Gene variant data can predict trees vulnerable to climate change

A thorough knowledge on the adaptation potential of trees to fluctuating climatic conditions is a prerequisite in conservation programs. In this regard, application of genomic tools is often found to be highly informative. In fact, they have revolutionized the field of understanding genetics, particularly in the long-lived forest tree species. Recently, scientists from Spain have utilized gene variant data of Maritime pine (Pinus pinaster) to identify individuals that are vulnerable to climate change. In a similar fashion, incorporation of genetic data for managing biodiversity of tropical forests could boost the sector in the developing nations.

Maritime pine is a long-lived out-crossing coniferous forest tree occurring widely in southwestern Europe and several parts of northern Africa. Besides the economic importance of the species, it has substantial ecological value in the region where it inhabits both wet-coastal as well as seasonally dry continental forests. Hence the tree populations are expected to harbour a healthy population structure influenced by climatic and demographic factors. Moreover, the characteristics of conifers such as their distribution in recurrently shifting geographical ranges, predictable changes through phylogeographic studies and exhibition of large differences in adaptive phenotypic traits made the Maritime pine as a suitable species for the present investigation.

Researchers working on pine forests rely mostly on computer models to predict the regions that can sustain growth of pine in near future. However, they less consider the genetic and evolutionary effects acting on the species. Trees have evolved for several hundred years and adapted to withstand drier conditions. This leads to isolation of tree populations based on topography and climate and hence they obviously possess distinct genetic characteristics across populations. "These genetic effects are not included in forest range shift models, but we know they can completely change the resulting predictions. Our goal was to identify such effects in a way that can be readily incorporated into the forecasts," said study leader Santiago González-Martínez, from the Forest Research Centre of Spain's Institute for Agricultural Research (CIFOR-INIA).

A Maritime pine forest in the Mediterranean region

To find genetic variants that affect the species' fitness in different climate conditions, maritime pine researchers from around the world pooled their expertise and the results of previous research, yielding a list of more than 300 variants in 200 candidate genes. Creating a shortlist of

targets is considerably faster and more economical than searching the entire genome of the maritime pine, which is about nine times larger than the human genome. From this list, the team tested whether any of the candidates were more common in regions that shared similar climates. Such geographic patterns can be the result of natural selection and point to gene variants that influence tree survival and reproduction according to climate. By testing the frequency of each variant at 36 locations in Portugal, Spain, France, Morocco, and Tunisia, the researchers found 18 variants that showed correlations with the local climate. These variants affected genes involved in many different biological processes, including growth and response to heat stress.

The researchers then looked for evidence that these variants are important for the trees' fitness by planting seedlings from 19 of the locations together in a dry part of Spain, at the extreme end of the species' climatic range. This allowed the team to compare how well genetically different trees would survive under similar conditions. After five years, the seedlings carrying gene variants predicted to be beneficial in the local climate indeed tended to have higher survival rates.

These results demonstrate the feasibility of this relatively fast approach of finding and confirming genetic variants associated with climate. "Now that we have shown that the method works well, we are planning similar experiments on a bigger scale, with more test sites, looking at more genes, and different traits. For example, the single biggest climate change threat to pine forests is the increased frequency of wildfires, so we're searching for variants that affect fire tolerance," said González-Martínez.

Source:

http://www.sciencedaily.com/releases/2015/03/150304104151.htm