Foundational Research Tools for Floriculture Genetics and Biotechnology

PRINCIPAL INVESTIGATOR:
Dr. David G. Clark, University of Florida Environmental Horticulture Department.

PROJECT OBJECTIVES:

1. Produce a standard petunia microarray for use in screening for genes involved in flower related processes.
2. Isolate and characterize flower specific genes with potential commercial or scientific value in ornamental plants.
3. Isolate flower-specific and ethylene regulated promoter elements and determine their regulatory DNA sequences.
4. Foster new collaborations by making all resources widely available. Utilize new collaborations and technology advancements to provide new resources for researchers and plant breeders.

ACCOMPLISHMENTS (by objective):

1. After making successful microarrays in-house in 2003-2006, we worked closely with Dr. Michelle Jones at Ohio State University to produce a standard microarray to be utilized by the broader scientific community. With additional funding provided by the Kiplinger Chair, a 70-mer oligonucleotide-based glass microarray containing over 4,600 genes expressed in petunia flowers was produced in 2006-2007 and made available to any scientist wanting to utilize it in their experiments at cost. Both labs have utilized this microarray in several experiments focused on finding genes encoding transcription factors involved in controlling floral fragrance biosynthetic pathway genes, and also for finding genes involved in floral senescence. Arrays have also been distributed to other labs for other purposes as well.

2. Over the past 3 years our lab has isolated and characterized the biological function of eight genes involved in the biosynthesis of fragrance from petunia. In addition to these genes, we have isolated six additional genes that encode transcription factor proteins which regulate key processes in floral fragrance production and floral development.

3. Previous work to identify genes expressed exclusively in flowering tissues has led to the cloning of upstream promoter elements for several flower specific genes. These DNA elements can be utilized for experiments targeted on the focused expression of genes in flowering tissues.

4. All resources produced as a result of this work have been made widely available to the scientific community through publicly accessible databases. This has allowed us to make several successful collaborations that have led to joint publication of manuscripts and subsequent pooling of resources from a larger set of laboratories to develop new technologies for advancing the goals of scientists and plant breeders. Most recently, we have been working with several research groups around the world to produce a complete set of DNA sequences from genes expressed in all tissues of the progenitor species of modern-day

Petunia x hybrida – the model system of choice for the study of genetics and molecular biology of ornamental plants.

TECHNOLOGY TRANSFER/IMPACT:
In the past 3 years, we sent data or technical support items to a wide variety of researchers around the world to assist them with making progress in their research. During this period, we directly provided critical data, DNA samples, seeds, and laboratory protocols related to petunia genetics and molecular biology to approximately 30 labs around the world – countless other laboratories accessed the data and utilized it independently. This has resulted in over 10 individual or joint refereed and trade publications with new collaborators and several others (we estimate over 20 manuscripts) from labs working independently with the data. Most importantly, the resources produced from this project have been made publicly available and have now reached a point where they can be easily utilized by industry breeders to develop DNA markers to assist them in breeding for virtually any trait of interest in any plant species.

ADDITIONAL FUNDING/EXTERNAL SUPPORT:
During the last 3 years, we have been fortunate to attract additional extramural funding for this work from the Fred Gloeckner Foundation, Inc. and the American Floral Endowment. We have been able to garner internal support from the Florida Agricultural Experiment Station for new collaborative projects that resulted from this project. Beyond that, we have received additional funding support and personnel support from direct collaborators in our efforts to make cDNA microarrays (Jones – Ohio State University) and our recent efforts to sequence the transcriptomes of Petunia x hybrida progenitor species (Gerats – Netherlands; Pezzotti – Italy). Further efforts to obtain additional DNA sequence data are currently being discussed. We have also submitted a USDA specialty crops research initiative grant proposal to obtain additional support this work, which is pending (Warner & Barry – Michigan State University).

COLLABORATORS:
The following collaborators have directly contributed to or benefitted from the advancement of the goals of this project: Dr. Michelle Jones – Ohio State University – floral and leaf senescence (all genes); Dr. Harry Klee – University of Florida – plant volatiles; Dr. Jim Giovannoni – USDA/Cornell – plant volatiles; Dr. Cornelius Barry – Michigan State University – fruit ripening (Tomato); Dr. Ryan Warner – Michigan State University – abiotic stress tolerance; Dr. Michael Reid – University of California-Davis – floral senescence; gene function analysis; Dr. Tony Stead – University of London (U.K.) – floral and leaf senescence; Dr. Eran Pichersky – University of Michigan – floral scent; Dr. Natalia Dudareva – Purdue University – floral scent; Dr. Jeff Kuehny – Louisiana State University – drought stress tolerance; Dr. Cris Kuhlemeier – University of Bern (Switzerland) – floral scent/insect interactions; Dr. Mario Pezzotti – University of Verona (Italy) – cell expansion; Dr. Ronald Koes – Free University (Amsterdam) – cellular pH, flower color; Dr. Tom Gerats – University of Nijmegen (Netherlands) – floral development; Dr. Marcos Egea – University of Valencia (Spain) – flower size; Dr. Dider Reinhardt – University of Fribourg (Switzerland) – mychorrizae; Dr. Tim Robbins – University of Nottingham (U.K.) – pollen self-incompatibility; Dr. Gerco Angenent – Wageningen (Netherlands) – floral development; Dr. Michel Haring – University of Amsterdam (Netherlands) – floral scent/insect interactions; Dr. Robert Schuurink – University of Amsterdam (Netherlands) – floral scent/insect interactions; and Dr. Hsiang Chang – Taiwan National University (Taiwan) – genetic engineering of dwarfism.