

Debiasi et al., 2022. How do macroinvertebrate communities respond to declining glacial influence in the Southern Alps? *Limnetica* 41-1, 2022: 121-137

SUPPLEMENTARY INFORMATION

Table S1. Environmental parameters measured in the eight sampling sites (mean \pm SD) in 2018. MA1 was sampled only in late summer (September 2018). GI = Glacial Index. Water temperature: T_{mean} ($^{\circ}\text{C}$) = mean temperatures, T_{min} ($^{\circ}\text{C}$) = minimum temperature, T_{max} ($^{\circ}\text{C}$) = maximum temperature, mT_{max} ($^{\circ}\text{C}$) = mean maximum temperature in one week before sampling; T_{air} ($^{\circ}\text{C}$) = point air temperature. The variables in bold showed significant differences ($p < 0.05$) among sampling sites. *Parámetros ambientales medidos en los ocho sitios de muestreo (media \pm SD) en 2018. MA1 ha sido muestreado solo a finales de verano (septiembre 2018). GI = Índice Glacial. Temperatura del agua: T_{mean} ($^{\circ}\text{C}$) = temperatura media, T_{min} ($^{\circ}\text{C}$) = temperatura mínima, T_{max} ($^{\circ}\text{C}$) = temperatura máxima, mT_{max} ($^{\circ}\text{C}$) = media de las temperaturas máximas una semana antes del muestreo; T_{air} ($^{\circ}\text{C}$) = temperatura puntual del aire. las variables en negrita muestran diferencias significativas entre los sitios de muestreo.*

Table S1.

System	Agola	Mandrone	Careser	Careser	Carè Alto	Careser	Carè Alto	Agola
Site	AG1	MA1	CR0	CR1	C0	CR2	C2	AG_pond
GI	1.00	0.98	0.61	0.50	0.31	0.34	0.14	0.95
Tmean (°C)	0.09 ± 0.0	0.29	4.05 ± 0.5	4.45 ± 0.6	4.35 ± 1.5	5.45 ± 0.6	7.6 ± 1.3	7.91 ± 4.8
Tmin (°C)	0.08 ± 0.0	0	0 ± 0.0	0.3 ± 0.3	2.65 ± 1.2	1.0 ± 0.3	3.75 ± 1.5	4.58 ± 4.8
Tmax (°C)	0.15 ± 0.1	1.51	9.7 ± 1.6	8.65 ± 0.6	10.35 ± 3.0	11.75 ± 0.6	13.05 ± 0.5	9.92 ± 6.0
mTmax (°C)	0.15 ± 0.1	0.37	5.5 ± 0.3	7.05 ± 1.2	4.05 ± 2.4	9.65 ± 0.6	10.96 ± 0.5	9.92 ± 6.0
Tair (°C) (point)	5.70 ± 1.5	6.9	4.35 ± 1.6	8.2 ± 2.3	6.25 ± 1.3	8.2 ± 2.7	8.35 ± 1.3	5.70 ± 1.5
pH (20°C)	7.60 ± 0.3	6.9	7.05 ± 0.5	7.1 ± 0.3	6.25 ± 0.1	6.95 ± 0.4	6.7 ± 0.1	8.35 ± 0.2
Conductivity (µS/cm)	24.0 ± 1.4	5.0	137 ± 66.5	89.0 ± 29.7	3.0 ± 0.0	86.0 ± 22.6	11.0 ± 4.2	71.5 ± 6.4
Alcalinity as Ca(HCO₃)² (mg/l)	23.5 ± 0.7	7.0	20.5 ± 4.9	19.5 ± 4.9	5.5 ± 0.7	16.5 ± 0.7	10.0 ± 1.4	67.0 ± 7.1
Hardness (°F)	1.3	0.9	7.25 ± 3.6	4.65 ± 1.8	0.5 ± 0.6	3.4	0.6 ± 0.4	4.7
N-NO ₃ (µg/l)	0.03 ± 0.03	0.14	0.08 ± 0.04	0.06 ± 0.03	0.09 ± 0.01	0.07 ± 0.04	0.17 ± 0.1	0.21 ± 0.1
SO₄²⁻(mg/l)	0.09 ± 0.0	0.3	56.5 ± 31.8	32.5 ± 13.4	0.50 ± 0.6	32.5 ± 12.0	0.55 ± 0.2	0.40 ± 0.1

P _{tot} (µg/l)	8.0 ± 1.4	58.0	69 ± 79.2	90.5 ± 119.5	21.5 ± 17.7	73.5 ± 95.5	4.9 ± 0.0	11.5 ± 0.7
SiO ₂ (mg/l)	0.09 ± 0.0	1.1	3.05 ± 1.6	1.8 ± 0.7	0.3 ± 0.3	2.6 ± 1.6	2.85 ± 0.8	0.25 ± 0.1
Pfankuch Index	39	47	58	51	31	48	30	15
Discharge (m³/s)	0.59 ± 0.7	3.8	1.6 ± 0.9	1.73 ± 0.9	0.04 ± 0.0	2.07 ± 0.7	0.02 ± 0.0	0
Current velocity (m/s)	0.50 ± 0.03	0.61	0.73 ± 0.1	0.49 ± 0.01	0.52 ± 0.2	0.624 ± 0.1	0.57 ± 0.3	0
Suspended solids (mg/l)	4.8 ± 6.2	76.8	46 ± 41.9	166 ± 27.2	29.1 ± 25.1	49.2 ± 58.3	11.15 ± 12.5	2.60 ± 3.1
Chl <i>a</i> (µg/cm²)	0.002 ± 0.0	0.25	0.01 ± 0.004	0.02 ± 0.0	0.21 ± 0.1	0.634 ± 0.6	0.69 ± 0.3	0.07 ± 0.0
BPOM (mg/m²)	0.37 ± 0.5	6.60	1.0 ± 1.4	7.99 ± 9.4	44.9 ± 15.3	11.49 ± 15.1	61.93 ± 6.1	0.59 ± 0.2

	AG1	MA1	CR0	CR1	C0	CR2	C2	AG_pond
<i>Dictyogenus</i> sp.							14	
<i>Perlodes</i> sp.						2		
<i>Brachyptera</i> sp.		16				20		
<i>Nemoura</i> sp.						10	2	
<i>Protonemura</i> sp.					7	4	806	
<i>Leuctra</i> sp.						6	96	
Helophoridae							2	
Elmidae						2	4	2
Limoniidae				12	40	12	132	
Tipulidae					10		2	
Blephariceridae							2	
Psychodidae							4	
Dixidae							16	
Simuliidae					350	80	26	

	AG1	MA1	CR0	CR1	C0	CR2	C2	AG_pond
Ceratopogonidae						20	10	
Chironomidae	22	2016	170	124	4260	2446	15650	3496
Rhagionidae							8	
Empididae							20	
Dolichopodidae							2	
Anthomyiidae							92	
<i>Rhyacophila</i> sp.						4	38	
Limnephilidae					1	10	920	
N° of ind/m ² (average of the two dates)	22	2032	170	136	6741	2692	19582	3584
Taxa richness (highest value between the dates)	1	2	1	2	7	11	22	3
Dominance (D)	1	0.98	1	0.87	0.51	0.83	0.65	0.96
Shannon (H)	0	0.05	0	0.21	0.86	0.47	0.92	0.11

Table S3. P-values obtained from Mann-Whitney non-parametric U test for macroinvertebrate communities of kryal sites (A) and of glacio-rhithral sites plus C0 (B). Significant values ($p < 0.05$) are shown in bold type. *Los valores P que derivan del non-parametric U-test de Mann-Whitney para la comunidad de macroinvertebrados de los sitios kryal (A) y de los sitios glacio-rhithral más C0 (B). Valores significativos ($p < 0.05$) se muestran en negrita.*

A					
	AG1	CR0	CR1	C0	MA1
AG1			0.584	0.001	0.584
CR0			0.670	0.002	0.584
CR1	0.584	0.670		0.006	0.957
C0	0.001	0.002	0.006		0.013
MA1	0.584	0.584	0.957	0.013	

B			
	CR2	C2	C0
CR2		3.84E-04	0.099
C2	3.84E-04		6.28E-06
C0	0.099	6.28E-06	

Table S4. P-values obtained from the post-hoc Tukey's HSD test showing the two-by-two comparisons between sites for the three variables selected as best predictors by the dbRDA: glacial index (GI), mean maximum temperature (mTmax), and chlorophyll *a* concentration (lnChl *a*). Significant values ($p < 0.05$) are shown in bold. *Valores P obtenidos del test HSD post-hoc de Tukey que muestran la comparación de dos en dos entre sitios para las tres variables seleccionadas como mejores indicadores por la dbRDA: índice glacial (GI), media de la temperatura máxima (mTmax), y concentración de clorofila a (lnChl a). Los datos significativos ($p < 0.05$) se muestran en negrita.*

GI	{1} (M=.94500)	{2} (M=1.0000)	{3} (M=.60500)	{4} (M=.49500)	{5} (M=.33500)	{6} (M=.30500)	{7} (M=.13500)	{8} (M=.98000)
AG_pond {1}		0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.038
AG1 {2}	0.001		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.326
CR0 {3}	<0.0001	<0.0001		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
CR1 {4}	<0.0001	<0.0001	<0.0001		<0.0001	<0.0001	<0.0001	<0.0001
CR2 {5}	<0.0001	<0.0001	<0.0001	<0.0001		0.030	<0.0002	<0.0001
C0 {6}	<0.0001	<0.0001	<0.0001	<0.0001	0.030		<0.0003	<0.0001
C2 {7}	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001		<0.0001
MA1 {8}	0.038	0.326	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	

mTmax	{1} (M=9.9200)	{2} (M=.15000)	{3} (M=5.5000)	{4} (M=7.0500)	{5} (M=9.6500)	{6} (M=4.0500)	{7} (M=10.960)	{8} (M=.37000)
AG_pond {1}		0.064	0.657	0.925	1.000	0.383	1.000	0.160
AG1 {2}	0.064		0.473	0.031	0.042	0.041	0.040	1.000
CR0 {3}	0.657	0.473		0.997	0.712	0.998	0.453	0.704
CR1 {4}	0.925	0.031	0.997		0.952	0.910	0.759	0.454
CR2 {5}	1.000	0.042	0.712	0.952		0.428	0.999	0.033
C0 {6}	0.383	0.041	0.998	0.910	0.428		0.242	0.909

C2	{7}	1.000	0.040	0.453	0.759	0.999	0.242		0.108
MA1	{8}	0.160	1.000	0.704	0.454	0.033	0.909	0.108	
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lnChl a		{1}	{2}	{3}	{4}	{5}	{6}	{7} (M=-	{8} (M=-
		(M=-2.766)	(M=-6.400)	(M=-4.937)	(M=-4.099)	(M=-.7025)	(M=-1.604)	.4200)	1.407)
AG_pond	{1}		0.005	0.073	0.390	0.090	0.524	0.051	0.569
AG1	{2}	0.005		0.306	0.056	<0.0001	0.001	<0.0001	0.003
CR0	{3}	0.073	0.306		0.806	0.002	0.008	0.001	0.018
CR1	{4}	0.390	0.056	0.806		0.007	0.038	0.005	0.069
CR2	{5}	0.090	<0.0001	0.002	0.007		0.754	0.999	0.959
C0	{6}	0.524	0.001	0.008	0.038	0.754		0.506	1.000
C2	{7}	0.051	<0.0001	0.001	0.005	0.999	0.506		0.831
MA1	{8}	0.569	0.003	0.018	0.069	0.959	1.000	0.831	

Table S5. Two-by-two site β -diversity comparisons (I = early summer, II = late summer). *Comparación de la β -diversidad teniendo en cuenta dos sitios a la vez (I = principios de verano; II = finales de verano).*

	AG1_I	CR0_I	CR1_I	C0_I	CR2_I	C2_I	AG_pond_I	AG1_II	MA1_II	CR0_II	CR1_II	C0_II	CR2_II	C2_II	AG_pond_II
AG1_I	0.0	0.0	0.3	0.8	0.8	0.9	0.3	0.0	0.3	0.0	0.0	0.7	0.8	0.9	0.6
CR0_I	0.0	0.0	0.3	0.8	0.8	0.9	0.3	0.0	0.3	0.0	0.0	0.7	0.8	0.9	0.6
CR1_I	0.3	0.3	0.0	0.8	0.7	0.8	0.5	0.3	0.5	0.3	0.3	0.5	0.7	0.8	0.7
C0_I	0.8	0.8	0.8	0.0	0.5	0.6	0.6	0.8	0.8	0.8	0.8	0.4	0.6	0.5	0.6
CR2_I	0.8	0.8	0.7	0.5	0.0	0.4	0.9	0.8	0.7	0.8	0.8	0.4	0.4	0.5	0.8
C2_I	0.9	0.9	0.8	0.6	0.4	0.0	0.8	0.9	0.9	0.9	0.9	0.6	0.5	0.3	0.8
AG_pond_I	0.3	0.3	0.5	0.6	0.9	0.8	0.0	0.3	0.5	0.3	0.3	0.5	0.7	0.8	0.3
AG1_II	0.0	0.0	0.3	0.8	0.8	0.9	0.3	0.0	0.3	0.0	0.0	0.7	0.8	0.9	0.6
MA1_II	0.3	0.3	0.5	0.8	0.7	0.9	0.5	0.3	0.0	0.3	0.3	0.8	0.7	0.9	0.7
CR0_II	0.0	0.0	0.3	0.8	0.8	0.9	0.3	0.0	0.3	0.0	0.0	0.7	0.8	0.9	0.6
CR1_II	0.0	0.0	0.3	0.8	0.8	0.9	0.3	0.0	0.3	0.0	0.0	0.7	0.8	0.9	0.6
C0_II	0.7	0.7	0.5	0.4	0.4	0.6	0.5	0.7	0.8	0.7	0.7	0.0	0.3	0.6	0.6
CR2_II	0.8	0.8	0.7	0.6	0.4	0.5	0.7	0.8	0.7	0.8	0.8	0.3	0.0	0.6	0.8
C2_II	0.9	0.9	0.8	0.5	0.5	0.3	0.8	0.9	0.9	0.9	0.9	0.6	0.6	0.0	0.9
AG_pond_II	0.6	0.6	0.7	0.6	0.8	0.8	0.3	0.6	0.7	0.6	0.6	0.6	0.8	0.9	0.0