Drought priming enhanced tolerance to drought stress in wheat

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Introduction

Background: Drought stress occurring during the reproductive growth stage of crops usually leads to considerable reductions in grain yield and quality. Therefore, enhancing tolerance to drought stress is important for food security in a future warmer and drier climate. Our previous studies have shown that pre-treatment of high temperature before anthesis could alleviate negative effects of the same stress occurring after anthesis in wheat. However, the underlying molecular mechanisms are far from clear.

Objective: Investigate whether the early drought priming could alleviate negative effects of later drought stress occurring during grain filling, and to elucidate the underling mechanisms at the proteome level.

Conclusions

Proteins in flag leaves differently expressed by the priming and drought stress were mainly related to photosynthesis, stress defence, metabolism, molecular chaperone, and cell structure. Furthermore, the protein abundance of Rubisco small subunit, Rubisco activase and ascorbate peroxidase were up-regulated in primed plants compared with non-primed plants under drought stress during grain filling. In conclusion, the altered protein expression and up-regulated activities of photosynthesis and ascorbate peroxidase in primed plants may indicate their potential roles in alleviating a later-occurring drought stress episode, thereby contributing to higher wheat grain yield under drought stress during grain filling.

Results

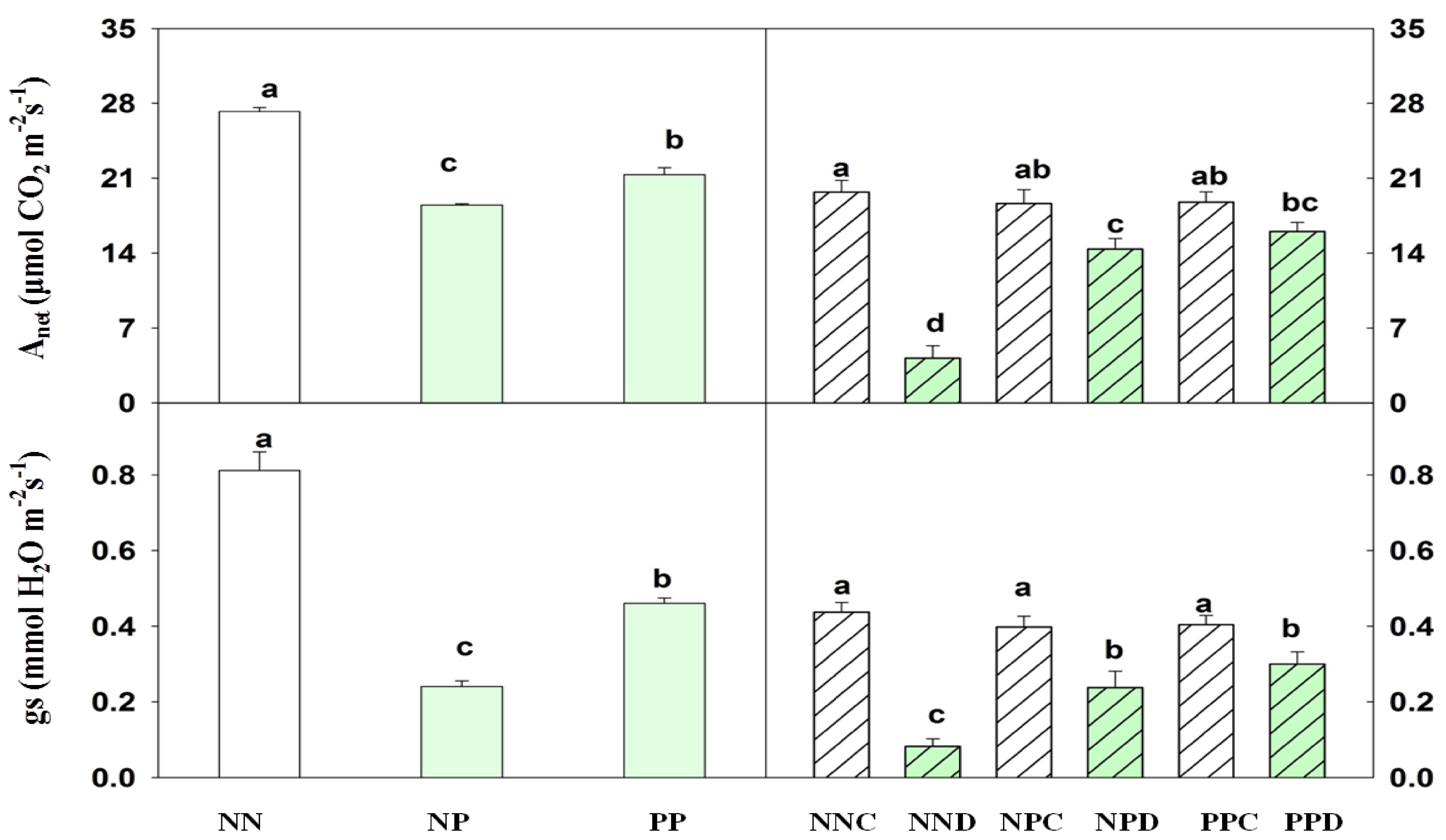

Fig. 1 The effect of drought priming on gas exchange characters of wheat leaf under drought stress during grain filling.

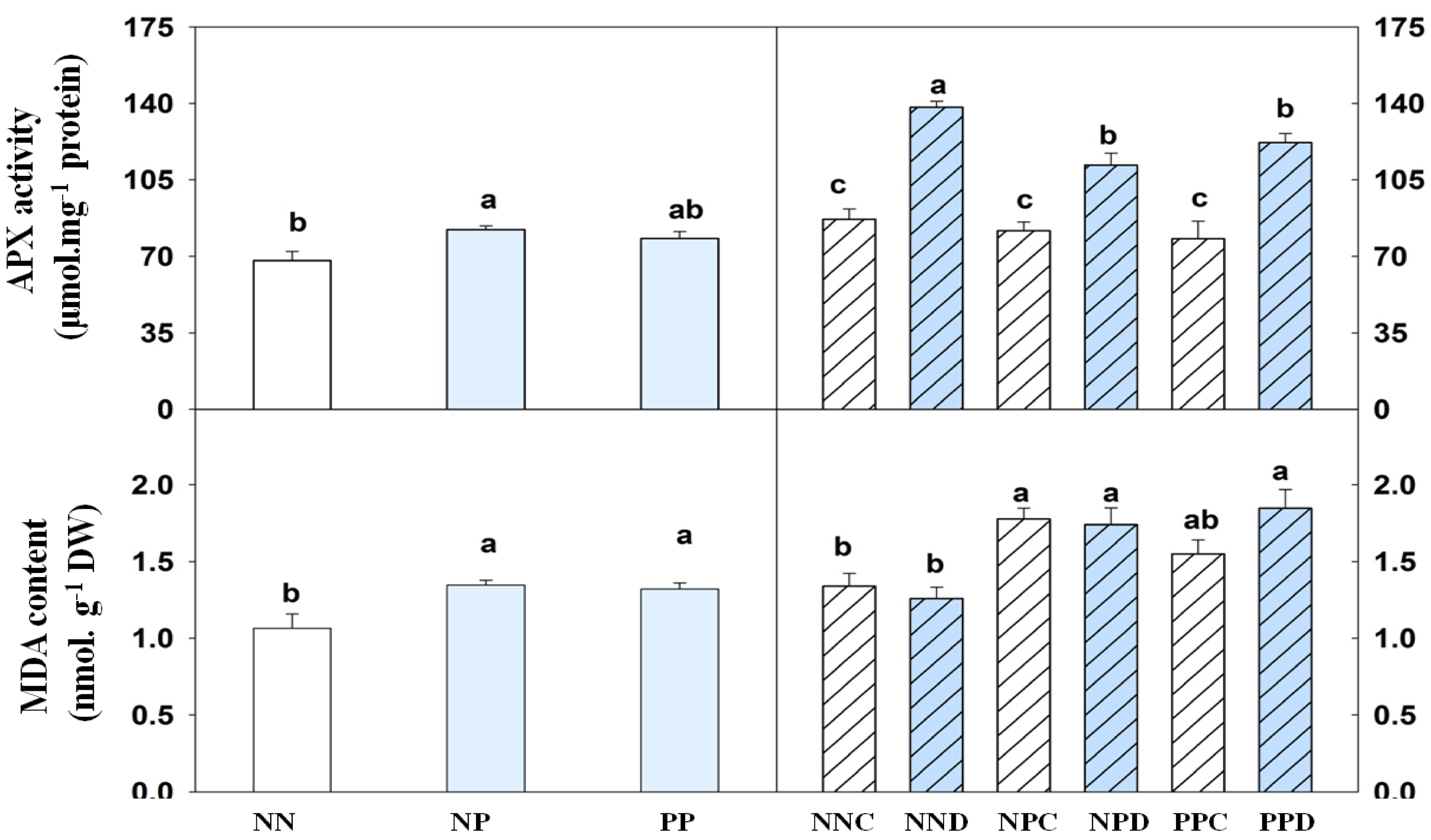

Fig. 2 The effect of drought priming on membrane lipid peroxidation and ascorbate peroxidase activity in wheat leaves under drought stress during grain filling.

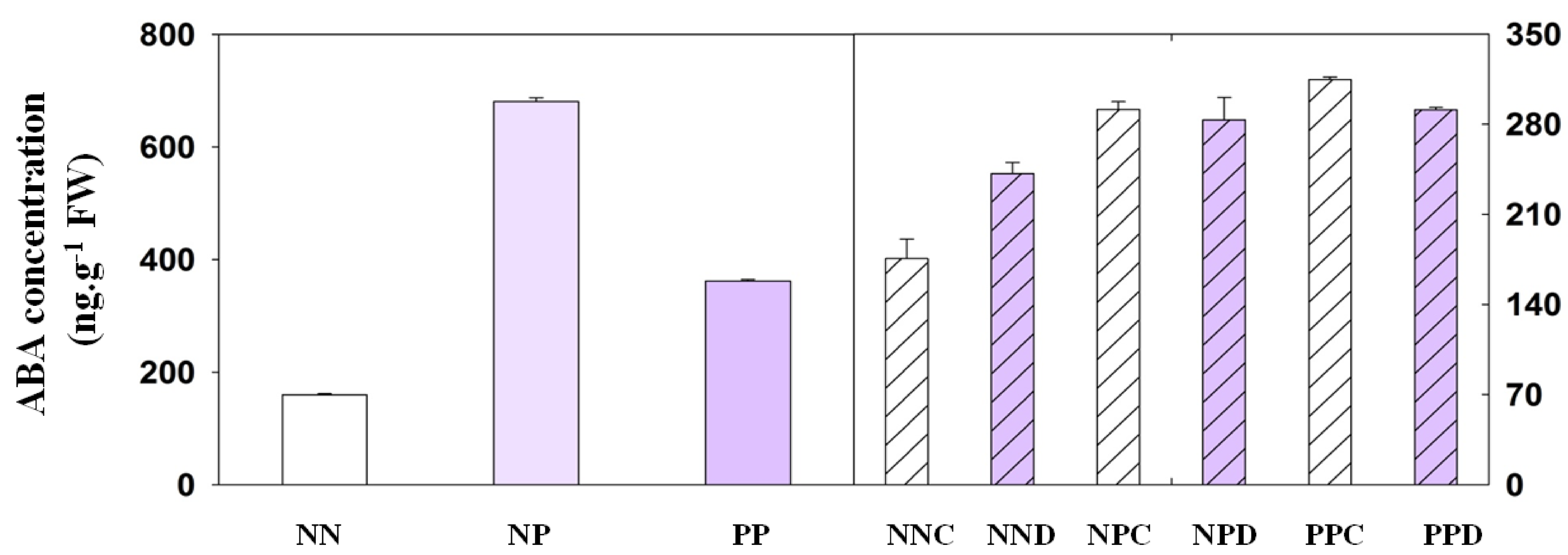

Fig. 3 The effect of drought priming on ABA concentration under drought stress.

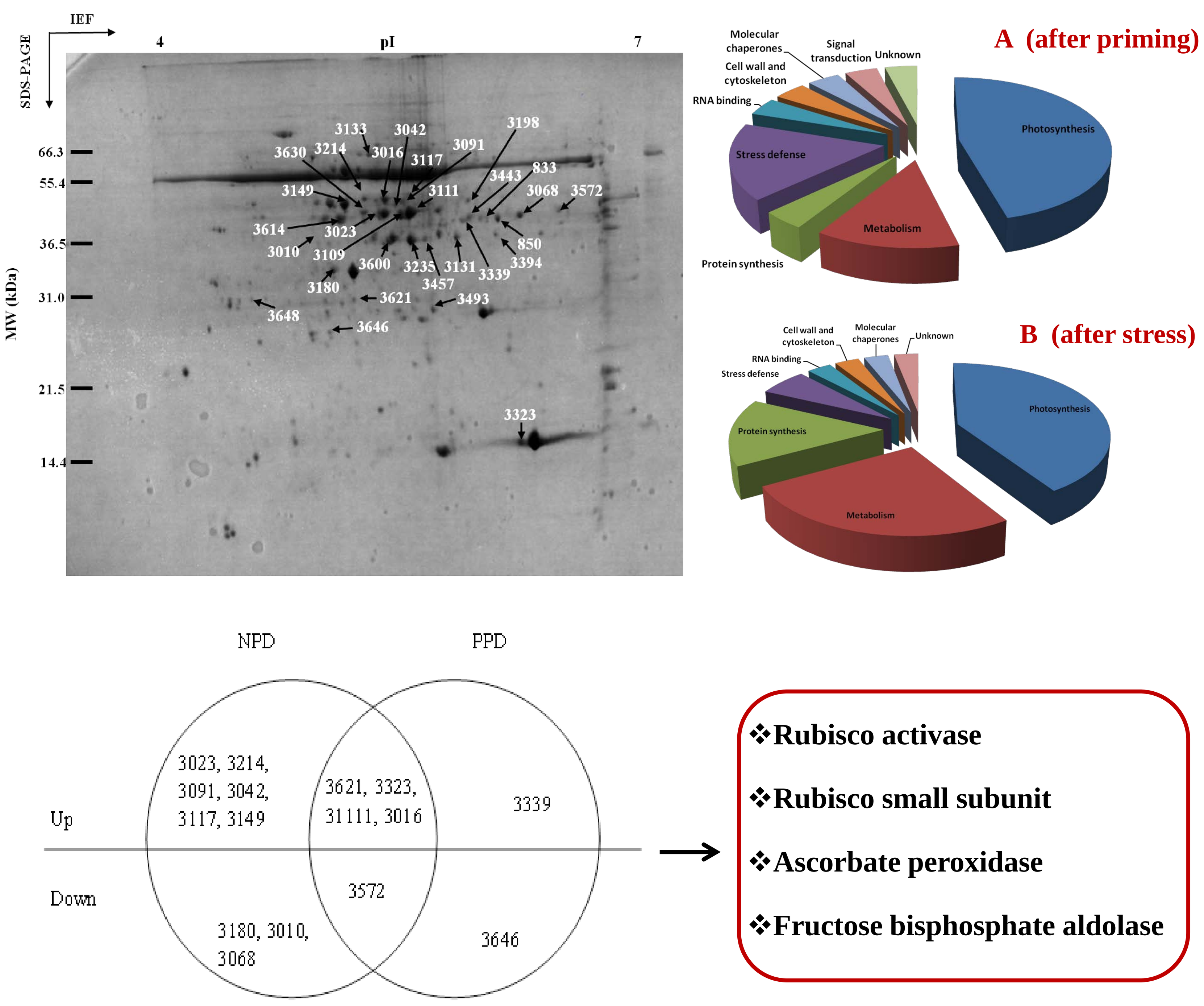

Fig. 4 Proteome analysis of wheat leaves after drought priming and drought stress

Table 1 Selected results of differentially expressed proteins between primed and non-primed plants under drought stress during grain filling in wheat leaves

Spot no.	FC[a]	Protein name	Accession no.	Taxonomy	Theor. Mr^b/pI	Exp. Mr^c/pI	Match no.[d]	SC[e]	E-value	Peptides sequences	Function
Up-regulated under drought stress											
3180	1.8	Oxygen-evolving enhancer protein 1	gi|357111487	*Brachypodium distachyon*	34.8/5.7	35/5.2	10	39	3.3E-07		Photosynthesis
3621	1.6	Ascorbate peroxidase	gi|226897533	*Triticum aestivum*	26.8/5.5	32/5.3	11	38	5.2E-05		Stress defense
3646	1.6	2-Cys peroxiredoxin BAS1	gi|2499477	*Hordeum vulgare*	23.4/5.5	28/5.2	6	32	5.1E-04		Stress defense
3010	2.7	Plastid glutamine synthetase isoform GS2c	gi|71362640	*Triticum aestivum*	47/5.8	43/5.1	6	17	8.4E-03		Protein synthesis
Down-regulated under drought stress											
3600	1.5	Fructose-bisphosphate aldolase 2	gi|326499908	*Hordeum vulgare*	41.8/6.4	39/5.6	18	38	5.2E-08		Metabolism
3572	2.3	Fructose bisphosphate aldolase, cytoplasmic isozyme 1-like	gi|326493652	*Hordeum vulgare*	38.1/6.1	42/6.7	9	21	2.1E-08		Metabolism
833	2.2	Fructose-bisphosphate aldolase, cytoplasmic isozyme 1-like	gi|326523629	*Hordeum vulgare*	41.6/7.1	42/6.2	7	11	1.4E-02		Metabolism
3023	2.5	Chloroplast fructose-bisphosphate aldolase	gi|223018643	*Triticum aestivum*	42.2/5.9	46/5.6	17	50	5.2E-12		Metabolism
3235	1.3	Fructose-bisphosphate aldolase, cytoplasmic isozyme 1-like	gi|326499908	*Hordeum vulgare*	41.7/6.4	37/5.7	17	38	3.7E-02		Metabolism
3493	1.7	Triosephosphate-isomerase	gi|326496613	*Hordeum vulgare*	32.7/7.0	30/5.8	9	28	6.4E-03		Metabolism
850	1.9	Cytosolic malate dehydrogenase	gi|37928995	*Triticum aestivum*	24.6/6.6	41/6.3	6	23	1.3E-02		Metabolism

Materials and methods

Spring wheat (*Triticum aestivum* L. cv. Vinjett) was used. Soil relative water content (*SRWC*) was used for reference of drought priming or treatment. Drought priming applied at seedling and/or at stem elongation stage was done by withholding watering until the *SRWC* reached approximately 35-40%, drought stress was applied during grain filling and control *SRWC* around 20-25%.

Leaf proteins were identified by MALDI-TOF MS and MS/MS, The leaf gas exchange, cell membrane lipid peroxidation and ascorbate peroxidase (APX) activity were measured.

Reference

Wang, X., et al. (2014). Journal of Experimental Botany

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