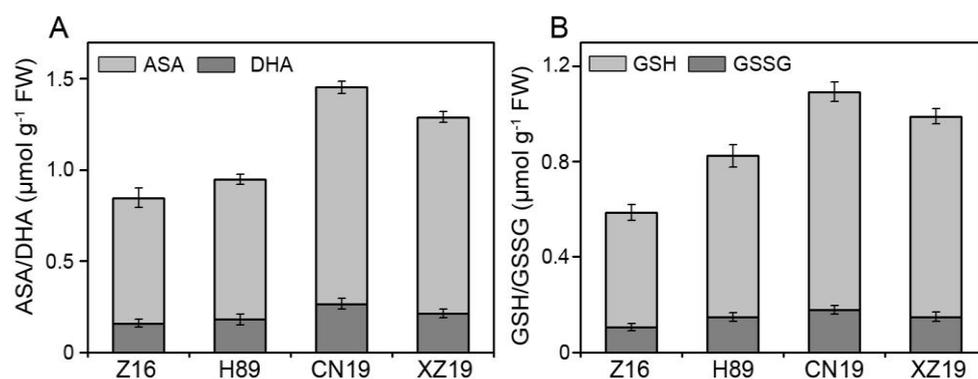
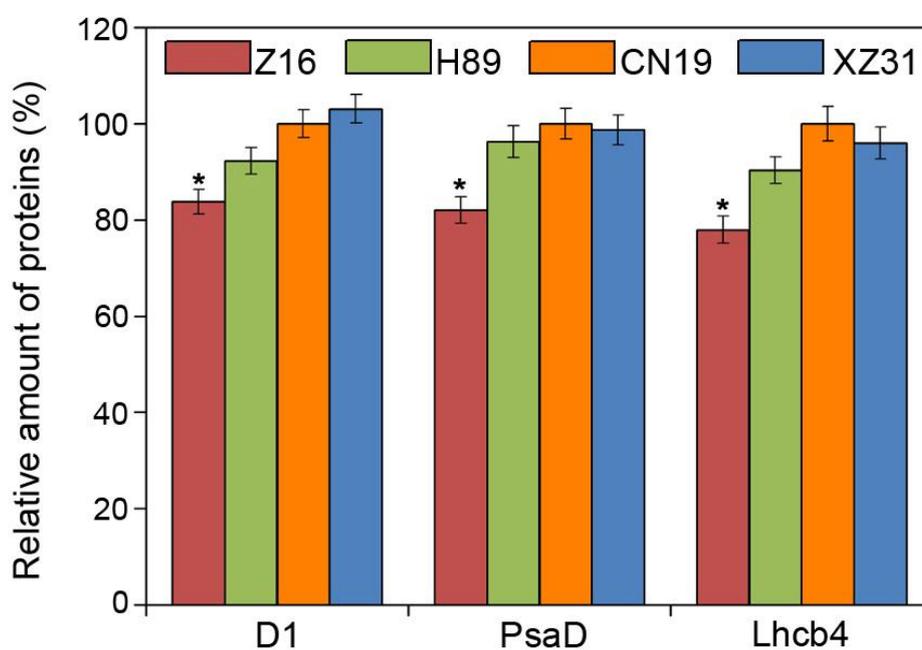


**Figure S1.** Genetic background of wheat with different ploidy levels and octoploid Triticale during the evolutionary process. Blue and orange indicate natural hybridization and man-made crossing, respectively.





**Figure S4.** The content of ASA/DHA (A) and GSH/GSSG (B) in Z16, H89, CN19, and XZ31. Values are expressed as the means  $\pm$  SD ( $n = 4$ ). Z16, H89, CN19, and XZ31 present accessions of *Triticum monococcum* (W2n), *Triticum dicoccum* (W4n), *Triticum aestivum* (W6n), and octaploid Triticale (T8n), respectively.



**Figure S5.** Quantification of D1, PsaD, and Lhcb4 proteins in Z16, H89, CN19, and XZ31. Data are presented relative to the amount of respective CN19 (100%). Values are means  $\pm$  SD from four independent biological replicates ( $n = 4$ ). Asterisks indicate statistically significant differences at  $P < 0.05$  level (Duncan's multiplication range test). Z16, accessions of *Triticum monococcum* (W2n); H89, accessions of *Triticum dicoccum* (W4n); CN19, accessions of *Triticum aestivum* (W6n); XZ31, accessions of octaploid Triticale (T8n).

**Table S1.** Results of two-way analysis of variance (ANOVA) of 1000-grain weight and chlorophyll fluorescence, P700, and gas exchange parameters.

Dependent variable	Pearson Correlation Coefficient	Dependent Variable	Pearson Correlation Coefficient
Fv/Fm	0.597**	$\Phi_{ND}$	0.384
$\Phi_{PSII}$	0.618**	$\Phi_{NA}$	-0.553*
NPQ/4	0.629**	$P_n$	0.550*
qP	0.535*	Tr	0.279
$P_m$	0.582*	Gs	0.383
qL	-0.725**	Ci	0.414
$\Phi_{PSI}$	0.664**	Chl	0.896**

Numbers represent  $F$  values at 5% level. \*, \*\* indicate statistically significant correlation at  $P < 0.05$  and  $P < 0.01$  levels, respectively. Z16, H89, CN19, and XZ31 present accessions of *Triticum monococcum* (W2n), *Triticum dicoccum* (W4n), *Triticum aestivum* (W6n), and octaploid Triticale (T8n), respectively. Fv/Fm, the maximum efficiency of PSII photochemistry;  $\Phi_{PSII}$ , the quantum yield of PSII electron transport; NPQ, the non-photochemical quenching; qP, the photochemical quenching;  $P_m$ , maximal P700 signal; qL, the fraction of PSII centers that are open;  $\Phi_{PSI}$ , effective quantum yield of PSI;  $\Phi_{ND}$ , quantum yield of non-photochemical energy dissipation in PSI reaction centers due to donor-side limitation;  $\Phi_{NA}$ , quantum yield of non-photochemical energy dissipation of PSI reaction centers due to acceptor side limitation;  $P_n$ , Net photosynthetic rate; Tr, transpiration rate; Gs, stomatal conductance; Ci, intercellular CO<sub>2</sub> concentration; Chl, chlorophyll.