The evolution of sex chromosomes in brown algae

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Video Abstract

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Abstract

A recent study provides a first glimpse into the evolution of the unusual sex-determination system in brown algae. Sex chromosomes – the tightly wound bundles of DNA responsible, in many species, for determining the sex of an organism – have arisen independently many times across the tree of life. While the molecular and evolutionary dynamics of these genomic regions are well understood in some organisms, very little is known about sex chromosomes in other groups such as brown algae. The brown algae are a large group of mostly marine multicellular organisms, and include many seaweeds. They are distantly related to plants and animals – separated by over a billion years of evolutionary time. The mode of sex determination can be quite different between groups of organisms. In humans for example, males possess both an X and a Y chromosome. Females: two X's. In most brown algae, sex is determined during part of the life-cycle in which there is only one copy of each chromosome. The female sex is determined by a female-specific region in the 'U' chromosome. Males, on the other hand, are determined by a male-specific region in the 'V' chromosome. A team of researchers in France set out to better understand this UV system of sex determination. Examining DNA sequences of seven brown algal species, the team found that, while very few genes currently reside in the sex-specific regions, the evolution of the U and V chromosomes is a complicated and dynamic process involving gene duplication, engulfing nearby genes, relocating genes, and losing genes entirely. Important gene movements were found to occur into and out of both the male and female chromosomes. By creating detailed genetic maps and comparing gene content across different species, the researchers found that in this particular group of brown algae, sex chromosomes arose over 100 million years ago, making this among the oldest sex-determining systems ever described. Interestingly, despite extensive evolutionary distance, the same type of gene involved in gender determination in fungi and animals was also found in the V chromosomes of brown algae. This study provides the first insights into the complex UV sexual system. Mapping the sex-determining region of chromosomes and understanding the mechanisms underlying gene movements has broad applications from agriculture to medicine. These results represent an important step toward understanding the evolution of sex determination across the tree of life.