ScienceDaily
Your source for the latest research news

Web address:
http://www.sciencedaily.com/releases/2012/08/120806151242.htm

Researchers Peek at the Early Evolution of Sex Chromosomes

ScienceDaily (Aug. 6, 2012) — Two new studies offer insight into sex chromosome evolution by focusing on papaya, a multimillion dollar crop plant with a sexual problem (as far as growers are concerned) and a complicated past. The findings are described in two papers in the *Proceedings of the National Academy of Sciences.*

Researchers analyzed the sex chromosomes of papaya, which can produce male, female and/or hermaphrodite flowers. (Credit: L. Brian Stauffer and Rishi Aryal)

The research reveals that the papaya sex chromosomes have undergone dramatic changes in their short evolutionary histories (they are about 7 million years old; by comparison, human sex chromosomes began their evolution more than 167 million years ago). One of the two studies compares the papaya X chromosome with that of a closely related non-sex chromosome (called an autosome) in a sister species. The other looks at differences between the X and Y chromosomes.

The studies show that the papaya sex chromosomes are increasing in size -- mostly through the accumulation of repetitive sequences -- while also reorganizing themselves and losing some genes carried over from their days as autosomes. Some of the lost genes are gone without a trace, while other remnants of genes that are no longer functional -- called "pseudogenes" -- are still present. (The pseudogenes give researchers an opportunity to see evolution in action; they are evidence that the chromosomes are in the process of losing them.)

The papaya Y chromosome also has independently gained some genes from the autosomes, the researchers report.

Gene loss in the Y chromosome is well documented in ancient Y chromosomes, but gene loss in the X chromosome, particularly at this early stage, is unexpected, as is the expansion of the X chromosome, said University of Illinois plant biology professor Ray Ming, who led both studies.

"The pace of gaining repetitive sequences and losing genes is faster in the Y than in the X chromosome, however," he said.

"This is the first look at an early stage of sex chromosome evolution," said Andrea Gschwend, who conducted the research with Ming while she was a doctoral student in his lab. "Usually people will focus on the ancient sex chromosomes because they are the most relevant to us," she said. "So this is the first direct and complete look at a more recently evolved sex chromosome system."

Analyzing the X chromosome is vital to understanding the evolution of sex, said Ming, an affiliate of the Institute for Genomic Biology at Illinois. The new findings in papaya suggest that the human X chromosome, too, has undergone numerous changes since it first distinguished itself from the autosomes, Ming said. Such changes are not detectable because the ancestral autosomes are no longer available for comparison, he said.

Because the papaya sex chromosomes are young and can be compared to closely related autosomes in a sister species, they offer a view of the early events of both X and Y chromosome evolution, Ming said.

Studying papaya sex chromosomes is a complicated task, however. The papaya has male, female and hermaphrodite sexual types, with two kinds of Y chromosomes (the male Y and the slightly modified, hermaphrodite Yh). Papaya plants may produce combinations of male and female (from the XY system) or hermaphrodite and female (from the XYh system) plants.

This complexity causes problems for papaya growers, Ming said. Hermaphrodites are the most productive of the papaya sexual types and yield the best fruit, but the offspring of hermaphrodites are not all hermaphrodites. To aid growers, Ming and his colleagues aim to develop a "true-breeding" hermaphrodite papaya variety that consistently produces hermaphrodite offspring.

When the researchers compared the X chromosome and the hermaphrodite Yh chromosome, they found that two major sequence inversions in the sex-determining regions of the Yh had taken place. One of these inversions occurred about 7 million years ago, and led the sex chromosomes and the autosomes down very different evolutionary paths, Ming said. The second inversion occurred about 1.9 million years ago and led to further differentiation between them. Each inversion has also undergone numerous sequence rearrangements.

All of the findings are significant and useful, Ming said, but the X chromosome, which is generally overlooked in models of sex chromosome evolution, offered the most surprises.

"These studies are changing our view of sex chromosome evolution, particularly X chromosome evolution," he said. "We now know that both the X and Y chromosomes are dynamic in the early stages of their evolution, not only the Y chromosome, as previously thought."

The study team also included researchers from the Hawaii Agriculture Research Center; Texas A&M University; the University of Hawaii, Honolulu; the University of Wisconsin, Madison; the University of Edinburgh; the University of Georgia; and Youngstown State University, Ohio.

Story Source:

The above story is reprinted from materials provided by **University of Illinois at Urbana-Champaign**.

Note: Materials may be edited for content and length. For further information, please contact the source cited above.

Journal References:

1. Jianping Wang, Jong-Kuk Na, Qingyi Yu, Andrea R. Gschwend, Jennifer Han, Fanchang Zeng, Rishi Aryal, Robert VanBuren, Jan E. Murray, Wenli Zhang, Rafael Navajas-Pérez, F. Alex Feltus, Cornelia Lemke, Eric J. Tong, Cuixia Chen, Ching Man Wai, Ratnesh Singh, Ming-Li Wang, Xiang Jia Min, Maqsudul Alam, Deborah Charlesworth, Paul H. Moore, Jiming Jiang, Andrew H. Paterson, and Ray Ming. **Sequencing papaya X and Yh chromosomes reveals molecular basis of incipient sex chromosome evolution**. *PNAS*, August 6, 2012 DOI: 10.1073/pnas.1121096109
2. Jianping Wang, Jong-Kuk Na, Qingyi Yu, Andrea R. Gschwend, Jennifer Han, Fanchang Zeng, Rishi Aryal, Robert VanBuren, Jan E. Murray, Wenli Zhang, Rafael Navajas-Pérez, F. Alex Feltus, Cornelia Lemke, Eric J. Tong, Cuixia Chen, Ching Man Wai, Ratnesh Singh, Ming-Li Wang, Xiang Jia Min, Maqsudul Alam, Deborah Charlesworth, Paul H. Moore, Jiming Jiang, Andrew H. Paterson, and Ray Ming. **Sequencing papaya X and Yh chromosomes reveals molecular basis of incipient sex chromosome evolution**. *PNAS*, August 6, 2012 DOI: 10.1073/pnas.1207833109

Need to cite this story in your essay, paper, or report? Use one of the following formats:

- APA
- MLA

University of Illinois at Urbana-Champaign (2012, August 6). Researchers peek at the early evolution of sex chromosomes. *ScienceDaily*. Retrieved October 29, 2012, from http://www.sciencedaily.com/releases/2012/08/120806151242.htm

Note: If no author is given, the source is cited instead.