Appendix 1. Summary of studies examining the temperature impacts of cushion plant species.

Species	Cushion form (from Aubert *et al.*, 2014)	Study area	Effect	Frequency and duration of temperature measurements	Sample size	Reference
Azorella aretioides (Apiaceae)	Intermediate between C & F types	Tropical alpine environment in the Ecuadorian Andes, 4400 – 4700 m a.s.l.	Soil temperature, air temperature and relative humidity were lower beneath cushions than in the adjacent ground. Soil moisture and soil organic matter were significantly higher beneath cushions. K, Ca and Mg content was higher beneath cushions; NH_4 and P showed no difference and Cu and Fe was lower beneath cushions.	Every 15 minutes, for at least 16 days	7 pairs for air temperature, 11 pairs for soil temperature	Anthelme *et al.* (2012)
Azorella monantha (Apiaceae)	Intermediate between C & F types	Chilean Patagonian Andes, 700 m a.s.l. and 900 m a.s.l.	At 700 m a.s.l. surface temperature was higher beneath the cushions, and at 900 m a.s.l. surface temperature and soil temperatures at 5 cm and 10 cm depths were all higher beneath cushions. Cushions maintained similar temperatures at both elevations while the temperatures of the adjacent ground decreased with elevation.	Temperature taken at midday for 2 days (14 and 15 January 1992)	8 pairs	Arroyo *et al.* (2003)

		Andes, central Chile	Cushions maintained temperatures that were 12 to 18 °C lower than open areas, except when temperatures in the open areas dropped below 5 °C, when cushions had temperatures 5 – 9 °C warmer than open ground. Moisture was significantly higher beneath the cushions, with no difference in macronutrient concentrations.	Every hour over one and a half months (29 November 3003 – 17 January 2004)	4 pairs	Badano *et al.* (2006)
		Andes, central Chile, 3600 m a.s.l.	Temperatures beneath cushion plants (2 cm depth) were higher than in the open, but the difference disappeared towards the end of the growing season. Temperatures beneath *A. monantha* only dropped below 0 °C on 2 days, while the temperatures in the open were sub-zero 32% of the time. There was no difference in soil moisture between cushions and open areas.	Every hour for four months (December 2004 – March 2005)	4 pairs	Cavieres *et al.* (2007)
			When substrate temperatures at 2 cm depth in the bare ground were higher than 20 °C, temperatures beneath cushion plants were lower	Every hour for four months (28 November 2003 – 30 March 2004)	4 pairs	Cavieres *et al.* (2008)

			than the open ground, but when temperatures in the bare ground dropped below 20 °C there was no difference between the two microhabitat temperatures. Soil moisture, N and K content beneath cushions were higher than in the bare ground. No difference was found in the P content.			
		Andes, central Chile	Substrate temperatures at 1 cm depth (measured every two hours) were lower beneath cushions than in the surrounding areas for most of the day, except at 8:00 and 20:00 when cushion temperatures were higher than the surrounding areas. Soil moisture at 10 cm depth was higher beneath cushions than in surrounding soil. Moisture beneath *A. monantha* was higher than that beneath *L. acaulis*.	Every 2 hours from 8:00 to 20:00 over two consecutive days (February 2003)	5 pairs	Molina-Montenegro *et al.* (2006)
Laretia acaulis (Apiaceae)	Intermediate between C & F types	Andes, central Chile, 2800 m a.s.l.	Substrate temperatures at 2 cm were higher beneath cushion plants than in the open ground. Soil moisture was higher beneath cushions.	Every hour for four months (December 2004 – March 2005)	4 pairs	Cavieres *et al.* (2007)

		Andes, central Chile	When substrate temperatures at 2 cm depth in the bare ground were higher than 20 °C, temperatures beneath cushion plants were lower than the open ground, but when temperatures in the bare ground dropped below 20 °C there was no difference between the two microhabitat temperatures. Soil moisture, N and K content beneath cushions were higher than in the bare ground. No difference was found in the P content.	Every hour for four months (28 November 2003 – 30 March 2004)	4 pairs	Cavieres *et al.* (2008)
		2700 m a.s.l., 3200 m a.s.l.	Substrate temperatures at 1 cm depth (measured every two hours) were lower beneath cushions than in the surrounding areas. Soil moisture at 10 cm depth was higher beneath cushions than in surrounding soil.	Every 2 hours from 8:00 to 20:00 over two consecutive days (February 2003)	5 pairs	Molina-Montenegro *et al.* (2006)
		Central Chile, 2800 m a.s.l.	Mean soil temperatures were cooler (22°C compared to 35°C) and water content was higher inside the cushions than outside.	Unknown	8 pairs	Cavieres and Peñaloza (1998)

		La Parva, Andes of central Chile, 2800 m a.s.l.	The hydric potential beneath the cushions was significantly lower than in the open soil (i.e. more water beneath cushions). Temperatures at a depth of 1 cm beneath the cushions were more buffered (smaller daily range).	Every 2 hours from 8:00 to 20:00 over two consecutive days	3 pairs	Molina-Montenegro *et al.* (2005)
		Central Chilean Andes, 2800 m a.s.l. and 3200 m a.s.l.	At 2800 m a.s.l. the bare ground showed a larger temperature range than within the cushions, with maximum temperatures on the bare ground reaching 45 °C and cushion temperatures not exceeding 25 °C. At 3200 m a.s.l. the differences between bare ground and cushions were smaller than at 2800 m. Cushion plants still maintained lower maximum temperatures than the bare ground (22 °C compared to 30 °C).	Every hour for four months (the duration of the growing season; 28 November 2003 – 30 March 2004)	4 pairs at each elevation (total of 8 pairs)	Cavieres *et al.* (2006)
Diapensia lapponica (Diapensiaceae)	Hemispherical (dome shaped) cushion	Swedish Lapland	Cushion plant temperatures were higher than adjacent soil temperatures.	During two days	1 pair	Fischer and Kuhn (1984)
Azorella compacta (Apiaceae)	Intermediate between C & F types	Chile	Temperatures of *A. compacta* were lower than air temperature at 6:00 and 14:00 (by as much as 23 °C), but higher than air temperature at 10:00 and 18:00 (by about 10 °C).	15 months (November 1998 – January 2000)	Unknown	Kleier and Rundel (2009)

		Jujuy province, Andes	Cushions were cooler than the soil at three depths (1-2 cm, 5 cm and 10 cm) when compared to soil temperature (at a depth of 1-2 cm). There is an instance of warming in autumn. Changes in temperature inside the cushion are slow; there is no rapid heating or cooling.	Unknown	Unknown	Ruthsatz (1978)
Pycnophyllum molle (Caryophyllaceae)	Low cushion	Jujuy province, Andes	Cushions had inconsistent effects on temperature. Different patterns were observed at different depths and during the different seasons (even at the same depth). In winter cushions were warmer than the adjacent substrate, in summer cushions maintained cooler temperatures than the open ground, while in autumn and spring their effects on the temperature were mixed.	Unknown	Unknown	Ruthsatz (1978)
Trifolium andersonii (Fabaceae)	Other	White Mountains, eastern California	Shoot temperature of cushion plants higher than air temperature 1 m above the surface (by 8 – 20 °C).	90 – 120 minute intervals over 2 days	Unknown	Rundel *et al.* (2005)
Penstemon heterodoxus (Scrophulariaceae)	Other	White Mountains, eastern California	Shoot temperature of cushion plants higher than air temperature 1 m above the surface (by 8 – 20 °C).	90 – 120 minute intervals over 2 days	Unknown	Rundel *et al.* (2005)

Eriogonum ovalifolium (Polygonaceae)	Other	White Mountains, eastern California	Shoot temperature of cushion plants higher than air temperature 1 m above the surface (by 8 – 20 °C).	90 – 120 minute intervals over 2 days	Unknown	Rundel *et al.* (2005)
Arenaria obtusiloba (Caryophyllaceae)	Other	Mount Evans, Colarado, 4300 m a.s.l.	Cushion leaf temperatures remained above air temperature at plant height (6 cm above ground) during the day. Between 23:00 and around 5:30 cushion temperatures dropped to the same as air temperature or below air temperature.	Every 30 minutes over nine hours on 21 June 1961, and 21.5 hours between 14 and 15 July 1961	Unknown	Salisbury and Spomer (1964)
Xenophyllum humile (Asteraceae)	Intermediate between C & F types	Volcán Iliniza, Ecuador, 5263 m a.s.l.	The top of the cushion was significantly warmer than the air temperature 2 cm above the cushion during the day. During the day the top of the cushion was 5 – 27 °C colder than the soil surface temperature, while at night the top of the cushion was mostly warmer than the soil surface temperature (maximum difference of 2.2 °C).	4 days (14 – 17 October 2006)	1 pair	Sklenář (2007)
Haplopappus acaulis (Asteraceae)	Other	Shortgrass prairie, Wyoming, 2480 m a.s.l.	Leaf temperature reached 8.3 – 10.7 °C warmer than air temperature at 1 m above the ground. The soil directly adjacent to the cushion was warmer than the mean soil temperature.	9 days (9 – 17 April 1980)	5 pairs	Smith *et al.* (1983)
Hymenoxys acaulis (Asteraceae)	Other	Shortgrass prairie, Wyoming, 2480 m a.s.l.	Leaf temperatures were more than 10 °C warmer	9 days (9 – 17 April 1980)	5 pairs	Smith *et al.* (1983)

			than the air temperature at 1 m			
Arenaria polytrichoides (Caryophyllaceae)	Hemispherical (dome shaped) cushion	Lakaka pass, South-West China, 4500 m a.s.l. and 4700 m a.s.l.	During the dry season temperatures at 2 cm inside the cushions were no different from temperatures at 2 cm in adjacent soil at 4700 m a.s.l., but at 4500 m a.s.l. the cushions were on average 1.7 °C warmer. During the rainy season the cushion temperatures were an average of 1.75 °C lower than the soil temperatures at both elevations. At both elevations water content was much higher beneath *A. polytrichoides* than in the adjacent soil. At 4500 m a.s.l. there was no difference in any of the nutrients measured between the cushion plants and adjacent soil. However, at 4700 m a.s.l., N and K were significantly higher beneath cushions.	Every 15 minutes over 7 days in the dry season, and every 5 minutes over 7 days in the rainy period	4 pairs at each elevation (total of 8 pairs)	Yang *et al.* (2010)
		South-eastern Himalayas, 4700 m a.s.l.	Temperature 2 cm into the cushion was lower than 2 cm beneath the soil throughout the growing season. Soil samples from 15 cm depth showed higher levels of N and K beneath the cushions than in the adjacent soil, but	Every 150 seconds over 7 days for three periods (early, middle, late growing season, 21 days total)	4 pairs	Chen *et al.* (2015)

			lower levels of P beneath the cushions.			
		Baima Snow Mountain, Yunnan province, China, 4380 m a.s.l., 4660 m a.s.l., 4920 m a.s.l.	In all three communities (4380 m a.s.l., 4660 m a.s.l. and 4920 m a.s.l.) temperatures were significantly lower under cushions than in the surrounding soil. In the highest and middle communities (4920 m a.s.l. and 4660 m a.s.l.) the temperatures in the cushions fluctuated less than in the surrounding soil, while in the lowest community (4380 m a.s.l.) the temperatures in the cushions showed more fluctuation than in the surroundings. Soil nutrients in the lowest community were very similar to those in surrounding areas, but were higher beneath cushions than in the open for the middle and higher communities. Soil water content showed no significant difference between cushions and open soil in the lower and middle communities, whereas soil water content was significantly higher than beneath cushions in the highest community.	Measurements taken during June and July 2018		Chen *et al.* (2019)

Potentilla articulata (Rosaceae)	Tufted cushion, densely caespitose	South-eastern Himalayas, 4700 m a.s.l.	Temperature 2 cm into the cushion was lower than 2 cm beneath the soil throughout the growing season. Soil samples from 15 cm depth showed higher levels of N, K, and P beneath the cushions than in the adjacent soil. P and K contents under *P. articulata* were significantly higher than under *A. polytrichoides*.	Every 150 seconds over 7 days for three periods (early, middle, late growing season, 21 days total)	4 pairs	Chen *et al.* (2015)
Azorella selago (Apiaceae)	Intermediate between C & M types	Marion Island	Mean maximum and mean minimum temperatures in the top 0.5 cm of *A. selago* were higher than at a depth of 2 cm in the soil adjacent to the cushions. The mean temperature range was higher in *A. selago* than in the soil.	6 times a day for 5 months (November – March)	1 pair	Chown and Crafford (1992)
		Marion Island	The mean, minimum, and maximum temperatures within the cushion plant (at three different depths) and the adjacent soil surface temperature showed no significant differences in any of the seasons. The daily temperature range showed no significant difference between the cushion and soil in winter. However, in summer, spring, and autumn there were significant differences between the cushion	Every hour for 10 days in each of the 4 seasons	4 pairs	Nyakatya & McGeoch 2008

			temperatures and soil temperature. The daily temperature range was always lower within the cushion plant than on the adjacent soil surface.			
Silene acaulis (Caryophyllaceae)	Low cushion	Whistler Mt., British Columbia, Canada	Average temperatures in cushions (11.9 ± 6.6 °C) were cooler than in the open (13.2 ± 8.5 °C). Open areas maintained higher daily maximum temperatures, but similar minimum temperatures when compared to cushions. The average relative humidity within the cushion plants was similar to that in the open areas, with much lower variance. When there was precipitation, the increase in relative humidity was higher in the open than underneath cushions.	Every 30 minutes over 40 days (17 July 2010 – 25 August 2010)	12 pairs	Molenda *et al.* (2012)
		Majella massif, central Italy	Soil organic carbon, nitrogen, C:N ratio and salinity were all higher inside the cushions than outside, while pH was lower inside cushions. Cushions temperatures were higher than outside temperatures at 2 and 4 cm depths, at both elevations (2336 m, 2697 m). These differences in temperature were found to	Every 10 minutes over 52 days (28 July 2012 – 17 September 2012)	40 pairs	Bonanomi *et al.* (2015)

			be positively related to the compactness of the cushion plants, as the cushion plants' morphology changed with altitude.			
Thylacospermum caespitosum (Caryophyllaceae)	Hemispherical (dome shaped) cushion	Trans-Himalaya, India	At the lower site (5000 m) cushions had warmer annual mean temperatures (-0.3 °C) than adjacent open areas (-3.4 °C) and cushions stayed frost-free for a month longer. At the higher elevation (5960 m), however, there were very small differences and even some cases where the open areas were warmer than the cushions. Soil physical properties were tested at both sites (4850 – 5250 m and 5350 – 5850 m) within and outside the cushion species. At the lower site, $N\text{-}NH^{4+}$, $P\text{-}PO_4^{3-}$, Mg, gravimetric water content, volumetric water content and pH were all higher in the open than beneath cushions. The only parameter with higher values beneath the cushion than in the open was organic matter. The other properties ($N\text{-}NO^{3-}$, TN, Ca, K, Na and percentage of soil particles larger than 0.5 mm) showed no significant differences. Soils at the higher site had higher	Every 3 hours over 11 months (September 2009 – August 2010)	3 pairs	Dvorský *et al.* (2013)

			values for $N\text{-}NH^{4+}$, $N\text{-}NO^{3-}$, $P\text{-}PO_4^{3-}$, Ca and pH outside cushions, while the volumetric water content was higher underneath the cushions than in the open. The remaining properties showed no significant differences.			
Potentilla biflora (Rosaceae)	Intermediate between F & M types	Altai Mountains, Russia, 2950 m a.s.l.	The temperatures within the cushions (at depths of 2 cm, 4 cm, or 14 cm) were more stable than air temperature at 2 cm. The maximum temperatures and minimum temperatures within the cushions did not reach the maximum and minimum air temperature, but the average temperature within the cushions was exceeded the average air temperature by about 2 °C. Soil organic matter was higher beneath the cushion than in the adjacent substrate.	Every 30 minutes for one day (14 July)	2 pairs for temperature measurements and 1 cushion for soil organic matter measurements	Volkov & Volkova 2015
Oxytropis tragacanthoides (Fabaceae)	Hemispherical (dome shaped) cushion	Altai Mountains, Russia, 1780 m a.s.l.	Cushion temperatures at depths of 10 cm and 20 cm were more stable than air temperatures and soil surface temperatures. Average temperatures at a 10 cm depth within the cushion were lower than the air and soil surface temperatures. Soil organic matter, P, and N content	Every hour over three days	1 pair	Volkov & Volkova 2015

			were lower beneath the cushion than on the adjacent slope (both above and below the cushion).			

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