Genetic adaptation of Tibetan poplar (Populus szechuanica var. tibetica) to high altitudes on the Qinghai-Tibetan Plateau

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Abstract

Plant adaptation to high altitudes has long been a substantial focus of ecological and evolutionary research. However, the genetic mechanisms underlying such adaptation remain poorly understood. Here, we address this issue by sampling, genotyping, and comparing populations of Tibetan poplar, Populus szechuanica var. tibetica, distributed from low (~2000 m) to high altitudes (~3000 m) of Sejila Mountain on the Qinghai-Tibet Plateau. Population structure analyses allow clear classification of two groups according to their altitudinal distributions. However, in contrast to the genetic variation within each population, differences between the two populations only explain a small portion of the total genetic variation (3.64%). We identified asymmetrical gene flow from high- to low-altitude populations. Integrating with population genomic and landscape genomic manner, we detected a hot spot region containing ten genes under natural selection and associated with five environmental factors. These genes participate in abiotic stress resistance and regulating the reproductive process. Our results provide insight into the genetic mechanisms underlying high-altitude adaptation in Tibetan poplar.

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GO Terms

(a)

Intersection Size

(b)

Regulation of transcription, DNA-templated
Carbohydrate metabolic process
Phosphorelay signal transduction system
Peptidyl-serine phosphorylation
Signal transduction
Metabolic process
Protein phosphorylation
Translation
Transcription, DNA-templated
Intracellular signal transduction
Sequence-specific DNA binding
Protein kinase activity
DNA binding transcription factor activity
Metal ion binding
Zinc ion binding
Structural constituent of ribosome
Protein serine/threonine kinase activity
DNA binding
RNA binding
ATP binding
Nucleosome
Intracellular membrane-bounded organelle
cytosolic large ribosomal subunit
Membrane
cytosol
Plasma membrane
Integral component of membrane
Cyttoplasm
Nucleus

CC
MF
BP

GO Terms

(a) Upset Venn

(b) GO Terms

83
48
31
20
86
15
8
6
2
21
7
8
3
1
59
24
2
1
57
10
9
5
11
1
0
25
50
75
Intersection Size