nature genetics
volume 20 no. 4 december 1998

Sharecroppers or shareholders?


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Ten years ago, a small group of *Arabidopsis thaliana* researchers met to set objectives for the future of the higher plant model system. "We were just trying to build critical mass", says Joseph Ecker of the University of Pennsylvania. Recently, Ecker and others sat down once again, with plant scientists working in other systems and disciplines, to discuss the next decade of *Arabidopsis* and plant research. The major goals were to determine the future of *Arabidopsis* research and to integrate the significant advances in plant genomics—using *Arabidopsis* as a model—into other plant systems.

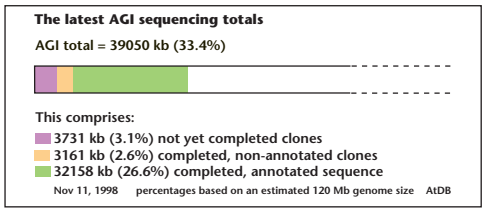
This meeting comes shortly after the largest plant genomics funding initiative to date in the United States, approximately $US 90 million, administered by the National Science Foundation (US), a longtime supporter of *Arabidopsis* research. Most of the money is earmarked for research on crop plants, until now largely underwritten by commercial interests such as Dupont, Novartis and Monsanto. *Arabidopsis* research will also benefit significantly; an explicit objective of the funding initiative is to build infrastructure for genomics research—such as the Center for Comparative Genomics in Model and Crop Plants at Cold Spring Harbor Laboratories—allowing academic researchers access to advanced and expensive technologies.

The accelerating construction of academic infrastructure parallels similar developments in industry, where a wave of startup companies, such as Mendel Biotechnology and Paradigm Genetics, exploiting high-throughput sequencing and other technologies has helped shift *Arabidopsis* genomics into high gear. "Mendel's goal is to discover the functions of many of the genes that have been sequenced," says Chris Somerville, of the Carnegie Institute at Stanford University, an *Arabidopsis* researcher and co-founder of Mendel. Somerville feels the new companies fill an essential niche, carrying out high-throughput *Arabidopsis* genomics difficult to perform in a university environment, but doing so more efficiently than big companies. Nevertheless, agricultural giants have not ignored the newcomers; last year Monsanto and Mexican conglomerate ELM purchased 15% stakes in Mendel, as well as rights to develop and commercialize Mendel's technical capabilities.

The success of the *Arabidopsis* genome project has been admirable, despite (or perhaps spurred on by) low fanfare and funding. Original estimates projected completion of *Arabidopsis* genome sequencing by the year 2004; Michael Bevan, of the John Innes Centre and coordinator of the European Union *Arabidopsis* Genome Project, now predicts sequencing will be finished by the year 2000. This success is due largely to the well-organized and nearly frictionless collaborative relationship among *Arabidopsis* researchers. Cooperation was established early, with the launching in 1990 of the Multinational Coordinated *Arabidopsis thaliana*

Plant genomics information resources

- Arabidopsis Information Management System (http://aims.cps.msu.edu/aims/)
- Arabidopsis Database (http://genome-www.stanford.edu/Arabidopsis/)
- Arabidopsis newsgroup (bionet.genome.arabidopsis)
- Cold Spring Harbor Genome Sequencing and Analysis (http://sciclio.cshl.org/genseq/)
- DeKalb Genetics (http://www.dekalb.com/)
- Dupont (http://www.dupont.com/ag/)
- Mendel Biotechnology (http://www.mendelbio.com/)
- Monsanto (http://www.monsanto.com/Arabidopsis/)
- National Science Foundation (http://www.nsf.gov)
- Novartis (http://www.cp.novartis.com/)
- Paradigm Genetics (http://www.paradigmgenetics.com/)
- Pioneer Hi-bred International (http://www.pioneer.com/)
- TIGR Arabidopsis Database (http://www.tigr.org/tdb/agi/index.html)



Arabidopsis Genome Initiative, AtDB

Genome Research Project. Centralized databases for information and stock distribution (AtDB and AIMS), stock centres in the US and United Kingdom and an online discussion group have also fostered development of the *Arabidopsis* community. These efforts have been subsidized in large part by a consortium of US and European funding agencies and universities at levels which have slowly, yet steadily, increased throughout the last decade.

Arabidopsis researchers have been quick to take advantage of new trends in genomics research. *Arabidopsis* EST sequencing projects in the US and Europe commenced in the early 1990s, and EST sequences were quickly made available online. *Arabidopsis* ESTs are now being placed on microarrays for use in measurements of differential expression by Monsanto (in collaboration with Synteni) as well as by investigators funded by the recent NSF award. Other technological advances have also fueled *Arabidopsis* genomics, such as the improvement of *Agrobacterium*-mediated transformation, allowing rapid creation of insertionally mutagenized lines.

With critical mass achieved and completion of genome sequencing imminent, *Arabidopsis* genomics is soon to arrive at a crossroads. Key issues in the near future will be ensuring that information from the model system benefits the genomics efforts of commercially important species, and how the increasingly intimate interaction between industry and academia will evolve. When sequencing is finished, what many expect will be the most time- and money-consuming task will enter full swing—the functional characterization of every gene in the genome.

The area of functional characterization is where conflicts may arise. As academic researchers seek to utilize the genomics infrastructure to understand basic functions and industry pushes its agenda of identifying more commercially useful (and patentable) processes, overlap in their interests may devolve into struggles over property rights. Nevertheless, the distinction between the two camps is blurring as academics colonize new genomics institutes and startups, becoming shareholders in the process. Many scientists view the blossoming academic–industry genomics interface as a tremendous resource for all, with enormous amounts of data entering the public domain as a result of industrial scale efforts and genomics companies targeting only small portions as proprietary. “Mendel’s only secrets are its favorite categories of genes,” says Somerville. Others foresee less benefit, with companies using their greater resources to obtain exclusive rights to intellectual property and limiting accessibility of data, ultimately creating a privileged class of researchers ‘in bed’ with companies and another lacking access to proprietary resources. Perhaps instructive in this regard are the experiences of academic investigators with insertionally mutagenized collections of crop plants maintained by seed companies such as DeKalb Genetics and Pioneer Hi-Bred International, where researchers have been allowed to screen populations in exchange for the intellectual property rights to discoveries. Although these collaborations have often been productive, others have resulted in conflict over publication and limitations on researchers’ ability to determine the direction of future work.

With clear potential for infighting between academic and industry factions in plant genomics, it is essential to recognize and minimize potential problems before they fester. By providing money to supply academia with plant genomics technology, the NSF has taken one step of many which will be required to extract maximal value from plant genomics data. Equally important will be maintaining the sense of community and spirit of collaboration which have served *Arabidopsis* research and plant genomics during the last decade, continuing what has been, to date, a remarkably productive exercise.