

## OECD Fellowship Summary Report

Fellow's name: Peter Dodds

Title: Resolving the two haploid genomes of *Puccinia graminis* f. sp. *tritici* to identify structural variation underlying pathogen virulence

Theme II: Managing risks in a connected world.

Host institution: University of Minnesota, Dept of Plant pathology

Host supervisor: Prof. Jim Bradeen

Fellowship dates: July 17, 2017- Sep 22, 2017

Consent statement. I agree with posting this report on the Co-operative Research Programme's website.

### **1. What were the objectives of the research project? Why is the research project important?**

The overall objective of this collaborative project is to use long-read sequencing to generate an improved genome assembly for Australian isolates of *Puccinia graminis* f. sp. *tritici* that explicitly resolves structural differences between the two haploid genomes present in this dikaryotic pathogen.

Wheat stem rust is a constant threat to wheat production as evidenced by the repeated epidemics caused by new stem rust strains in East Africa over recent years. Rusts are unusual among fungi in having two separate and different haploid nuclei but variation between these are not explicitly resolved in the existing reference genome, which limits the identification of structural changes that underlie the evolution of new virulent strains. A more complete haplotype-resolved assembly would be a valuable tool to understand virulence evolution in *Pgt* and will help develop predictive diagnostic tools for pathogen population monitoring necessary for optimal deployment of genetic resistance.

### **2. Were the objectives of the fellowship achieved?**

Yes. The collaborative work with the University of Minnesota (UMN) was successful in generating a genome assembly for *Pgt* based on long read sequences of our Australian stem rust isolate. The haplotypes are resolved assembly contains separate sequences for the two haplotypes and is double the size of a previous collapsed haploid genome assembly. Ongoing and future work will annotate this assembly using gene expression data for *Pgt* and identify variation between haplotypes.

### **3. What were the major achievements of the fellowship? (up to three)**

High quality genomic DNA of large size range was generated using procedures developed and shared by the host institution (Figueroa lab). Long read sequencing was performed yielding 180x coverage with average read length of >10kbp. A complete genome reference was assembled from the obtained long read sequence data and analysis indicated that both haplotypes represented and orthologous regions can be identified.

As part of this fellowship, I also held talks with Prof. Pardey and Dr Silverstein of the UMN-based International Agroinformatics Alliance (IAA), the Australian Grains Research and Development Corporation and Prof Figueroa (UMN) and mapped out a collaborative project to compare Australian and US populations of oat crown rust. This will strengthen formal ties between Australian institutes and the IAA.

A draft manuscript describing long-read assembly and haplotype phasing of the oat crown rust genome was completed. The manuscript was deposited as a pre-print on the BioRxiv server and has now been accepted for publication.

### **4. Will there be any follow-up work?**

- Is a publication envisaged? Will this be in a journal or a publication? When will it appear?

Yes. The research conducted in this fellowship will be published as part of a journal manuscript describing genome structure variation of Australian *Pgt* isolates. This is expected to be completed in 2018. A manuscript describing our work on oat crown rust genome assembly has been accepted for publication and will appear in print in early 2018.

- Is your fellowship likely to be the start of collaboration between your home institution and your host?

Yes. This fellowship has strengthened ties between my group at CSIRO and UMN researchers working on cereal rusts. More formal connections through the International Agriinformatics Alliance are being developed around joint projects that will support future collaborative research efforts.

- Is your research likely to result in protected intellectual property, novel products or processes?

Yes. It is expected that the foundational knowledge generated as part of this fellowship and in future collaborative work could result in the development of more effective DNA-based diagnostic tools for wheat stem rust virulence, which will enable more effective and informed deployment of resistant cultivars. No intellectual property protection is envisaged as the research outcomes will be made available as a public good.

**5. How might the results of your research project be important for helping develop regional, national or international agro-food, fisheries or forestry policies and, or practices, or be beneficial for society?**

Please express this in terms of environmental/food security/food safety/economic/health (human and livestock and plant) benefits, etc.

The research outputs have the potential to contribute to long-term improvement and sustainability of the production of small grains, particularly wheat and barley. The knowledge derived from this fellowship may influence the design of crop protection programs for wheat across the world. Considering the globalization of agriculture, it is important to approach problems at the international level. This research will contribute to the development of environmentally-safe management strategies that rely on the use of genetic resistance to reduce or eliminate rust epidemics. Alternative practices to prevent and control stem rust involve multiple rounds of fungicide treatments, which come with environmental and economic costs, as well as problems with their efficacy and risks to human health. Wheat stem rust is a globally significant disease that can spread at continental and intercontinental scales. Thus efforts to combat this disease require international cooperation and the *Pgt* genomic resources generated here will be of global relevance.

**6. How was this research relevant to:**

- The objects of the CRP?

This fellowship strengthened scientific knowledge in the field of agriculture and rust pathology. The research plan is motivated by the limited effective and durable means to control *Puccinia graminis f. sp. tritici*, a rust pathogen that significantly hampers the production of wheat across the globe. Thus, this project has a potential to impact global food production.

- The CRP research theme?

This fellowship addresses CRP Theme II: Managing risks in a connected world. Wheat provides one fifth of the calories and protein intake for human consumption across the globe and the recent emergence of new *Pgt* strains, such as Ug99 in Africa, their rapid evolution towards increased virulence and potential for long range spread poses a menace to grain production worldwide. Developing enhanced genomic resources for *Pgt* will enable the identification of virulence gene and allow improvement of DNA-based diagnostic tools to accurately predict pathogen virulence. This will lead to improved deployment strategies that enhance the durability of resistance deployed in new wheat cultivars and reduce the impact of stem rust disease.

## 7. Satisfaction

- Did your fellowship conform to your expectations?  
Yes.

- Will the OECD Co-operative Research Programme fellowship increase directly or indirectly your career opportunities? Please specify.

I have developed new knowledge of advanced genome assembly approaches in this project which will be shared with my group in Australia to advance our research capacity. Ongoing collaborations with UMN forged in this project will also enhance the impact of my future research.

- Did you encounter any practical problems?  
No

- Please suggest any improvements in the Fellowship Programme.  
None suggested.

## 8. Advertising the Co-operative Research Programme

- How did you learn about the Co-operative Research Programme?  
I previously hosted an OECD CRP fellow.

- What would you suggest to make it more “visible”?  
Perhaps more extensive advertising and communication directly with research offices of Universities and other research organisations.

- Are there any issues you would like to record?  
No