A single domestication for cultivated potato

G.J. Bryan, K. McLean, R. Waugh, D. Spooner[a] & G. Ramsay

The potato has been grown as a native food crop in South America for over 7000 years. First introduced to the UK as a curiosity in the late 16th century, the potato rose to its current position as a staple food following its adaptation to local conditions in the late 17th century. The precise origins of the humble potato, intimately linked with the pre-Inca civilisations of the central Andes, have always been enigmatic. We have recently been engaged in some work that has shed significant light on the evolutionary origins of the cultivated potato. Potato is part of the plant genus *Solanum*, an extremely diverse group of flowering plants containing over 1500 species. Over 200 tuber-bearing potato species have been described, including the common cultivated tetraploid potato, *Solanum tuberosum* ssp. *tuberosum*, and a small number of other primitive cultivated species. These other types include the tetraploid *S. tuberosum* ssp. *andigena*, the primitive form of the European potato, as well as *S. phureja*, a diploid species which is now being used in UK breeding programmes, as typified by the varieties Mayan Gold and Inca Sun.

Our study is based on the use of 450 Amplified Fragment Length Polymorphism (AFLP) markers on a large collection of potato germplasm known as the Commonwealth Potato Collection (CPC), which is maintained at SCRI. In 2001 we embarked on a groundbreaking study to obtain the genetic fingerprints of all 1500 'accessions' in the CPC, as part of a project to elucidate the evolutionary relationships of potato species, and perhaps more importantly, to allow us to make better future use of the CPC in potato breeding. AFLP markers were chosen because of their high level of reliability and their high multiplex ratio, whereby a single primer combination can yield 50-100 scoreable markers. AFLPs represent an extremely efficient method for generating DNA-based marker fingerprints for plants representing genebank accessions. Moreover, AFLPs have been shown to be suitable for the phylogenetic analysis of diverse potato germplasm[1]. The AFLP marker data set we have generated is one of the largest ever generated for a plant germplasm collection and presents significant oppor-

[a] US Department of Agriculture, Agricultural Research Service, Vegetable Crops Research Unit, Department of Horticulture, University of Wisconsin, Madison, WI53706-1590, USA

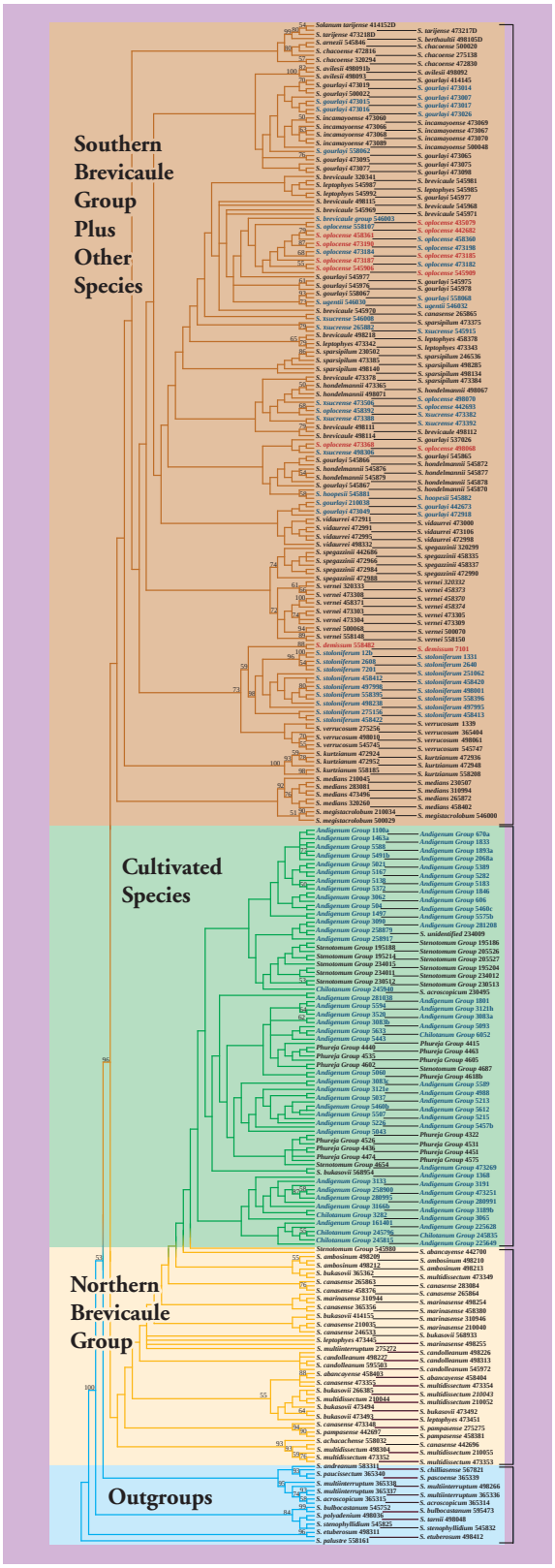

Figure 1 A simplified phylogenetic tree containing 264 wild (including 3 outgroup accessions) and 98 cultivated accessions of potato.

tunities for the improvement of knowledge concerning the taxonomy of the over 150 wild and cultivated potato species included in the study. To facilitate analysis the data set has been partitioned into smaller data sets designed to examine particular questions. One of these relates to the evolutionary history of the various species of cultivated potato, the most well-known of which is the common potato *S. tuberosum* ssp. *tuberosum*. The potato has been cultivated for thousands of years, but there has been a great deal of scientific debate about its origins. Our study was designed to assess whether the domestic potato arose from a single wild progenitor or whether it arose multiple times from species distributed across the whole length of Southern America. Most evolutionary hypotheses have centred around a group of about 20 morphologically very similar tuber-bearing wild species, referred to as the *S. brevicaule* complex, distributed from central Peru to northern Argentina. In order to address this question we have performed a phylogenetic analysis of an AFLP marker data set from 264 wild and 98 cultivated potato accessions. The phylogenetic tree, reprinted in simplified form from a recent publication[2], resulting from this analysis is shown in Fig. 1. This tree is concordant with previous trees based on use of morphological and other types of marker data in suggesting a clear 'northern' and 'southern' split for the members of the *S. brevicaule* complex. These data are also suggestive of the need for a reduction in the number of species in the complex. The most significant result from this analysis is the observation that, in contrast to many prior hypotheses of multiple geographically-diverse origins of the cultivated potato, a single origin from a broad area of southern Peru has been identified. The 'multiple-origins' theory was based in part on the broad distribution of potatoes from north to south across many different habitats, through morphological resemblance of different wild species to cultivated species, and through other types of data. Our data are unequivocal in suggesting a single domestication from the 'Northern' component of the *S. brevicaule* complex.

References

[1] Kardolus, J.P., Herman, J.V.E., Van Den Berg, R.G. (1998). *Plant Systematics and Evolution* **210,** 87-103.

[2] Spooner, D.M., McLean, K., Ramsay, G., Waugh, R. & Bryan, G.J. (2005). *Proceedings of the National Academy of Sciences of the United States of America* **102,** 14694-14699.