JAMES RENNIE BEQUEST

REPORT ON EXPEDITION/PROJECT/CONFERENCE

Expedition/Project/Conference Title: The effect of long-term balancing selection on estimates on divergence between sequences of a gene in two species

Travel Dates: 8 June – 24 July, 2009

Location: University of Toronto, Canada

Group Member(s): Arvid Ågren

Aims: The aim of this project was to study how long-term balancing selection affects estimates of divergence between sequences of a gene in two species. If there has been long-term balancing selection, the selected sites (and very closely linked ones) will have high diversity, so if one chooses one sequence from such a population (as is usual when estimating divergence between sequences of a gene in two species), it could show high divergence in the DNA sequence from the corresponding sequence from a related species. This project examined how strong this effect is for genes under long-term balancing selection.

OUTCOME

The financial support from the James Rennie Bequest was used to fund the travel to a seven-week long stay at Dr Stephen Wright's lab at the University of Toronto, Canada. The Wright lab is dedicated to investigate the effect of sexual systems on the efficiency of natural selection within natural plant populations.

I became involved in a project investigating the effect of long-term balancing selection, caused by intragenomic conflict, on estimates of divergence between sequences of a gene in two species. Due to differences in modes of inheritance, conflicts of interest can repeatedly arise between the nuclear and mitochondrial genome. The nuclear genome is biparentally inherited, whereas the mitochondrial genome is maternally inherited. Therefore, mutations in the mitochondrial genome that enhance female fertility, even at a net cost to an individual's survival and total reproduction, will spread via natural selection since they enhance cytoplasmic transmission. This cyto-nuclear conflict is well documented in gynodioecious (hermaphrodites and females co-exist) species. Here, sex is determined by the interaction between cytoplasmic determinants of male sterility (CMS-genes) located in the mitochondrial genome and nuclear genes: the male-sterility genes prevent successful pollen production, which will lead to the spread of females in the population. However, CMS-genes can be suppressed by nuclear-encoded restorer alleles, which are favoured by natural selection as pollen becomes limited in populations with high frequencies of CMS-genes. This interaction will lead to balancing selection acting on both CMS-genes and nuclear restorer genes.

To test this we compared the divergence of *Silene* species with varying breeding systems (5 hermaphroditic, 3 gynodioecious, 3 dioecious). This was done by aligning previously published mitochondrial and nuclear sequences and using a computer software package to analyse diversity and polymorphism characters of the sequences.

This project is part of a larger study that will be continued during autumn. This will take place together with Professor Deborah Charlesworth at Edinburgh. Preliminary results, however, confirm some of our predictions about the correlation between breeding system and diversity.

Visiting Dr Wright's lab was of direct benefit for my future studies as well as my ambitions for a career in science. Despite the contributions to modern biological research, computational modelling and programming is still neglected to a large extent in undergraduate biology teaching. The project provided me with an excellent opportunity to gain a foundation in that area. In addition, as a student in any field, it is always vital to let your ideas and assumptions be challenged by the views of others. Spending time in the young and international environment that the Wright lab provided certainly widened my horizons, on an academic, as well as a personal level.

One of my main fascinations is the evolution of sex and breeding systems. The plant kingdom is characterised by the uniquely common presence of hermaphrodite individuals, making sexual reproduction more complex than in any other life form. Here, I was allowed to study the effect of breeding systems sequence evolution. This allowed me to, once again, appreciate the power and exceptionality of plants as a system for study of major evolutionary questions. This realisation has strengthened my ambition to become a plant evolutionary geneticist.

During my time in the Wright lab I participated fully in the day-to-day activities of the lab. This included everything from lab-meetings and journal clubs to cake eating when someone gets a paper published. Science is pursuit with two faces. One with fulfilling biological discussion and exciting progress; the other with tedious labour work and a world where Murphy's Law constantly applies. Spending time in the Wright lab has allowed me to experience both and both realisations have been important to me.

Finally, I would like to take the opportunity to thank the James Rennie Bequest for providing me with the financial support that made this experience possible.