Virulence and Molecular Characterization of *Globodera pallida* from Idaho

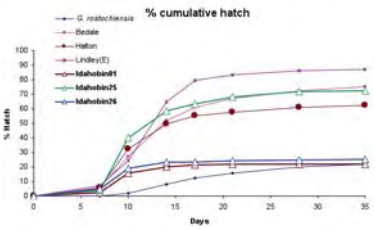
Vivian C. Blok and Mark S. Phillips
Plant Pathology Programme, SCRI, Invergowrie, Dundee DD2 5DA Scotland.

Cysts of the potato cyst nematode *Globodera pallida* were found for the first time in Idaho, U.S.A. in 2006. Samples of these cysts were used at the Scottish Crop Research Institute to conduct biological and molecular eexperiments to characterise the isolates.

Hatching tests

Juveniles hatching from three batches of cysts from Idaho and three UK G. pallida populations (Beadle, Halton and Lindley glasshouse cultures) and one G. rostochiensis populations were compared. Cysts were exposed to tomato root exudates and juveniles hatching were counted over a 5 week period. Idahobin01 and 06 was of low viability (Fig 1) providing an explanation of the problems encountered by ourselves and others in reproducing the Idaho isolates.

Figure 1 Percentage cumulative hatch over 35 days.



Virulence

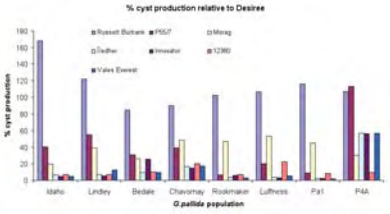
Two glasshouse pot experiments were conducted comparing the reproduction of the Idaho population to other *G. pallida* populations on susceptible and partially resistant potato hosts with resistance from *Solanum vernei* or *S. tuberosum* ssp *andigena* CPC2802. The first experiment used the original cysts obtained from Idaho, however the reproduction was extremely low making interpretation of the data very difficult. The second virulence test which used cysts from the first experiment showed good levels of reproduction (Table 1) and indicted that there was no inherent lack of fitness in the Idaho population and confirmed that the pattern of virulence when tested against resistance from *Solanum vernei* and *S. tuberosum* spp *andigena* CPC2802 was similar to the Pa2/3 virulence group.

Table 1 Mean cyst production of eight *G. pallida* populations reared on eight potato cultivars.

	Desiree	Russet Burbank	P56/7[b]	Morag[a]	Tedher[a]	Innovator[a]	12380[a]	Vales Everest[a]
Pa1[1]	1486.8	1718.3	132.0	673.3	37.5	31.0	123.3	28.8
Rookmaker[1]	1189.5	1214.8	76.3	555.8	43.5	68.3	85.3	38.0
Luffness[1]	1041.0	1108.8	210.3	556.5	37.0	33.5	237.5	58.3
Lindley[1]	774.3	941.7	426.0	301.8	54.5	42.8	56.3	96.0
Idaho	526.0	884.3	212.8	101.8	34.0	24.5	38.5	26.5
P4A[1]	458.8	490.3	518.5	137.8	280.5	259.3	42.8	261.8
Beadle[1]	449.5	380.3	138.0	116.3	42.5	115.5	45.3	44.0
Chavornay[1]	339.0	303.8	133.8	165.8	57.3	50.0	68.0	58.3

[1] European populations
[2] South American population
a derived from *S. vernei*
b derived from *S.tuberosum* ssp *andigena* CPC2802
c has the H2 resistance gene which differentiates Pa1 populations.

Figure 2 Percentage reproduction relative to the susceptible cultivar Desiree.

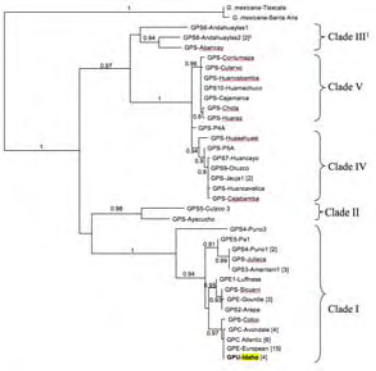


Molecular studies

Cytochrome B

Part of the mitochondrial Cytochrome B gene was obtained for the Idaho population and compared with sequences from a broad range of South American and European *G. pallida* population sequences available on Genbank. There was very little within population variation, and Idaho CytB had the greatest similarity to the European populations and the *G. pallida* population from southern Peru (Figure 3). It seems likely, that the Idaho and European populations originate from the same geographic region in southern Peru Plantard *et al*. (2008), however there is no data to indicate whether the Idaho population was introduced to the USA directly or indirectly through Europe.

Figure 3



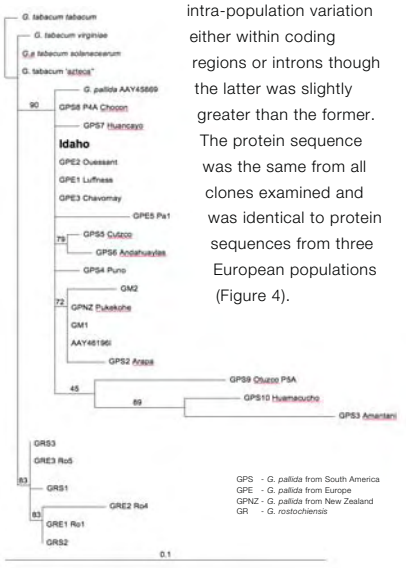
[1] Plantard *et al*. (2008) Molecular Ecology 17:2208-2218
[#] Indicates the number of samples from an area used.

GPS - *G. pallida* from South America
GPE - *G. pallida* from Europe
GPC - *G. pallida* from Canada
GPU - *G. pallida* from the USA

Pectate lyase and Cathepsin

Sequences of the nuclear genes, pectate lyase and cathepsin were obtained from the Idaho population. They did not distinguish groups of populations as clearly as the mitochondrial sequence but supported those findings. Pectate lyase gave the clearest differentiation among the populations and suggests that the Idaho population is most similar to other European *G. pallida* populations. Translation of the coding sequences indicated at least two different protein sequences but with no clear differentiation between populations from different origins. The cathepsin sequence showed very little intra-population variation either within coding regions or introns though the latter was slightly greater than the former. The protein sequence was the same from all clones examined and was identical to protein sequences from three European populations (Figure 4).

Figure 4
Dendrogram showing relationship between the Idaho *G. pallida* amino acid sequence and other cathepsin sequences from Genbank.



Conclusions – *The Idaho population in terms for virulence and molecular characterisation appears to be of the Pa2/3 virulence group and most closely resembles G. pallida populations from southern Peru and Europe. It is interesting to note that there are a populations found in Canada and New Zealand which in molecular terms are of the same type. It has long been suggested (Evans and Stone, 1977) that potato cyst nematodes while originating in South America have been spread to non-indigenous regions via Europe. The data we have obtained are compatible with this notion though an introduction from Southern Peru to Idaho cannot be ruled out.*

Acknowledgements

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