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Quaternary origin of the inverse latitudinal diversity gradient among southern Chilean mollusks

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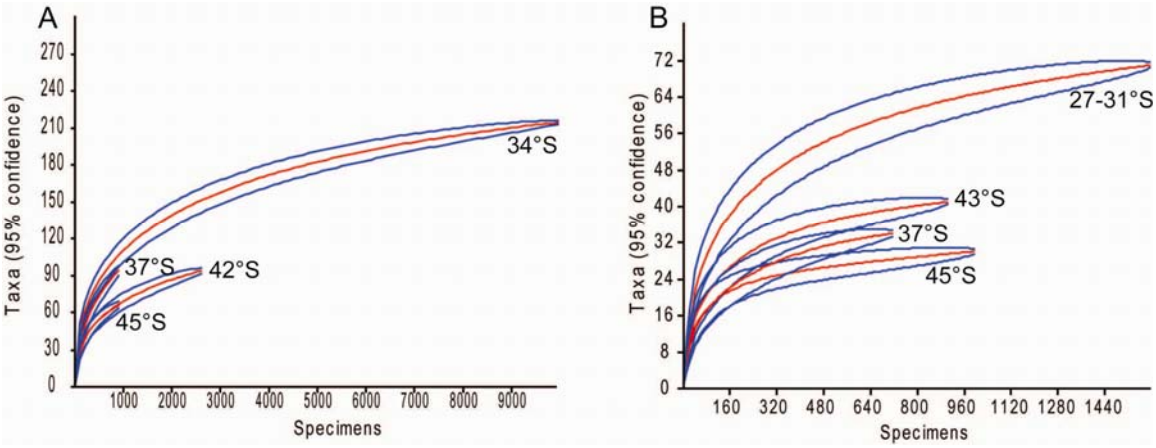

Figure DR1. Rarefaction curves for the early Miocene (A) and the late Pliocene-early Pleistocene (B), based on the data of Tables DR1 and DR2.

Table DR1. Early Miocene species, their occurrences and specimen counts. Juvenile specimens of superabundant species were not counted because they tend to obscure ecologic pattern (cf. Olszewski and Kidwell, 2007).

Species	Navidad	Ranquil	Lacui	Los Chonos
Acanthina chattertoni			1	
Acanthina katzi			43	
Acanthina sp.	3			
Acesta sp.		1		
Acteocina n. sp.	5			
Acteon chilensis	9		338	
Acteon sp.	146		2	
Acteon sp. A	46			
Acteon sp. B	25			
Acteon sp. C	6			
Acteon sp. D			21	
Adelomelon alta	2	1		
Adelomelon obesa			8	3
Aequipecten sp.	200			
Agathistoma antiqua	1			
Agathistoma chilena	1		1	
Alvania chilensis	113			
Amalda n. sp.	1	21		
Ameranella verruculosa	16	1		3
Amiantis domeykoana			1	
Amiantis navidadensis	3			2
Anachis sp.	31			
Anadara lirata	33			5
Anomia crepiduliformis			2	
Anomia sp.	1	3		
Arca sp.	1			
Architectonica karsteni	2			
Astele chilensis	59	2	1	1
Austrocominella sp. 1	229		1	
Austrocominella sp. 2	1			
Austrofusus cleryanus	1			
Austrofusus nodulifer	2			
Austrofusus sp. 1	1			
Austrofusus sp. 2	6			
Austrotoma echinulatus	21	14	29	34
Awheaturris quisquilia		1		
Bathybembix mcleani		2		
Bathytoma sp. 1	3			
Bathytoma sp. 2		18		
Bedeva sp. 1	3			
Bedeva sp. 2	1			
Borsonella sp.	1	6		
Borsonia sp. 1	3	20		
Borsonia sp. 2	7			
Buccinaria sp.	1			

Bulbus n. sp.	2		2	6
Bulla acutiuscula	308		14	
Bulla ovulum	232		113	
Bulla sp.	14			
Bulla triticum	318		250	
Caecum sp.	1			
Calliostoma covacevichi	3	8		
Calliostoma kleppi	1			
Calliostoma mapucherum	1			
Calliostoma sp.		5	1	
Cancellaria medinae	16	5	2	6
Cancellaria nassariformis	4			
Cancellaria reyesi	3			
Cancellaria rudolphi	8			
Cancellaria sp.	6	2	2	4
Cantharus sp.	1			
Cantrainea sp.	2			
Carditella sp.	401	400		12
Caryocorbula sp.		1		
Cerithiopsis pyrgiscus	2			
Cerithiopsis sp.			1	
Chilina sp.	3		1	
Chione chiloensis				
Chione coquandi	271	3	201	56
Chione rodulfi	1			
Choromytilus chorus			1	
Chorus sp.	1			
Circomphalus patagonica	1			6
Cirsotrema sp.	31	12	1	
Clio sp.	3			
Cochlespira n. sp.		1		
Columbella sp.	1			
Comitas sp.		2		
Crassatellites sp.	5			
Crassilabrum wattersi			3	
Crassostrea sp.	5	2	1	
Crenella sp.		1	2	
Crepidula sp. 1	14		6	
Crepidula sp. 2				2
Crepipatella sp.			1	
Cucullaea alta				5
Cucullaea chilensis	3			
Dalium n. sp.		44		
Dentimargo sp.	133			
Diloma miocenica	6	1		
Diodora fragilis	2			
Diodora pupuyana	2			
Diodora sp. 1		2		
Diodora sp. 2		2		
Diplodonta sp. 1	8			

Discotectonica navidadensis	4			
Distorsio ringens	23	24	3	
Dosina semilaevis	1		1	
Echinophoria monilifera	57	10	42	27
Echinophoria sp.	9	3		1
Ennucula sp.	200	4	73	1
Eulima antarctica	24			
Exilia alanbeui	2	48		
Fagnastesia matanzana	1			
Fagnastesia venefica	11			
Falsilunatia sp.	1	18		
Ficus distans	11			
Ficus gayana	8			
Fissurella sp. 1		1		
Fissurella sp. 2		11		
Fusiguraleus hordeum	362	3		
Gemmula sp.				5
Gibbula poeppigii	2			1
Glycymeris colchaguensis	729		1	
Glycymeris ibariformis	9			
Glycymeris sp. 1	23	5		5
Glycymeris sp. 2				15
Glycymeris taverai			17	1
Grandeliacus antu	4			
Haurokoa sp.		2		
Imbricaria chiloensis	6	18	2	3
Incatella hupei	19		101	21
Incatella leptogramma	1			
Incatella trilirata	105	30		
Inquisitor lingulacaninus	66	1		
Intitectonica inti	3			
Ipunina vladimiri			3	2
Ireneia calandrellii	4		1	
Ireneia testudinaria		1		
Iselica sulcosa	41			
Jupiteria sp. 1	306	4		
Jupiteria sp. 2				6
Kellia sp.				1
Kurtzia sp. 1	5			
Kurtzia sp. 2			2	
Lahillia angulata	5			
Lamprodomina dimidiata	221	52	134	38
Ledella sp.	4	1		
Leionucula lebuensis				2
Lembulus sp.		1		
Limopsis sp.	2			
Lucinoma promaucana	281	2	13	1
Macron vermeiji	2			
Mactra oblonga	402	2	400	37
Magnatica chiloensis			3	4

Magnatica subsolida	50			
Maoridaphne n. sp.	8			
Marginella n. sp.	25			
Marshallena polypleurus	3			
Matanziella vidali	64			
Miomelon pelantaroi				1
Miraclathurella darwini	1	1		
Mitra martini			2	2
Mitrella sp.	1			
Modiolus sp.			16	1
Monilea riorapelensis	1			
Mulinia sp.			2	
Muricidae n. gen.1, n. sp.	1			
Muricidae n. gen.2, n. sp.	2			
Muricidae n. gen.3, n. sp.	2			
Muricidae n. gen.4 rhopalicus	18			
Muricidae n. gen.4 subclavatus	2			
Musculus sp.	3			
Mysella sp.			2	
Mytilus sp.	63			1
Nacella intiforma		1		
Nacella nielseni			1	
Nassarius diminutivum	278		194	
Naticidae n.gen. striolata			11	19
Neilo volckmanni	4	23		2
Nemocardium sp.	2			5
Nerita chilensis	3			
Neverita pachystoma	200	4	4	
Neverita sp.			2	
Nihonia sp. 1	4			
Nihonia sp. 2		1		
Nucella medinae	22	1		
Nucula sp.	4		4	410
Nuculana sp.	2			
Nuculanidae n.gen., n.sp.	500		1	
Odostomia obtusa	23		2	
Olivancillaria claneophila	67	1	38	3
Olivancillaria matanzana	25			
Onoba sp.	1			
Pachycymbiola vidali	2	2	15	12
Palaeomelon domeykoana	11	4	4	
Palaeomelon jeffi	128	9		
Palaeomelon taverai	2		1	
Panopea chiloensis	1	3	2	1
Panopea ibari			3	
Panopea sp.		2		
Penion domeykoanus	107	2	4	
Penion oncodes	1			
Penion sp.			15	
Penion subreflexus	12		15	

Penion subregularis	9	1		50
Peonza benjamina				25
Peonza pyruliformis	55	1		
Perissodonta chilensis	50			
Pilosabia sp.	4	1		
Pinna semicostata	7			4
Pitar baylii				1
Pitar colchaguana	4		1	4
Polinices famula	139	1	1	
Polinices medinae	33	8	1	
Polinices n. sp.			39	
Polinices sp.				22
Propeamussium sp.		1		
Ptychosyrinx pseudodiscors	11	2		
Ptychosyrinx sp. 1	3	7		
Ptychosyrinx sp. 2		1		
Ptychosyrinx sp. 3	8			
Pycnodonte n. sp.	8			
pyramidellid sp. A			10	
pyramidellid sp. B	28		11	
pyramidellid sp. C			7	
pyramidellid sp. D	3		1	
pyramidellid sp. E			26	
pyramidellid sp. F	141		47	
pyramidellid sp. G	86			
pyramidellid sp. H	464		8	
pyramidellid sp. I	84		26	
Pyrula exigua				13
Ranella chilena	4			
Ranellidae n. gen., n. sp.	1			
Saccella oxyrrhyncha	11	2	161	
Sassia armata	29	5		
Scaphander brevicula	9			5
Scaphander remondi	203	12	5	2
Scaphander sp.	95	1		6
Septifer sp.				2
Sinum pullum	11	3		
Sinum subglobosum	111	1	1	1
Solariella n. sp.	4			
Solatisonax bieleri		1		
Solemya sp.		1		
Solen crucis			2	
Stramonita zinsmeisteri		1		
Strombus medinae	3			
Struthiochenopus bandeli		20		
Struthiochenopus n. sp.				1
Struthiochenopus philippii	75			
Tagelus sp.				1
Tegula austropacifica	1			
Tegula matanzensis	1			

Tellidora sp.	6			
Tellina sp.	8		7	1
Tellina sp. 2	1			
Terebra undulifera	26		1	
Teredo sp.	3			
Testallium cepa	19		18	50
Torinista bahamondei	3			
Torinista chonos				27
Torinista taverai	3			
Trachycardium multiradiatum	1			
Triumphis maitenlahuensis	1			
Trochita araucana	4	20		
Trochita costellata		14		
Trophon climacodes		2		
Trophon ovallei	1			
Trophon sp. 1		5		
Trophon sp. 2	5			
Trophon sp. 3			2	
Turbonilla acicula	36			
Turbonilla sp.	1			
Turbonilla subcylindrica	434		21	
turrid sp. A			39	
turrid sp. AA		5		
turrid sp. AB		2		
turrid sp. AC		1		
turrid sp. AD		1		
turrid sp. AE		4		
turrid sp. AF		1		
turrid sp. AH				4
turrid sp. AL				1
turrid sp. AM				5
turrid sp. B			62	
turrid sp. C			8	
turrid sp. D			4	
turrid sp. E			2	
turrid sp. F	2			
turrid sp. G	3			
turrid sp. H	3			
turrid sp. I	2			
turrid sp. L	13			
turrid sp. M	3			
turrid sp. N	5			
turrid sp. O	10			
turrid sp. P	20			
turrid sp. Q	4			
turrid sp. R	2			
turrid sp. S	1			
turrid sp. T	1			
turrid sp. U	1			
turrid sp. V	1			

turrid sp. W	1			
turrid sp. X	1			
turrid sp. Y		1		
turrid sp. Z		1		
Turritella ambulacrum				10
Turritella pseudosuturalis	187			
Xanthochorus kuscheli			2	
Xenophora paulinae	6			1
Xenostrobus sp.			1	
Xymene n. sp.	1			
Xymenella sp.	8			
Yoldia sp. 1	19	1		3
Yoldia sp. 2		2		
Zeacuminia costellata	88	3		
Zeacuminia n. sp.			55	
Zonaria frassinettii	2	11		
Zygochlamys hupeanus		8		1
Zygochlamys simpsoni			2	2
Total # of specimens	**10025**	**1028**	**2754**	**1015**

Table DR2. Late Pliocene-early Pleistocene species, their occurrences and specimen counts. Juvenile specimens of superabundant species were not counted because they tend to obscure ecologic pattern (cf. Olszewski and Kidwell, 2007).

Species	Coquimbo	Tubul	Guafo	Guamblín
Acanthina unicornis	4	1		
Acar pusilla	2			
Adelomelon ancilla		1		
Adelomelon reconditus			3	
Agathistoma patagonicum	1			
Agladrillia fuegoensis				3
Argobuccinum ranelliforme				8
Argopecten purpurata	19			
Austrofusus fontainei	23			
Austrofusus loisae		1		
Barnea lamellosa	1			
Bela paesleri		27		
Bostrycapulus calyptraeformis	13			
Brachidontes granulata	7			
Bulla subambigua	1			
Caecum chilense	62			
Cancellaria buccinoides	10			
Cerithiopsis sp.	2			
Chama pellucida	40			
Chione sp.			2	22
Chlorostoma ater	23			
Chlorostoma luctuosum	19			
Choromytilus chorus	8			
Chorus doliaris			4	3
Chorus giganteus		23		
Chorus grandis				3
Clinocardium sp.	4			
Clio promaucana			10	
Concholepas concholepas	66			
Crassilabrum crassilabrum	42			
Crassostrea transitoria	1			
Crepidula coquimbensis	61			
Crepipatella dilatata	11	1		
Crepipatella sp.	49			
Crucibulum quiriquinae	22			
Cryptogemma senex				21
Cumingia mutica	1			
Cyclocardia velutinus	4	25	70	66
Cyclostremiscus trigonatus	1			
Darina solenoides		1		
Diodora inaequalis	1			
Diplodonta inconspicua	2			
Drillia janseni		10		
Eatoniella latina	1			
Echinolittorina peruviana	2			

Echinophoria monilifera			7	
Ennucula grayi	7	70		
Ensis macha	13	39	4	
Epitonium magellanicus		3	5	13
Eurhomalea rufa	4			
Euspira guamblinensis		41	50	79
Euspira patagonica				3
Fissurella maxima	64			
Fissurella nigra	2			
Fissurella picta	1			
Fissurella sp.				
Fusinus sp.				1
Fusitriton magellanicus		21		
Fusiturricula sp.				1
Glycymeris ovata	2			
Glycymeris sp.			53	
Hindsiclava ignorata		9	3	22
Incatella chilensis			260	
Incatella cingulata	243			
Iselica chilensis	3			
Jupiteria sp.			1	
Kaitoa cosmophila			13	2
Leionucula barrosi			2	
Limatula covacevichi			8	
Liotia cancellata				
Lottia orbignyi	2			
Lucinoma sp.			2	
Macoma inornata		8	9	
Macrocallista pannosa	58			
Mactra sp.				1
Malletia chilensis		9		1
Mesodesma donacium	13			
Mitrella unifasciata	6			
Mulinia chilota			30	6
Mulinia edulis	24			
Muregina marijkeae	1			
Mysella mabillei	77			
Mytilus sp.		1		
Nassarius gayi	71			1
Nassarius taeniolatus		23		87
Nucula subaraucana			25	
Nuculana sp. 1			1	
Nuculana sp. 2			3	
Oliva peruviana	75			
Omalogyra atomus	1			
Pandora cistula		60		2
Panopea chiloensis			40	
Panopea sp. 1			1	
Pecten n.sp.				2
Penion crassus			11	

Penion diversum			5	
Perumytilus purpuratus	3			
Petricolaria rugosa	4			
Phos chilensis			1	
Polinices sp.				3
Polinices uber	6			
Priene scabrum	77			
Prisogaster niger	49			
Protothaca thaca	4			
Psammotreta tenuicula			16	
Ptychosyrinx subaequalis			54	46
Retrotapes exalbidus		71	70	3
Retrotapes lenticularis	5			
Retrotapes sp.				5
Rissoina inca	4			
Sassia kampyla		12		2
Sassia leucostomoides			88	
Scaphander interruptus		6		
Scurria araucana	1			
Scurria ceciliana	8			
Scurria plana	1			
Scurria scurra	8			
Scurria variabilis	13			
Scurria zebrina	2			
Semele corrugata	6			
Tagelus dombeii	6			
Tegula tridentata	30			
Tellina sp.			3	
Thyasira chilensis			5	
Tindariopsis sulculata		185	26	250
Trigonostoma tuberculosum	4			
Trochita trochiformis	76			
Trophon covacevichi			5	
Trophon geversianus		9		
Trophon huilliche		9	6	21
Trophon parcus		3	1	
Trophon sp.				2
Trophon vetulus			9	
turrid sp. AG			1	
turrid sp. AH				3
turrid sp. AI			5	
turrid sp. AJ				13
turrid sp. AK				1
Xanthochorus buxeus	4			
Xanthochorus cassidiformis	122			
Xymenopsis dispar		16		
Xymenopsis hero		3		25
Zygochlamys hupeanus			1	
Zygochlamys patagonica		317		7
Total # of specimens	**1599**	**1004**	**913**	**728**

Table DR3. Literature data included in our analysis. The species and species counts provided in these references are included in Tables DR1 and DR2.

Reference	Fossil location(s)
Philippi (1887)	All of south-central Chile
Tavera (1979)	Navidad area, early Miocene
Frassinetti and Covacevich (1993)	Navidad area, early Miocene
Watters and Fleming (1972)	Chiloé, early Miocene
Frassinetti (2001, 2004)	Chonos Archipelago, early Miocene
Frassinetti (1997, 2000)	Guafo Island, late Pliocene
Frassinetti and Covacevich (1995)	Guamblín Island, late Pliocene-early Pleistocene

Table DR4. The 20 most species-rich extant gastropod genera on the Chilean Pacific coast and their species numbers between 40°S and 60°S.

Genus (family)	Original # of species	Revised # of species	Revision	Habitat	Neogene Southern Hemisphere fossil record	First occurrence	Reference to first occurrence
Xymenopsis (Muricidae)	21	4	(Pastorino and Harasewych, 2000)	Mostly hard substrate	Chile, Pleistocene	early Pleistocene	(Nielsen and Valdovinos, 2008)
Lamellaria (Lamellariidae)	13	n.a.*		Under rocks	None	late Palaeocene	(Sepkoski, 2002)
Collisella (Lottiidae)	12	8**	(Espoz et al., 2004)	Rocky shore	Chile, Plio-Pleistocene	Pleistocene	(Herm, 1969)
Patinigera (Nacellidae)	11	7	(Valdovinos and Rüth, 2005)	Rocky shore	Chile, Miocene	early Miocene	(Watters and Fleming, 1972)
Calliostoma (Calliostomatidae)	11	n.a.		Hardground	Chile, Miocene	Cenozoic	(Hickman and McLean, 1990); Mesozoic occurrences doubtful
Onoba (Rissoidae)	11	n.a.		Intertidal hardgrounds	Chile, Miocene	Eocene	(Sepkoski, 2002)
Fissurella (Fissurellidae)	10	n.a.		Rocky shore	Chile, Miocene	Miocene, ?Maastrichtian	(Sohl, 1992; Finger et al., 2007)
Pareuthria (Buccinidae)	10	9	(Castellanos and Fernández, 1976)	Soft bottom	Southern Patagonia, Quaternary	Eocene	(Beu, 2009)
Bela (Turridae)	9	n.a.		Variable	Chile, Miocene	Eocene	(Sepkoski, 2002)
Eatoniella (Eatoniellidae)	8	n.a.		Intertidal hardgrounds	None	Miocene	(Sepkoski, 2002)
Savatieria (Buccinidae)	8	3	(Castellanos and Fernández, 1975)	Soft bottom	None	Holocene	(Aguirre et al., 2008)
Hydrobia (Hydrobiidae)	8	n.a.		Variable	None	?	uncertain due to limited shell characters
Natica (Naticidae)	8	4***	(Pastorino, 2005a)	Soft bottom	Chile, Miocene	n.a.	
Littoridina (Littorinidae)	7	n.a.****		Soft bottom	Southern Patagonia, Quaternary		(Aguirre et al., 2008)
Admete (Cancellariidae)	6	5*	(Petit and Harasewych, 2005)	Unclear	Chile, Lo Abarca	Danian	(Sepkoski, 2002)
Photinula (Trochidae)	6	4	(Smith, 1905)	hardground	Southern Patagonia, Quaternary	Quaternary	(Aguirre et al., 2008)
Trophon (Muricidae)	6	3	(Pastorino, 2005b)	Mostly hard substrate	Chile, Miocene	late Oligocene	(Griffin and Pastorino, 2005)
Glypteuthria (Buccinidae)	5	3	(Castellanos, 1992)	Soft bottom	None	n.a.	
Adelomelon (Volutidae)	5	3	(Wiggers and Veitenheimer-Mendes, 2008)	Soft bottom	Chile, Miocene	?Eocene, Miocene	(Nielsen and Frassinetti, 2007)
Margarites (Trochidae)	5	5		Rocks	None	Cretaceous	(Kiel and Bandel, 2001)

The number of revised species includes valid species considered as belonging to other genera; *genera identified as being highly polymorphic in polar regions (cf., (Clarke, 1978); **all species transferred to *Scurria* and "*Lottia*"; ***none of the revised species belongs to *Natica* sensu strictu; ****Members of this genus are considered as extremely variable (Aguirre and Urrutia, 2002); n.a. = not available.

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