

The following Appendixes ([Appendixes 1-8](#)) is the Electronic Supplementary Material of the article entitled “Glacial biodiversity of the southernmost glaciers of the European Alps (Clapier and Peirabroc, Italy)” at <https://doi.org/10.1007/s11629-022-7331-8>.



A



B



C



D



E



F

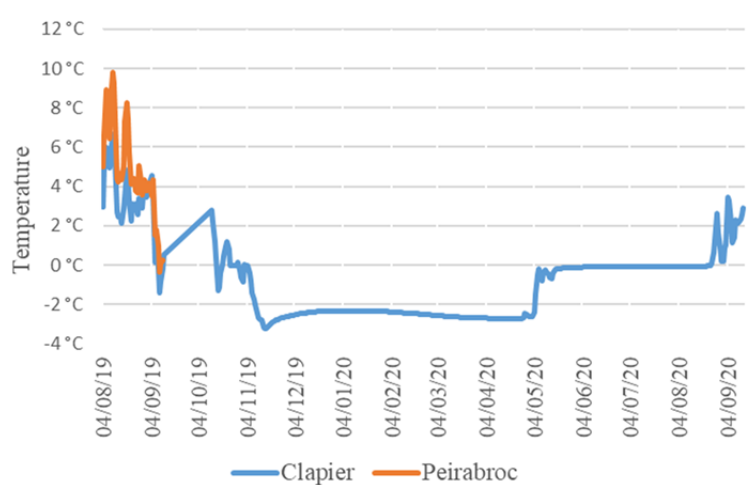
Appendix 1 A, Peirabroc glacier foreland; B, Clapier glacier foreland (younger sites); C, Supraglacial habitat (Peirabroc, PEI1); D, Young glacier foreland (Clapier, CLA2); E, young moraine (Clapier, CLA3); F, LIA moraine (Peirabroc, PEI3).

Appendix 2 Sampling point coordinates

CODE	Glacier	Landform	Age of deglaciation	Latitude (WGS8433N)	Longitude (WGS8433N)	Altitude (m asl)	Aspect (°)	Slope (°)
PEI11A	Peirabroc	Debris covered glacier	-	44.120542	7.414760	2573	5	35
PEI11B	Peirabroc	Debris covered glacier	-	44.120788	7.414786	2557	10	30
PEI11C	Peirabroc	Debris covered glacier	-	44.121437	7.414489	2519	340	20
PEI12A	Peirabroc	Debris covered glacier	-	44.121354	7.414603	2522	350	25
PEI12B	Peirabroc	Debris covered glacier	-	44.121397	7.414534	2523	20	30
PEI12C	Peirabroc	Debris covered glacier	-	44.121395	7.414570	2564	10	15
PEI21A	Peirabroc	Moraine	1920-1980?	44.123551	7.414007	2422	40	20
PEI21B	Peirabroc	Moraine	1920-1980?	44.123609	7.413931	2421	55	15
PEI21C	Peirabroc	Moraine	1920-1980?	44.123558	7.413879	2426	80	30
PEI22A	Peirabroc	Moraine	1920-1980?	44.123620	7.414100	2429	55	15
PEI22B	Peirabroc	Moraine	1920-1980?	44.123629	7.414026	2421	60	25
PEI22C	Peirabroc	Moraine	1920-1980?	44.123760	7.413980	2431	40	20
PEI31A	Peirabroc	LIA Moraine	LIA (ca 1850)	44.124159	7.413020	2474	110	35
PEI31B	Peirabroc	LIA Moraine	LIA (ca 1850)	44.124181	7.413048	2464	100	20
PEI31C	Peirabroc	LIA Moraine	LIA (ca 1850)	44.124223	7.413088	2451	70	10
PEI32A	Peirabroc	LIA Moraine	LIA (ca 1850)	44.124125	7.412946	2476	70	15
PEI32B	Peirabroc	LIA Moraine	LIA (ca 1850)	44.124186	7.413003	2464	95	20
PEI32C	Peirabroc	LIA Moraine	LIA (ca 1850)	44.124315	7.413062	2463	110	25
PEI51A	Peirabroc-Clapier	LG Terrains	LG terrain	44.124916	7.409793	2519	100	20
PEI51B	Peirabroc-Clapier	LG Terrains	LG terrain	44.124846	7.409839	2519	70	15
PEI51C	Peirabroc-Clapier	LG Terrains	LG terrain	44.124788	7.410003	2515	70	20
PEI52A	Peirabroc-Clapier	LG Terrains	LG terrain	44.126320	7.412136	2401	40	30
PEI52B	Peirabroc-Clapier	LG Terrains	LG terrain	44.126486	7.411946	2403	40	20
PEI52C	Peirabroc-Clapier	LG Terrains	LG terrain	44.126462	7.412269	2396	70	25
CLA11A	Clapier	Debris covered glacier	-	44.113631	7.422554	2767	-	-
CLA11B	Clapier	Debris covered glacier	-	44.113733	7.422864	2813	-	-
CLA11C	Clapier	Debris covered glacier	-	44.113725	7.422903	2796	-	-
CLA12A	Clapier	Debris covered glacier	-	44.113915	7.422893	2778	-	-
CLA12B	Clapier	Debris covered glacier	-	44.114022	7.422893	2771	-	-
CLA12C	Clapier	Debris covered glacier	-	44.114060	7.422782	2764	-	-
CLA21A	Clapier	young glacier foreland	after 1980	44.117917	7.421312	2620	40	25
CLA21B	Clapier	young glacier foreland	after 1980	44.117949	7.421353	2632	25	15
CLA21C	Clapier	young glacier foreland	after 1980	44.117950	7.421266	2636	35	5
CLA22A	Clapier	young glacier foreland	after 1980	44.117997	7.421563	2620	280	<5
CLA22B	Clapier	young glacier foreland	after 1980	44.118033	7.421480	2626	350	<5
CLA22C	Clapier	young glacier foreland	after 1980	44.118056	7.421636	2646	350	10
CLA31A	Clapier	Young Moraine	1920-1980?	44.118318	7.421995	2641	300	20
CLA31B	Clapier	Young Moraine	1920-1980?	44.118304	7.421896	2636	270	35
CLA31C	Clapier	Young Moraine	1920-1980?	44.116667	7.421889		220	30
CLA32A	Clapier	Young Moraine	1920-1980?	44.118356	7.421858	2636	110	0
CLA32B	Clapier	Young Moraine	1920-1980?	44.118525	7.421872	2649	320	5
CLA32C	Clapier	Young Moraine	1920-1980?	44.118470	7.421681	2635	255	5
CLA41A	Clapier	LIA Moraine	LIA (ca 1850)	44.122222	7.418972		70	35
CLA41B	Clapier	LIA Moraine	LIA (ca 1850)	44.122582	7.419043	2539	65	40
CLA41C	Clapier	LIA Moraine	LIA (ca 1850)	44.122809	7.418921	2528	60	35
CLA42A	Clapier	LIA Moraine	LIA (ca 1850)	44.123245	7.418810	2509	345	25
CLA42B	Clapier	LIA Moraine	LIA (ca 1850)	44.123243	7.418775	2506	10	20
CLA42C	Clapier	LIA Moraine	LIA (ca 1850)	44.123327	7.418908	2494	40	10

Appendix 3 Plant species occurring in a single sampling point

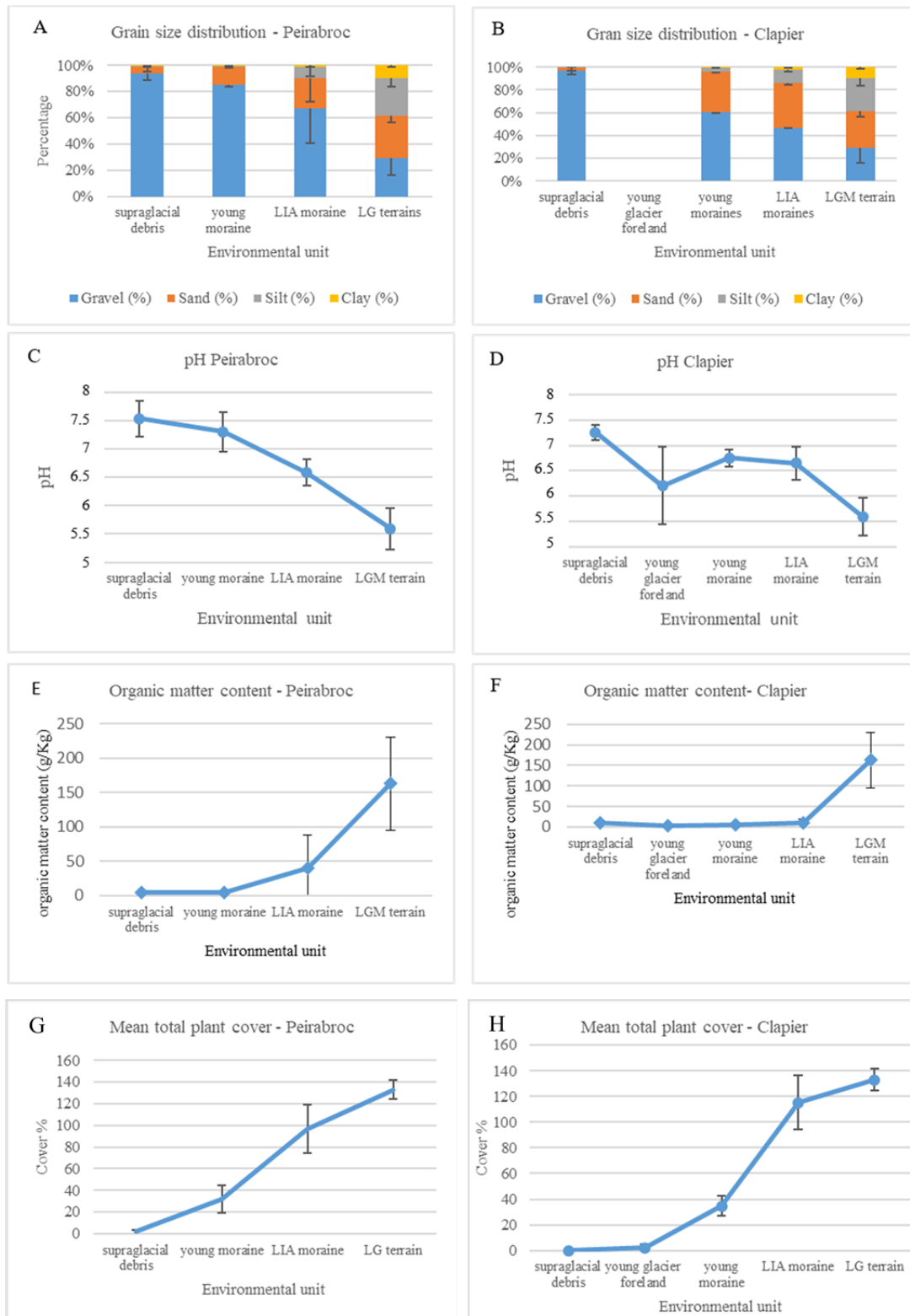
Species	Plot
<i>Androsace vitaliana</i> (L.) Lapeyr.	PEI2
<i>Astragalus penduliflorus</i> Lam.	CLA4
<i>Athamantha cretensis</i> L.	CLA4
<i>Avenella flexuosa</i> (L.) Drejer	PEI5
<i>Cerastium arvense</i> L.	PEI3
<i>Dianthus pavonius</i> Tausch	PEI3
<i>Doronicum clusii</i> (All.) Tausch	PEI2
<i>Festuca rubra</i> L. subsp. <i>commutata</i> (Gaudin) Markgr.-Dann	PEI5
<i>Galium pumilum</i> Murray	PEI3
<i>Hieracium pilosum</i> Schleich. ex Froel.	PEI3
<i>Homogyne alpina</i> (L.) Cass.	PEI5
<i>Luzula sylvatica</i> Huds.) Gaudin ssp. <i>sieberi</i> (Tausch) K. Richt.	PEI5
<i>Oreochloa seslerioides</i> (All.) K.Richt.	CLA4
<i>Phleum alpinum</i> L.	PEI5
<i>Pilosella</i> cf. <i>glacialis</i> (Reyn. ex Lachen.) F.W. Schultz & Sch. Bip.	PEI3
<i>Rhodiola rosea</i> L.	PEI2
<i>Rumex scutatus</i> L.	PEI3
<i>Selaginella selaginoides</i> (L.) P. Beauv. ex Schrank & Mart.	PEI5
<i>Sibbaldia procumbens</i> L.	PEI5
<i>Veronica fruticans</i> Jacq.	CLA4



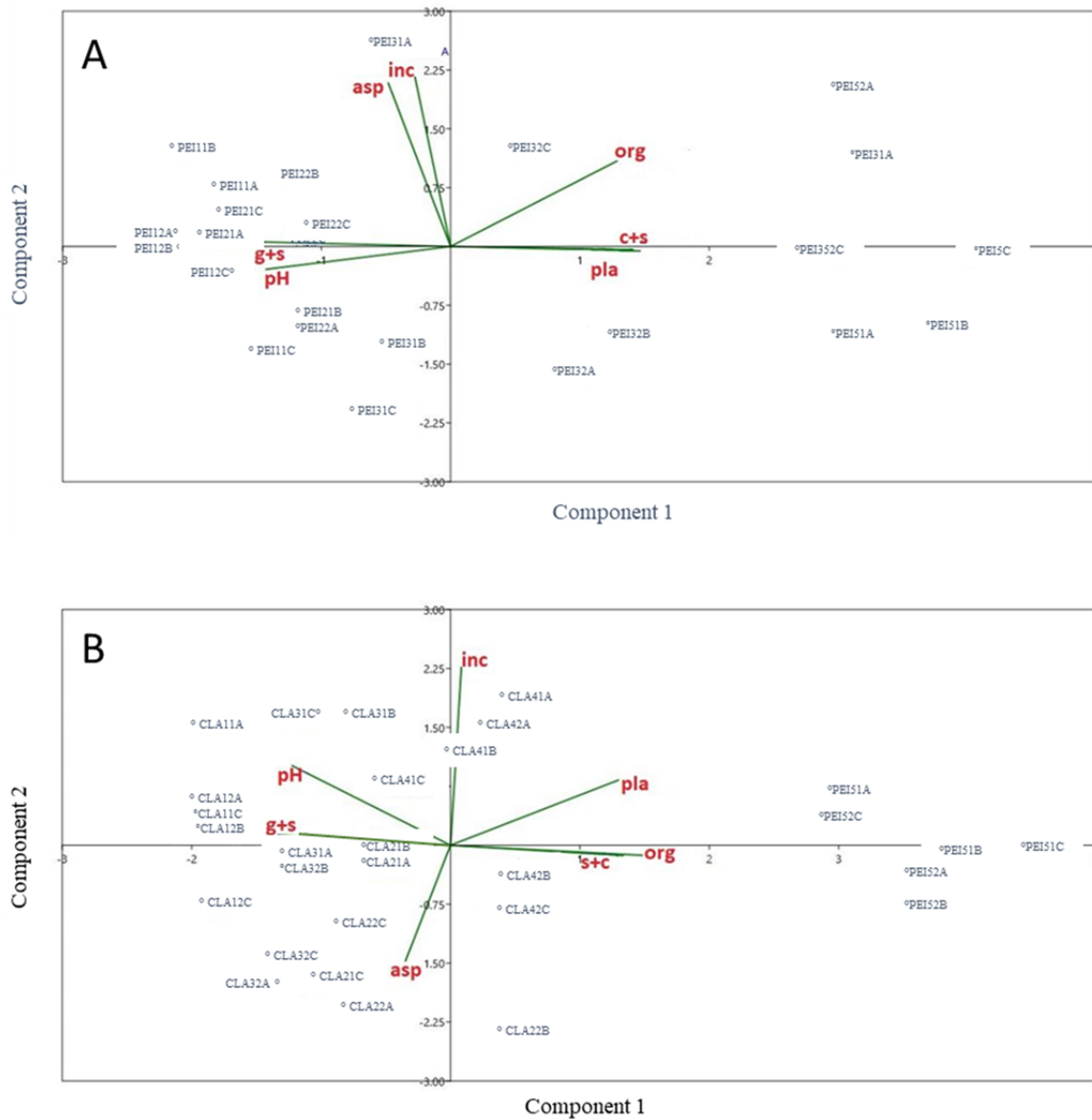
Appendix 4 Comparison between Clapier and Peirabroc supraglacial ground temperature at soil level.

Appendix 5 Spearman correlation index among site variables and soil variables for Peirabroc (A) and Clapier (B)

A_ Rho spearman Peirabroc (from PEI1 to PEI5)	Aspect (°)	Slope (°)	Total plant cover (%)	Gravel and sand (%)	Clay and silt (%)	pH	Soil organic matter content (g/kg)
Aspect		0.3786	-0.3705	0.2064	-0.2064	0.2320	-0.0171
Slope			-0.2349	0.2404	-0.2404	0.1511	0.0675
Total plant cover (%)				-0.8808	0.8808	-0.8496	0.7502
Gravel and sand (%)					-1.0000	0.8251	-0.7723
Clay and silt (%)						-0.8251	0.7723
pH							-0.8593
Soil organic matter content (g/kg)							
B - Rho spearman CLAPIER (from CLA1 to PEI5)	Aspect	Slope	Total plant cover (%)	Gravel and sand (%)	Clay and silt (%)	pH	Soil organic matter content (g/kg)
Aspect		-0.1980	-0.2007	0.1190	0.1625	0.0529	0.0600
Slope			0.0419	0.0919	0.0755	0.2295	0.0278
Total plant cover (%)				-0.7566	-0.7504	-0.6251	0.6841
Sand and gravel (%)					0.1561	0.8538	-0.5189
Silt and clay (%)						0.2829	-0.6250
pH							-0.2784
Soil organic matter content (g/kg)							



Appendix 6 Soil parameters along the successional stages of Peirabroc and Clapier glacier foreland: grain size distribution (A-B); soil pH (C-D); organic matter content (E-F); total plant cover (G-H).



Appendix 7 Principal Component Analysis (PCA) analysis for Peirabroc (A) and Clapier (B). asp = aspect, inc= slope, org= organic matter, pH = soil pH, pla = plant cover, g+s = gravel and sand (%), s+c =silt and clay (%). Explained percentage for the first 3 axes are 63.505%, 19.791%, 9.2691% and 54.803%, 19.151%, 12.603% for Peirabroc and Clapier, respectively.

Appendix 8 Indicator Species Analysis values (indval) for Peirabroc and Clapiert glacier environments

Species	Supraglacial debris		Young glacier foreland		Young moraine		Mid-successional stages		Late-successional stages	
	PEI1 indval %	p-row	CLA2 indval %	p-row	PIE2-CLA3 indval %	p-row	PIE3-CLA4 indval %	p-row	PEI5 indval %	p-row
<i>Achillea erba-rota</i>	0	1	0	1	2.778	0.3410	11.110	0.1300	0	1
<i>Achillea nana</i>	1.905	0.7473	1.071	0.8465	8.929	0.4334	25.710	0.0260	5.714	0.5784
<i>Adenostyles leucophylla</i>	0	1	0	1	10.900	0.3559	30.770	0.0062	13.850	0.2503
<i>Agrostis rupestris</i> ssp. <i>rupestris</i>	0	1	0	1	0	1	37.180	0.0018	4.274	0.3960
<i>Agrostis schraderiana</i>	0	1	0	1	0	1	37.800	0.0016	4.065	0.4166
<i>Alchemilla gr alpina</i>	0	1	0	1	0	1	7.407	0.1973	9.259	0.2065
<i>Alchemilla flabellata</i>	0	1	0	1	0	1	30.330	0.0087	32.000	0.0237
<i>Anthoxanthum nipponicum</i>	0	1	0	1	0	1	21.540	0.0536	67.690	0.0002
<i>Arabis alpina</i>	0	1	0	1	51.280	0.0002	3.846	0.6435	0	1
<i>Armeria alpina</i>	0	1	0	1	0	1	69.440	0.0001	2.778	0.6007
<i>Artemisia glacialis</i>	0	1	0	1	20.830	0.0353	1.389	0.5211	0	1
<i>Artemisia umbelliformis</i> .										
<i>ssp. eriantha</i>	0	1	0	1	16.670	0.0973	0	1	0	1
<i>Astrantia minor</i>	0	1	0	1	0	1	0	1	33.330	0.0225
<i>Atocion rupestre</i>	0	1	0	1	0	1	18.940	0.0383	27.270	0.0354
<i>Campanula scheuchzeri</i>	0	1	0	1	0	1	34.700	0.0018	53.730	0.0003
<i>Cardamine resedifolia</i>	0	1	0	1	32.810	0.0036	4.688	0.7756	18.750	0.1386
<i>Carex parviflora</i>	0	1	0	1	0	1	22.500	0.0286	0	1
<i>Carex sempervirens</i>	0	1	0	1	0	1	0.1366	0.9323	98.360	0.0001
<i>Cherleria sedoides</i>	0	1	0	1	0	1	31.410	0.0044	23.080	0.0520
<i>Cirsium spinosissimus</i>	0	1	0	1	0.641	0.7311	7.692	0.1753	7.692	0.2559
<i>Doronicum clusii</i>	0	1	0	1	16.670	0.1028	0	1	0	1
<i>Dryopteris villarii</i>	0	1	0	1	0	1	50.000	0.0004	0	1
<i>Epilobium nutans</i>	0	1	0	1	16.670	0.095	0	1	0	1
<i>Erigeron alpinus</i>	0	1	0	1	0	1	50.000	0.0002	0	1
<i>Euphrasia alpina</i>	0	1	0	1	0	1	83.330	0.0001	0	1
<i>Euphrasia minima</i>	0	1	0	1	0	1	59.520	0.0001	9.524	0.3079
<i>Festuca halleri</i> ssp. <i>halleri</i>	0	1	0	1	0	1	41.670	0.002	0	1
<i>Festuca nigricans</i>	0	1	0	1	8.276	0.8053	58.790	0.0001	19.540	0.2303
<i>Festuca varia</i>	0	1	0	1	0	1	46.580	0.001	15.070	0.1653
<i>Festuca violacea</i> ssp. <i>violacea</i>	0	1	0	1	0	1	2.778	0.41	27.780	0.0180
<i>Helictichloa versicolor</i> ssp. <i>versicolor</i>	0	1	0	1	0	1	3.333	0.5364	53.330	0.0027
<i>Hornungia alpina</i>	0	1	0	1	41.670	0.0015	0	1	0	1
<i>Jacobaea incana</i>	0	1	0	1	0	1	16.030	0.0723	41.030	0.0065
<i>Leucanthemopsis alpina</i>	0	1	2.206	0.6715	7.843	0.3974	13.480	0.1524	11.760	0.2582
<i>Linaria alpina</i>	0	1	0	1	41.670	0.0014	0	1	0	1
<i>Lotus corniculatus</i> ssp. <i>alpinus</i>	0	1	0	1	0	1	25.930	0.0156	61.110	0.0002
<i>Luzula alpinopilosa</i>	0	1	3.571	0.4814	1.190	0.7591	29.760	0.0075	0	1
<i>Luzula lutea</i>	0	1	0	1	0	1	10.710	0.1319	19.050	0.0929
<i>Luzula spicata</i>	0	1	0	1	0	1	66.670	0.0001	0	1
<i>Meum athamanticum</i>	0	1	0	1	0	1	0	1	33.330	0.0225

(-To be continued-)

Appendix 8 Indicator Species Analysis values (indval) for Peirabroc and Clapier glacier environments(-Continued-)

Species	Supraglacial debris		Early successional stages		Young moraine		Mid-successional stages		Late-successional stages	
	PEI1	CLA2	Young glacier foreland	PIE2-CLA3	LLA moraine	PIE3-CLA4	LG terrains	PEI5		
<i>Minuartia recurva</i>	0	0	1	0	1	0	41.670	0.0023	0	1
<i>Mutellina adonidifolia</i>	0	0	1	0	1	0	0	1	50.000	0.0033
<i>Myosotis alpestris</i>	0	0	1	0	1	0	91.670	0.0001	0	1
<i>Nardus stricta</i>	0	0	1	0	1	0	0	1	83.330	0.0001
<i>Nocca corymbosa</i>	0	0	1	15.930	0.0896	0	36.030	0.0014	0	1
<i>Omalothea supina</i>	0	0	1	0	1	0	33.330	0.0079	0	1
<i>Oreojuncus trifidus</i>	0	0	1	0	1	0	50.000	0.0006	0	1
<i>Oxyria digyna</i>	0	2.206	0.7429	83.580	0.0001	0	0	1	0	1
<i>Pedicularis rostratospicata</i> ssp. <i>Hebetica</i>	0	0	1	0	1	0	31.250	0.0053	12.500	0.1722
<i>Phyteuma globulariifolium</i> ssp. <i>pedemontanum</i>	0	0	1	0	1	0	25.000	0.0297	0	1
<i>Phyteuma michelii</i>	0	0	1	0	1	0	0	1	50.000	0.0021
<i>Pilosella lactucella</i>	0	0	1	0	1	0	16.670	0.1061	0	1
<i>Poa alpina</i>	0	2.174	0.9922	21.920	0.1578	0	36.960	0.0001	34.780	0.0018
<i>Poa cenisia</i>	0	0	1	21.880	0.0319	0	28.120	0.0097	0	1
<i>Poa laxa</i>	18.390	0	1	17.240	0.0801	0	9.483	0.2871	0	1
<i>Polystichum lonchitis</i>	0	0	1	0	1	0	25.000	0.0304	0	1
<i>Ranunculus montanus</i>	0	0	1	0	1	0	0	1	83.330	0.0001
<i>Rhododendron ferrugineum</i>	0	0	1	0	1	0	0	1	50.000	0.0034
<i>Sabulina verna</i>	0	0	1	0	1	0	16.670	0.1023	0	1
<i>Sagina glabra</i>	0	0	1	1.852	0.7019	0	18.520	0.0412	5.556	0.3406
<i>Sagina saginoides</i>	0	0	1	0	1	0	41.670	0.0023	0	1
<i>Saxifraga aizoides</i>	8.889	0.2678	0	30.560	0.0064	0	0	1	0	1
<i>Saxifraga bryoides</i>	0	16.790	0.3542	34.200	0.0031	0	30.220	0.0096	0	1
<i>Saxifraga exarata</i>	0	1.103	0.9762	39.090	0.0002	0	52.940	0.0001	0	1
<i>Saxifraga oppositifolia</i>	0	0	1	25.000	0.0289	0	0	1	0	1
<i>Saxifraga paniculata</i>	0	0	1	8.929	0.1797	0	16.070	0.0517	0	1
<i>Saxifraga pedemontana</i> ssp. <i>pedemontana</i>	14.290	0.1459	0	38.100	0.0012	0	0	1	0	1
<i>Saxifraga retusa</i> ssp. <i>Augustana</i>	19.750	0.1304	0	12.350	0.1419	0	8.333	0.2734	0	1
<i>Scorzoneroides hebetica</i>	0	0	1	0.149	0.9633	0	0.446	0.9331	92.860	0.0001
<i>Sedum alpestre</i>	0	0	1	21.880	0.0680	0	42.010	0.0001	12.500	0.5269
<i>Sempervivum arachnoideum</i>	0	0	1	4.487	0.7112	0	68.380	0.0001	0	1
<i>Sempervivum montanum</i>	0	0	1	11.110	0.1256	0	2.778	0.3379	0	1
<i>Sempervivum tectorum</i>	0	0	1	5.128	0.3058	0	1.923	0.4962	7.692	0.1861
<i>Silene acaulis</i>	0	0	1	10.670	0.1912	0	28.330	0.0088	0	1
<i>Soldanella alpina</i> ssp. <i>alpina</i>	0	0	1	0	1	0	0	1	50.000	0.0021
<i>Thymus oenipotanus</i>	0	0	1	0	1	0	41.670	0.0022	0	1
<i>Trifolium alpinum</i>	0	0	1	0	1	0	17.240	0.0548	15.520	0.1038
<i>Trifolium thalii</i>	0	0	1	0	1	0	75.000	0.0001	0	1
<i>Tussilago farfara</i>	0	0	1	0	1	0	25.000	0.0283	0	1
<i>Vaccinium myrtillus</i>	0	0	1	0	1	0	0.439	0.7698	47.370	0.0018

(-To be continued-)

Appendix 8 Indicator Species Analysis values (indval) for Peirabroc and Clapier glacier environments(-Continued-)

Species	Supraglacial debris		Early successional stages		Young moraine		Mid-successional stages		Late-successional stages		
	PEI1	PEI2	CLA2	CLA3	PIE2-CLA3	PIE3-CLA4	PIE5	LG terrains	PEI5	LG terrains	
<i>Vaccinium uliginosus</i>	0	1	0	1	0	0	1	0	1	50.000	0.0034
<i>Veronica alpina</i>	0	1	0	1	7.883	0.4319	0	24.320	0.0220	10.810	0.3133
<i>Viola calcarata</i>	0	1	0	1	0	0	1	0	1	33.330	0.0216
<i>Oreonebria angusticollis</i> sp.	25.960	0.0202	5.128	0.3963	0	0	1	0	1	0	1
<i>microcephala</i>	0	1	0	1	8.333	0.3138	0	0	1	0	1
<i>Nebria jockischii</i>	0	1	0	1	0	0	1	10.000	0.2577	0	1
<i>Cicindela gallica</i>	0	1	0	1	0	0	1	10.000	0.2607	0	1
<i>Laemostenus janthinus coeruleus</i>	0	1	0	1	0	0	1	10.000	0.2607	0	1
<i>Amaru carduii</i> sp. <i>psyllocephala</i>	0	1	0	1	0	0	1	30.000	0.0029	13.330	0.1297
<i>Carabus pedemontanus</i>	0	1	0	1	0	0	1	28.820	0.0071	58.820	0.0022
<i>Pterostichus morio</i> sp. <i>fenestrellanus</i>	0	1	0	1	0	0	1	0	1	100.000	0.0002
<i>Harpalus rubripes</i>	0	1	0	1	0	0	1	0	1	33.330	0.0751
<i>Oreonebria macrodera</i>	0	1	0	1	0	0	1	0	1	0	1
<i>Entelegara</i> sp	0	1	25.640	0.0350	0	0	1	2.308	0.5176	0	1
<i>Mughiphantes</i> sp	0	1	16.670	0.1560	0	0	1	0	1	0	1
<i>Diplocephalus helleri</i>	0	1	0	1	8.333	0.3013	0	0	1	0	1
<i>Vesubia jugorum</i>	0	1	0	1	16.670	0.0858	0	0	1	0	1
<i>Coelotes pabulator</i>	0	1	0	1	25.640	0.0084	0	2.308	0.3890	0	1
<i>Coelotes pickardi pastor</i>	0	1	0	1	3.788	0.2433	0	5.455	0.2189	0	1
<i>Pardosa nigra</i>	0	1	0	1	2.451	0.2870	0	14.120	0.0779	0	1
<i>Dysdera cribrata</i>	0	1	0	1	0	0	1	10.000	0.2607	0	1
<i>Xysticus desidiosus</i>	0	1	0	1	0	0	1	10.000	0.2607	0	1
<i>Zelotes gallicus</i>	0	1	0	1	0	0	1	30.000	0.0124	0	1
<i>Drassodes pubescens</i>	0	1	0	1	1.667	0.5249	0	0	1	26.670	0.0510
<i>Centromerus pabulator</i>	0	1	0	1	0	0	1	0	1	33.330	0.0751
<i>Coelotes osellai</i>	0	1	0	1	0	0	1	0	1	33.330	0.0751
<i>Palliduphantes pallidus</i>	0	1	0	1	0	0	1	0	1	33.330	0.0741
<i>Pardosa blanda</i>	0	1	0	1	0	0	1	0	1	100.000	0.0002
<i>Orchesella cf. frontimaculata</i>	21.800	0.0562	38.760	0.0046	6.202	0.5726	0	0	1	0	1
<i>Isotomidae</i> sp.	5.357	0.1584	0	1	9.524	0.1536	0	0	1	0	1
<i>Deuterosminthurus pallipes</i>	6.818	0.3069	3.030	0.5309	0	1	27.270	0.0112	0.112	0	1
<i>Lepidocyrtus gr curvicolis</i>	6.670	0.6356	1.318	0.9099	32.940	0.0028	7.589	0.6113	0.6113	5.270	0.4901
<i>Orchesella alticola</i>	0	1	13.330	0.0891	30.000	0.0043	0	0	1	0	1
<i>Tomoceris minor</i>	0	1	0	1	16.670	0.0883	0	0	1	0	1
<i>Sminthurus</i> sp.	0	1	0	1	17.860	0.0323	2.857	0.2950	0.2950	0	1
<i>Cerathophysella armata</i>	0	1	0	1	0	0	10.000	0.2607	0.2607	0	1
<i>Fascosminthurus sauteri</i>	0	1	0	1	0	0	40.000	0.0019	0.0019	0	1
<i>Entomobrya lanuginosa</i>	0	1	0	1	0	0	40.000	0.0018	0.0018	0	1
<i>Lepidocyrtus gr cyaneus</i>	0	1	0	1	0	0	21.820	0.0115	0.0115	15.150	0.1155
<i>Orchesella quinquefasciata</i>	0	1	0	1	0	0	0	0	1	100.000	0.0002