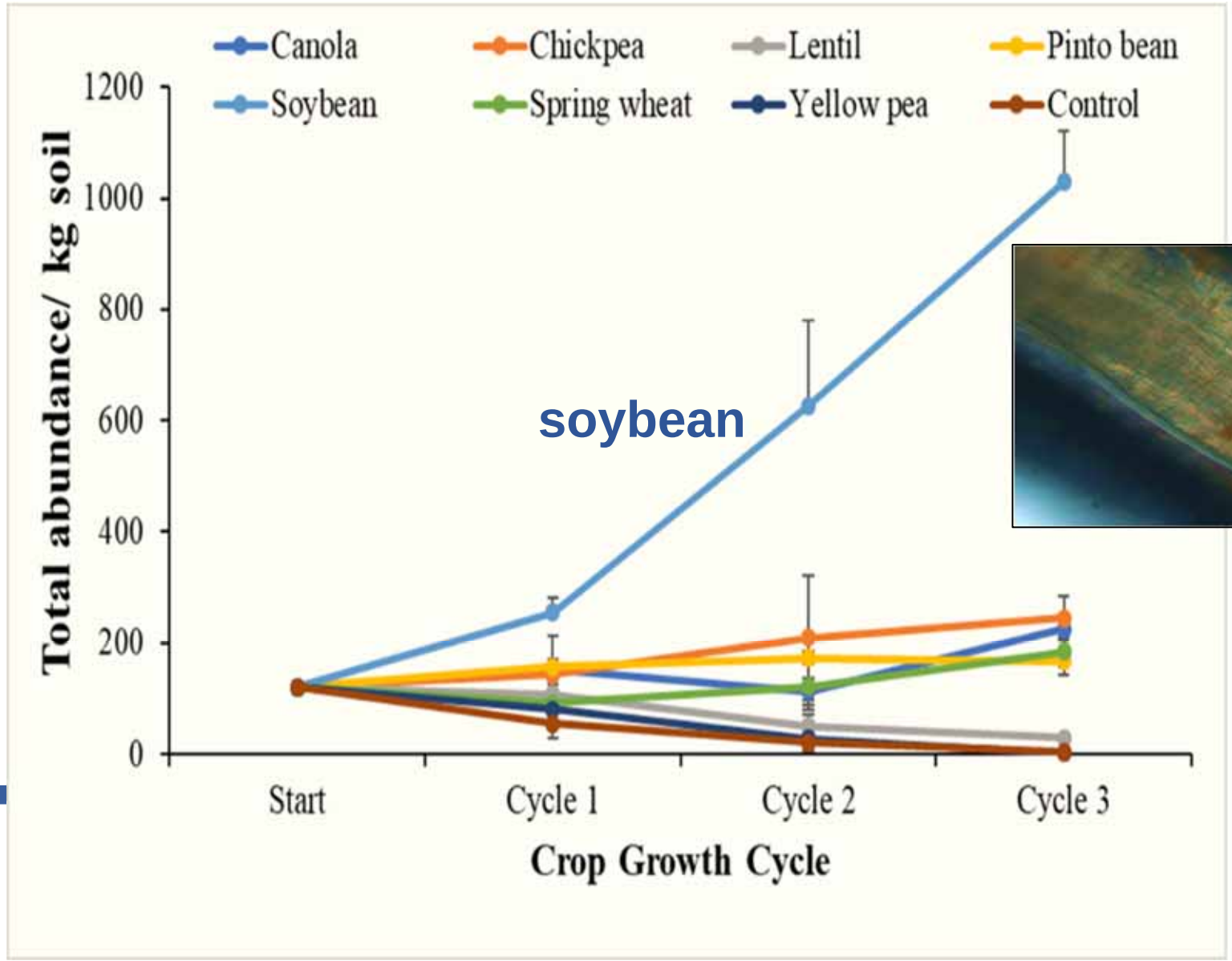
Host screening *P. neglectus*

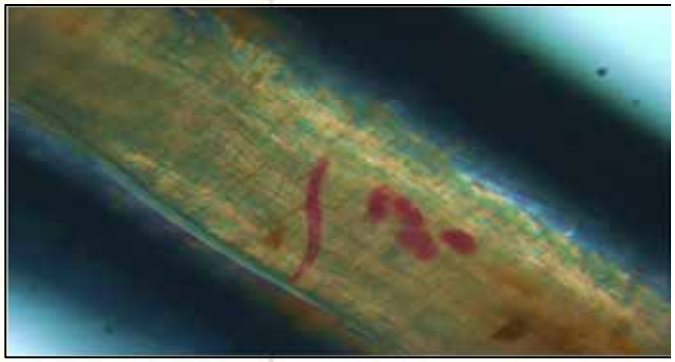
Rf > 1= crop is a host



Mean reproductive factor (Rf) values of *Pratylenchus* spp. for the selected pulse and non-pulse crops in the host screening study at the end of each of three growth cycles

P. neglectus Population Increase





Looming Nematode Issues

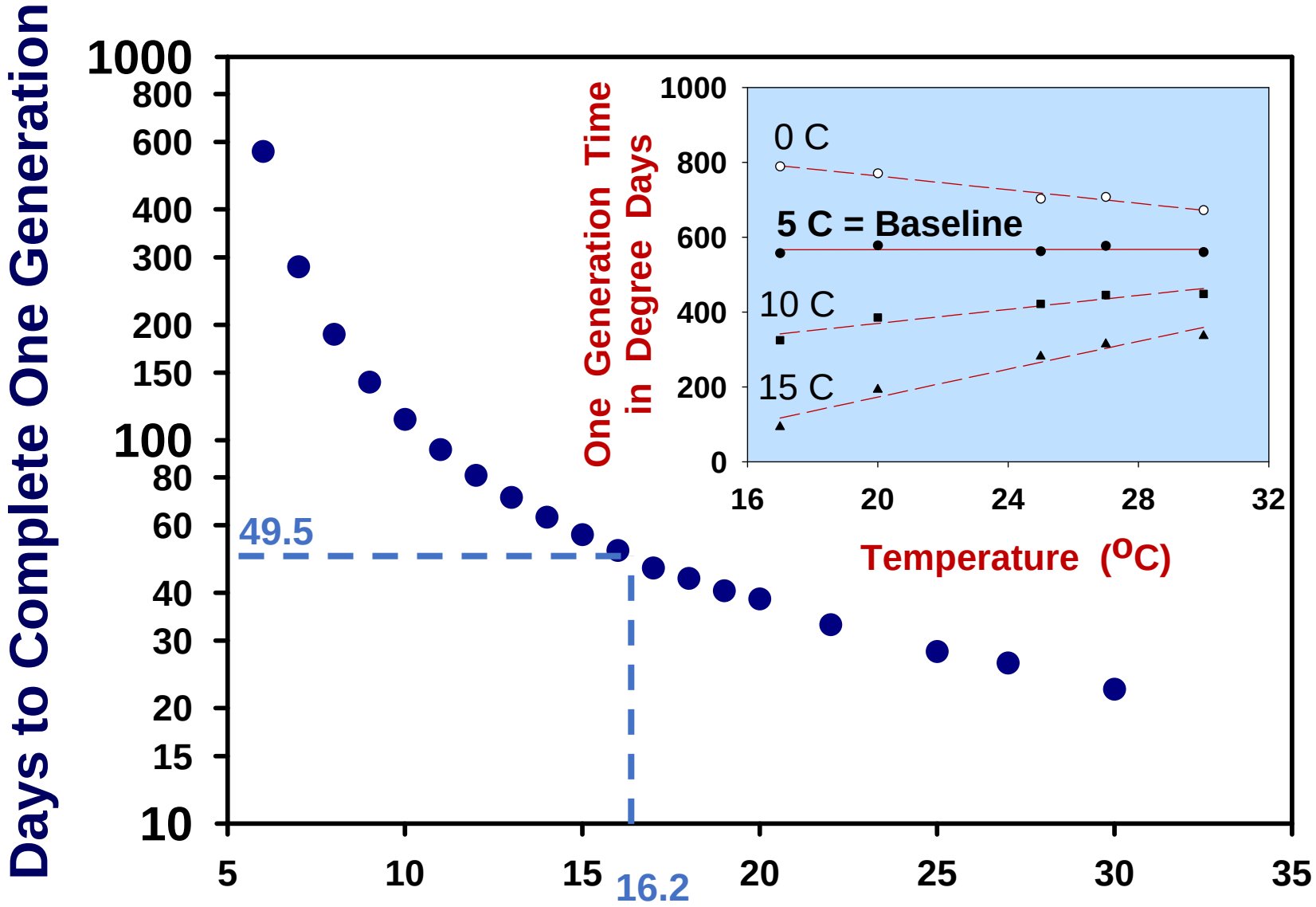
Constant threat

- Potato Cyst Nematodes
- Sugar Beet Cyst Nematode

Emerging Issues

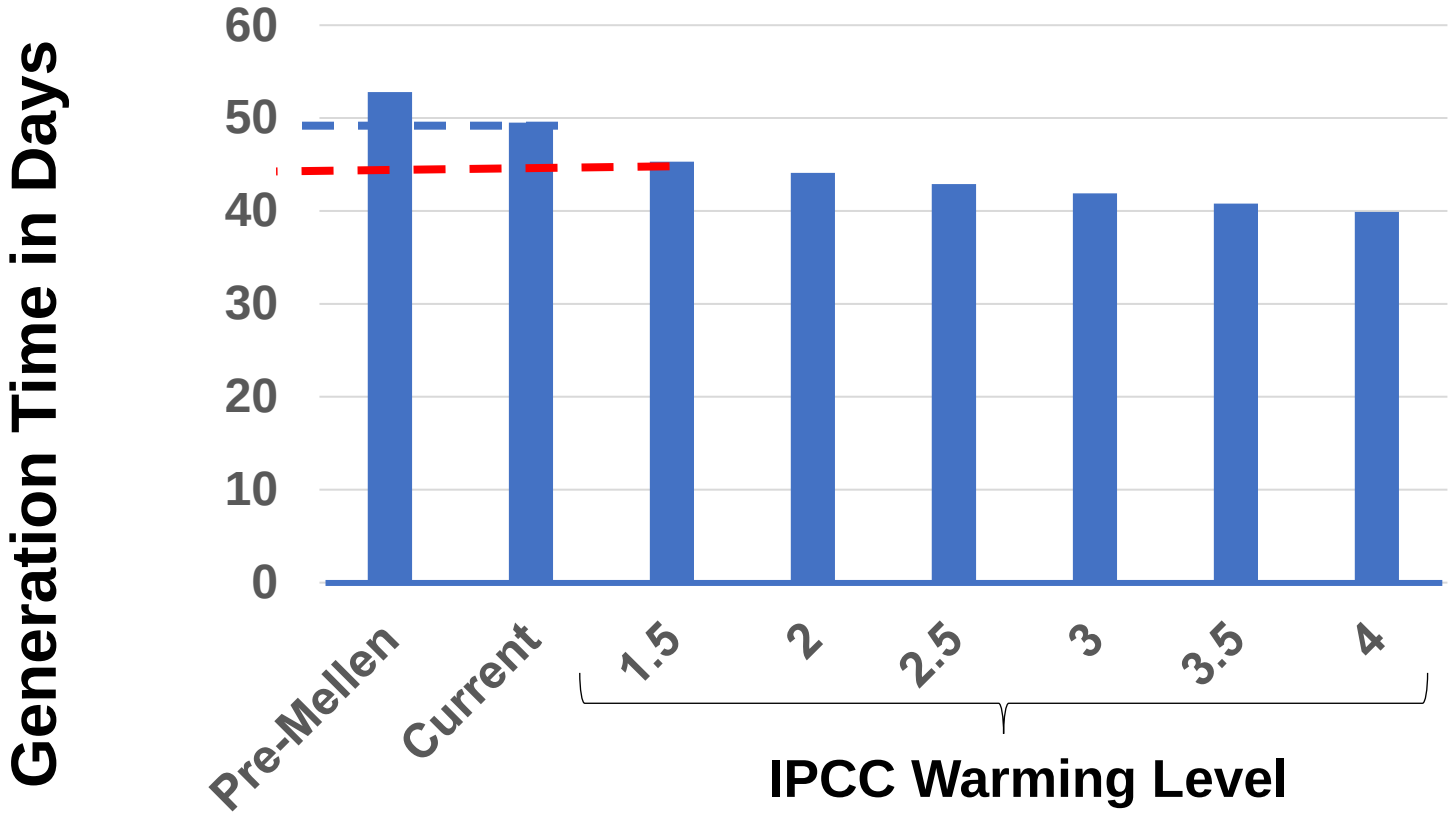
- Root Know Nematode of Carrot
- Cereal Cyst Nematodes
- *P. penetrans* affecting potato on Prairies
- Stubby Root Nematode of Corn and Corky Ringspot of Potato
- *D. dipsaci* from garlic
- *P. neglectus* for soy and other crops
- Is *D. weischeri* an issue in warm climates
- SCN and soybean and resistance breakdown

Warming Will Increase Nematode Issues



Data source: Mizukubo and Adachi 1997
Analysis: Mario Tenuta, unpublished

Predicted Generation Time *P. penetrans* With Warming



Tenuta, unpublished

Many Contributors

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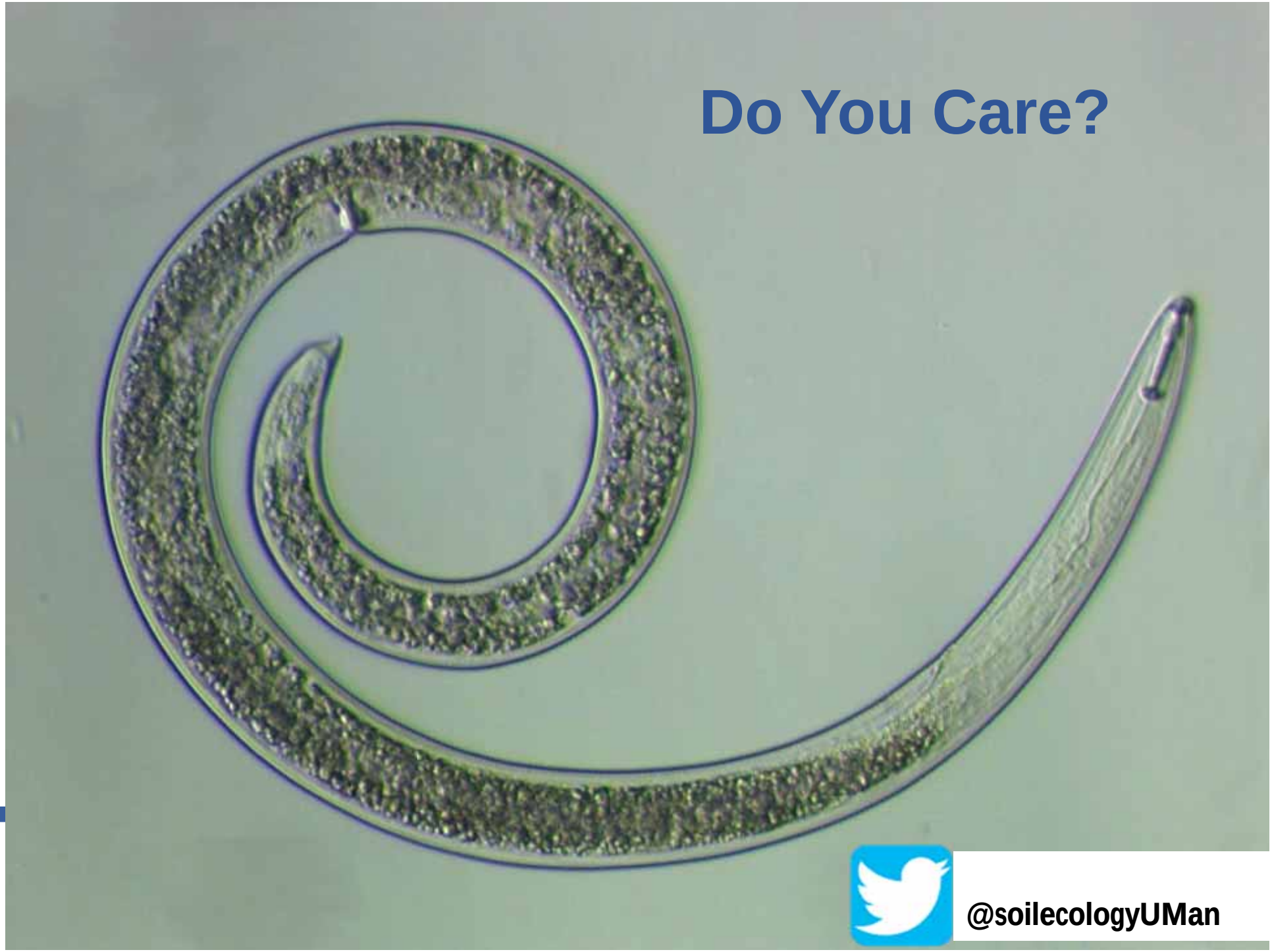
Do You Care?



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