



THE DETECTION OF 30 NEW NEARCTIC MOTHS: SUPPORT FOR INCORPORATING DNA BARCODING INTO THE SURVEILLANCE OF NON-INDIGENOUS SPECIES

Jeremy R. deWaard



Coauthors



■ Vazrick Nazari
Agriculture and Agri-Food Canada
Ottawa, Canada



■ Jean-François Landry
Agriculture and Agri-Food Canada
Ottawa, Canada



■ Leland Humble
Natural Resources Canada
Victoria, Canada

* modified from European Congress of Lepidopterology, Luxemburg, May 2011

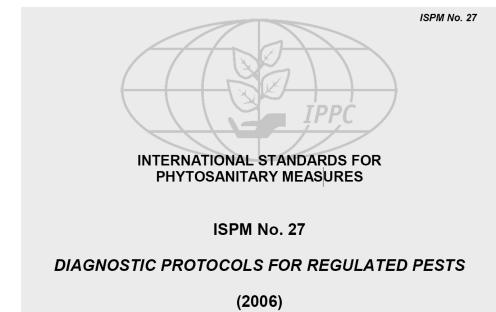
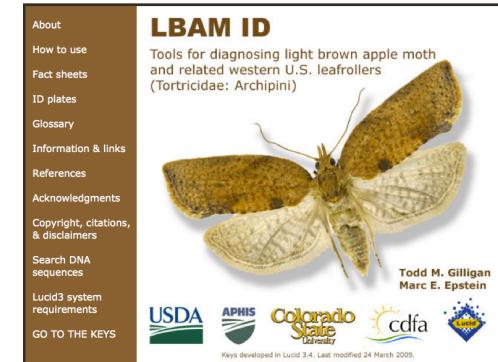
Biosecurity and DNA barcoding

- DNA barcoding provides a rapid and universal alternative to morphological or ad hoc molecular methods of species identification
- now numerous examples where DNA barcoding has facilitated, or is being employed for, the recognition of non-indigenous species from the background diversity of native fauna



Progress since Mexico 2009

- protocol: Floyd et al. 2010
- diagnostic tools and libraries, e.g. LBAM ID, deWaard et al. 2010
- provenance assignment and invasion genetics e.g. Rubinoff et al. 2011
- combining species delimitation & biosurveillance: Boykin et al. 2011
- International Plant Protection Convention (IPPC) and Quads paying attention
- QBOL and iBOL assembling libraries

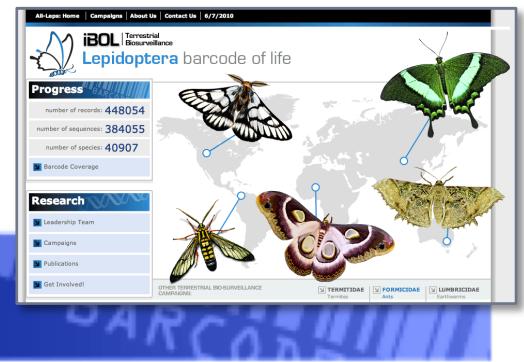


iBOL Lepidoptera of North America campaign

- lots of contributors and types of contributors
- active field collection and museum harvesting
- completing data releases (e.g. Hebert et al. 2010) and regional libraries (e.g. deWaard et al. 2011)
- putting names to a unnamed barcode clusters



Progress



specimens barcoded: **118428**

species barcoded: **6644**

unnamed barcode clusters found: **1841**

Other Lepidoptera campaigns

- assisted by fantastic progress elsewhere, such as in:
 - Germany – Axel Hausmann & colleagues
(Hausmann et al. 2011a,b)
 - Finland – Marko Mutanen & colleagues
(Mutanen 2011 abstract)



Germany
National Node



National Organization
G-Bol

SSC Representative
Wolfgang Waegele
ZFMK Bonn

SSC Alternate
Axel Hausmann
ZSM Munich



Finland
National Node



National Organization
FinBOL

SSC Representative
Marko Mutanen
University of Oulu

SSC Alternate
Helena Korpelainen
University of Helsinki

Detection of new records

- during library construction & validating, finding new records in two ways:
 - 1) unnamed barcode clusters are matching taxa from other national projects
 - 2) additional barcode clusters are showing up after regional libraries are complete
- * analogous to biosecurity applications



Winter moth *Operophtera brumata* (Linnaeus, 1758)
detected in Middle East
(Rajaei et al. in press)

Detection of new records

- not all new records are non-indigenous
 - native range extensions
 - arise from correcting synonymies
- refining our Nearctic native faunal list



Water carpet,
Lampropteryx suffumata
([Denis & Schiffermüller],
1775) found in Canada and
to be Holarctic (deWaard
et al. 2009)

30 new Nearctic species

1. *Coleophora albidella* (Draudt)
2. *Coleophora vitisella* Grote
3. *Coleophora squamosella* (Graeser)
4. *Coleophora granulatella* (Graeser)
5. *Anthophila fabriciana* (Linnaeus)
6. *Altenia perspersella* (Wocke)
7. *Sophronia gelidella* Nordström
8. *Parornix betulae* (Stainton)
9. *Stigmella salicis* (Stainton)
10. *Lyonetia pulverulentella* (Graeser)
11. *Plutella hyperboreella* Sennikov
12. *Paraswammerdamia concolor* (Graeser)
13. *Lampropteryx suffumata* (Graeser)
14. *Coleophora atriplicis* Malmsten
15. *Tinea svenssoni* Opheij, 1993 (Yponomeutidae)

- represent 13 families
- 28 are “tiny nasty little microleps”
 - limited study, expertise, taxonomic resources
- only ~2 were suspected prior to barcode detection
- all morphologically confirmed

30 new Nearctic species

1. *Coleophora albidella* ([Denis & Schiffermüller], 1775) (**Coleophoridae**)
2. *Coleophora vitisella* Gregson, 1856 (**Coleophoridae**)
3. *Coleophora squamosella* (Stainton, 1856) (**Coleophoridae**)
4. *Coleophora granulatella* (Zeller, 1849) (**Coleophoridae**)
5. *Anthophila fabriciana* (Linnaeus, 1767) (**Choreutidae**)
6. *Altenia perspersella* (Wocke, 1862) (**Gelechiidae**)
7. *Sophronia gelidella* Nordman, 1941 (**Gelechiidae**)
8. *Parornix betulae* (Stainton, 1854) (**Gracillariidae**)
9. *Stigmella salicis* (Stainton, 1854) (**Nepticulidae**)
10. *Lyonetia pulverulentella* Zeller, 1839 (**Lyonetidae**)
11. *Plutella hyperboreella* Strand, 1902 (**Plutellidae**)
12. *Paraswammerdamia conspersella* (Tengström, 1848) (**Yponomeutidae**)
13. *Lampropteryx suffumata* ([Denis & Schiffermüller], 1775) (**Geometridae**)
14. *Coleophora atriplicis* Meyrick, 1928 (**Coleophoridae**)
15. *Tinea svenssoni* Opheim, 1965 (**Tineidae**)

- first ~15 are Holarctic species neglected or overlooked (last 2 tentatively)
 - localities, host, barcode divergence and type specimens can help determine if native
 - revising native faunal list in the process (i.e. synonyms)

30 new Nearctic species

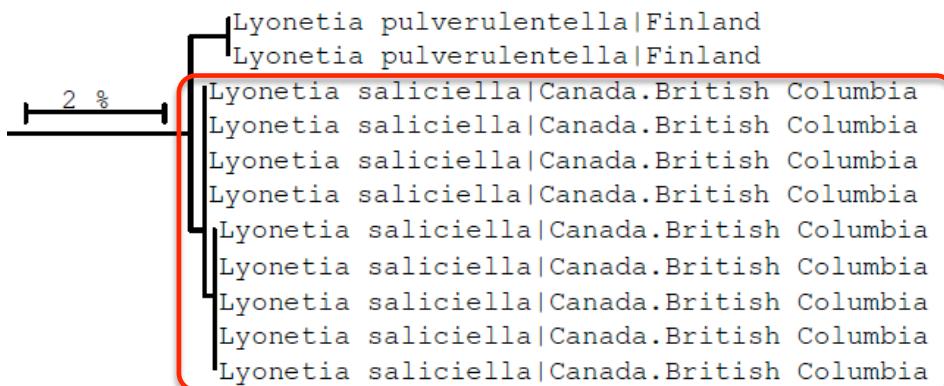
- last ~15 are non-indigenous species (NIS) (last 2 tentatively)
 - mostly on introduced hosts
 - mostly on woody plants
 - often perfect match with barcoded specimens from native range

16. *Coleophora bernoulliella* (Goeze, 1783) (**Coleophoridae**)
17. *Oegoconia deauratella* Herrich-Schäffer, 1855 (**Autostichidae**)
18. *Depressaria depressana* (Fabricius, 1775) (**Elachistidae**)
19. *Phyllonorycter maestingella* (Müller, 1764) (**Gracillariidae**)
20. *Caloptilia suberinella* (Tengström, 1848) (**Gracillariidae**)
21. *Triaxomera parasitella* (Hübner, 1796) (**Tineidae**)
22. *Argyresthia pruniella* (Clerck, 1759) (**Yponomeutidae**)
23. *Paraswammerdamia lutarea* (Haworth, 1828) (**Yponomeutidae**)
24. *Paraswammerdamia albicapitella* (Scharfenberg, 1805) (**Yponomeutidae**)
25. *Prays fraxinella* (Bjerkander, 1784) (**Yponomeutidae**)
26. *Gypsonoma aceriana* (Duponchel, 1843) (**Tortricidae**)
27. *Dichelia histrionana* (Frölich, 1828) (**Tortricidae**)
28. *Eupithecia pusillata* ([Denis & Schiffermüller], 1775) (**Geometridae**)
29. *Nemapogon cloacella* (Haworth, 1828) (**Tineidae**)
30. *Scrobipalpa acuminatella* (Sircom, 1850) (**Gelechiidae**)

Lyonetidae:

10. *Lyonetia pulverulentella* Zeller, 1839

(= *Lyonetia saliciella* Busck 1904 syn. nov.) (TL: BC)



Known distribution: Europe and Russia to Ukraine.

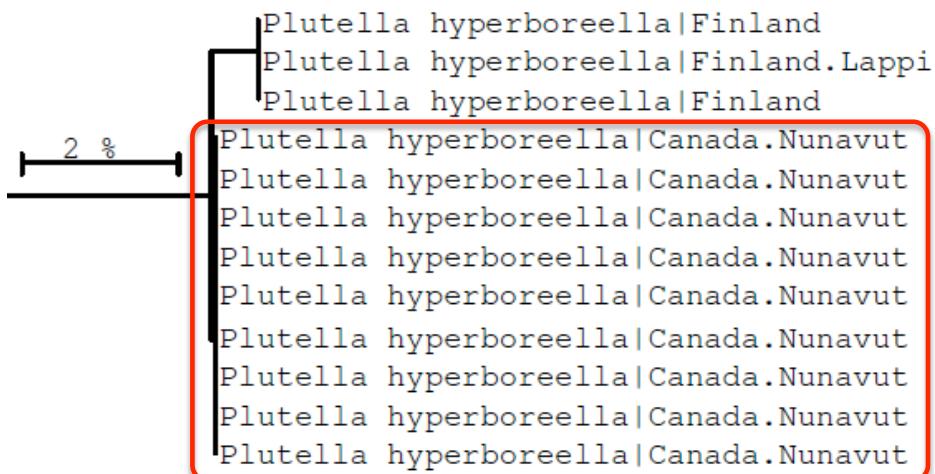
New Records: Canada (British Columbia).

Host: various Willows (*Salix* spp.).

- example of a Palearctic taxon unknowingly re-described; synonymy identified and revised

Plutellidae:

11. *Plutella hyperboreella* Strand, 1902



Known distribution: Northern Europe and Arctic Russia.

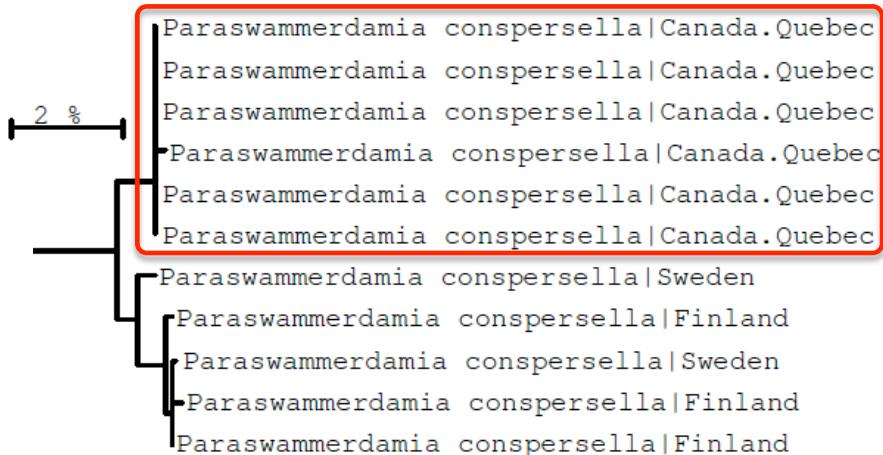
New Records: Canada (Nunavut).

Host: unknown, possibly *Draba* (Brassicaceae).

- example where barcode + locality data sufficient to classify as 'new holarctic'

Yponomeutidae:

12. *Paraswammerdamia conspersella* (Tengström, 1848)



Known distribution: Northern Europe and Northwestern Russia.

New Records: Canada (Quebec, Magdalen Islands).

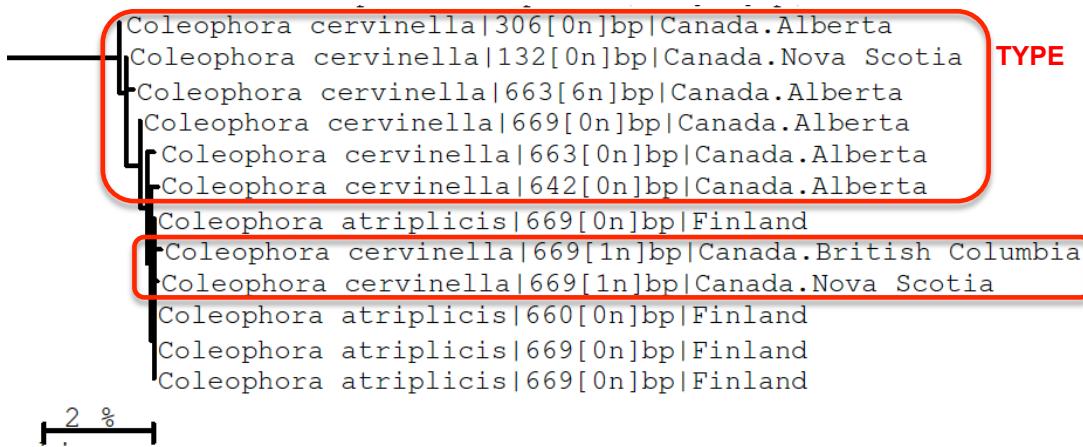
Host: *Empetrum nigrum* (Circumpolar).

- typical divergence pattern for holartic species ($d_{min} = 1.1\%$)

Coleophoridae:

14. *Coleophora atriplicis* Meyrick, 1928

(=*Coleophora cervinella* McDunnough, 1946 syn. nov.)



Known distribution: Northern and central Palaearctic.

New Records: Canada (Nova Scotia, Alberta, British Columbia).

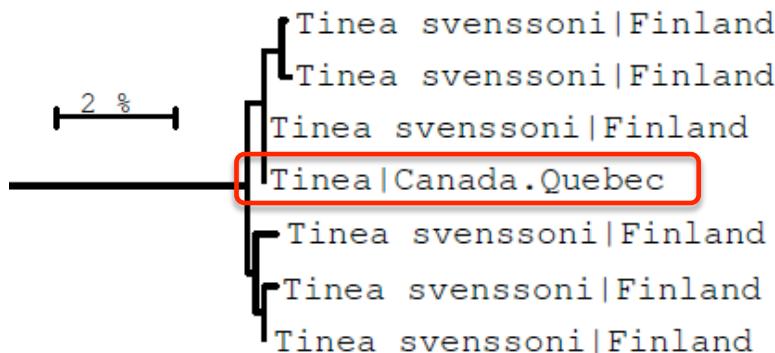
Host: *Halimione portulacoides*, *Suaeda*, *Salicornia* and *Atriplex littoralis* (salt marsh species). *C. cervinella* host is unknown; types collected in a salt marsh.



- demonstrates utility of barcoding types – holotype analyzed here

Tineidae:

15. *Tinea Svenssoni* Opheim, 1965



Known distribution: Northern Europe and Russia.

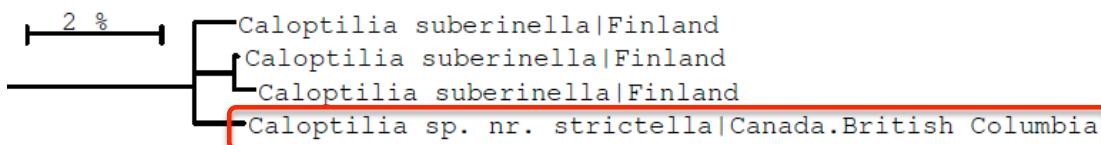
New Records: Canada (Quebec).

Host: larvae live in the nests of the Ural Owl (*Strix uralensis*), not present in NA (host switch to another bird?)

- uncertain whether native or introduced; more data needed

Gracillaridae:

20. *Caloptilia suberinella* (Tengström, 1848)



Known distribution: Northern and Central Europe, Russia to China.

New Records: Canada (British Columbia).

Host: Asian White Birch, *Betula platyphylla* (introduced to NA).

- straightforward example of introduced leafminer on introduced host

Gelechiidae:

30. *Scrobipalpa acuminatella* (Sircom, 1850)

Scrobipalpa acuminatella|United Kingdom.England
Scrobipalpa acuminatella|Canada.Quebec
Scrobipalpa acuminatella|Canada.Quebec
Scrobipalpa acuminatella|United Kingdom.England
Scrobipalpa acuminatella|United Kingdom.England
Scrobipalpa acuminatella|Italy.Abruzzi
Scrobipalpa acuminatella|Italy.Abruzzi
Scrobipalpa acuminatella|Canada.Quebec
Scrobipalpa acuminatella|Canada.Quebec
Scrobipalpa acuminatella|Canada.Quebec
Scrobipalpa acuminatella|Canada.Ontario
Scrobipalpa acuminatella|United Kingdom.England
Scrobipalpa acuminatella|Austria.Steiermark
Scrobipalpa acuminatella|Italy
Scrobipalpa acuminatella|Austria.Vorarlberg
Scrobipalpa acuminatella|Finland.Aland
Scrobipalpa acuminatella|Finland
Scrobipalpa acuminatella|Finland
Scrobipalpa acuminatella|Finland
Scrobipalpa acuminatella|Finland

2 %



MM03835 (Finland)



CNCLEP00067527 (Canada: QC)

Known distribution: Widespread in Europe, West and Central Asia, Siberia and Eastern China.

New Records: Canada (Quebec).

Host: Various Asteraceae.

- typical divergence pattern for NIS (9 of 15 NIS have exact barcode match in Palearctic)

Geometridae:

28. *Eupithecia pusillata* ([Denis & Schiffermüller], 1775)

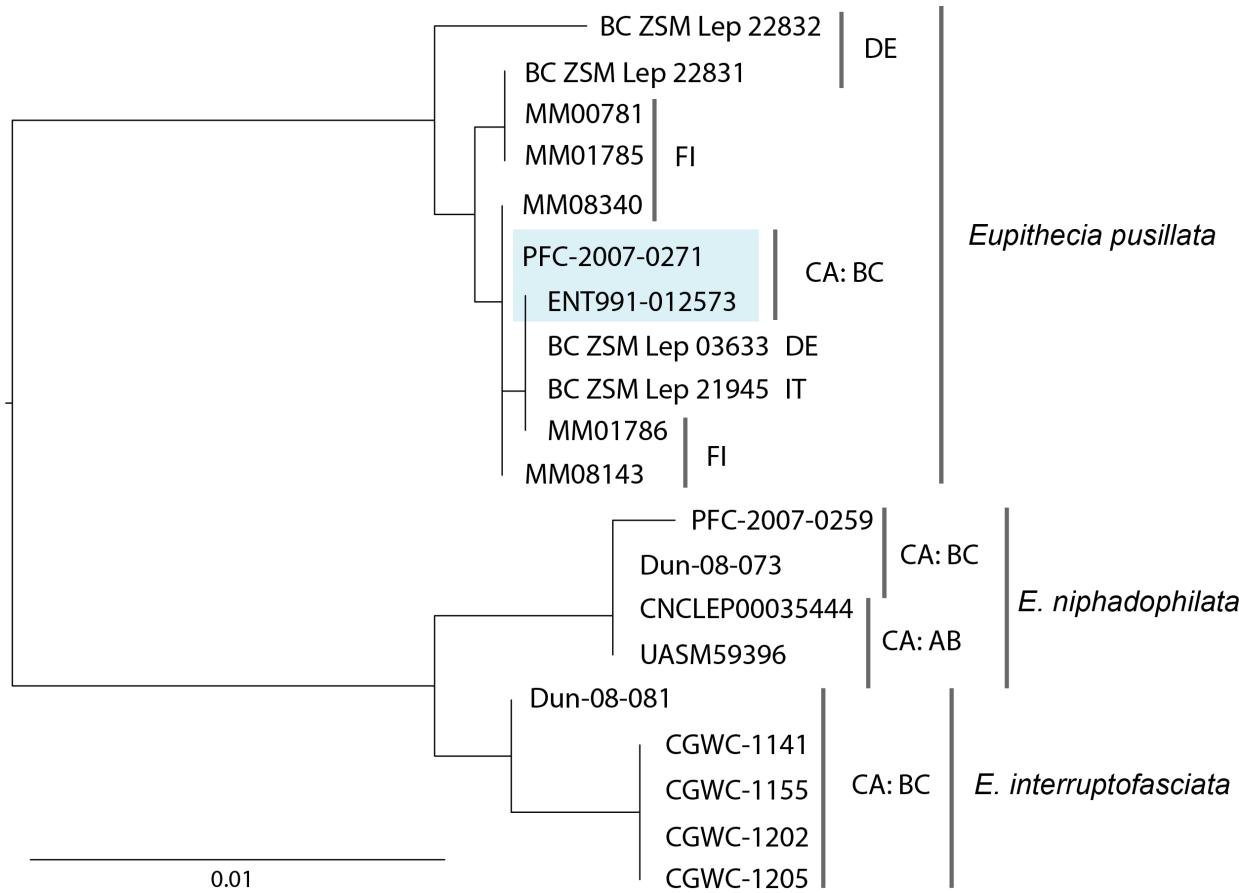


Fig 1 from deWaard et al. 2010b

- in completing reference library for BC (deWaard et al 2010a), unnamed cluster became apparent
- BOLD-ID tentatively assigned it the Eurasian juniper pug based on identical matches

Geometridae:

28. *Eupithecia pusillata* ([Denis & Schiffermüller], 1775)

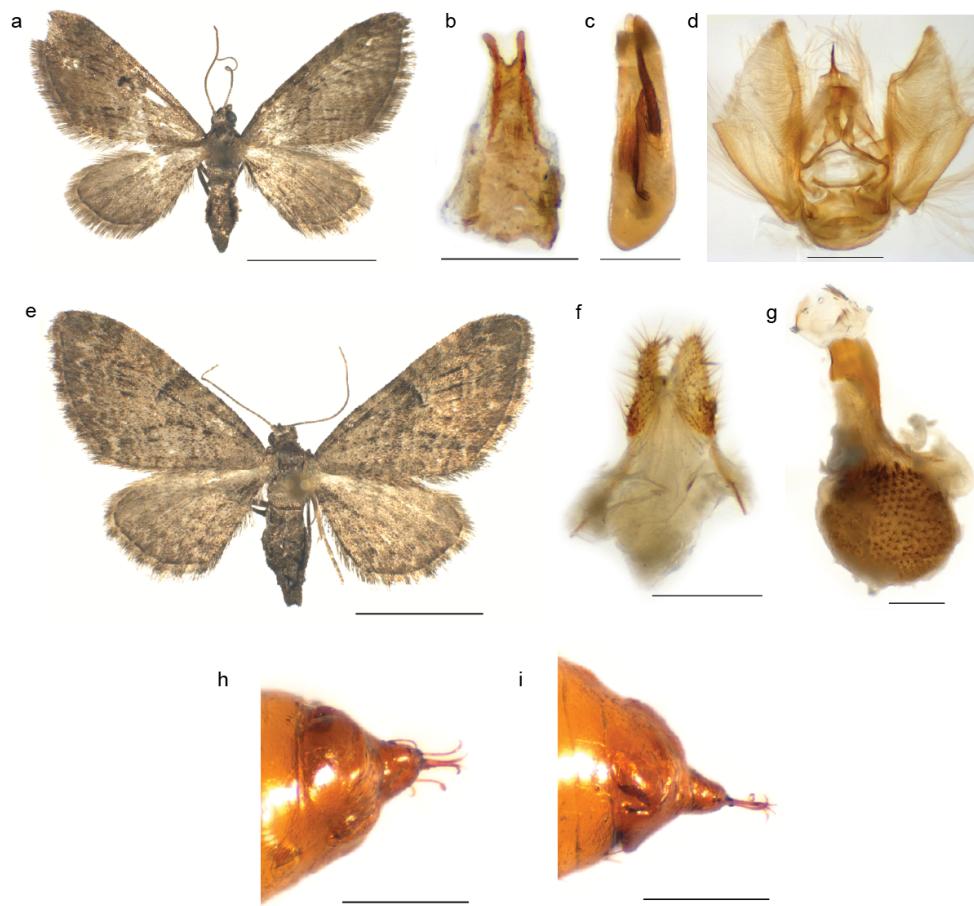
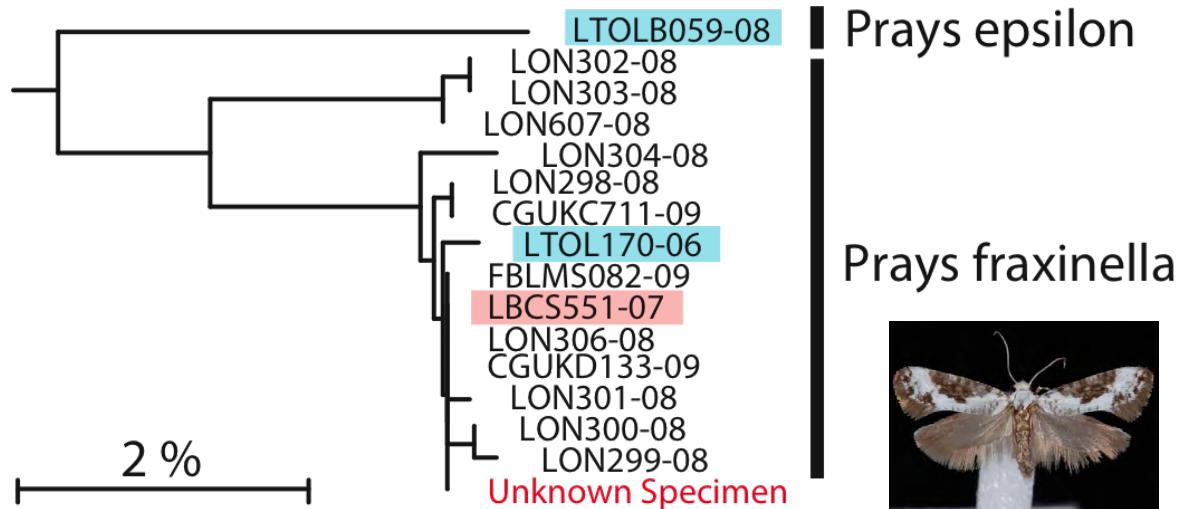


Fig 2 from deWaard et al. 2010b

- again confirmed by genitalic dissection
- collection in urban Vancouver and not inland BC suggests introduction
- old introduction: associated documentation points to an established population of 34 years

Praydidae:

25. *Prays fraxinella* (Donovan, 1793)

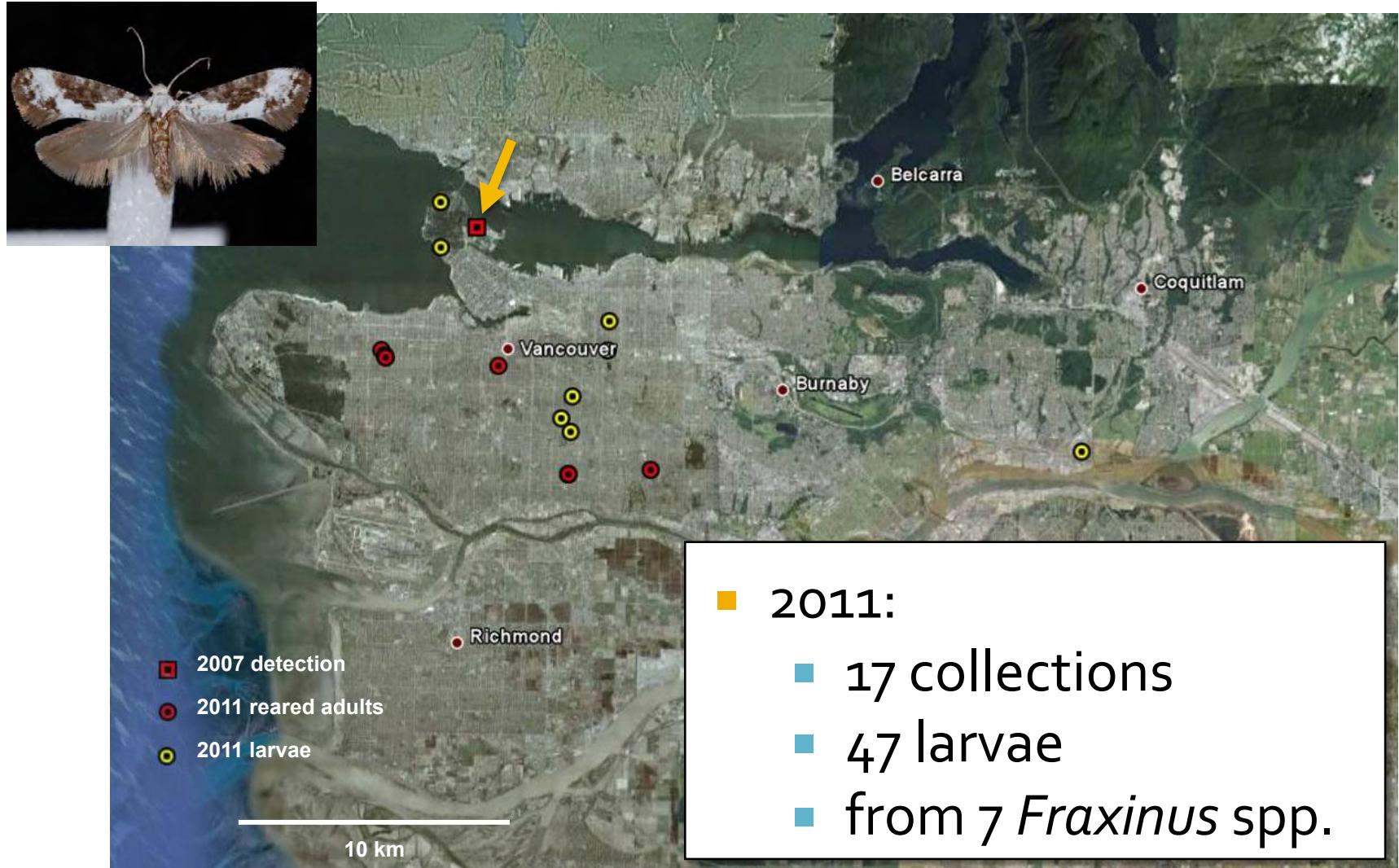


modified BOLD-ID tree, Nov. 2010

- example of a recent introduction – ash bud moth
- at the time of detection (deWaard et al. 2009), only two close barcode matches (blue)
- today, 103 barcoded specimens from 15 species on BOLD

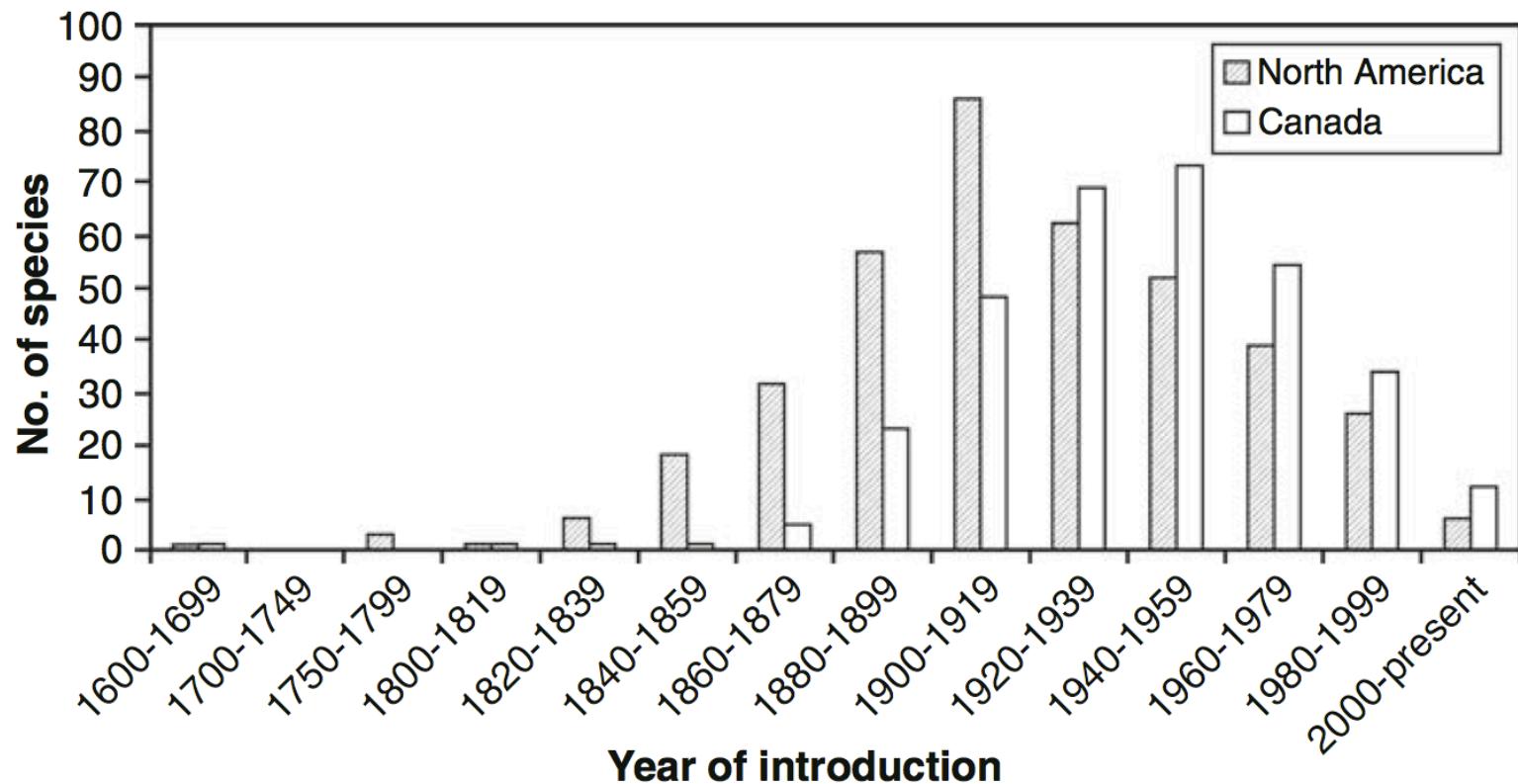
Praydidae:

25. *Prays fraxinella* (Donovan, 1793)



To put 15 NIS in context...

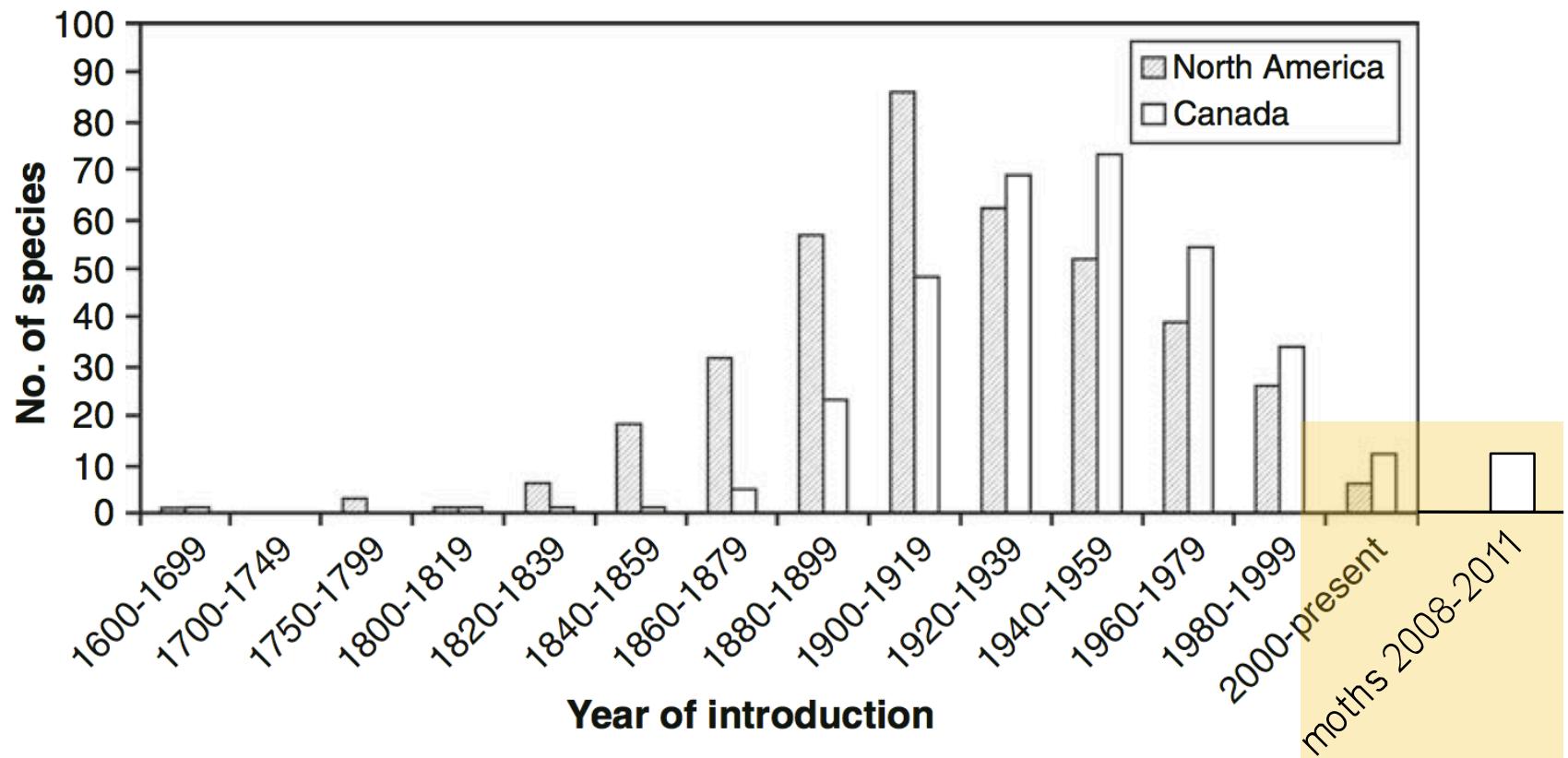
Langor et al. 2009 (all insects and mites; woody plant feeders only):



- 10 of 15 are woody plant feeders

To put 15 NIS in context...

Langor et al. 2009 (all insects and mites; woody plant feeders only):



- 10 of 15 are woody plant feeders; add 10% to Lepidoptera NIS historic list of 92

Conclusions

- constructing and refining national reference libraries and faunal lists is making an impact now
- BOLD is becoming even more useful over time, but continual curation and validation is necessary
- if detection by 4 nerds + barcodes for 3 years = total detection of Canadian insects over 8 years previous, this *certainly* would be a powerful tool in the hands of biosecurity agencies





GenomeCanada

international
BARCODE
OF LIFE



Canada Foundation for Innovation
Fondation canadienne pour l'innovation



Ontario**Genomics**Institute



NSERC
CRSNG



MINISTRY OF
RESEARCH AND INNOVATION

Marko Mutanen (U.Oulu, Finland)

Axel Hausmann (ZSM, Germany)

Erik van Nieukerken (Naturalis, The Netherlands)

Greg Pohl (NRC, Canada)

Dave Holden (CFIA, Canada)

Chris Schmidt & Don Lafontaine (CNC, Canada)

Paul Hebert and BIO staff (CCDB, Canada)

