The following supplements accompany the article

Lack of substrate specificity contributes to invasion success and persistence of *Membranipora membranacea* in the northwest Atlantic

Danielle Denley*, Anna Metaxas

*Corresponding author: danielle.denley@dal.ca

Marine Ecology Progress Series 580: 117–129 (2017)

Supplement 1

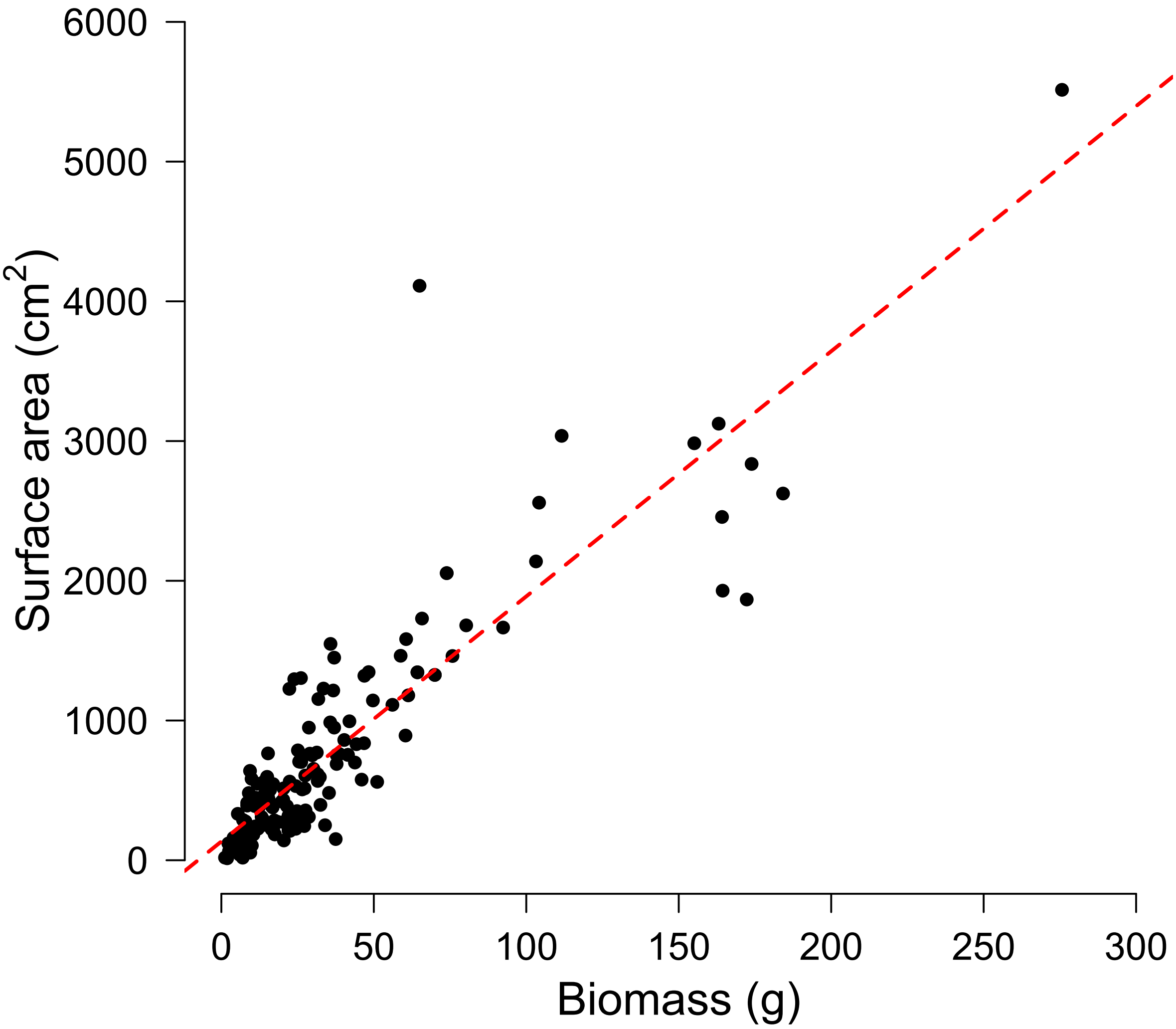

Fig. S1: The relationship between surface area (SA) and biomass (M) for 172 blades of *Agarum clathratum* collected at 3 sites (The Lodge, Paddy's Head and Sandy Cove) and 2-3 depths per site (4 and 8 m at Sandy Cove; 4, 8 and 12 m at The Lodge and Paddy's Head) from Jun 2012 to Aug 2013. [SA = 17.54 M + 134.2, R^2 = 0.78, P < 0.0001]

Supplement 2

The effect of understory kelp on bryozoan settlement

Density of kelp within kelp bed treatments

At Sandy Cove, kelp density within the kelp bed did not vary substantially over the study period (Table S1) and was significantly greater than for areas clear of kelp (4 m: One-sample *t*-test: $t = 8.45$, $df = 4$, $p = 0.001$; 8 m: One-sample *t*-test: $t = 9.97$, $df = 4$, $p = 0.0003$). At The Lodge, the abundance of kelp declined in 2012-2013, resulting in low kelp densities within "kelp beds", particularly at shallow depths (Table S1). However, the density of kelp within kelp beds remained significantly greater than for areas clear of kelp at both depths (8 m: One-sample *t*-test, $t = 2.16$, $df = 4$, $p = 0.048$; 12 m: One-sample *t*-test, $t = 6.05$, $df = 4$, $p = 0.002$). At both sites, but particularly at The Lodge, the collectors were placed to ensure that the bottom plate was completely covered by individual kelp plants, and within the immediate proximity of any cue that the kelp may have provided.

Table S1: Density of mixed kelp beds consisting of *Saccharina latissima, Laminaria digitata,* and *Agarum clathratum* at 8 m (shallow) and 12 m (deep) at The Lodge and at 4 m (shallow) and 8 m (deep) at Sand Cove in areas adjacent to (within ~ 5 m) settlement collectors placed in "kelp" treatments. During each sampling date at the Lodge, the abundance of all established kelps (>20 cm in length) was measured within a 2 x 30 m transect oriented parallel to the shore and following the specified depth contour (8 or 12 m). Kelp density was calculated for each sampling date by dividing the number of kelps by the corresponding sampling area (60 m^2). At Sandy Cove, the abundance of all established kelps was measured within 8-11 haphazardly-placed 0.5-m^2 quadrats at each of 4 and 8 m. Kelp density per 0.5 m^2 was converted to kelp density per m^2 by multiplying the abundance of kelp in each quadrat by a factor of 2. Kelp density (m^{-2}) at Sandy Cove presented for each sampling date is the average over all quadrats sampled at each depth on that date (n = 8-11). Kelp density in the corresponding areas clear of kelp was zero for all sampling dates. Settlement collectors were deployed from Sep 2012 to Nov 2013; mean kelp density is the average over all sampling dates (n = 5)

	Depth (m)	Density (m^{-2})		Depth (m)	Density (m^{-2})
The Lodge			**Sandy Cove**		
13 Sep 2012	8	0.85	25 Sep 2012	4	17.9
	12	3.2		8	16.3
20 Nov 2012	8	0.03	29 Nov 2012	4	9.5
	12	1.3		8	12
27 Mar 2013	8	0.18	15 Mar 2013	4	12.3
	12	2.7		8	10.25
01 Jun 2013	8	0.4	5 Jun 2013	4	10.25
	12	1.5		8	14.0
09 Aug 2013	8	1.6	01 Aug 2013	4	12.22
	12	2.1		8	9.5
Mean ± SD	8	0.612 ± 0.633	Mean ± SD	4	12.43 ± 3.29
(n = 5)	12	2.16 ± 0.799	(n = 5)	8	12.41 ± 2.78

Supplement 3

Table S2: The effects of understory kelp (treatment: within kelp bed, outside kelp bed), distance above the substratum (position: top plate, bottom plate), and depth (shallow, deep) on settlement of *Membranipora membranacea* and *Electra pilosa* larvae. Results of model selection using zero-inflated negative binomial models (ZINB). ZINB was chosen over zero-inflated Poisson (ZIP) to account for overdispersion in the count data. The mean (μ_i) for the count data and the probability (π_i) for the binomial distribution are modelled in terms of the fixed (treatment, position, depth) and both the fixed and random (site, date, collector) variables, respectively. Significant *p*-values shown in bold at $\alpha = 0.05$

Dropped term	df	AIC	Likelihood ratio test
Membranipora membranacea			
π_I = modelled in terms of Treatment, Position, Depth, Site, and Date			
None	17	970.6	
Treatment from μ_i	12	968.3	$\chi^2 = 3.18$ (df = 1, $p = 0.075$)
Position from μ_i	**10**	**1017**	**$\chi^2 = 36.2$ (df = 1, $p < 0.0001$)**
Depth from μ_i	**11**	**982.9**	**$\chi^2 = 16.6$ (df = 1, $p < 0.0001$)**
Treatment x position from μ_i	13	967.1	$\chi^2 = 2.58$ (df = 1, $p = 0.108$)
Treatment x depth from μ_i	14	966.5	$\chi^2 = 0.722$ (df = 1, $p = 0.395$)
Position x depth from μ_i	15	967.8	$\chi^2 = 0.942$ (df = 1, $p = 0.332$)
Treatment x position x depth from μ_i	16	968.8	$\chi^2 = 0.264$ (df = 1, $p = 0.607$)
Treatment from π_i	16	968.7	$\chi^2 = 0.124$ (df = 1, $p = 0.725$)
Position from π_i	**15**	**984.3**	**$\chi^2 = 17.6$ (df =1, $p < 0.0001$)**
Depth from π_i	14	984.3	$\chi^2 = 2.20$ (df = 1, $p = 0.138$)
Site from π_i	**13**	**1016**	**$\chi^2 = 33.9$ (df =1, $p < 0.0001$)**
Date from π_i	**10**	**1170**	**$\chi^2 = 159$ (df =1, $p < 0.0001$)**
π_I = modelled in terms of Collector			
None	89	1242	
Collector from π_i	17	1172	$\chi^2 = 74.6$ (df = 72, $p = 0.395$)
Electra pilosa			
π_I = modelled in terms of Treatment, Position, Depth, Site, and Date			
None	15	505.3	
Treatment from μ_i	10	503.0	$\chi^2 = 0.228$ (df = 1, $p = 0.633$)
Position from μ_i	8	508.7	$\chi^2 = 1.83$ (df = 1, $p = 0.176$)
Depth from μ_i	**9**	**508.8**	**$\chi^2 = 7.78$ (df = 1, $p = 0.005$)**
Treatment x position from μ_i	11	504.8	$\chi^2 = 5.43$ (df = 1, $p = 0.020$)
Treatment x depth from μ_i	12	501.4	$\chi^2 = 1.92$ (df = 1, $p = 0.165$)
Position x depth from μ_i	13	501.5	$\chi^2 = 0.169$ (df = 1, $p = 0.681$)
Treatment x position x depth from μ_i	14	503.3	$\chi^2 = 0.006$ (df = 1, $p = 0.939$)
Treatment from π_i	**14**	**508.1**	**$\chi^2 = 4.89$ (df = 1, $p = 0.028$)**
Position from π_i	13	509.2	$\chi^2 = 3.03$ (df =1, $p = 0.082$)
Depth from π_i	12	508.9	$\chi^2 = 1.75$ (df = 1, $p = 0.186$)
Site from π_i	11	507.2	$\chi^2 = 0.260$ (df =1, $p = 0.611$)
Date from π_i	**10**	**546.8**	**$\chi^2 = 41.6$ (df =1, $p < 0.0001$)**
π_I = modelled in terms of Collector			
None	89	608.2	

Dropped term	df	AIC	Likelihood ratio test
Collector from π_i	17	550.2	$\chi^2 = 86.0$ (df = 72, $p = 0.125$)

Supplement 4

The effect of strength of the settlement cue on the rate of settlement of *Membranipora membranacea* larvae in laboratory experiments

Saccharina latissima was chosen as the algal substrate for these experiments based on observations of consistently high settler abundance on this substrate in the field (D. Denley pers obs). Competent larvae were isolated from plankton samples collected from St. Margarets Bay in Sep-Oct 2016. Blades of *S. latissima* were collected during the same period from 8 m at The Lodge and/or Sandy Cove. Thirty competent larvae were introduced into 250-ml beakers of 1µm-filtered seawater containing a single small (1 cm x 1 cm) or large (2 cm x 2 cm) segment of *S. latissima.* We allowed larvae to settle over 72 h, after which *S. latissima* segments were examined for settlers. Replicates of the settlement cue experiment were conducted over the course of 4 separate trials from Sep-Oct 2016.

We used linear mixed models to determine whether the rate of settlement (number of settlers 72 h^{-1}) was affected by the strength of the settlement cue. Settlement cue (2 levels: strong cue, weak cue) was a fixed effect, with separate intercepts for the random effect of trial and random slopes for the interaction between trial and settlement cue. The number of settlers was log(x+0.01)-transformed to better approximate a normal distribution. There was no effect of strength of the settlement cue on the rate of settlement (mean number of settlers ± SD, large cue: 2.8 ± 2.9; small cue: 2.2 ± 2.7; LMM likelihood ratio test: $\chi^2_{(1)} = 0.454$, $p = 0.50$, $n = 15$).