

Supplementary materials

Article title: Study of Ecophysiological Responses of the Antarctic Fruticose Lichen *Cladonia borealis* Using the PAM Fluorescence System under Natural and Laboratory Conditions

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Table S1. The mean, min and max values of Y(II) of *C. borealis* and the microclimates. These data were excluded night time. Characters A, B, and C in parentheses indicates Region in Figure 2.

Date		Y(II)	PPFD	Temp.	Soil	Air RH	Rainfall*
		$\mu\text{mol}/\text{m}^2/\text{s}$	$^{\circ}\text{C}$	moisture %	%	mm	
23 th	Mean	0.335	323	3.37	0.213	90.34	2
	SD	(± 0.044)	(± 260)	(± 2.47)	(± 0.004)	(± 3.04)	
	Min	0.263	10	0.10	0.206	83.50	
	Max	0.433	730	8.20	0.219	94.20	
24 th (A)	Mean	0.287	319	4.41	0.233	87.11	60
	SD	(± 0.061)	(± 300)	(± 1.97)	(± 0.011)	(± 1.36)	
	Min	0.190	5	0.10	0.202	84.60	
	Max	0.480	1295	8.80	0.247	90.40	
25 th	Mean	0.288	355	0.92	0.231	78.27	18
	SD	(± 0.033)	(± 275)	(± 1.38)	(± 0.007)	(± 5.64)	
	Min	0.241	5	-1.10	0.217	69.94	
	Max	0.362	1040	4.30	0.239	90.70	
26 th (B)	Mean	0.189	342	4.32	0.208	82.96	0
	SD	(± 0.042)	(± 256)	(± 3.06)	(± 0.004)	(± 3.16)	
	Min	0.115	4	-0.60	0.203	77.41	
	Max	0.294	1146	10.50	0.216	90.80	
27 th (C)	Mean	0.205	300	4.77	0.204	89.31	9
	SD	(± 0.069)	(± 210)	(± 1.51)	(± 0.003)	(± 4.00)	
	Min	0.114	4	2.10	0.199	81.20	
	Max	0.447	641	7.90	0.214	95.10	
28 th	Mean	0.202	466	5.99	0.204	90.06	1
	SD	(± 0.043)	(± 447)	(± 3.37)	(± 0.006)	(± 5.66)	
	Min	0.100	3	2.20	0.195	80.10	
	Max	0.284	1545	14.10	0.212	96.60	

* This is the sum of accumulated rainfall during one day.

Table S2. Linear regression of Y(II) with three microclimate factors during all period of field observation. These data was calculated from Figure S2.

Y(II) vs.		<i>C. borealis</i>		<i>Usnea</i> sp.	
		Slop (SE)	R ²	Slop (SE)	R ²
PPFD	#1	-2.163E-4 (1.53E-5)	0.344	-3.50E-4 (2.92E-5)	0.504*
	#2	-2.068E-4 (1.76E-5)	0.217	-6.27E-4 (3.22E-5)	0.713*
Temperature	#1	-0.013 (0.002)	0.104	-0.033 (0.004)	0.255
	#2	-0.023 (0.001)	0.261	-0.060 (0.004)	0.555*
Soil moisture	#1	-0.884 (0.400)	0.010	0.837 (0.999)	-0.002
	#2	1.664 (0.440)	0.026	-1.946 (1.221)	0.010

Table S3. Results of high-throughput amplicon sequencing output amplifying the algal specific ITS region from two samples of *C. borealis*.

	Total reads (Sequencing)		Joined pairs		Total reads (Clustered)	
	Length (bp)	No.	No.	%	Length (bp)	No.
#1	392,023,002	1,302,402	453,505	69.64	53,111,651	423,923
#2	399,665,994	1,327,794	480,246	72.34	49,578,246	396,086

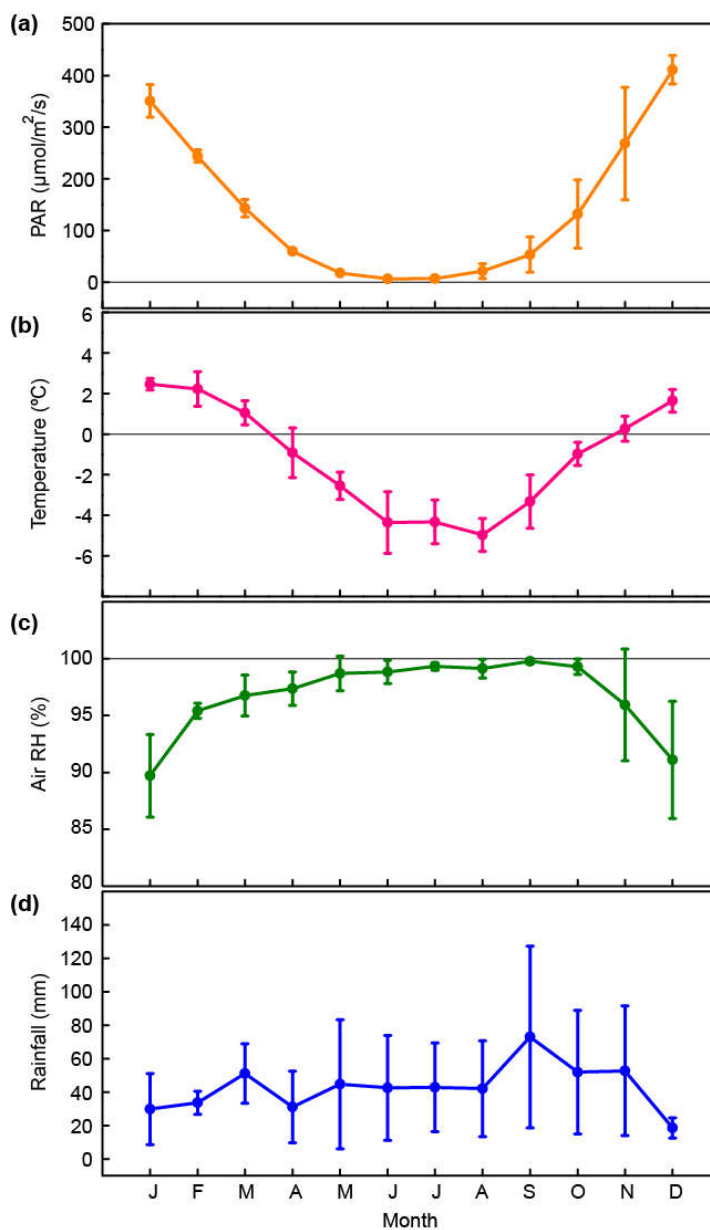


Figure S1. Monthly changes in microclimate factors at the study site, KGL01, in Barton Peninsula, Antarctica. The data are presented as the monthly average values of the data obtained from the HOBO loggers installed on the site (2013 to 2018 years), except for the rainfall data (2014 to 2017 years). Error bars indicate standard deviations.

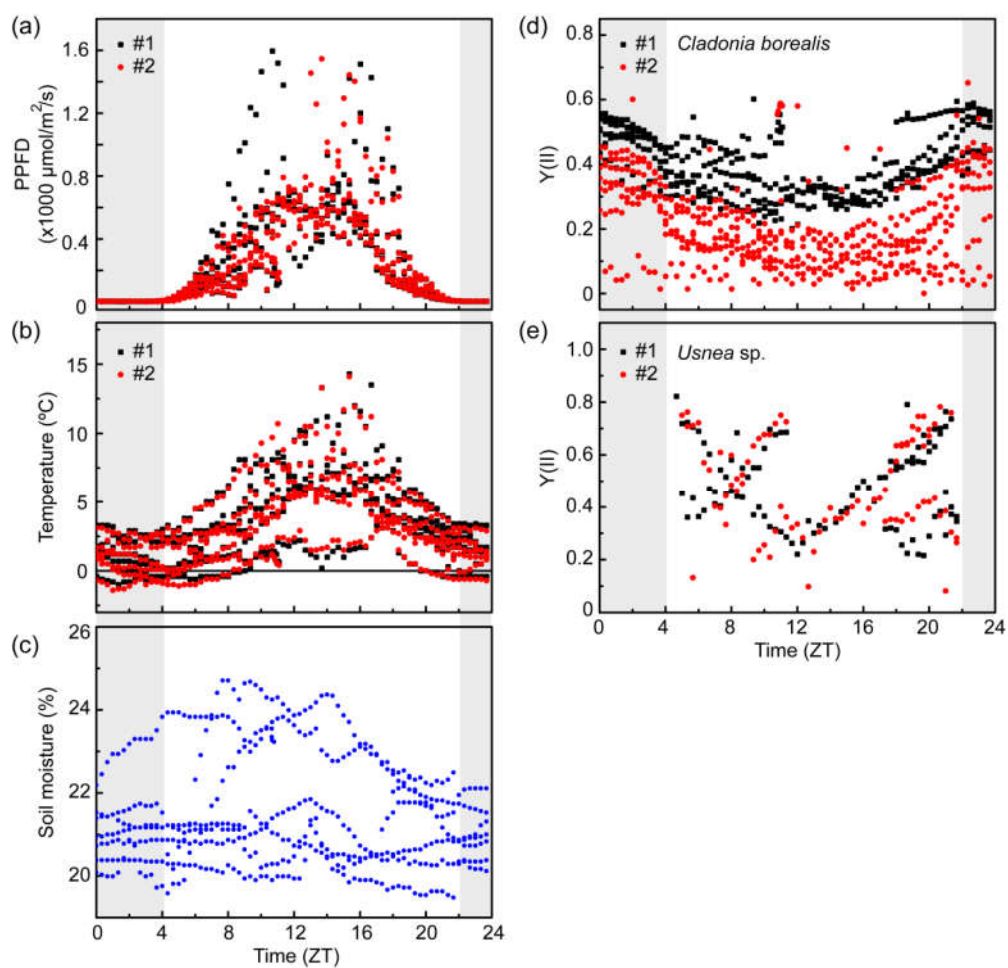


Figure S2. Diurnal dynamics of (a) PPFD ($\mu\text{mol}/\text{m}^2/\text{s}$), (b) temperature ($^{\circ}\text{C}$), (c) volumetric soil moisture (%), (d) the Y(II) of *C. borealis* and (e) the Y(II) of *Usnea* sp. These data were prepared from the observation during 22nd-30th of January in 2019. The grey shading indicates the night time (from 10 PM to 4 AM) defined by less than $10 \mu\text{mol}/\text{m}^2/\text{s}$ of PPFD. Black and red symbols indicate the sample #1 and #2, respectively.

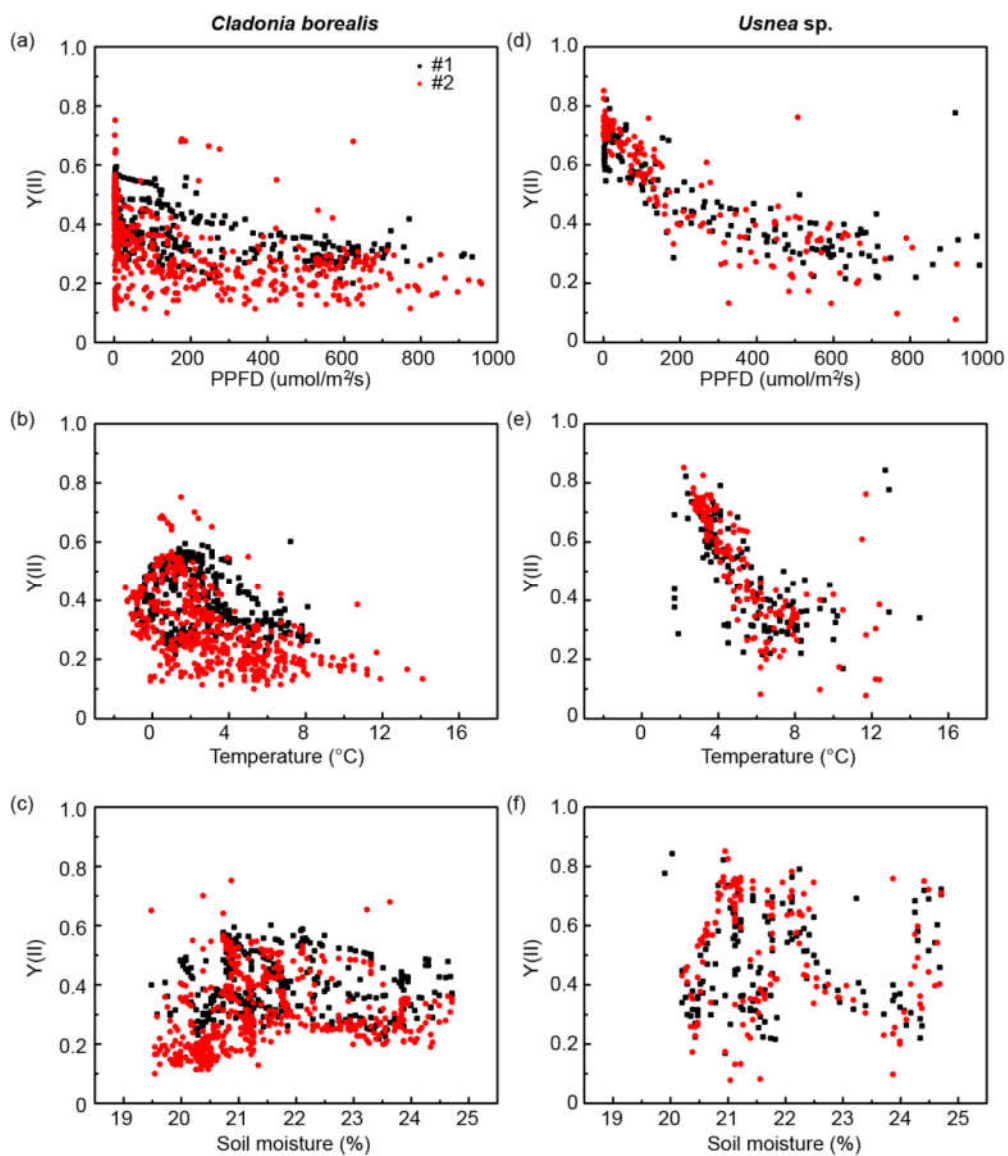


Figure S3. Plots of Y(II) with three microclimate factors recorded during all period of field observation. (a-c) Data from two samples of *Cladonia borealis* (d-f) Data from two samples of *Usnea sp.* Black and red symbols indicate the sample #1 and #2, respectively.

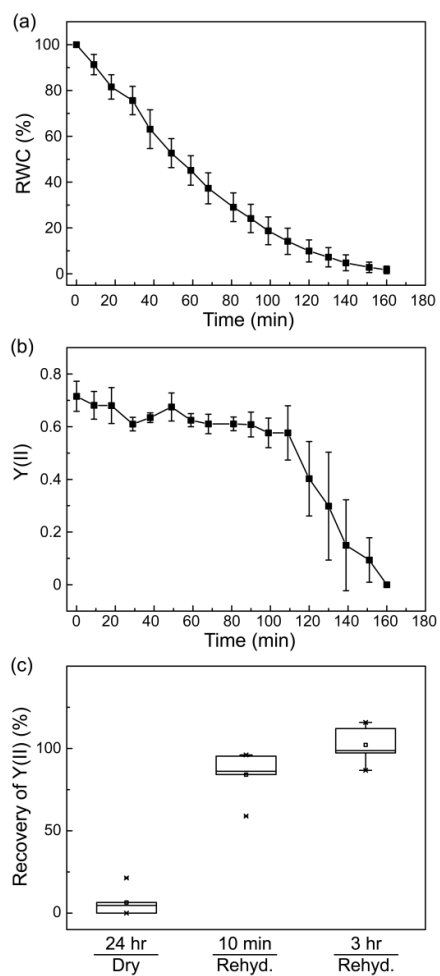


Figure S4. Air-drying of field *C. borealis* samples with changes of (a) RWC (%), (b) the Y(II) value, and (c) the relative recovery rate of Y(II) after rehydration. Experiment was performed using ten biological replicates ($n = 10$) and the average with standard deviations were shown.

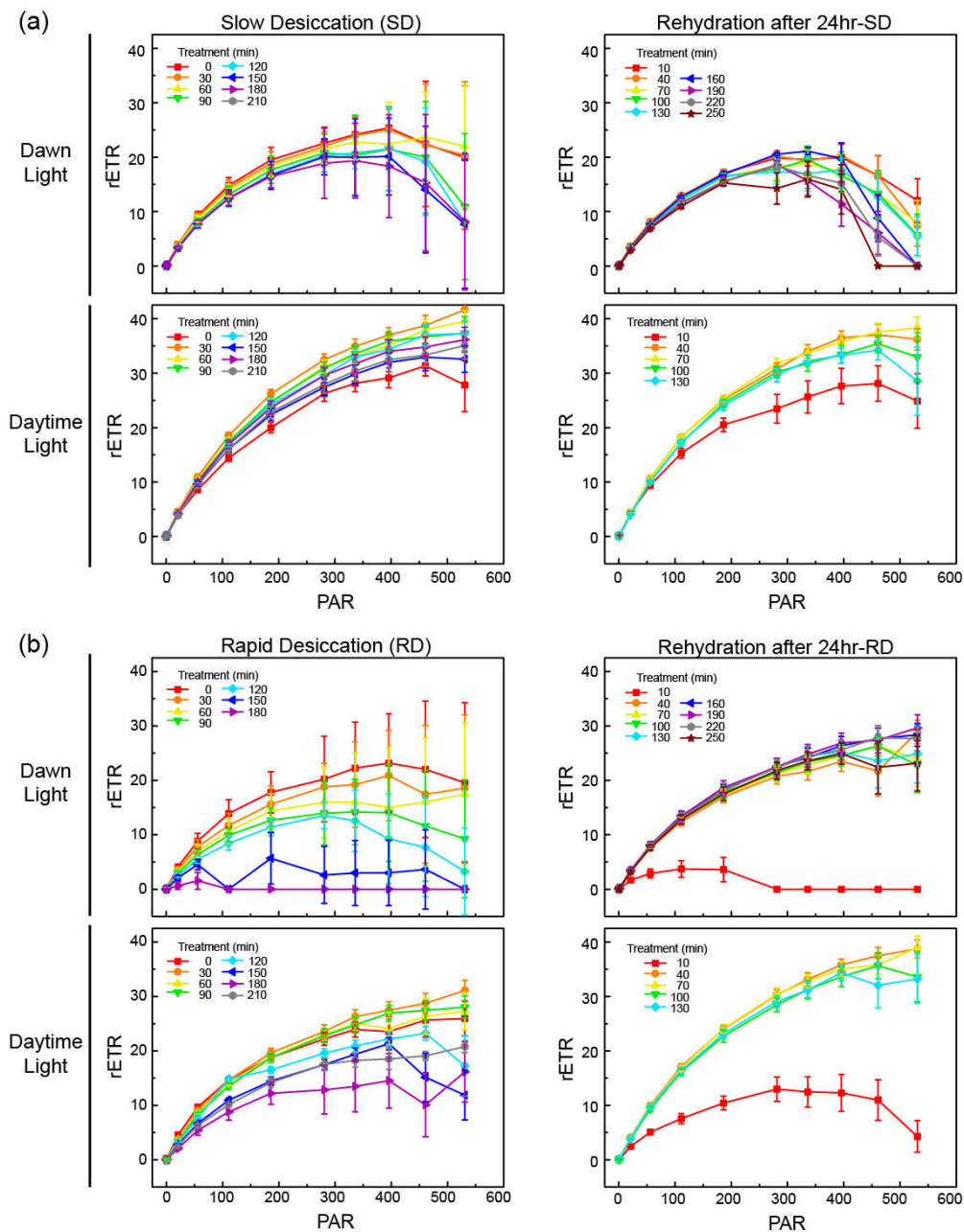


Figure S5. The rapid light curves of *C. borealis* by desiccation and rehydration treatment under different light intensity, Dawn (50 $\mu\text{mol}/\text{m}^2/\text{s}$) and Daytime (220 $\mu\text{mol}/\text{m}^2/\text{s}$). (a) Slow desiccation (SD) and rehydration after 24hr-SD. (b) Rapid desiccation (RD) and rehydration after 24hr-RD. Each value indicates the average score \pm standard deviation. The ten biological replicates were used for each treatment ($n = 10$). Experiments were repeated at least two or three times using the same thalli after re-stabilizing at 50 $\mu\text{mol}/\text{m}^2/\text{s}$ light with an 18:6 light:dark cycle at 8 $^{\circ}\text{C}$ with hydration for a week.

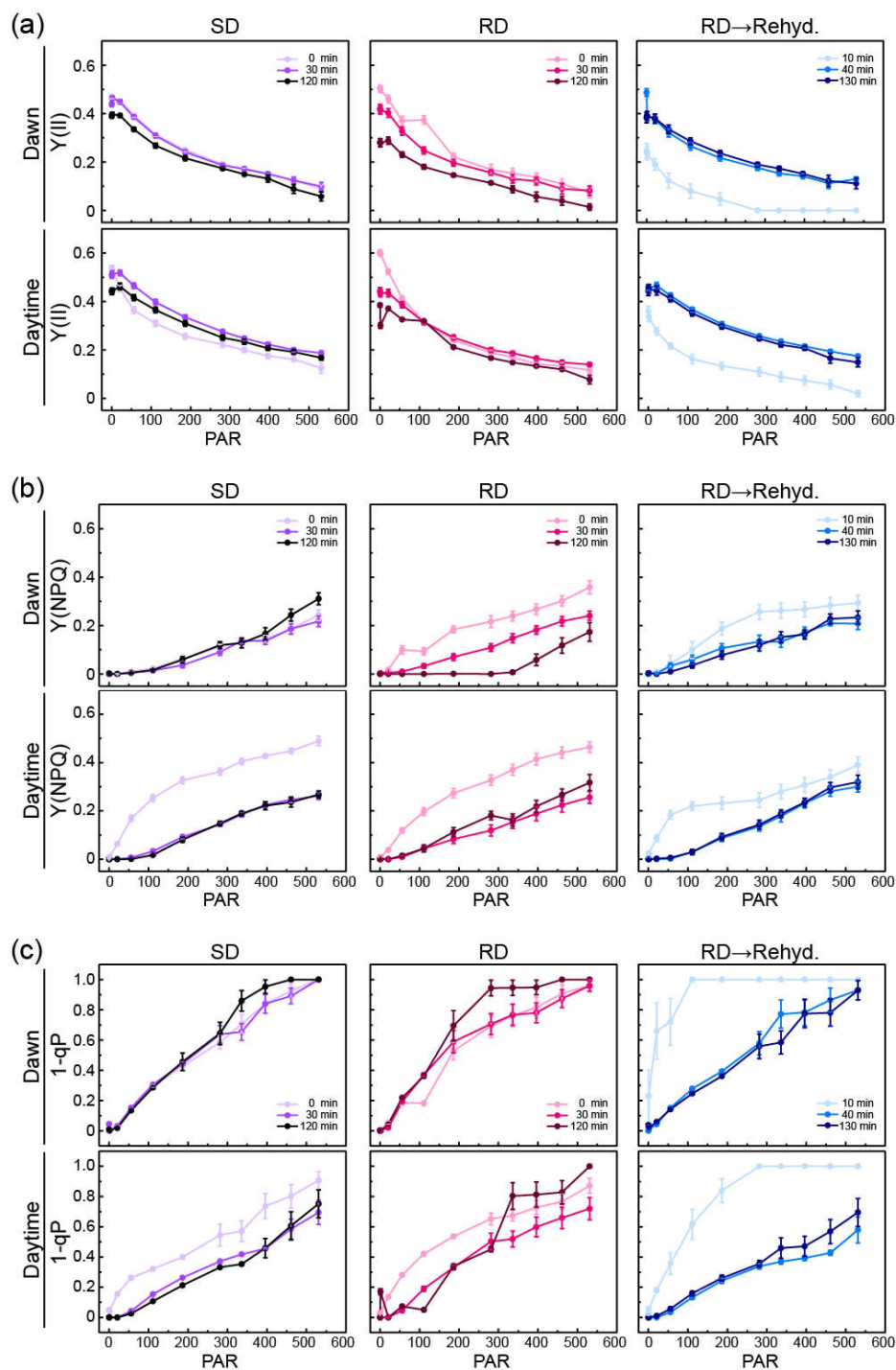


Figure S6. Changes of Y(II), Y(NPQ) and 1-qP of *C. borealis* during rapid light curve experiment under the slow desiccation (SD), rapid desiccation (RD) and rehydration after 24hr-RD treatment (RD→Rehyd.) with different light intensity, dawn ($50 \mu\text{mol}/\text{m}^2/\text{s}$) and daytime ($220 \mu\text{mol}/\text{m}^2/\text{s}$). Each value indicates the average score \pm standard deviation. The ten biological replicates were used for each treatment ($n = 10$). Experiments were repeated at least two or three times using the same thalli after re-stabilizing at $50 \mu\text{mol}/\text{m}^2/\text{s}$ light with an 18:6 light:dark cycle at 8°C with hydration for a week.