

Trophic structure of benthic communities in the Cabo Frio upwelling system (southeastern Brazilian shelf): a temporal study using stable isotope analysis

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Supplement. Detailed information on stable isotope ratios of carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$) for consumers on the inner and outer shelf off Cabo Frio, SE Brazil, under different oceanographic conditions. They are listed by general trophic mode (Table S1); more detailed trophic mode is also given (Table S2).

Table S1. Mean or single $\delta^{13}\text{C}$ (‰) values for the consumers sampled in the 3 study periods on the inner and outer shelves off Cabo Frio; n: number of samples; * composite samples; SD: standard deviation; n.i.: not identified

Group/Species	Code	$\delta^{13}\text{C}$ (‰)								
		Summer 2001			Winter 2001			Summer 2002		
		n	Mean	SD	n	Mean	SD	n	Mean	SD
Cabo Frio – inner shelf										
Pelagic consumers										
Zooplankton	Zoop	3	-19.34	1.13	3	-19.54	0.21	3	-19.24	0.5
Benthic consumers										
Suspension feeders										
Bivalvia	<i>Angulus versicolor</i> , <i>Tellina petitiana</i>	Tell	1*	-17.12		1*	-16.62		1*	-16.67
	<i>Pitar rostratus</i>	Piro	1	-17.17						
	<i>Trachycardium muricatum</i>	Trmu	1	-17.59						
Deposit feeders										
Polychaeta	Ampharetidae	Amph	1*	-17.04					1*	-16.90
	Capitellidae	Capi				1*	-16.14			
	Magelonidae	Magel				1*	-18.67		1*	-18.48
	Maldanidae	Mald	2*	-17.37	0.28	1*	-17.03		1*	-16.80
	Orbiniidae	Orbi				1*	-18.23		1*	-16.36

Echiura		Echiu			1	-17.40		1	-15.19		
Bivalvia	<i>Adrana patagonica</i>	Adpa	1*	-17.17							
Amphipoda	Gammaridea	Gamm	1*	-17.31							
	Maeridae	Maer			1*	-18.07					
	Phoxocephalidae	Phox			1*	-16.80					
Ophiuroidea	<i>Amphiura complanata, Ophiactis savagi</i>	Amco/Opsa	6*	-18.06	0.16						
Carnivores											
Anthozoa, Actiniaria	<i>Calliactis tricolor</i>	Catr	1*	-14.99		1	-17.31	1*	-17.50		
Nemertea		Neme	1*	-16.12		1	-15.12	1	-15.61		
Polychaeta	<i>Aphrodita</i> sp	Aphr						1*	-15.82		
	Glyceridae and/or Goniadidae	Glyc/Goni	1*	-16.83		1*	-16.04	1*	-16.51		
	Lumbrineridae	Lumb				1*	-17.13				
	Nephtyidae	Neph				1*	-16.40	1*	-16.01		
	Onuphidae	Onup	1*	-17.45							
	Onuphidae, Lumbrineridae, Polynoidae	PolyC						1*	-16.81		
	Polychaeta (n.i.)	PolyC				1*	-17.93				
Gastropoda	<i>Adelomelon beckii</i>	Adbe						2*	-15.36	0.37	
	<i>Amalda dimidiata, Carinodrillia braziliensis</i>	Amdi/Cari						1*	-16.77		
	<i>Anachis</i> sp.	Anac						1	-14.87		
	<i>Buccinanops cochlidium</i>	Buco				2*	-15.51	0.23			
	<i>Olivella defiorei</i>	Olde				1*	-17.23				
	<i>Pleurobranchus areolatus</i>	Plar	1*	-18.17				1*	-17.07		
	<i>Tonna galea</i>	Toga				2*	-16.13	1.07			
	<i>Zidona dufresnei</i>	Zidu	1	-15.05		1	-14.69	2*	-15.03	0.78	
Isopoda	<i>Politolana eximia</i>	Poli	1*	-14.69							
Penaeidae	<i>Farfantepenaeus brasiliensis</i>	Fabr	4*	-15.38	1.17			2*	-14.58	0.56	
	Penaeidae juveniles (<2 cm)	Pena j				1*	-18.19				
	<i>Trachypenaeus constrictus</i>	Trco				1*	-16.73				
Palinura	<i>Scyllarides brasiliensis</i>	Scbr						1	-16.25		
Stomatopoda	<i>Squilla brasiliensis</i>	Sqbr				1*	-18.29				
Anomura	<i>Dardanus insignis</i>	Dain	8*	-15.85	0.15	1*	-16.07	2*	-15.74	0.12	
	<i>Pagurus exilis</i>	Paex				1*	-15.76				
Brachyura	<i>Achelous spinicarpus</i>	Acsp	7*	-17.22	0.30		-	7*	-16.90	0.18	
	<i>Arenaeus cribrarius</i>	Arcr				2*	-14.89	0.55			
	<i>Hepatus pudibundus</i>	Hepu				5*	-15.67	0.21			
	<i>Leurocyclus tuberculatus</i>	Letu	3*	-17.27	0.09	2*	-16.18	0.21	4*	-16.28	0.16
	<i>Libinia spinosa</i>	Lisp	7*	-16.98	0.21				7*	-16.25	0.36
	<i>Persephona mediterranea</i>	Peme				2*	-15.23	0.18			
Asteroidea	<i>Astropecten brasiliensis</i>	Asbr	4*	-17.14	0.34	2	-14.60	1.68	2*	-15.67	0.11
	<i>Luidia clathrata</i>	Luch	4*	-16.54	0.82	2	-13.99	1.80			
	<i>Luidia ludwigi scotti</i>	Lusc							2*	-12.97	1.29
Fishes		Fish	4	-17.32	0.37	26	-16.51	0.76	27	-17.09	0.63

Group/Species	Code	Summer 2001			Winter 2001			Summer 2002			
		n	Mean	SD	n	Mean	SD	n	Mean	SD	
<u>Cabo Frio - Outer shelf</u>											
Pelagic consumers											
Zooplankton	Zoop	3	-19.17	0.54	3	-19.24	0.5	5	-20.71	0.81	
Benthic consumers											
Suspension feeders											
Bivalvia	Bivalvia (n.i.)							1*	-17.67		
	<i>Corbula patagonica</i>				1*	-18.93					
Amphipoda	Ampeliscidae				1*	-20.21		1*	-18.24		
Deposit feeders											
Sipuncula		1*	-19.11					1*	-18.88		
Polychaeta	Magelonidae							1*	-18.89		
	Maldanidae				1*	-18.09		1*	-17.15		
	Orbiniidae							1*	-18.17		
	Polychaeta (n.i.)	PolyD	1*	-18.16							
Echiura					1	-17.93					
Bivalvia	<i>Malletia cumingii</i>				1*	-17.38					
Ophiuroidea	<i>Amphiura complanata</i>				1*	-16.36		1*	-15.85		
	<i>Amphiura joubini</i>				1*	-18.80					
	<i>Ophiactis savignyi</i>	2*	-19.59	0.10				1*	-14.74		
Carnivores											
Polychaeta	<i>Aphrodita</i> sp							1	-16.07		
	Nephtyidae, Glyceridae, Lumbrineridae							1*	-17.95		
	Polychaeta (n.i.)	PolyC	1*	-17.84							
Gastropoda	Sigalionidae				1*	-17.82		1*	-17.32		
	<i>Pleurobranchus areolatus</i>							1	-19.25		
	<i>Prunum martini</i> , <i>P. rubens</i>							1*	-17.70		
	<i>Tonna galea</i>				1*	-17.83		2*	-16.57	0.30	
	<i>Zidona dufresnei</i>	Zidu						1	-14.46		
Octopoda	<i>Argonauta</i> sp.	Argo	2	-18.15	0.02						
	<i>Octopus</i> spp.	Octo	5*	-17.23	0.23	1*	-17.00		2	-16.89	0.06
Isopoda	<i>Politolana eximia</i>	Poli						1*	-18.24		
Penaeidae	<i>Parapenaeus americanus</i>	Paam	2*	-17.61	0.05	1*	-17.72		2*	-17.12	0.22
Caridea	<i>Plesionika edwardsii</i>	Pled				1*	-17.72		3*	-17.66	0.45
Astacidae	<i>Metanephrops rubellus</i>	Meru				1*	-16.47		2*	-16.23	0.11
Stomatopoda	<i>Squilla brasiliensis</i>	Scbr	3*	-17.75	0.21	2*	-17.25	0.15	2*	-17.23	0.53
Anomura	<i>Dardanus insignis</i>	Dain	4*	-16.93	0.30	2*	-16.55	0.14	4*	-16.28	0.23
	<i>Munida irrasa</i>	Muir	3*	-18.00	0.07	1*	-17.12		2*	-17.20	0.02

Brachyura	<i>Achelous spinicarpus</i>	Acsp				4*	-17.30	0.37		
	<i>Heterocrypta lapidea</i>	Hela							1*	-17.04
	<i>Libinia spinosa</i>	Lisp							3*	-17.29 0.48
	<i>Stenocionops spinosissimus</i>	Stsp	2	-18.50	0.03	1	-17.69		4*	-17.55 0.07
Asteroidea	<i>Astropecten brasiliensis</i>	Asbr	4*	-15.15	2.53	4*	-12.53	1.35	2*	-12.59 0.58
Fishes		Fish	10	-18.63	1.37	33	-17.43	0.49	26	-17.75 0.66

Table S2. Mean or single $\delta^{15}\text{N}$ (‰) values for the consumers sampled in the 3 study periods on the inner and outer shelves off Cabo Frio (n: number of samples; * composite samples; SD: standard deviation); TM: trophic mode (SF: suspension feeder, SDF: surface deposit feeder, SSDF: subsurface deposit feeder, C: carnivore, Sca: scavenger, Omn: omnivore); n.i.: not identified

Group/Species	TM	$\delta^{15}\text{N}$ (‰)								
		Summer 2001			Winter 2001			Summer 2002		
		n	Mean	SD	n	Mean	SD	n	Mean	SD
Cabo Frio - Inner shelf										
Pelagic consumers										
Zooplankton		3	7.01	0.56	3	8.46	0.29	3	7.8	0.11
Benthic consumers										
Suspension feeders										
Bivalvia	<i>Angulus versicolor, Tellina petittiana</i>	SDF/SF	1*	7.51		1*	7.18		1*	6.99
	<i>Pitar rostratus</i>	SF	1	7.17						
	<i>Trachycardium muricatum</i>	SF	1	6.33						
Deposit feeders										
Polychaeta	Ampharetidae	SDF	1*	9.41				1*	8.17	
	Capitellidae	SSDF				11.20				
	Magelonidae	SDF			1*	8.39		1*	7.46	
	Maldanidae	SSDF	2*	9.14	0.22	1*	10.81		1*	8.80
	Orbiniidae	SSDF			1*	9.52		1*	10.51	
	Echiura	SDF			1	9.25		1	6.27	
Bivalvia	<i>Adrana patagonica</i>	SDF	1*	7.23						
Amphipoda	Gammaridea	SSDF	1*	11.61						
	Maeridae	SDF			1*	8.67				
	Phoxocephalidae	SSDF			1*	11.41				
Ophiuroidea	<i>Amphiura complanata, Ophiactis savagi</i>	SDF/SF	6*	10.85	0.33					
Carnivores										
Anthozoa, Actiniaria	<i>Calliactis tricolor</i>	C	1*	12.20		1	12.22		1*	10.62
Nemertea		C	1*	10.50		1	13.00		1	8.08
Polychaeta	<i>Aphrodita</i> sp.	C							1*	12.74
	Glyceridae and/or Goniadidae	C	1*	11.81		1*	12.29		1*	11.50
	Lumbrineridae	C/Sca				1*	11.17			
	Nephtyidae	C				1*	11.00		1*	9.90
	Onuphidae	Omn/Sca	1*	10.18						
	Onuphidae, Lumbrineridae, Polynoidae	C/Sca/Omn							1*	10.09
	Polychaeta (n.i.)	C				1*	9.58			
Gastropoda	<i>Adelomelon beckii</i>	C							2*	11.15
	<i>Amalda dimidiata, Carinodrillia braziliensis</i>	C							1*	10.10
	<i>Anachis</i> sp.	C							1	12.18
	<i>Buccinanops cochlidium</i>	C				2*	12.20	0.50		

	<i>Olivella defioerei</i>	C/Sca				1*	9.27			
	<i>Pleurobranchus areolatus</i>	C	1*	11.52				1*	11.13	
	<i>Tonna galea</i>	C				2*	11.44	0.50		
	<i>Zidona dufresnei</i>	C	1	12.53		1	11.69		2*	10.85 0.38
Isopoda	<i>Politolana eximia</i>	C	1*	11.77						
Penaeidae	<i>Farfantepenaeus brasiliensis</i>	C/Omn	4*	12.39	0.82				2*	10.57 0.39
	Penaeidae juveniles (<2 cm)	C/Omn				1*	10.27			
	<i>Trachypenaeus constrictus</i>	C				1*	10.59			
Palinura	<i>Scyllarides brasiliensis</i>	C							1	9.26
Stomatopoda	<i>Squilla brasiliensis</i>	C				1*	9.88			
Anomura	<i>Dardanus insignis</i>	C/Sca/Omn	8*	13.48	0.37	1*	12.96		2*	12.38 0.41
	<i>Pagurus exilis</i>	C/Sca/Omn				1*	11.56			
Brachyura	<i>Achelous spinicarpus</i>	C	7*	11.55	0.28		-		7*	10.91 0.24
	<i>Arenaeus cribrarius</i>	C				2*	11.47	0.23		
	<i>Hepatus pudibundus</i>	C				5*	12.64	0.19		
	<i>Leurocyclus tuberculatus</i>	C	3*	11.42	0.22	2*	11.85	0.41	4*	10.78 0.36
	<i>Libinia spinosa</i>	C	7*	12.41	0.46				7*	11.94 0.59
	<i>Persephona mediterranea</i>	C				2*	13.15	0.07		
Asteroidea	<i>Astropecten brasiliensis</i>	C	4*	13.00	1.04	2	10.10	0.18	2*	10.37 0.14
	<i>Luidia clathrata</i>	C	4*	14.17	1.46	2	9.15	0.61		
	<i>Luidia ludwigi scotti</i>	C							2*	10.44 0.49
Fishes		C	4	12.44	0.42	26	14.39	0.81	27	13.57 1.02

Group/Species	TM	$\delta^{15}\text{N}(\text{‰})$									
		Summer 2001			Winter 2001			Summer 2002			
		n	Mean	SD	n	Mean	SD	n	Mean	SD	
Cabo Frio - Outer shelf											
Pelagic consumers											
Zooplankton		3	9.59	1.96	3	7.7	1.59	5	6.40	1.23	
Benthic consumers											
Suspension feeders											
Bivalvia	Bivalvia (n.i.)	SF						1*	6.39		
	<i>Corbula patagonica</i>	SF			1*	9.17					
Amphipoda	Ampeliscidae	SF/SDF			1*	7.98		1*	6.94		
Deposit feeders											
Sipuncula		SDF	1*	9.01				1*	7.90		
Polychaeta	Magelonidae	SDF						1*	8.31		
	Maldanidae	SSDF			1*	12.75		1*	11.48		
	Orbiniidae	SSDF						1*	10.15		
	Polychaeta (n.i.)	SSDF	1*	10.55							
Echiura		SDF			1	9.32					
Bivalvia	<i>Malletia cumingii</i>	SDF			1*	9.45					
Ophiuroidea	<i>Amphiura complanata</i>	SDF/SF			1*	10.03		1*	8.45		
	<i>Amphiura joubini</i>	SDF/SF	2*	9.80	0.08	1*	9.85				
	<i>Ophiactis savignyi</i>	SDF/SF						1*	8.83		
Carnivores											
Polychaeta	<i>Aphrodita</i> sp.	C						1	13.53		
	Nephtyidae, Glyceridae, Lumbrineridae	C						1*	10.88		
	Polychaeta (n.i.)	C	1*	11.17							
	Sigalionidae	C				1*	11.44		1*	10.80	
Gastropoda	<i>Pleurobranchus areolatus</i>	C						1	9.91		
	<i>Prunum martini</i> , <i>P. rubens</i>	Sca				1*	11.47				
	<i>Tonna galea</i>	C	1*	9.75		2*	12.71	0.06	1*	11.19	
	<i>Zidona dufresnei</i>	C						1	14.36		
Octopoda	<i>Argonauta</i> sp.	C	2	8.95	0.17						
	<i>Octopus</i> spp.	C	5*	13.42	0.16	1*	13.44		2	12.72	0.28
Isopoda	<i>Politolana eximia</i>	C						1*	12.70		
Penaeidae	<i>Parapenaeus americanus</i>	C	2*	12.91	0.11	1*	10.99		2*	10.72	0.26
Caridea	<i>Plesionika edwardsii</i>	C				1*	11.23		3*	10.33	0.49
Astacidae	<i>Metanephrops rubellus</i>	C				1*	11.42		2*	10.71	0.03
Stomatopoda	<i>Squilla brasiliensis</i>	C	3*	12.76	0.34	2*	11.78	0.42	2*	11.48	0.36
Anomura	<i>Dardanus insignis</i>	C/Sca/Omn	4*	14.50	0.69	2*	13.87	0.17	4*	12.99	0.91

Brachyura	<i>Munida irrasa</i>	C/Sca/Omn	3*	11.15	0.26	1*	11.78		2*	10.44	0.15
	<i>Achelous spinicarpus</i>	C				4*	11.70	0.39			
	<i>Heterocrypta lapidea</i>	C							1*	10.64	
	<i>Libinia spinosa</i>	C							3*	12.06	0.68
	<i>Stenocionops spinosissimus</i>	C	2	13.52	0.10	1	12.75		4*	11.38	0.44
Asteroidea	<i>Astropecten brasiliensis</i>	C	4*	13.61	2.42	4*	13.20	2.29	2*	11.23	0.10
Fishes		C	10	12.25	1.27	33	14.25	1.23	26	12.08	1.14