

Supplementary Material

**Intertidal Biogeographic Subprovinces: Local and Regional Factors
Shaping Fish Assemblages**

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This Supplementary file includes Tables S1 to S7.

TABLES

Table S1. Categories and environmental variables considered for analysis.

Category	Variables
Landscape	Distance to subtidal area - DSA (m) Distance to plateau (m) Shape of rock formation - SRF ($R = D1/D2$) Fractal dimension - Frac Perimeter of rock formation (m) Area of rock formation - ARF (m^2) Pool planar area (m^2) Pool area (m^2) Pool volume (m^3)
Substrate	Rugosity % Algae cover % Mud % Sand % Gravel % Rock Carbonate Ferruginous sandstone Sandstone Pool max depth (cm)
Local and regional	Latitude Rainfall (mm) Temperature ($^{\circ}C$) pH Salinity Tidal range (m)

Table S2. PERMANOVA results of environmental data based from Euclidian distance values of "site" (random, nested within subprovince) and "subprovince" effects. The pseudo- F and probability values [P (perm)] were computed though the PERMANOVA routine with 9,999 permutations of tidepool samples ($n = 149$). Samples with no fish data ($N = 3$) were removed from analysis. The estimated sizes of effects for each source in the model are shown in Euclidian distance units as the square root of the components of variation, and variation attributable to each individual source is also expressed as a percentage of the total (%).

Source	df	SS	MS	Pseudo- F	P (perm)	Sqrt (component of variation)	%
Subprovince	3	1117.5	372.5	4.2965	0.0001	2.8643	30.6
Site (nested in subprovince)	15	1304.1	86.9	10.056	0.0001	3.1601	37.2
Residual	130	1123.9	8.6			2.9403	32.2
Total	148	3548.4					

Table S3. Taxonomic list, trophic groups, residency status and density (individuals / m³) in tidepools of four Brazilian subprovinces: Amazon estuary = AE; Northern mangrove = NM; Northeastern semiarid = NS; Tropical warm = TW. Trophic group: Carn = carnivore; Omni = omnivore; Herb = herbivore. R = resident; NR = non-resident. Family order follows Nelson (2006). Epinephelidae follow Craig and Hastings (2007) and Craig *et al.* (2011), and Labridae follow Westneat and Alfaro (2005).

Family / <i>Taxa</i>	Trophic group	Residency status	Subprovince			
			AE	NM	NS	TW
Muraenidae						
<i>Enchelycore nigricans</i> (Bonaterre, 1788)	Carn	R	—	—	—	0.736 ± 3.438
<i>Gymnothorax funebris</i> Ranzani, 1840	Carn	NR	—	0.076 ± 0.371	0.030 ± 0.190	3.017 ± 9.820
<i>Gymnothorax moringa</i> (Cuvier,1829)	Carn	R	—	—	—	0.256 ± 1.078
<i>Gymnothorax vicinus</i> (Castelnau, 1855)	Carn	NR	—	—	—	0.092 ± 0.740
Ophichthidae						
<i>Ahlia egmontis</i> (Jordan, 1884)	Carn	R	—	—	2.258 ± 13.11	0.598 ± 2.825
<i>Ichthyapus ophioneus</i> (Evermann & Marsh, 1900)	Carn	R	0.698 ± 3,419	—	—	—
<i>Myrichthys ocellatus</i> (Lesueur, 1825)	Carn	NR	—	—	—	0.477 ± 1.898
Batrachoididae						
<i>Batrachoides surinamensis</i> (Bloch & Schneider, 1801)	Carn	NR	1.134 ± 2.915	0.457 ± 2.239	1.034 ± 6.541	—
<i>Thalassophryne nattereri</i> Steindachner, 1876	Carn	NR	—	8.996 ± 22.87	1.203 ± 6.556	0.250 ± 2.000
Mugilidae						
<i>Mugil curema</i> Valenciennes, 1836	Herb	NR	—	12.65 ± 24.12	0.583 ± 3.686	—
<i>Mugil hospes</i> Jordan & Culver, 1895	Herb	NR	—	3.351 ± 16.42	—	—
<i>Mugil liza</i> (Valenciennes,1836)	Herb	NR	—	10.58 ± 34.01	1.680 ± 7.263	0.074 ± 0.589
Atherinopsidae						
<i>Atherinella brasiliensis</i> (Quoy & Gaimard, 1825)	Herb	NR	6.336 ± 20.91	—	—	—
Holocentridae						
<i>Holocentrus adscensionis</i> (Osbeck, 1771)	Carn	NR	—	—	—	0.053 ± 0.421
Syngnathidae						
<i>Anarchopterus tectus</i> (Dawson, 1978)	Carn	NR	—	—	1.172 ± 5.426	—
<i>Bryx</i> cf. <i>dunckeri</i> (Metzelaar, 1919)	Carn	NR	0.223 ± 1.090	—	—	—
<i>Micrognathus crinitus</i> (Jenyns, 1842)	Carn	NR	—	—	—	0.026 ± 0.211
Scorpaenidae						
<i>Scorpaena plumieri</i> Bloch, 1789	Carn	NR	—	—	—	0.132 ± 1.058

Table S3 (Continued). Taxonomic list, trophic groups, residency status and density (individuals / m³) in tidepools of four Brazilian subprovinces: Amazon estuary = AE; Northern mangrove = NM; Northeastern semiarid = NS; Tropical warm = TW. Trophic group: Carn = carnivore; Omni = omnivore; Herb = herbivore. R = resident; NR = non-resident. Family order follows Nelson (2006). Epinephelidae follow Craig and Hastings (2007) and Craig *et al.* (2011), and Labridae follow Westneat and Alfaro (2005).

Family / Taxa	Trophic group	Residency status	Subprovince			
			AE	NM	NS	TW
Epinephelidae						
<i>Cephalopholis fulva</i> (Linnaeus, 1758)	Carn	NR	–	–	–	0.158 ± 0.749
<i>Epinephelus adscensionis</i> (Osbeck, 1765)	Carn	NR	–	–	–	0.689 ± 2.916
<i>Rypticus subbifrenatus</i> Gill, 1861	Carn	NR	–	–	–	0.026 ± 0.211
Apogonidae						
<i>Apogon americanus</i> Castelnau, 1855	Carn	NR	–	–	–	0.360 ± 2.086
Lutjanidae						
<i>Lutjanus alexandrei</i> Moura e Lindeman, 2007	Carn	NR	–	0.731 ± 1.859	2.900 ± 8.126	0.065 ± 0.518
<i>Lutjanus jocu</i> (Bloch & Schneider, 1801)	Carn	NR	–	0.597 ± 2.926	2.661 ± 13.25	–
<i>Lutjanus synagris</i> (Linnaeus, 1758)	Carn	NR	–	2.044 ± 9.419	2.312 ± 13.13	–
Gerreidae						
<i>Eucinostomus melanopterus</i> (Bleeker, 1863)	Carn	NR	–	–	–	0.753 ± 4.708
Haemulidae						
<i>Genyatremus luteus</i> (Bloch, 1790)	Carn	NR	–	5.858 ± 11.03	–	–
<i>Haemulon aurolineatum</i> Cuvier, 1830	Carn	NR	–	–	0.081 ± 0.513	–
<i>Haemulon parra</i> (Desmarest, 1823)	Carn	NR	–	–	12.39 ± 71.91	–
<i>Orthopristis ruber</i> (Cuvier, 1830)	Carn	NR	–	–	–	0.330 ± 2.640
<i>Pomadasys corvinaeformis</i> (Steindachner, 1868)	Carn	NR	–	0.597 ± 2.926	–	–
Pomacentridae						
<i>Abudefduf saxatilis</i> (Linnaeus, 1758)	Omni	NR	–	–	15.68 ± 45.72	1.554 ± 4.533
<i>Stegastes fuscus</i> (Cuvier, 1830)	Herb	NR	–	–	–	13.95 ± 41.89
<i>Stegastes variabilis</i> (Casteunal, 1855)	Herb	NR	–	–	–	11.11 ± 29.75
Labridae						
<i>Sparisoma axillare</i> (Steindachner, 1878)	Herb	NR	–	–	–	0.397 ± 3.174
<i>Sparisoma frondosum</i> (Agassiz, 1831)	Herb	NR	–	–	0.576 ± 2.056	–

Table S3 (Continued). Taxonomic list, trophic groups, residency status and density (individuals / m³) in tidepools of four Brazilian subprovinces: Amazon estuary = AE; Northern mangrove = NM; Northeastern semiarid = NS; Tropical warm = TW. Trophic group: Carn = carnivore; Omni = omnivore; Herb = herbivore. R = resident; NR = non-resident. Family order follows Nelson (2006). Epinephelidae follow Craig and Hastings (2007) and Craig *et al.* (2011), and Labridae follow Westneat and Alfaro (2005).

Family / Taxa	Trophic group	Residency status	Subprovince			
			AE	NM	NS	TW
Dactyloscopidae						
<i>Dactyloscopus tridigitatus</i> Gill, 1859	Carn	R	–	–	–	0.079 ± 0.632
Blenniidae						
<i>Entomacrodus vomerinus</i> (Valenciennes, 1836)	Herb	R	–	–	–	40.28 ± 164.2
<i>Lupinoblennius paivai</i> (Pinto, 1958)	Omni	R	3.402 ± 12.85	–	–	–
<i>Omobranchus punctatus</i> (Valenciennes, 1836)	Omni	R	–	11.65 ± 18.13	2.193 ± 6.651	1.266 ± 8.449
<i>Scartella cristata</i> (Linnaeus, 1758)	Herb	R	–	–	684.8 ± 1770.0	246.4 ± 689.8
<i>Hypleurochilus fissicornis</i> (Quoy & Gaimard, 1824)	Omni	NR	–	–	1.509 ± 6.021	0.105 ± 0.842
<i>Ophioblennius trinitatis</i> Miranda-Ribeiro, 1919	Herb	R	–	–	0.112 ± 0.706	0.092 ± 0.740
<i>Parablennius</i> sp.		NR	–	–	0.090 ± 0.571	–
Labrisomidae						
<i>Labrisomus nuchipinnis</i> (Quoy & Gaimard, 1824)	Carn	R	–	–	0.708 ± 1.898	13.78 ± 24.95
<i>Malaccoctenus delalandei</i> (Valenciennes, 1836)	Carn	R	–	–	7.180 ± 27.99	5.723 ± 24.74
<i>Paraclinus arcanus</i> Guimarães & Bacellar, 2002	Carn	R	–	–	0.340 ± 1.607	–
<i>Paraclinus</i> sp.	Carn	R	–	–	1.185 ± 6.587	–
Chaenopsidae						
<i>Emblemariopsis signifer</i> (Ginsburg, 1942)	Carn	NR	–	–	0.491 ± 3.103	0.116 ± 0.925
Gobiesocidae						
<i>Gobiesox barbatulus</i> Starks, 1913	Carn	R	–	23.87 ± 45.02	0.197 ± 1.247	1.160 ± 9.282
<i>Tomicodon</i> sp.	Carn	R	–	–	0.151 ± 0.956	1.739 ± 13.91
Eleotridae						
<i>Eleotris</i> sp.	Carn	R	1.305 ± 4.420	–	–	–
Gobiidae						
<i>Barbulifer ceuthoecus</i> (Jordan & Gilbert, 1884)	Carn	R	–	–	–	0.080 ± 0.644
<i>Barbulifer enigmaticus</i> Joyeux, Van Tassell & Macieira, 2009	Carn	R	–	11.97 ± 21.50	2.069 ± 13.08	–
<i>Bathygobius geminatus</i> Tornabene, Baldwin & Pezold, 2010	Carn	R	–	–	6.913 ± 16.07	92.76 ± 218.0

Table S3 (Continued). Taxonomic list, trophic groups, residency status and density (individuals / m³) in tidepools of four Brazilian subprovinces: Amazon estuary = AE; Northern mangrove = NM; Northeastern semiarid = NS; Tropical warm = TW. Trophic group: Carn = carnivore; Omni = omnivore; Herb = herbivore. R = resident; NR = non-resident. Family order follows Nelson (2006). Epinephelidae follow Craig and Hastings (2007) and Craig *et al.* (2011), and Labridae follow Westneat and Alfaro (2005).

Family / Taxa	Trophic group	Residency status	Subprovince			
			AE	NM	NS	TW
Gobiidae						
<i>Bathygobius soporator</i> (Valenciennes, 1837)	Carn	R	225.9 ± 298.2	13.60 ± 25.44	16.75 ± 26.35	94.48 ± 260.6
<i>Ctenogobius boleosoma</i> (Jordan & Gilbert, 1882)	Omni	R	0.498 ± 1.689	0.299 ± 1.463	–	11.70 ± 34.18
<i>Evorthodus lyricus</i> (Girard, 1858)	Omni	R	0.132 ± 0.646	–	–	–
<i>Gobiosoma alfei</i> Joyeux & Macieira 2015	Carn	R	–	2.838 ± 8.980	8.499 ± 40.41	0.268 ± 1.337
<i>Gobiosoma</i> spp.	Carn	R	5.130 ± 10.20	–	–	–
Microdesmidae						
<i>Microdesmus bahianus</i> Dawson, 1973	Carn	R	–	0.761 ± 3.729	–	0.137 ± 1.100
Ephippidae						
<i>Chaetodipterus faber</i> (Broussonet,1782)	Carn	NR	–	0.457 ± 2.239	–	–
Acanthuridae						
<i>Acanthurus bahianus</i> Castelnau, 1855	Herb	NR	–	–	0.106 ± 0.672	0.169 ± 1.351
<i>Acanthurus chirurgus</i> (Bloch, 1787)	Herb	NR	–	–	0.131 ± 0.831	–
Paralichthyidae						
<i>Citharichthys arenaceus</i> Evermann & Marsh, 1900	Carn	NR	–	0.547 ± 1.955	–	–
Tetraodontidae						
<i>Colomesus psittacus</i> (Bloch & Schneider, 1801)	Carn	NR	0.223 ± 1.090	–	–	–
<i>Sphoeroides greeleyi</i> Gilbert, 1900	Carn	NR	–	–	0.188 ± 1.190	–

Table S4. Fish family presence/absence in intertidal subprovinces. Asterisks (*) denote families that contained only marine permanent resident species.

Family	AE	NM	NS	TW
Acanthuridae*	0	0	1	1
Apogonidae*	0	0	0	1
Atherinopsidae	1	0	0	0
Batrachoididae	1	1	1	1
Blenniidae	1	1	1	1
Chaenopsidae*	0	0	1	1
Dactyloscopidae	0	0	0	1
Eleotridae	1	0	0	0
Ephippidae	0	1	0	0
Epinephelidae*	0	0	0	1
Gerreidae	0	0	0	1
Gobiesocidae	0	1	1	1
Gobiidae	1	1	1	1
Haemulidae	0	1	1	1
Holocentridae*	0	0	0	1
Labridae*	0	0	1	1
Labrisomidae*	0	0	1	1
Lutjanidae	0	1	1	1
Microdesmidae	0	1	0	1
Mugilidae	0	1	1	1
Muraenidae*	0	1	1	1
Ophichthidae	1	0	1	1
Paralichthyidae	0	1	0	0
Pomacentridae*	0	0	1	1
Scorpaenidae*	0	0	0	1
Syngnathidae	1	0	1	1
Tetraodontidae	1	0	1	0

Table S5. Species richness, number and rate of exclusive species, and number of local endemics of intertidal subprovinces.

Subprovince	Richness	Exclusive species	Exclusive species rate (%)	Local endemics
AE	11	6	55	2
NM	20	4	20	—
NS	32	8	25	1
TW	40	19	48	—

Table S6. Summary of PERMANOVA analysis based on Bray-Curtis similarity values to test for "site" (random, nested within subprovince) and "subprovince" effects on fish fauna composition (density / ind.m⁻³). The pseudo-F value and the probability values [P (perm)] are computed by the PERMANOVA routine with 9,999 permutations on tidepool samples (n = 149).

Source	df	SS	MS	Pseudo-F	P (perm)	Sqrt (component of variation)	%
Subprovince	3	1.31e ⁵	43658	3.6161	0.0001	30.079	22.5
Site (nested in subprovince)	15	1.81e ⁵	12060	6.659	0.0001	36.157	32.5
Residual	130	2.35e ⁵	1811.1			42.557	45.0
Total	148	5.47e ⁵					

Table S7. Results of a distance-based linear modeling analysis using Step-wise procedure and 9,999 permutations determining the suite of environmental variables that describe significant proportions of the variation.

Environmental variables	BIC	SS (trace)	Pseudo-F	<i>p</i>	%
Marginal tests					
Pool planar area (m ²)	—	15866	4.389	0.0001	2.9
Pool volume (m ³)	—	16802	4.656	0.0003	3.1
Rugosity	—	5932.5	1.611	0.1053	1.1
Temperature °C	—	7098.2	1.932	0.0496	1.3
pH	—	14182	3.910	0.0009	2.6
Salinity	—	61866	18.734	0.0001	11.3
Tidal range (m)	—	45763	13.413	0.0001	8.4
% Mud	—	8869.1	2.421	0.0037	1.6
% Sand	—	4004	1.083	0.3473	0.7
% Gravel	—	7639.7	2.081	0.0358	1.4
% Rock	—	7307.5	1.989	0.0417	1.3
% Algae cover	—	47608	14.005	0.0001	8.7
Distance to subtidal area - DSA (m)	—	26529	7.488	0.0001	4.8
Distance to plateau (m)	—	8848.1	2.416	0.0165	1.6
Pool max depth (cm)	—	17287	4.795	0.0002	3.2
Area of rock formation (m ²)	—	22049	6.171	0.0001	4.0
Shape of rock formation - SRF (R = D1/D2)	—	45429	13.306	0.0001	8.3
Frac	—	16707	4.629	0.0001	3.1
Rainfall (mm)	—	40559	11.765	0.0001	7.4
Latitude	—	49770	14.705	0.0001	9.1
Carbonate	—	9350.9	2.555	0.0099	1.7
Ferruginous sandstone	—	50219	14.851	0.0001	9.2
Sandstone	—	37067	10.679	0.0001	6.8
Sequential tests					
Salinity	1215.3	61866	18.734	0.0001	11.3
Tidal range (m)	1209.1	35142	11.394	0.0001	6.4
SRF - Shape of rocky shore formation (R = D1/D2)	1203.7	30137	10.400	0.0001	5.5
% Algae cover	1199.5	25373	9.2547	0.0001	4.6
DSA - Distance to subtidal area (m)	1198.3	16123	6.0885	0.0001	2.9
Latitude	1198.2	12527	4.8581	0.0001	2.3
Rainfall (mm)	1197.4	141816	5.6809	0.0001	2.6