

Supplementary Figures

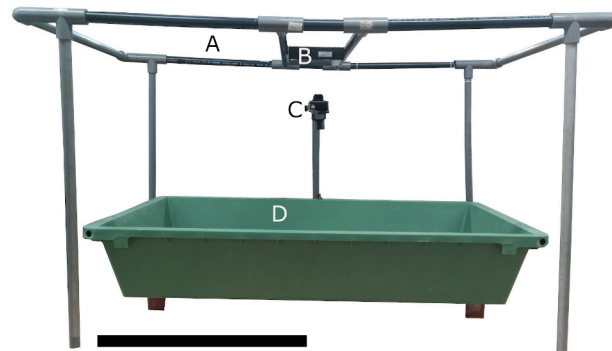


Fig. S1. The experiment 2 behavior experiment microcosm set-up. A) The PVC frame, B) is the red LED lamp mounted on the PVC frame, C) is the GoPro camera mounted over D) the microcosm tank. The black scale bar is 50 cm.

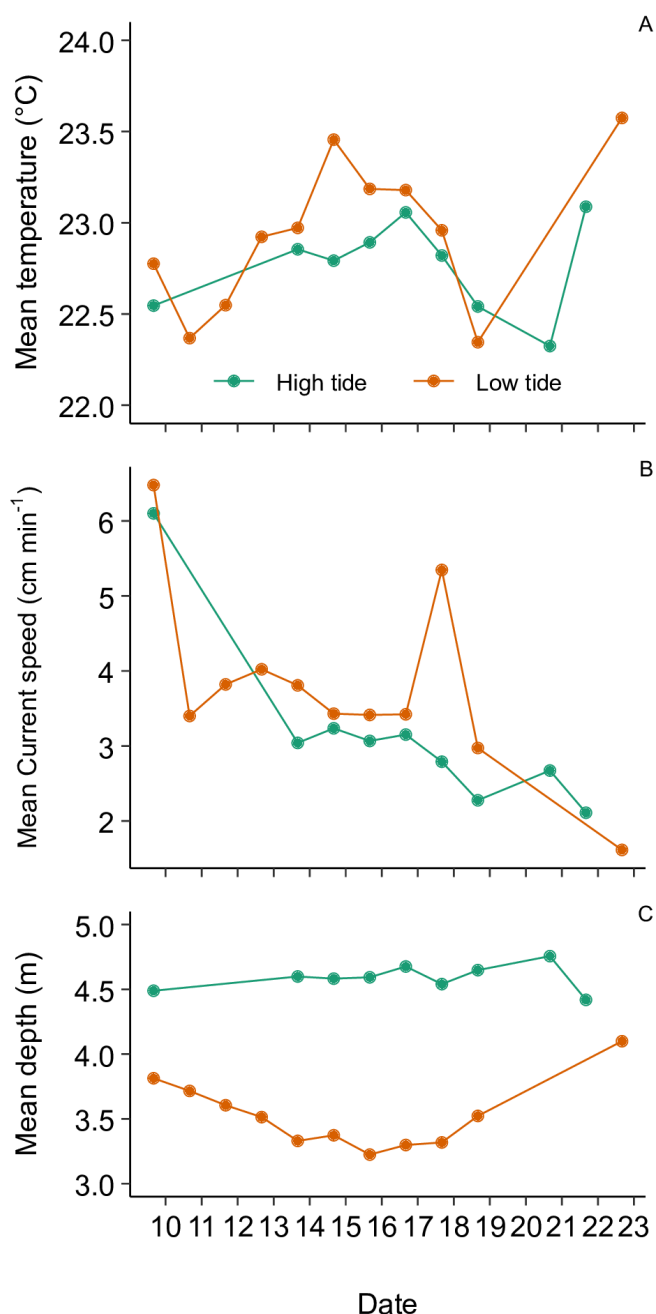


Fig. S2. The field experiment conditions in July 2019 at low and high tide. A) Shows the mean temperature conditions. B) Shows the mean current speed (cm sec⁻¹), C) Shows mean depth. Points represent experiment times. The passing of tropical storm No. 5 (“Danas”) appears as a trough in the mean temperature and as an abrupt spike in mean current speed from the 18th to 19th of July 2019 (https://www.data.jma.go.jp/fcd/yoho/typhoon/route_map/bstv2019.html).

Supplementary Tables

Table S1. Results of the Bayesian linear models on light distribution of experiment 2 microcosm tank. The table shows the estimates, mean and the lower and upper limits of the 95% confidence interval.

Estimates	Mean	2.5%	97.5%
B1.) Light distribution (Lux)			
Center	3.1	2.8	3.3
Middle	2.1	2.0	2.3
Outer	0.5	0.3	0.7

Table S2. Mean and 95% highest density predicted intervals (HDI) of experiment 2 sea urchin behavior counts.

Hunger state	Behavior	Summer-Autumn		Winter-Spring	
		Mean	95% HDI	Mean	95% HDI
Control					
Fed	Movement	42.7	2-96	34.5	2-84
	Interaction	21.8	2-52	22.3	1-52
	Outside	48.2	3-119	49.6	3-116
Starved	Movement	45.5	3-116	45.6	2-107
	Interaction	27.1	2-96	34.9	2-101
	Outside	52.6	4-110	48.0	1-122
Dead urchin					
Fed	Movement	29.3	2-67	44.9	2-107
	Interaction	16.3	1-37	17.5	1-39
	Outside	63.9	4-144	52.4	1-125
Starved	Movement	28.6	2-65	42.7	3-100
	Interaction	22.9	1-53	22.8	1-56
	Outside	62.0	1-140	56.7	3-137
Algae					
Fed	Movement	23.3	1-54	32.8	3-73
	Interaction	33.8	2-71	26.6	1-61
	Outside	70.2	4-154	48.4	1-112
Starved	Movement	25.5	1-61	24.4	2-58
	Interaction	66.7	1-161	66.0	1-163
	Outside	67.1	3-173	58.9	3-153
Dead urchin and algae					
Fed	Movement	13.8	1-32	31.3	1-76
	Interaction	12.9	1-32	8.3	1-21
	Outside	76.3	3-183	60.6	3-140
Starved	Movement	21.4	1-50	15.0	1-35
	Interaction	51.1	5-116	24.5	2-60
	Outside	44.8	3-107	55.3	2-130

Table S3. Mean and 95% highest density predicted intervals (HDI) on the probability of the behavior achieving zero counts.

Hunger state	Behavior	Summer-Autumn		Winter-Spring	
		Mean	95% HDI	Mean	95% HDI
Control					
Fed	Movement	0.437	0.257-0.613	0.553	0.321-0.794
	Interaction	0.752	0.624-0.876	0.818	0.670-0.939
	Outside	0.593	0.414-0.774	0.635	0.399-0.853
Starved	Movement	0.738	0.517-0.925	0.570	0.304-0.817
	Interaction	0.915	0.822-0.982	0.930	0.836-0.996
	Outside	0.867	0.723-0.983	0.741	0.516-0.947
Dead urchin					
Fed	Movement	0.180	0.034-0.344	0.371	0.147-0.614
	Interaction	0.635	0.449-0.830	0.694	0.474-0.888
	Outside	0.252	0.070-0.456	0.521	0.270-0.758
Starved	Movement	0.264	0.065-0.484	0.375	0.118-0.627
	Interaction	0.723	0.531-0.915	0.821	0.625-0.978
	Outside	0.387	0.158-0.617	0.566	0.286-0.827
Algae					
Fed	Movement	0.234	0.093-0.383	0.398	0.197-0.608
	Interaction	0.508	0.341-0.670	0.589	0.381-0.783
	Outside	0.344	0.185-0.512	0.481	0.284-0.726
Starved	Movement	0.345	0.142-0.589	0.382	0.137-0.638
	Interaction	0.567	0.343-0.786	0.697	0.437-0.900
	Outside	0.810	0.620-0.961	0.697	0.448-0.922
Dead urchin and algae					
Fed	Movement	0.116	0.007-0.260	0.434	0.188-0.699
	Interaction	0.550	0.329-0.774	0.651	0.429-0.882
	Outside	0.145	0.0143-0.303	0.441	0.170-0.693
Starved	Movement	0.083	0.002-0.227	0.306	0.072-0.561
	Interaction	0.336	0.109-0.565	0.575	0.311-0.849
	Outside	0.487	0.230-0.753	0.526	0.254-0.797

Table S4. Mean and 95% highest density predicted intervals (HDI) of experiment 2 sea urchin behavior time (min).

Hunger state	Behavior	Summer-Autumn		Winter-Spring	
		Mean	95% HDI	Mean	95% HDI
Control					
Fed	Movement	21.5	1.06-49.0	17.1	0.682-42.0
	Interaction	10.6	0.570-24.2	10.9	0.165-26.7
	Outside	22.9	1.23-50.9	25.1	0.958-61.9
Starved	Movement	23.2	1.49-59.0	23.2	0.815-54.6
	Interaction	14.7	0.167-40.2	17.6	1.52-60.5
	Outside	26.2	1.29-59.9	26.1	1.21-67.5
Dead urchin					
Fed	Movement	15.0	0.994-35.1	22.6	0.848-52.9
	Interaction	7.9	0.579-19.3	9.6	0.888-23.2
	Outside	32.1	1.61-76.2	25.1	0.933-58.8
Starved	Movement	14.5	1.06-35.2	19.9	1.08-47.1
	Interaction	10.6	0.400-27.7	12.2	0.271-33.6
	Outside	30.8	1.42-74.2	28.9	2.09-77.4
Algae					
Fed	Movement	11.8	0.738-27.6	17.0	0.844-38.6
	Interaction	17.7	0.988-40.5	13.6	1.24-33.3
	Outside	34.7	1.27-79.3	23.0	1.19-54.5
Starved	Movement	31.1	0.484-31.3	12.3	0.416-30.2
	Interaction	33.4	1.61-82.1	33.2	0.982-81.1
	Outside	31.1	2.54-82.1	29.1	0.772-75.7
Dead urchin and algae					
Fed	Movement	6.9	0.276-15.7	16.2	0.928-38.1
	Interaction	6.5	0.180-14.7	4.3	0.180-10.6
	Outside	38.8	2.19-91.2	30.6	0.645-73.5
Starved	Movement	10.8	0.568-25.3	7.3	0.366-17.5
	Interaction	25.3	0.929-59.2	12.9	0.552-31.5
	Outside	22.7	0.354-58.0	28.2	1.11-68.5

Table S5. Mean and 95% highest density predicted intervals (HDI) on the probability of the behavior time (min) being zero.

Hunger state	Behavior	Summer-Autumn		Winter-Spring	
		Mean	95% HDI	Mean	95% HDI
Control					
Fed	Movement	0.436	0.269-0.636	0.546	0.310-0.788
	Interaction	0.756	0.624-0.889	0.816	0.659-0.945
	Outside	0.589	0.412-0.783	0.637	0.405-0.850
Starved	Movement	0.731	0.526-0.931	0.574	0.317-0.822
	Interaction	0.915	0.826-0.989	0.931	0.835-0.995
	Outside	0.867	0.723-0.987	0.746	0.509-0.947
Dead urchin					
Fed	Movement	0.178	0.032-0.345	0.368	0.138-0.606
	Interaction	0.638	0.447-0.823	0.695	0.483-0.905
	Outside	0.254	0.068-0.442	0.524	0.266-0.774
Starved	Movement	0.263	0.064-0.483	0.377	0.121-0.634
	Interaction	0.722	0.526-0.906	0.820	0.626-0.974
	Outside	0.386	0.148-0.614	0.563	0.290-0.828
Algae					
Fed	Movement	0.235	0.107-0.393	0.386	0.175-0.590
	Interaction	0.503	0.344-0.659	0.589	0.401-0.795
	Outside	0.345	0.187-0.507	0.483	0.266-0.699
Starved	Movement	0.340	0.119-0.563	0.386	0.130-0.645
	Interaction	0.561	0.342-0.780	0.696	0.450-0.893
	Outside	0.816	0.631-0.968	0.700	0.440-0.930
Dead urchin and algae					
Fed	Movement	0.118	0.007-0.262	0.437	0.173-0.677
	Interaction	0.552	0.332-0.781	0.656	0.427-0.873
	Outside	0.145	0.015-0.302	0.436	0.184-0.707
Starved	Movement	0.083	0.004-0.216	0.304	0.058-0.560
	Interaction	0.341	0.124-0.580	0.577	0.323-0.836
	Outside	0.493	0.248-0.772	0.522	0.249-0.800

Table S6. Mean and 95% highest density predicted intervals (HDI) of experiment 2 sea urchin behavior speed (cm sec⁻¹).

Hunger state	Behavior	Summer-Autumn		Winter-Spring	
		Mean	95% HDI	Mean	95% HDI
Control					
	Movement	7.22	0.106-19.8	12.5	0.094-35.6
Fed	Interaction	13.3	0.065-35.3	17.5	0.089-53.3
	Outside	8.3	0.049-23.4	14.3	0.051-37.9
	Movement	10.6	0.006-31.8	7.7	0.038-23.7
Starved	Interaction	11.1	0.082-33.7	8.5	0.138-23.3
	Outside	4.2	0.063-14.4	3.5	0.028-11.2
Dead urchin					
	Movement	13.1	0.095-36.3	9.9	0.065-27.6
Fed	Interaction	21.9	0.098-62.2	16.9	0.092-48.4
	Outside	6.7	0.065-18.5	9.5	0.076-28.5
	Movement	18.1	0.416-50.8	11.2	0.087-32.2
Starved	Interaction	17.4	0.138-49.8	23.5	0.156-69.3
	Outside	4.7	0.057-13.0	9.1	0.091-27.0
Algae					
	Movement	13.4	0.019-33.9	12.7	0.402-36.1
Fed	Interaction	16.6	0.243-46.5	12.5	0.164-34.3
	Outside	13.4	0.026-37.2	12.7	0.072-33.8
	Movement	8.4	0.026-24.5	8.6	0.017-24.0
Starved	Interaction	7.9	0.030-21.7	6.8	0.073-18.7
	Outside	8.6	0.044-26.3	6.2	0.037-20.0
Dead urchin and algae					
	Movement	20.1	0.081-57.0	15.0	0.007-38.6
Fed	Interaction	24.0	0.141-65.9	21.1	0.375-64.4
	Outside	13.4	0.052-38.5	9.1	0.063-26.6
	Movement	6.1	0.041-17.5	10.4	0.027-30.7
Starved	Interaction	8.3	0.043-23.0	21.4	0.302-60.9
	Outside	22.8	0.065-70.3	14.7	0.123-42.8

Table S7. Mean and 95% highest density predicted intervals (HDI) on the probability of the behavior speeds (cm sec^{-1}) being zero.

Hunger state	Behavior	Summer-Autumn		Winter-Spring	
		Mean	95% HDI	Mean	95% HDI
Control					
	Movement	0.501	0.326-0.704	0.547	0.299-0.776
Fed	Interaction	0.757	0.630-0.883	0.786	0.625-0.920
	Outside	0.609	0.423-0.779	0.626	0.389-0.841
	Movement	0.722	0.495-0.907	0.571	0.302-0.825
Starved	Interaction	0.893	0.792-0.980	0.915	0.805-0.992
	Outside	0.864	0.718-0.984	0.744	0.506-0.940
Dead urchin					
	Movement	0.327	0.138-0.539	0.375	0.127-0.608
Fed	Interaction	0.701	0.524-0.879	0.745	0.548-0.915
	Outside	0.310	0.110-0.524	0.537	0.280-0.784
	Movement	0.299	0.102-0.534	0.369	0.129-0.640
Starved	Interaction	0.676	0.462-0.865	0.810	0.625-0.974
	Outside	0.394	0.166-0.638	0.565	0.285-0.824
Algae					
	Movement	0.408	0.242-0.573	0.430	0.238-0.650
Fed	Interaction	0.551	0.387-0.701	0.585	0.393-0.775
	Outside	0.345	0.184-0.509	0.480	0.256-0.690
	Movement	0.441	0.212-0.691	0.387	0.134-0.650
Starved	Interaction	0.528	0.308-0.752	0.708	0.472-0.909
	Outside	0.803	0.613-0.971	0.708	0.467-0.935
Dead urchin and algae					
	Movement	0.594	0.331-0.819	0.559	0.298-0.820
Fed	Interaction	0.748	0.566-0.914	0.801	0.624-0.958
	Outside	0.163	0.023-0.332	0.440	0.184-0.707
	Movement	0.509	0.230-0.770	0.507	0.214-0.764
Starved	Interaction	0.413	0.172-0.652	0.658	0.405-0.904
	Outside	0.494	0.226-0.748	0.519	0.228-0.773