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Expanded distributional records of Collembola and Acari in southern Victoria Land, Antarctica

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Summary

We provide new distributional records for the Collembola and Acari from south Victoria Land in the Ross Dependency, Antarctica, including the first extensive survey of Taylor Valley. We also describe the design of a modified device for the rapid sampling of Antarctic terrestrial arthropods. Sampling was carried out during the austral summers from 1998 to 2001. In several instances we found *Gomphiocephalus hodgsoni*, *Neocryptopygus nivicolus* and *Stereotydeus mollis* at sites where they were not reported in comprehensive surveys made some 40 years ago, which may imply recent range expansion (eg: local dispersal). By contrast, at McMurdo Station and at the former North Base (Marble Point) the distribution of *G. hodgsoni* and *S. mollis* was restricted, relative to previous records. We conclude that these latter changes may be the direct result of human activities.

Key words: Collembola, Acari, arthropod distribution, dispersal, invertebrate sampling

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Introduction

Antarctica has been isolated from other continents by a wide oceanic belt (c. 40°S–66°S) for at least 10 million years (Schultz 1995; Lawver & Gahagan 1998). The sub-Antarctic islands, southern New Zealand and Tierra del Fuego are now the only terrestrial areas that penetrate this oceanic zone. The isolation and harsh environment of Antarctica have produced a unique polar desert that is now dominated by mosses, lichens and algae (Broady 1996; Seppelt & Green 1998). In polar regions, species diversity of arthropods is extremely low (Vernon et al. 1998), and only those with adaptations to extreme cold temperatures through the use of behavioural and ecophysiological strategies are represented (Sømme & Block 1991). The community composition of free-living terrestrial soil fauna on the Antarctic continent includes Collembola (Wise 1967, 1971; Wise & Shoup 1971; Frati et al. 1997), Acari (Gressitt 1967; Strandtmann 1967; Pugh 1997), rotifers, nematodes and tardigrades (Tilbrook 1967; Jennings 1979; Freckman & Virginia 1989; Wharton & Brown 1989; Schwarz et al. 1993).

Information on the distribution and taxonomy of terrestrial arthropods of the Ross Dependency received considerable attention in the 1960s (Gressitt et al. 1963; Wise & Gressitt 1965; Gressitt 1967; Strandtmann 1967; Wise 1967; Wise & Spain 1967; Wise 1971; Wise & Shoup 1971). However, there has been a paucity of additional information since (eg: Potapov 1991; Frati et al. 1997). Although research has been sporadic, renewed interest in the arthropod fauna has enabled the distribution and species designations of arthropods to be re-examined following earlier studies some 40 years ago (eg: Strandtmann 1967; Wise 1967, 1971).

Accordingly, our aims were threefold. Firstly, to examine the distributional records for Collembola and Acari from south Victoria Land, Ross Dependency; secondly, to contrast this with previous records; and thirdly, to provide a more detailed benchmark for the long-term monitoring of arthropod populations.

Materials and Methods

Study sites

We assessed the presence of Collembola (Hypogastruridae and Isotomidae) and free-living Acari (Prostigmata) from Ross Island and throughout the continental region of south Victoria Land (Fig.1). During January 1999, we examined Bratina Island, Cape Bird and Hut Point Peninsula, and Granite Harbour. In January 2000 we sampled at Beaufort Island, Cape Royds, Cape Evans, Garwood Valley, Miers Valley and re-examined Hut Point Peninsula (Fig. 1). From November 2000 to January 2001 we sampled at Cape Crozier, Granite Harbour, Mt. England, Springtail Point, Marble Point and Taylor Valley (Fig. 1). Complete details are provided in the Appendix.

Sampling of arthropods

We modified the design of the common aspirator to collect from the underside of stones, while minimising environmental disturbance associated with other methods (eg: Berlese Funnel, Tulgren extractor, flotation method). We miniaturised the storage chamber of the aspirator with a Nalgene™ 1.2 ml internal thread cryo-vial (Fig. 2) and used this vial for storage of specimens.

This minimised the possibility of any transfer of specimens between locations as a new vial was used at each site. The center of the cryo-vial lid was drilled leaving a hole with the thread and sides of the lid intact. Two flexible clear plastic tubes with an internal diameter of 3 mm (4.5 mm external) were pushed through the hole in the lid. The collecting tube was cut at 45 degrees to minimise potential blockage by specimens (Fig. 2). The tube leading to the mouthpiece was covered with 0.05 mm mesh. After the tubes were in place, silicon sealant was used to seal around the tubes to prevent air and specimens from escaping.

Specimens were identified using the original authorities for *Neocryptopygus nivicolus* Salmon 1965 and *Stereotydeus mollis* Womersley & Strandtmann 1963. *Gomphiocephalus hodgsoni* Carpenter 1908 was identified using Salmon (1962). All specimens were stored in either liquid nitrogen or 95 % ethanol.

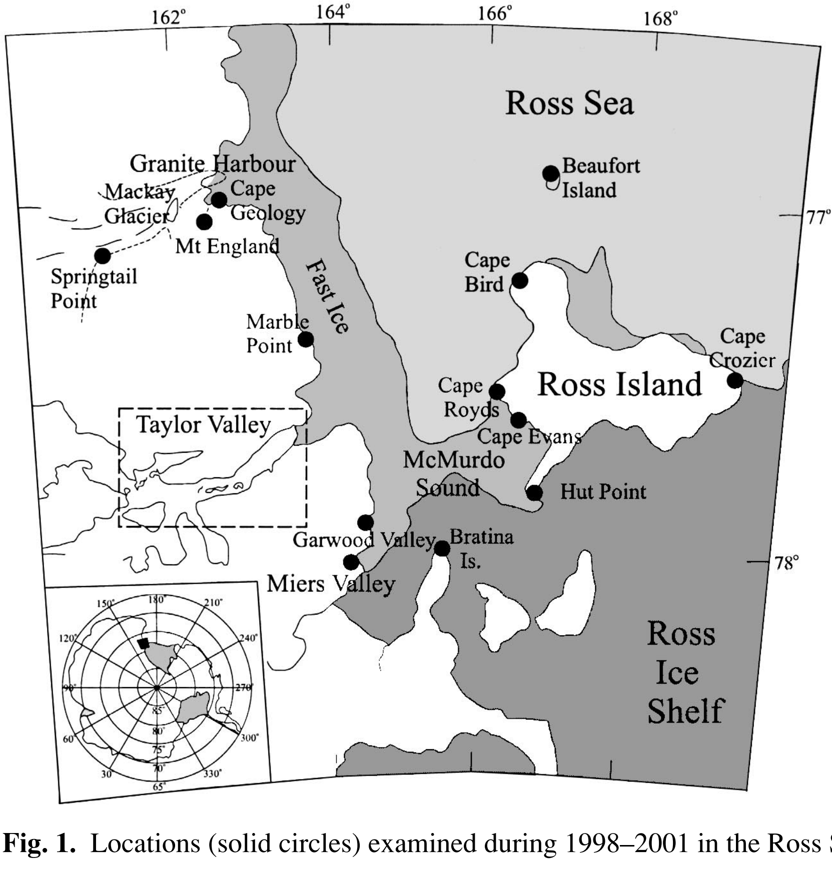

Fig. 1. Locations (solid circles) examined during 1998–2001 in the Ross Sea region

Results

Beaufort Island and Bratina Island

Gomphiocephalus hodgsoni (Collembola) and *Stereotydeus mollis* (Acari) were very abundant in moss samples taken from Beaufort Island (site I1, Appendix). By contrast, we found similar moss habitats on Bratina Island but did not find any evidence

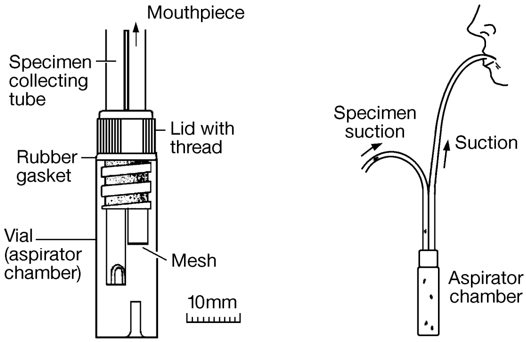

Fig. 2. The modified aspirator used to collect arthropods

(eg: live specimens or exuviae) that would suggest either Collembola or Acari were present. Further sampling in a number of other habitats on Bratina Island also revealed no evidence of either taxon.

Ross Island

G. hodgsoni and *S. mollis* were both found at Cape Bird (site B1), at two sites from Cape Crozier (sites C1-2), at Cape Royds (sites R1-7), and at sites south of Cape Royds towards Cape Barne (sites R8-13). At Cape Evans *S. mollis* was found to be quite extensive throughout the region, (sites E1-3) but *G. hodgsoni* was only found at two sites (sites E2-3), where site E2 was 220 m above sea level and was particularly abundant.

On two occasions (January 1999, 2000) sites were examined around the McMurdo Station area on Hut Point Peninsula, Ross Island. *S. mollis* was collected from Observation Hill at Cape Armitage (site O1), but we did not find any specimens on Hut Point where it had been previously recorded by Strandtmann & George (1973). Likewise, *G. hodgsoni* had been previously recorded from Hut Point and above McMurdo Station (Wise 1971), but we could find no evidence (either live specimens or exuviae) to indicate its presence.

South Victoria Land

Sampling at Cape Geology, Granite Harbour (Fig. 1), revealed two collembolid species, *G. hodgsoni* and *Neocryptopygus nivicolus* as well as *S. mollis*. *G. hodgsoni* was found at 24 sites in the Granite Harbour region, and at ten of these *N. nivicolus* was also found (sites G4-7, G16-19, G21). In the Mt. England region (Fig. 1), *G. hodgsoni*, *N. nivicolus* and *S. mollis* were found. All three species were found at various sites on the lower northern and eastern slopes of Mt. England (sites G25-28), and *G. hodgsoni* was also found with *S. mollis* between Mt. England and New Glacier (site G24).

At the site of the former North Base (Marble Point, Fig. 1), which was bulldozed into the ground between 1957-1959 (Broadbent 1994), *S. mollis* was found (site P2), but there was no evidence of *G. hodgsoni*, despite previous records (Wise et al. 1964; Wise 1967; Wise & Spain 1967). Only at less disturbed sites between Gneiss Point and Marble Point (sites P1, P4-6) and near the Wilson Piedmont Glacier (site P3) was *G. hodgsoni* found. At the current Marble Point Station site there was no evidence of either species.

S. mollis was present at all locations examined around Lake Fryxell in the Taylor Valley (sites T1-6, Fig. 3), and *G. hodgsoni* was only found from streambeds on the southern side of the lake (sites T4, 5). Below all glaciers examined on the south side of the valley (Fig. 3), from Howard Glacier (site T7) to Borns Glacier (site T19) we found both *G. hodgsoni* and *S. mollis*. These species were also found on the southeast side of Lake Chad, 3–4 m from the lake edge (site T21). The distribution of *G. hodgsoni* and *S. mollis* extended the entire length of the Delta Stream from Howard Glacier (site T7) to Lake Fryxel (site T5). Both species were found in a streambed area (site T17) that flows from a small glacier situated between Hughes and Calkin Glaciers, and were also found along several dry streambed areas from the south side of the valley (sites T8, T9, T15, T16, T20).

Both *G. hodgsoni* and *S. mollis* were extensively distributed throughout Miers Valley (sites M1-8). Regions adjacent to Miers Valley (sites M9-13) and Garwood Valley (site G1) were also found to harbour both species.

Discussion

The expanded distributional records for *Gomphiocephalus hodgsoni*, *Neocryptopygus nivicolus* and *Stereotydeus mollis* follow an extensive re-examination of Ross Island, Beaufort Island and south Victoria Land. Previous records (eg: Wise 1967, 1971) have found *G. hodgsoni* from Mt. George Murray (75°55'S) to Minna Bluff (78°28'S), on Black, White, Ross and Beaufort Islands in the Ross Sea, and now we provide detailed distributional records from Ross Island, Taylor Valley, Marble Point, Miers Valley and Granite Harbour regions. *N. nivicolus* was previously known from the Mt. Gran-Willett Range, Mt. Seuss, and on Mt. England (Gressitt et al. 1963; Wise 1971), and in the present study we report on its occurrence at Cape Geology and Mt. England, Granite Harbour. The distribution of *S. mollis* (Strandtmann 1967) is similar to *G. hodgsoni* but extends further north to Terra Nova Bay and is also found on Franklin Island, and here we provide detailed records of its distribution throughout Ross Island, Taylor Valley, Marble Point, Miers Valley region and Granite Harbour.

Previously, the only record of *G. hodgsoni* in Taylor Valley was from the south side with Acari below the terminus of the 3rd glacier from the mouth of the valley (77°40'S) (Gressitt et al. 1963). Since that time a record of 'Collembola' was made by Schwarz et al. (1993) between the Crescent and Howard Glaciers (see Fig. 3). *S. mollis* has previously been reported from Rhone Glacier, Canada Glacier and Lake Chad (Strandtmann 1967; Spain 1971; Block 1985; Schwarz et al. 1993), though its distribution throughout the remainder of the valley was unknown. At Lake Chad we found *S. mollis*, but also found *G. hodgsoni* (site T21, Fig. 3), and it is unlikely that *G. hodgsoni* would have been overlooked by Spain (1971) and Strandtmann & George (1973) if it was present at that time. Previous studies (Wise & Spain 1967; Spain 1971; Strandtmann & George 1973) also make reference to a total absence of any life around Lake Bonney, but we found both species in two streambeds near the Lake (site T16, Fig. 3). More recent studies in Taylor Valley have also provided no new records of Collembola or Acari (Powers et al. 1998; Treonis et al. 1999; McKnight et al. 1999; Priscu 1999; Virginia & Wall 1999).

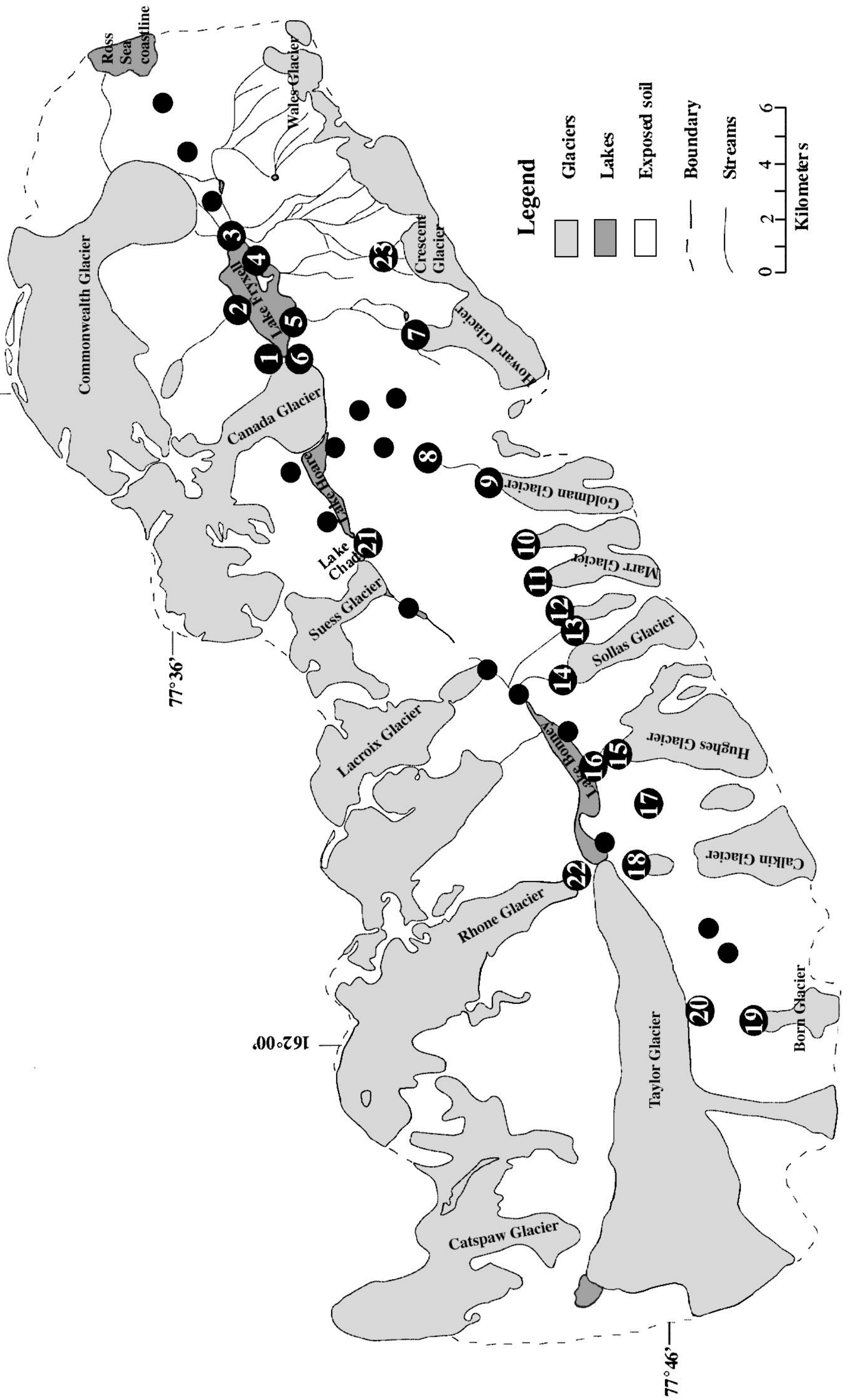

Fig. 3. Distribution of arthropods in Taylor Valley. Sites indicate where arthropods were present (numbered circles – see text), or absent (solid circles). Site 22 was previously examined by Strandtmann (1967) and site 23 by Schwarz et al. (1993)

By contrast, we have found them to be in high abundance near streams, particularly in the vicinity of glacial melt-water, throughout Taylor Valley (Fig. 3). One possible explanation is that differences in sampling strategies (eg: soil extraction techniques vs examination on site) may have biased studies for specific taxa. However, this is uncertain.

Previous studies in Granite Harbour made no record of *N. nivicolus* at Cape Geology nor were there any records of *G. hodgsoni* in the Mt. England region (Wise et al. 1964; Wise 1967; Wise & Shoup 1971; Davidson & Broady 1996). Furthermore, the only locations where *N. nivicolus* and *G. hodgsoni* have previously been found together were at Mt. Seuss and Convoy Range (see Wise 1967 for review). However, we also found them to co-exist at Cape Geology—a new record for *N. nivicolus*, and on Mt. England—a new record for *G. hodgsoni*. *N. nivicolus* had also supposedly been recorded from Cape Crozier (Salmon 1965). However, we did not find *N. nivicolus* in any of our samples, and we concur that this record is likely to have been made in error (Janetschek 1967; Wise 1971).

In contrast to the possible range expansions observed at the above sites, records from around McMurdo Station and at the site of the former North Base (Marble Point) seem to suggest that human activities over a period of less than 40 years have caused the reduction in distribution for these taxa. Such human influence was previously implicated by Strandtmann & George (1973) when reporting on the limited distribution and local abundance of *S. mollis* in the McMurdo Station region in the late 1960s. Previous studies (Wise et al. 1964; Wise 1967; Wise & Spain 1967) suggest that the distribution of *G. hodgsoni* was extensive from Marble Point to Gneiss Point and extended throughout the site of the former North Base to the Wilson Piedmont Glacier. In recent years, soils from both sites have been shown to have greater heavy metal concentrations compared to undisturbed sites (Claridge et al. 1995; Sheppard et al. 1997), and Campbell et al. (1994) showed that there has been no significant re-establishment of icy permafrost in the soils since land disturbance occurred at Marble Point. The absence of arthropods at these sites appears to be associated with the extensive human disturbance (see Broadbent 1994), and we also found moss communities to be damaged and desiccated, even when surface moisture appeared adequate (eg: melt-water).

Comparing previous records to our own from Lakes Chad and Bonney in Taylor Valley, and Cape Geology and Mt. England at Granite Harbour suggest local dispersal within the last 40 years for these taxa. The effects of human disturbance appears to be restricted to McMurdo Station and the former North Base, where the distribution of these arthropods was limited in comparison to previous records. The Ross Dependency is an ideal region to examine dispersal and re-colonisation of Antarctic habitats with both Collembola and Acari found from the most northern regions (c. 70°S) to the most southern recorded for any terrestrial animal (85°32'S, Wise & Gressitt 1965). It is only with accurate distributional records that species ranges can be examined, particularly with an increasing human presence in Antarctica, as well as the possibility of new habitats becoming available as a result of climatic shifts.

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Appendix: Field sites where arthropods were recorded over the austral summers from 1998 to 2001. Species identified: *Gomphiocephalus hodgsoni* [G], *Neocryptopygus nivicolus* [N], and *Stereotydeus mollis* [S]

Location	Site	Species	Lat (S)	Long (E)
Beaufort Island	I1	G,S	76°55.906’	166°54.808’
Cape Bird	B1	G,S	77°13.266’	166°26.810’
Cape Royds	R1	G	77°32.760’	166°09.779’
	R2	S	77°32.712’	166°09.538’
	R3	S	77°32.949’	166°09.429’
	R4	G	77°32.783’	166°09.130’
	R5	G	77°32.555’	166°09.312’
	R6	G	77°32.421’	166°09.190’
	R7	G	77°32.339’	166°09.400’
	R8	G	77°33.074’	166°12.454’
	R9	S	77°33.705’	166°14.325’
	R10	G,S	77°33.905’	166°13.748’
	R11	G,S	77°33.933’	166°13.822’
	R12	G,S	77°34.009’	166°13.736’
	R13	G	77°34.187’	166°14.204’
Cape Evans	E1	S	77°38.119’	166°26.315’
	E2	G,S	77°38.033’	166°26.551’
	E3	G,S	77°34.187’	166°14.204’
Observation Hill	O1	S	77°51.174’	166°40.804’
Cape Crozier	C1	G,S	77°27.795’	169°11.812’
Igloo Spur	C2	G,S	77°31.748’	169°17.208’
Granite Harbour				
Cape Geology	G1	G,S	77°00.863’	162°36.086’
	G2	G,S	77°00.882’	162°36.025’
	G3	G,S	77°00.920’	162°35.914’
	G4	G,N,S	77°00.957’	162°35.819’
	G5	G,N,S	77°00.942’	162°35.767’
	G6	G,N,S	77°00.834’	162°34.580’
	G7	G,N,S	77°00.738’	162°34.267’
	G8	G,S	77°00.635’	162°33.771’
	G9	G,S	77°00.534’	162°33.464’
	G10	G,S	77°00.470’	162°33.450’
	G11	G,S	77°00.500’	162°33.274’
	G12	G,S	77°00.511’	162°33.058’
	G13	G,S	77°00.534’	162°32.776’
	G14	G,S	77°00.548’	162°32.614’
	G15	G,S	77°00.562’	162°32.469’
	G16	G,N,S	77°00.591’	162°32.317’
	G17	G,N,S	77°00.579’	162°32.246’
	G18	G,N,S	77°00.562’	162°32.204’
	G19	G,N,S	77°00.552’	162°32.161’
	G20	G,S	77°00.525’	162°32.105’
	G21	G,N,S	77°00.742’	162°33.597’
Botany Bay	G22	G,S	77°00.402’	162°39.310’
Flatiron	G23	G,S	77°00.938’	162°22.069’

Location	Site	Species	Lat (S)	Long (E)
New Glacier	G24	G,S	77°01.339’	162°27.000’
Mt. England	G25	G,N,S	77°02.298’	162°28.180’
	G26	G,S	77°01.942’	162°26.400’
	G27	G,S	77°02.251’	162°26.100’
	G28	G,N,S	77°02.277’	162°25.800’
Springtail Point	W1	N	77°10.117’	160°43.433’
Marble Point	P1	G,S	77°26.122’	163°49.569’
	P2	S	77°25.328’	163°41.572’
	P3	G,S	77°25.297’	163°40.467’
	P4	G,S	77°25.020’	163°43.466’
	P5	G,S	77°25.328’	163°41.572’
Gneiss Point	P6	G,S	77°24.527’	163°44.249’
Taylor Valley				
Canada Glacier	T1	S	77°36.924’	163°02.505’
Huey Creek	T2	S	77°36.429’	163°07.539’
Lake Fryxell	T3	S	77°36.161’	163°15.701’
Von Guerard Stream	T4	G,S	77°36.570’	163°14.052’
Delta Stream	T5	G,S	77°37.428’	163°06.560’
Green Stream	T6	S	77°37.217’	163°05.102’
Howard Glacier	T7	G,S	77°39.735’	163°05.835’
	T8	G,S	77°39.985’	162°54.627’
Goldman Glacier	T9	G,S	77°41.083’	162°52.600’
Marr Glacier east lobe	T10	G,S	77°41.757’	162°46.737’
Marr Gl. central lobe	T11	G,S	77°42.140’	162°43.315’
Marr Gl. west lobe	T12	G,S	77°42.780’	162°39.365’
	T13	G,S	77°43.022’	162°38.082’
Sollas Glacier	T14	G,S	77°42.742’	162°35.580’
Hughes Glacier	T15	G,S	77°43.745’	162°30.327’
	T16	G,S	77°43.311’	162°26.349’
	T17	G,S	77°44.167’	162°20.712’
Calkin Glacier	T18	G,S	77°44.195’	162°16.728’
Borns Glacier	T19	G,S	77°45.833’	162°02.240’
	T20	G	77°45.536’	162°01.277’
Lake Chad	T21	G,S	77°38.571’	162°46.492’
Garwood Valley	G1	G,S	78°01.179’	164°03.404’
Miers Valley	M1	G,S	78°05.762’	163°45.540’
	M2	S	78°05.889’	163°47.828’
	M3	G	78°05.853’	163°46.810’
	M4	G	78°06.086’	163°49.436’
	M5	S	78°05.950’	163°53.354’
	M6	G,S	78°04.408’	163°47.791’
	M7	S	78°04.635’	163°46.736’
	M8	G	78°06.953’	163°41.645’
	M9	G	78°03.990’	163°52.049’
	M10	G,S	78°07.187’	163°41.373’
	M11	G,S	78°07.600’	163°40.777’
	M12	G	78°07.465’	163°42.341’
Marshall Valley	M13	G,S	78°03.944’	163°52.662’