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Globodera Alliance Newsletter

GLOBAL
Globodera Alliance

Potato Cyst Nematodes Around the World:
All you wanted to know about their distribution and evolution history

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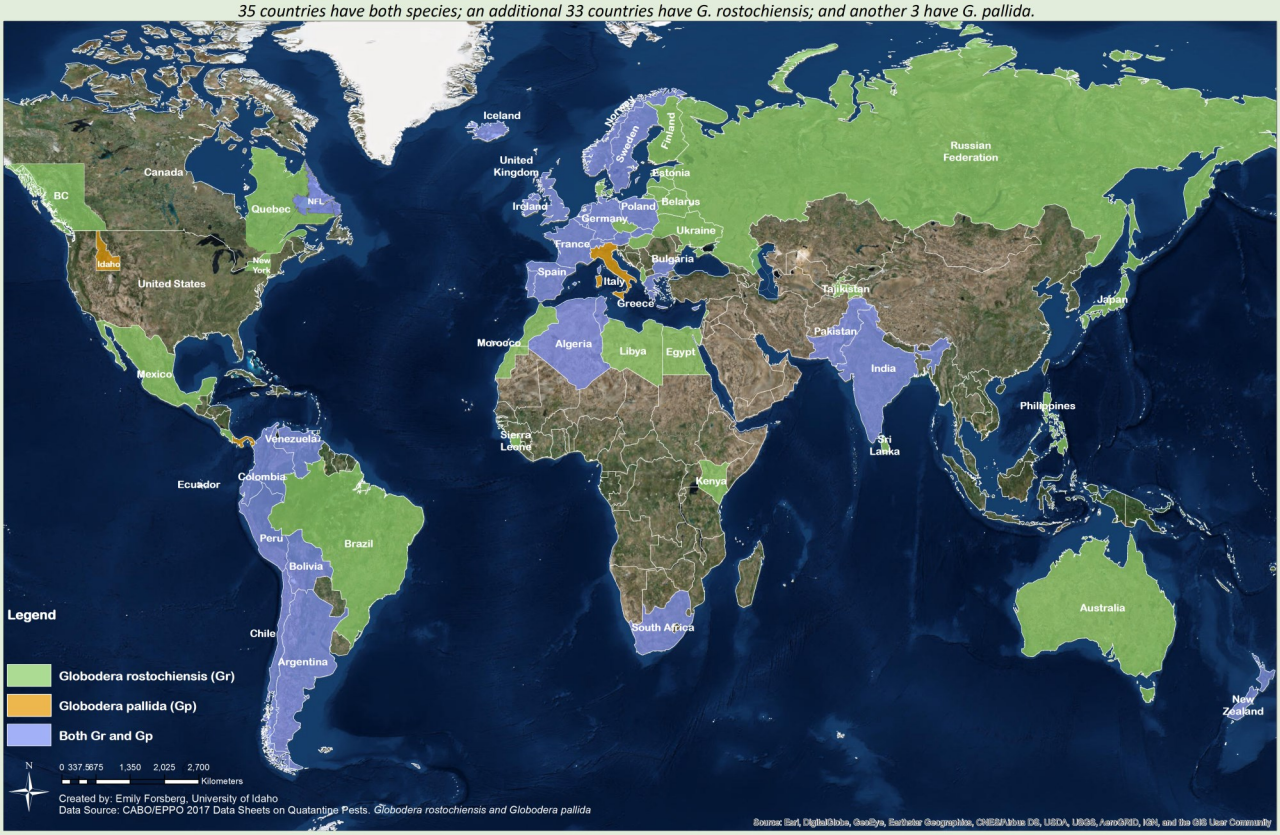
PCN Distribution

Potato cyst nematodes (PCN) are among the most highly specialized and successful plant parasitic nematodes. They rank 2nd in the 'top 10' list of the plant parasitic nematodes based on their scientific and economic importance. Like their main host crop, potato, PCN have spread to almost all parts of the world, initially in soil adhering to tubers from infested land but also by any other means that transport soil containing cysts. Their pathways of distribution are still a matter of speculation but PCN are believed to have originated in the Andean region of Peru and Bolivia. Today, PCN occur on all continents, in temperate, tropical or southern tropical zones, both at sea level and at higher altitudes. Results suggest that Europe is a secondary distribution center, but one exception may be transport of cysts from Peru to Japan in contaminated guano sacks.

Distribution of Potato Cyst Nematodes: *Globodera pallida* and *Globodera rostochiensis*

Nematodes - *G. rostochiensis and G. pallida- have been found in a total of 71 countries plus 6 islands worldwide: 35 countries have both species; an additional 33 countries have G. rostochiensis; and another 3 have G. pallida.*



Overview of *Globodera* diversity

Potato cyst nematodes belong to the genus *Globodera* which comprises of species, with the exception of *G. zelandica*, parasitic to plants belonging to either the Solanaceae or Compositae. At least eight *Globodera* species parasitizing Solanaceae have been identified. All eight species are parasitic on tomato but potato is not a host for *G. tabacum, G. virginiae, G. solanacearum or G. mexicana*. Among the remaining four is *G. leptonepia* which is unique. Found in a ship-borne consignment of potatoes, it is presumed to be a South American species parasitizing potato.

***Globodera* Species Parasitizing Solanaceae Family**
G. tabacum
G. virginiae
G. solanacearum
G. mexicana
G. leptonepia
G. ellingtonae
G. rostochiensis
G. pallida

However, extensive field collections of *Globodera* from the Andean highlands have not resulted in its rediscovery. *Globodera leptonepia* remains a rare and little-known *Globodera* spp. *Globodera ellingtonae* is a recently described *Globodera* species with a geographic distribution restricted to the Americas at this time. However, one should note that as a newly described species its geographic distribution may expand in the coming years. Initially found and described from a few potato fields sampled in Oregon and Idaho (U.S.), this species may also be present in Chile and Argentina as suggested by molecular data obtained on two populations sampled respectively in the Antofagasta region of Chile and the Salta Province in Argentina. Clearly, further characterization of these two South American populations are needed to definitely assign these two populations to *G. ellingtonae* or to another not yet described *Globodera* species.

The two remaining *Globodera* species are the well-known potato cyst nematodes, *G. pallida* and *G. rostochiensis*. *Globodera rostochiensis*, also known as the golden nematode, was identified in Germany in 1913. It was first discovered in the United States in 1941, in Canada and India during the 1960s, and in Mexico during the 1970s. It has also been found in various locations throughout Asia, Africa, and Australia. Currently it is reported in 77 countries and islands (see map pg. 1).

Cysts of Globodera rostochiensis (top—also know as the golden nematode) and *G. pallida* (bottom—also known as the pale cyst nematode) viewed under the microscope.
(Photos: X. Wang)

Globodera rostochiensis origins

The center of origin of *G. rostochiensis* seems to be Bolivia where the highest genetic diversity was observed. However, populations imported into Europe and from there to the U.S. originate from southern Peru. The genetic diversity of this species found in Europe and North America is quite low compared to the native diversity present in South America.

Globodera rostochiensis has long been the most prevalent potato cyst nematode species infesting potato fields of temperate regions. However, the increased cultivation of potato containing the *H1* resistance gene against *G. rostochiensis* has resulted in an increase in fields infested by *G. pallida*. Unfortunately, the *H1* gene does not provide resistance to *G. pallida*.

Globodera pallida origins

Worldwide, *G. pallida*, also known as the pale cyst nematode, is not as widely prevalent as *G. rostochiensis*. It is found in 55 countries (see map pg. 1), most-

ly in temperate regions. Due to strict quarantine measures, *G. pallida* and *G. rostochiensis* have, for the most part, been kept out of the U.S. An exception is the recent outbreak of *G. pallida* found in Idaho (see map pg. 1).

One should note that in most European countries where *G. pallida* is found, *G. rostochiensis* is also present. It is therefore highly probable that the two species were introduced into Europe at the same time and from the same geographic area. This supports the idea that a single or a limited number of introductions occurred in Europe. Whether this was truly a "rare" event remains questionable as it is also possible that several other introductions occurred from South America but failed to establish and spread once in Europe.

A phylogeographic study carried out on *G. pallida* populations sampled along the Andean Mountain Range in Peru revealed a phylogeographic pattern from south to north with five distinct groups, known as "clades" (see map pg. 4)

This phylogeographic pattern suggests that the evolution of the populations of *G. pallida* from Southern to Northern Peru was due to the formation of the Andes Mountains and the colonization of these new areas by wild potatoes. The colonization of northern Peru by *G. pallida* is estimated to have occurred 3 to 4 million years ago, well before the emergence of agriculture. This suggests that populations have evolved from wild relatives to the cultivated potato in each phylogeographic clade. All the European populations of *G. pallida* have evolved from a small fraction of nematodes originating on the north shore of Lake Titicaca in Peru.

Differences in virulence exist among PCN populations and the imported virulence both in Europe and North America is only a small fraction of what is found in the center of origin of PCN in South America. Potato varieties resistant to *G. pallida* developed in Europe from the wild relative *Solanum vernei*

Idaho Infestation

In 2006, the Idaho State Department of Agriculture (ISDA) and USDA Animal and Health Inspection Service (APHIS) announced the detection of the pale potato cyst nematode (*G. pallida*). This was the first detection of the pest in the U.S. The cysts were detected during a routine survey of tare soil at an ISDA grading facility in southeastern Idaho. Subsequent to this initial discovery, surveys to determine delimit and the distribution of the pest confirmed seven infested fields totaling 911 acres, within a one mile radius in Bingham and Bonneville Counties, Idaho. The infested fields and an area surrounding the fields were placed under a Federal Domestic Quarantine Order and parallel State Rule in August 2006, establishing restrictions on movement of certain regulated articles* from Idaho in order to prevent the spread of *G. pallida*. As a result of ongoing intensive soil sampling, an additional 20 *G. pallida*-infested fields have been found in the area. All 27 infested fields lay within an 8.5-mile radius. Fields associated through shared tenancy, farming practices, equipment, and/or shared borders have been extensively surveyed and are also regulated.

For a report on progress to fight the pale potato cyst nematode in Idaho go to: **https://www.aphis.usda.gov/plant_health/plant_pest_info/potato/downloads/pcndocs/surveyupdates/2017/pcn-2nd-quarter-2017.pdf**

*Regulated Articles

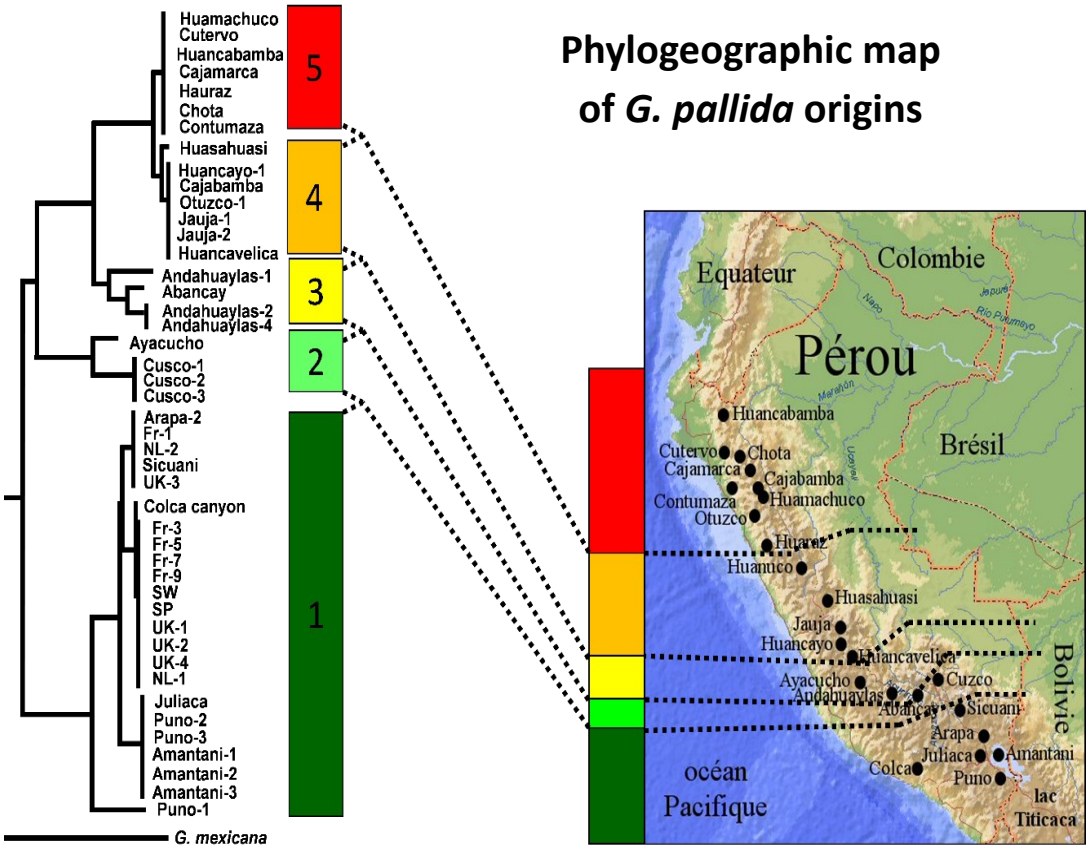
As defined by U.S. PCN regulations:

a) Pale cyst nematodes.
b) Pale cyst nematode host crops: Eggplant, Pepper, Potato, Tomatillo, Tomato.
c) Root crops.
d) Garden and dry beans and peas.
e) All nursery stock.
f) Soil, compost, humus, muck, peat, and manure, and products on or in which soil is commonly found, including grass sod and plant litter.
g) Hay, straw, and fodder.
h) Any equipment or conveyance used in an infested or associated field that can carry soil if moved out of the field.
i) Any other product, article, or means of conveyance not listed above that an inspector determines presents a risk of spreading the pale cyst nematode.

show good resistance to Peruvian clade I populations only. However, *G. pallida* populations originating from other clades are able to multiply on these resistant potatoes and thus represent a high risk if introduced to other parts of the world.

In light of this worldwide PCN genetic diversity, phytosanitary and other control measures must be maintained and diagnostic tools improved. Molecular tools for identification of PCN have recently been harnessed to assess the genetic diversity of different populations. However, not all such tools appear to be reliable when faced with the worldwide PCN diversity. Regulatory policy in place in most countries regarding seed or ware potatoes imported, minimizes the risk of introducing PCN. However, the possibility for PCN to "travel" by other means should not be overlooked; cysts can be easily dispersed by a range of pathways, such as soil adhering to other root crops grown in infested fields, and military or agricultural equipment moving around the world. Clearly, pathways for dispersion of PCN merits further investigation to improve control strategies.

Finally, plant resistance against PCN is an efficient and environmentally friendly means to control PCN populations and as such, The Council of the European Union Directive (2007/33/EC) recommends the use of resistant cultivars to reduce levels of PCN. However, use of resistant cultivars is certainly not a panacea because continuous cropping with resistant varieties exerts a strong selection pressure on PCN populations. In many cases, PCN have developed the capacity to overcome resistance. Thus, because we have no clear indicator of the durability of resistance to PCN, a good strategy is to manage the use of all sources of resistance very carefully. Ideally this includes regular sampling to monitor the levels and virulence characteristics of populations in infested fields. Hence, one of our goals for the GLOBAL project is to identify PCN virulence markers for accurate monitoring of virulence in infested fields.



Graphic depiction of the historical distribution of *G. pallida* populations along Peru's Andean Mountain Range. Research suggests that, 3-4 million years ago, *G. pallida* spread from Lake Titicaca northward. Clades #1-5 represent five distinct populations; clade 1 has been identified as the origin of the *G. pallida* populations found in Europe and in Idaho.

About the GLOBAL Project

GLOBAL stands for "Globodera Alliance", an international group of research, extension, and education professionals working to eradicate *Globodera spp.* in U.S. potato production.

GLOBAL Project members include scientists from the University of Idaho, Oregon State University, Cornell University, U.S. Department of Agriculture (USDA), Agriculture and Agri-Food Canada, The James Hutton Institute, and the French National Institute of Agricultural Research.

Follow the GLOBAL Project online at:

www.globodera.org

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Pale Cyst Nematode Field Tour Online

The 2017 Snake River Pest Management Tour -- sponsored by the University of Idaho's Aberdeen Research and Extension Center — provides an opportunity to learn about ongoing research and practices to control and eradicate the pale cyst nematode in southern Idaho. The tour – presented by Pam Hutchinson, University of Idaho; Tina Gresham, APHIS; and University of Idaho Graduate Students, Jn Bertrand Contina and Cole Harder – was attended by growers and the general public this past July.

PCN Field Tour video can also be found at:
https://www.globodera.org/nematode-control-approaches

Upcoming Event:

University of Idaho Potato Conference, Jan. 17-18, 2018

Pocatello, Idaho, **https://www.facebook.com/events/368363210194422/**

GLOBAL Investigators

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- Pam Hutchinson, PhD, University of Idaho
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- Rich Novy, PhD, USDA ARS
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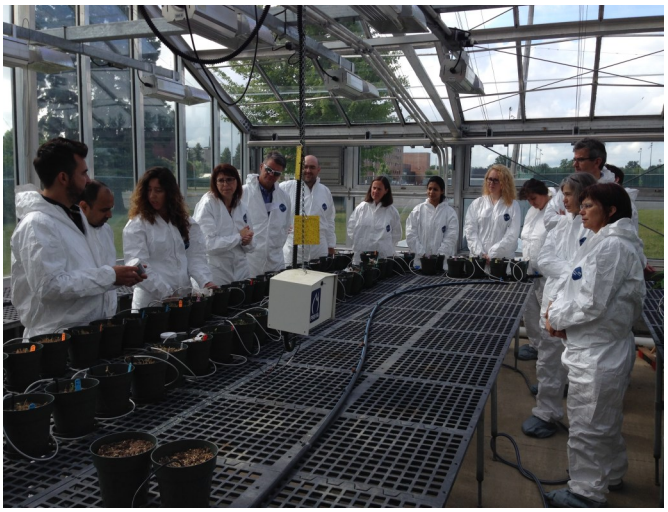
- Xiaohong Wang, PhD, USDA ARS and Cornell University
- Jonathan Whitworth, PhD, USDA



GLOBAL Project scientists tour the potato cyst nematode greenhouse research facility at Agriculture and Agri-Food Canada, a GLOBAL partner agency (I. Zasada)

GLOBAL Advisory Committee consists of potato industry, state and federal regulatory and academic individuals who have volunteered their time and efforts. We thank them!

GLOBAL Advisory Committee

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