

FIRST TREE GENOME PUBLISHED: CRACKING POPLAR DNA CODE PROMISES NEW POSSIBILITIES FOR SUSTAINABLE ENERGY¹

VIB, Flanders Interuniversity Institute of Biotechnology

Sustainable or renewable energy -- in the form of bio-ethanol, for example -- can be produced for us by trees. The influence trees have on our daily life is enormous. Forests cover 30% of the world's land area, accommodate two thirds of life on earth, and are responsible for 90% of the biomass on solid ground. Now, an international consortium, which includes researchers from the Flanders Interuniversity Institute for Biotechnology (VIB) at Ghent University, has succeeded in unraveling the first tree genome -- that of the poplar. Moreover, their research indicates that the poplar has about 45,000 genes. This knowledge is a first step toward being able to make trees grow faster or make them easier to process into paper or energy. The research results are being published this week in the authoritative journal *Science*.

Trees Are Jacks-of-All-Trades

It's difficult to overestimate the importance of trees as providers of clean air as well as raw material for bio-energy, paper, furniture and other useful objects. A lot of the properties that trees possess are not found in other plants, like their abilities to produce large quantities of wood, to synchronize their growth with the seasons, and to adapt to changing environmental conditions. They need these properties because they must be able to survive for many years in the same place. Poplars cover more than 75 million hectares worldwide, nearly 7 million of which are cultivated for timber production on the one hand (about 4 million hectares) and for environmental purposes on the other hand (about 3 million hectares).

It's in the Genes...

Because the size of its genome is relatively limited, the poplar serves as a model organism for trees. *Populus trichocarpa* (or black cottonwood, the largest American poplar) has 'only' 485 million base pairs -- the DNA building blocks -- which is about 50 times fewer than a pine tree. By the same token, the poplar has four times as many DNA as *Arabidopsis*, a small model plant whose genome was cracked six years ago. In May 2002, the international consortium began the project to determine the poplar's genome. To do this, they used a female poplar from the banks of the Nisqually River in the state of Washington (USA). Since then, the researchers have determined the 485 million base pairs on the 19 poplar chromosomes and have identified more than 45,000 possible genes. Scientists led by Yves Van de Peer have compared the genes of the poplar with those of *Arabidopsis* by using sophisticated computer programs. They've been able to show that for about 10% of the poplar genes there are no homologue genes in *Arabidopsis*. This is a first step toward determining the genetic difference between a tree (poplar) and an herb (*Arabidopsis*).

¹ VIB, Flanders Interuniversity Institute of Biotechnology (2006, September 15). First Tree Genome Published: Cracking Poplar DNA Code Promises New Possibilities For Sustainable Energy. *Science Daily*. <http://www.sciencedaily.com/releases/2006/09/060914182431.htm>

The Pace of Evolution

By comparing the genomes of various plants, bioinformaticians are discovering new things about the evolution of the poplar. Scientists know that the lines of descent of the poplar and *Arabidopsis* began to evolve in different directions some 100 to 120 million years ago. The researchers have determined that a doubling of a large part of the poplar's genes has occurred twice in history. One of these duplications happened at about the time the *Arabidopsis* line of descent went its separate way; the second duplication was much more recent. From the comparison of the genomes of the poplar and *Arabidopsis*, it is also clear that the DNA of *Arabidopsis* has evolved further than that of the poplar. Thus, evolution takes place at a different tempo in different plants.

A Variety of Applications

With the new data, molecular biologists, like Wout Boerjan and his research team, can set to work to discover the activities the genes are responsible for. This fundamental research can provide a wealth of information about how trees function, and it can also provide answers to general biology questions. In fact, a lot of the reactions and functions in plants -- and thus in trees -- are also found in humans and animals. Furthermore, this research can be applied very concretely -- to optimize bio-ethanol production, for example. Wood consists largely of cellulose and hemicellulose, the raw materials for bio-ethanol. However, these materials are locked up in the lignified cell wall and are therefore difficult to access for conversion to bio-ethanol. Wout Boerjan and his team are investigating which genes are important for wood formation and how they might genetically modify the formation of the cell wall to make cellulose and hemicellulose more accessible.

Knowledge of the poplar genome is also important in fields like ecology. In-depth genetic knowledge enables researchers to modify trees genetically to the benefit of people and the environment. The genome sequence can contribute to strategies for improving trees more quickly or for modifying them genetically. Trees are the lungs of the earth -- but they can be modified, for example, so that they fix CO₂ -- the major greenhouse gas -- more efficiently. New tree varieties can also be made so that, for example, their wood is better suited for paper production.