The following supplement accompanies the article

Stability and dynamic properties of octocoral communities in the Tropical Eastern Pacific

Catalina G. Gomez*, Hector M. Guzman, Andrew Gonzalez

*Corresponding author: catalina.gomezgomez@mail.mcgill.ca

Marine Ecology Progress Series 588: 71–84 (2018)

Supplement

Transition probabilities (Table S1) and stability properties (Table S2) of octocoral species and communities, as well as diversity measurements (Table S3), were quantified from transition matrices (Table S4), which indicate the frequency at which a space occupied by an octocoral colony changed between occupations (another octocoral species or another benthic sessile organism) in eight octocoral communities off the Pacific Coast of Panama. These estimates were calculated following the formulations of Hill et al. (2004), where: "P" is the transition matrix of the stationary community (Table S4), "*j*" is the column of species *j*, "*i*" is the row of species *i*, "*s*" is a non-octocoral state, called "bare rock" in Hill et al. (2004), "p" is an entry in any given point of P, "w" is the matrix dominant eigenvector normalized to sum to 1, "λ_1" and "λ_2"are the largest and second largest eigenvalues of P.

Table S1. Transition probabilities

	Species	Community
Colonization of *j*	$= p_{js}$	$= \sum_{i \neq s} p_{is} = 1 - p_{ss}$
Disturbance of *j*	$= p_{sj}$	$= \frac{\sum_{j \neq s} w_j p_{sj}}{\sum_{j \neq s} w_j}$
Replacement of *j*	$= 1 - p_{jj} - p_{sj}$	$= \frac{\sum_{i \neq s} w_i (1 - p_{ii} - p_{si})}{\sum_{i \neq s} w_i}$
Replacement by *j*	$= \frac{1}{s-2} \sum_{j \neq i, s} p_{ij}$	$= \frac{\frac{1}{s-2} \sum_{i \neq s} w_i \sum_{j \neq i, s} p_{ij}}{\sum_{i \neq s} w_i}$
Persistence of *j*	$= p_{jj}$	

Table S2. Stability properties

	Species	Community
Turnover rate of *i*	T = (1-p_{ii})	
Turnover time of *i*	= 1/ T	$\bar{\tau}_{\text{bio}} = \frac{\sum_{i \neq s} \frac{w_i}{\mathcal{T}_i}}{\sum_{i \neq s} w_i}.$
Recurrence time	$\theta_i = \frac{1 - w_i}{w_i(1 - p_{ii})}$	$\bar{\theta} = \sum_i w_i \theta_i,$
Entropy (Predictability)	$H(\mathbf{p}_{,j}) = -\sum_i p_{ij} \log p_{ij}.$	$H(\mathbf{P}) = -\sum_{j=1}^{s} w_j \sum_{i=1}^{s} p_{ij} \log p_{ij}.$ Normalized entropy= $H_r(\mathbf{P}) = \frac{H(\mathbf{P})}{H_{\max}(\mathbf{P})}.$

Table S3. Diversity measurements

Proportion of octocoral states	$w_i' = \frac{w_i}{1 - w_s} \quad i \neq s,$
Shannon-Wiener index	$H(\mathbf{w}') = -\sum_i w_i' \log w_i'.$
Community evenness	$J = \frac{H(\mathbf{w}')}{\log s}.$

Table S4. Octocoral transition matrices of the stationary community for each gulf (Gulf of Panama and Gulf of Chiriqui) and eight reefs off the Pacific coast of Panama. Transition probabilities were quantified by monitoring four 1m^2 fix plots per reef and counting the number of times each location occupied by an octocoral colony changed between states (occupation by another octocoral species or another sessile benthic organism) between June 2014 and January 2016. Warmer colors indicate higher transition values. Temporal mean ± standard error. Crustose coralline algae (CCA), algae turf (Turf).

Gulf of Chiriqui

	L.alba	*P.cairnsi*	*L.coffrini*	*P.irene*	*P.rubicunda*	*P.ferruginea*	*M.austera*	*P.arbuscula*	*H.verrucosa*	*C.riseii*	*P.eximia*	*L.cuspidata*	**Sponge**	**CCA**	**Turf**
L.alba	.50±.07	.0	.0	.01±.01	.0	.0	.0	.0	.0	.0	.0	.0	.0	.05±.03	.09±.01
P.cairnsi	.0	.57±.23	.0	.0	.22±.26	.0	.0	.0	.0	.57±	.0	.0	.24±.28	.08±.08	.13±.04
L.coffrini	.0	.0	.78±.10	.0	.0	.0	.0	.0	.0	.29±	.0	.0	.0	.01±.02	.0
P.irene	.0	.19±.19	.0	.48±.25	.0	.0	.0	.0	.0	.0	.0	.0	.0	.02±.02	.0
P.rubicunda	.0	.0	.0	.0	.67±.03	.0	.0	.0	.0	.0	.0	.0	.0	.03±.01	.06
P.ferruginea	.0	.0	.0	.0	.0	.84	.0	.0	.0	.0	.0	.0	.0	.13	.0
M.austera	.0	.0	.0	.0	.0	.0	.96	.0	.0	.0	.0	.0	.0	.04	.04
P.arbuscula	.0	.0	.0	.0	.0	.0	.0	.85	.0	.0	.0	.0	.0	.0	.02
H.verrucosa	.26±.27	.0	.0	.0	.0	.0	.0	.0	.42±.32	.0	.0	.0	.0	.11±.11	.05±.05
C.riseii	.01±.01	.14±.12	.0	.01±	.02	.0	.0	.0	.0	.0	.0	.0	.0	.14±.14	.03±.03
P.eximia	.0	.0	.0	.40±.34	.0	.0	.0	.0	.0	.0	.83	.0	.35	.05±.06	.04±.04
L.cuspidata	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1	.0	.0	.0
Sponge	.03±.05	.0	.0	.01±.01	.02±.02	.0	.0	.0	.09±.07	.0	.0	.0	.24±.29	.02±.02	.12±.13
CCA	.10±.10	.06±.05	.22±.10	.05±.03	.01±.01	.16	.0	.0	.36±.28	.0	.0	.0	.0	.30±.14	.05±.04
Turf	.10±.26	.04±.27	.0	.04±.33	.06±.32	.0	.04	.15	.13±.32	.14±	.17±	.0	.18±.18	.03±.28	.37±.14

Gulf of Panama

	L.alba	*L.coffrini*	*P.irene*	*P.ferruginea*	*P.firma*	*M.austera*	*C.riseii*	**Pocillopora**	**CCA**	**Turf**
L.alba	.56±.07	.07±.07	.0	.0	.0	.0	.0	.0	.08±.08	.24±.01
L.coffrini	.0	.58±.07	.0	.0	.0	.0	.0	1	.08±.05	.16±.11
P.irene	.0	.0	.70±.15	.0	.0	.0	.0	.0	.01	.0
P.ferruginea	.0	.0	.0	.76	.0	.0	.0	.0	.16	.0
P.firma	.0	.0	.0	.0	.86±.09	.0	.0	.0	.01±.01	.0
M.austera	.0	.0	.0	.0	.0	.83±.29	.0	.0	.09	.01±.01
C.riseii	.04	.0	.0	.0	.0	.0	.0	.0	.0	.05
Pocillopora	.0	.10	.0	.0	.0	.0	.0	.0	.0	.0
CCA	.11±.07	.11±.10	.22	.24	.03±.02	.0	.0	.0	.39±.02	.02±.02
Turf	.28±.12	.13±.08	.08±.06	.0	.11±.10	.17±.06	1	.0	.18±.12	.52±0.4

Roca Hacha	L.alba	P.cairnsi	L.coffrini	P.irene	P.rubicunda	M.austera	P.arbuscula	H.verrucosa	P.eximia	**Sponge**	**CCA**	**Turf**
L.alba	.75±.1	.0	.0	.02±.02	.0	.0	.0	.0	.0	.0	.09±.06	.14±.08
P.cairnsi	.0	.72±.08	.0	.0	.0	.0	.0	.0	.0	.0	.11±.08	.08±.04
L.coffrini	.0	.0	.67±.3	.0	.0	.0	.0	.0	.0	.0	.0	.0
P.irene	.0	.0	.0	.85±.03	.0	.0	.0	.0	.0	.0	.03±.03	.0
P.rubicunda	.0	.0	.0	.0	.89±.02	.0	.0	.0	.0	.0	.03±.03	.08±.08
M.austera	.0	.0	.0	.0	.0	.96±.04	.0	.0	.0	.0	.05±.03	.06±.06
P.arbuscula	.0	.0	.0	.0	.0	.0	.85±.1	.0	.0	.0	.0	.02±.02
H.verrucosa	.0	.0	.0	.0	.0	.0	.0	.92±.08	.0	.0	.0	.0
P.eximia	.0	.0	.0	.0	.0	.0	.0	.0	.83±.16	.5±.3	.0	.0
Sponge	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.03±.03
CCA	.06±.03	.21±.06	.66±.33	.07±.04	.02±.02	.0	.0	0	.0	.0	.67±.12	.07±.07
Turf	.19±.1	.08±.05	.0	.06±.04	.08±.01	.04±.04	.15±.1	.08±.08	.17±.16	.5±.3	.02±.02	.52±.1

Jicarita	L.alba	P.cairnsi	L.coffrini	P.irene	P.rubicunda	P.ferruginea	**CCA**
L.alba	.57±.07	.0	.0	.0	.0	.0	.13±.04
P.cairnsi	.0	1	.0	.0	.0	.0	.0
L.coffrini	.0	.0	.67±.33	.0	.0	.0	.05±.04
P.irene	.0	.0	.0	.88±.08	.0	.0	.06±.06
P.rubicunda	.0	.0	.0	.0	.97±.03	.0	.05±.03
P.ferruginea	0	.0	.0	.0	.0	.84±.09	.2±.05
CCA	.43±.07	.0	.33±.33	.12±.08	.03±0.3	.16±.09	.52±.15

Prosper	L.alba	P.cairnsi	L.coffrini	C.reseii	L.cuspidata	**Tubastrea**	**Sponge**	**CCA**	**Turf**
L.alba	.87±.02	.0	.0	.0	.0	.0	.0	.0	.11±.06
P.cairnsi	.0	.89±.04	.0	.57±.19	.0	1	1	.36±.14	.22±.11
L.coffrini	.0	.0	1	.29±.1	.0	.0	.0	.0	.0
C.reseii	.0	.0	.0	.0	.0	.0	.0	.0	.0
L.cuspidata	.0	.0	.0	.0	1	.0	.0	.0	.0
Tubastrea	.0	.0	.0	.0	.0	.0	.0	.0	.0
Sponge	.0	.0	.0	.0	.0	.0	.0	.03±.03	.0
CCA	.08±.02	.05±.03	.0	.0	.0	.0	.0	.55±.05	.15±.08
Turf	.06±.00	.05±.02	..0	.14±.05	.0	.0	.0	.06±.06	.52±.14

Catedrales	L.alba	P.cairnsi	P.irene	P.rubicunda	H.verrucosa	**CCA**	**Turf**
L.alba	.77±.03	.0	.0	.0	.0	.32±.19	.13±.02
P.cairnsi	.0	.67±.33	.0	.0	.0	.0	.0
P.irene	.0	.0	.95±.03	.0	.0	.16±.10	.10±.05
P.rubicunda	.0	.0	.0	.89±.11	.0	.02±.02	.22±.15
H.verrucosa	.0	.0	.0	.0	.79±.19	.02±.02	.0
CCA	.04±.02	.33±.33	.02±.02	.03±.03	.0	.40±.30	.09±.08
Turf	.19±.01	.0	.03±.03	.08±.08	.21±.17	.07±.07	.46±.22

Elefante	*L.alba*	*L.coffrini*	*P.irene*	*P.firma*	*M.austera*	*C.riseii*	**Turf**
L.alba	.67±.22	.0	.0	.0	.0	.0	.27±.09
L.coffrini	.0	.67±.18	.0	.0	.0	.0	.11±.11
P.irene	.0	.0	1	.0	.0	.0	.0
P.firma	.0	.0	.0	.67±.33	.0	.0	.0
M.austera	.0	.0	.0	.0	.83±.17	.0	.02±.02
C.riseii	.04±.04	.0	.0	.0	.0	.0	.06±.06
Turf	.29±.23	.33±0.18	.0	.33±.33	.17±.17	1±.33	.55±.17

San Telmo	*L.alba*	*L.coffrini*	*P.irene*	*P.firma*	**CCA**	**Turf**
L.alba	.70±0.18	.0	.0	.0	.21±.10	.24±.14
L.coffrini	.0	.61±.19	.0	.0	.20±.08	.10±.11
P.irene	.0	.0	.58±.21	.0	.02±.02	.0
P.firma	.0	.01±.01	.0	.93±.04	.02±.02	.0
CCA	.22±.14	.35±.19	.25±.12	.07±.04	.54±.17	.06±.07
Turf	.08±.05	.03±.00	.17±.10	.0	.02±.01	.60±.24

Galera	*L.coffrini*	*P.ferruginea*	*P.firma*	*M.austera*	**Pocillopora**	**CCA**	**Turf**
L.coffrini	.86±.10	.0	.0	.0	1	.08±.08	.5±.29
P.ferruginea	.0	.76±.12	.0	.0	.0	.19±.10	.0
P.firma	.0	.0	1	.0	.0	.0	.0
M.austera	.0	.0	.0	1	.0	.11±.11	.0
Pocillopora	.11±.11	.0	.0	.0	.0	.0	.0
CCA	.03±.03	.24±.12	.0	.0	.0	.44±.29	.0
Turf	.0	.0	.0	.0	.0	.17±.17	.5±.29

Pedro Gonzalez	*L.alba*	*L.coffrini*	**CCA**	**Turf**
L.alba	.44±.09	.25±.17	.0	.31±.15
L.coffrini	.01±.01	.50±.33	.0	.0
CCA	.02±.02	.0	.50±.33	.02±.02
Turf	.53±.07	.25±.17	.50±.33	.67±.18

References

Hill MF, Witman JD, Caswell H (2004) Markov chain analysis of succession in a rocky subtidal community. The American Naturalist 164: E46-E61