

ヒマラヤコムギ在来種におけるゲノム多様性および局所適応に関する解析
Genomic Diversity and Local Adaptation Analysis of Himalayan Wheat Landraces

京都大学大学院 農学研究科 Li Yunfei

研究成果概要

1. Introduction

Wheat (*Triticum aestivum* L.) is a fundamental global cereal crop, yet modern elite cultivars face a "genetic bottleneck" due to intensive breeding. This study explores the untapped genetic potential of 202 hexaploid wheat landraces collected from Nepal and Bhutan between 1952 and 1958. These pre-Green Revolution samples serve as a biological time capsule, preserving indigenous diversity and adaptive traits developed over millennia across the steep altitudinal gradients of the Himalayas.

2. Materials and Methods

Plant Materials: Himalayan landraces and global hexaploid wheat core collection accessions for comparative analysis.

Genotyping: DNA was analyzed using Genotyping by Random Amplicon Sequencing-Direct (GRAS-Di).

Computational Analysis: We employed population structure analysis (Admixture), Principal Component Analysis (PCA), and maximum-likelihood phylogenetic reconstruction (IQ-TREE). Gene flow barriers were modeled using Fast Estimation of Effective Migration Surfaces (FEEMS).

Phenotyping: Four agro-morphological traits were recorded: Plant Height (PH), Days to Heading (DTH), Days to Flowering (DTF), and Effective Number of Tillers (ETN).

3. Key Results

Population Stratification: The Himalayan germplasm resolved into six distinct genetic clusters (HA, LA, BT, Mid_1, Mid_2, and Admix). These clusters align closely with geographic and altitudinal origins.

Identification of "Untapped" Diversity: Comparative analysis with the global core collection revealed that the Mid_2 subgroup (concentrated in western/northwestern Nepal) represents a unique genetic reservoir. This diversity is currently absent from global germplasm repositories and the Watkins collection.

Local Adaptation and Gene Flow: FEEMS analysis identified severe genetic segregation between high-altitude (HA) and low-altitude (LA) populations. HA accessions exhibited significantly greater plant height and prolonged flowering times ($p < 0.001$), indicating strong local adaptation to mountain environments.