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ENTOMOLOGICAL INVESTIGATIONS IN ANTARCTICA, 1963-64 SEASON[1]

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Abstract: A preliminary report on ecological work in S. Victoria Land and Ross I., during the 1963-64 summer season, extending that started in the 1962-63 season. Regular observations at 6 localities are recorded, comparing environments where only mites occur, where collembolans and mites occur, and where neither is present. Environmental conditions and soil factors are described and related to diurnal and seasonal activity, distribution, and abundance of a collembolan, *Gomphiocephalus hodgsoni* Carp., and in part of mites.

At the beginning of the 1962-63 summer season I (K. A. J. W.) planned and started a series of 4 observation sites along the coast of S. Victoria Land for the purpose of collecting data and information on the environment of arthropods, particularly of the collembolan *Gomphiocephalus hodgsoni* Carp. 1908. Observations were mainly carried out by C. E. Fearon and reported by Wise, Fearon & Wilkes (1964).

This work continued and expanded in the 1963-64 season. The previous season's observation areas were re-occupied (L. Penny, L. Péwé, Marble Pt., and Flatiron at Granite Hbr), as well as 2 new site areas, Observation Hill, Ross I., where only mites occur, and near L. Bonney in the Taylor Dry Valley (S. Victoria Land) where no arthropods occur. The site areas used in 1963/64 were adjacent to those of the previous season. At Marble Point after the first observation period a site area was chosen nearby to the west of the knoll.

The Observation Hill site area was on the western lower slopes of the hill, in a seepage area where mites occurred, at *ca* 35 m. The hill is of volcanic origin, mainly basalt and scoria with coarse soil on the lower slopes.

The Lake Bonney observation site in the Taylor Valley, one of the 'dry valleys', was *ca* 50 m east of the lake and *ca* 10 m above it in a morainic area.

It was planned to occupy all sites at 4-week intervals, and, in addition Observation Hill and L. Penny 2 weeks after the first of the series, for 24-hr observation periods travelling between sites by helicopter in rotation from site to site so that all observations were made in as short a time as possible, and in the same order each time. This plan was adhered to as strictly as possible but circumstances interfered from time to time. Ideally 28 hours were allowed for occupation of each site, but the series always took from 8-10 days.

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At each site microclimatological and meteorological observations were made for a full 24 hours (25 observations), and were correlated with observations of insects and mites to determine times, periods, and conditions of activity.

In the 1962/63 season upper temperature recordings were limited by the range of the telethermometer which was scaled up to +10°C. Temperatures above that were estimated up to 11°C. This was overcome in the 1963/64 season by using a telethermometer of higher range so that temperatures above +10°C are actual, except for the Observation Hill readings of 10/11.XII.63 when the lower range telethermometer was used as the other was in use at L. Penny.

In the field the lower range (mercury cell operated) telethermometer was found most reliable and was used most of the time, the higher range (dry battery operated) instrument being coupled to the thermistors when temperatures rose towards +10°C, and changed again as temperatures fell.

Prior to the beginning of field work all thermistors and the two telethermometers were tested against mercury thermometers using water and anti-freeze baths at different temperatures. All those used were tested to within 1°C. Only 6 thermistor probes were used in the 1962/63 season but in the 1963/64 season 12 were used at each site.

Thermistor probes were placed as follows; Probe 1, In air, 1 m above ground level; 2, In soil, just below surface; 3, Under a stone usually about 8×8×2 cm in size; 4, In air, immediately above the exposed surface (within 5 mm) of the same stone as Probe 3; 5, As Probe 2 but usually adjacent to a snow patch; 6, As Probe 3 but usually adjacent to a snow patch; 7, In soil, 1 cm deep; 8, In soil, 5 cm deep; 9, In soil, 10 cm deep; 10, In soil, 15 cm deep; 11, Taped under stone similar to Probe 3 stone; 12, Taped on top of the same stone as Probe 11 with white tape.

In the laying of probes and hygrometer the soil and stones of the observation site were disturbed as little as possible but in order to mitigate the effect of such disturbance, and allow time for recovery of temperatures and humidities to normal levels, the first of the 25 observations has been disregarded so that the data used was collected at the end of each of the 24 hours.

At L. Penny and the Flatiron, ground probes were left *in situ* for the entire season. This practice was useful in minimizing ground disturbance but was disadvantageous if probes were not set correctly or were disturbed during the season. At the above 2 sites Probes 1 and 4 were lifted at the end of each observation period and replaced at the beginning of the next.

Hygrometers used for determination of RH at soil surface were the same as before. They were checked in a saturated atmosphere at the beginning of the season but were found difficult to adjust. Usually one hygrometer was used in the field so that results are comparative.

As in the 1962/63 season, a Speedy Moisture Tester was used in determining percentage of soil moisture. It was found to have two disadvantages. Firstly, it was able to melt ice in soil samples so that no diurnal rhythm of available (unfrozen) moisture was demonstrated, and secondly there was a noticeable operator error with different operators and different sample selections.

Further information on humidity was sought by trial use of Cobalt Thiocyanate papers and a standard color comparator. The difficulty of placing the papers and the necessity of leaving them *in situ* for two hours place restrictions on this method.

Soils at each of the observation site areas were tested by one of us (A. V. S.) to determine if there was any soil factor inhibiting collembolans and/or mites life at one or two of the sites (L. Bonney, Observation Hill). A Hellige-Truog Soil Testing Kit was used on samples throughout the season and a series of samples were returned to New Zealand for testing by standard methods. Only results from the latter are reported here.

At all times, presence or absence and activity periods of Collembola and Acarina were observed and information on seasonal abundance was gathered. Specimens were collected for counting and measurement.

AIR, SOIL, AND STONE TEMPERATURES

Tables 1–6 present diurnal maximum, minimum, and mean temperatures, with hours above O°C, for all probes at all 6 sites. In Table 1, temperatures for Probe 1 are higher than meteorological temperatures as the thermistor was unshaded but comparison of Probe 1 and Probe 4 data indicates that both temperatures and numbers of hours above 0°C. are greater at the stone-surface. A comparison of Tables 2 and 3 shows that maximum-minimum soil temperatures are usually higher than under-stone temperatures but the means are sometimes higher, sometime lower, and the numbers of hours above 0°C in the soil are generally less than under stones. The last confirms that protected surfaces retain warmth longer than bare soil. However the depth of protection given by Antarctic soil varies and is countered by the presence of perma-frost 15 cm–1 m below the surface (Black & Berg 1963). Tables 4, 5 indicate that maximum temperatures are generally higher near the surface and progressively lower at greater depths but minimum temperatures are reversed, and frequently the highest of the mean temperatures as well as the highest numbers of hours above 0°C are at 5 cm and/or greater depths. In Table 6 the differences between temperatures on the exposed (upper) and protected (lower) stone-surfaces are mainly small, the maximum and mean temperatures only sometimes higher on the protected surface but the minima always higher.

It may be of interest to note that all ground probes at all 6 observation sites registered 9 or more hours above 0°C for the 4 or 5 days on which observations were made, excepting Probe 10 at a depth of 15 cm on Observation Hill, which did not record any temperatures above 0°C. These results confirm and add to those recorded for 1962/63 (Wise, Fearon & Wilkes 1964). Maximum, minimum, and mean temperatures are generally higher at L. Bonney than elsewhere in December and January.

From a seasonal point of view Table 7 summarises the data from Tables 1–6 to indicate dates of seasonal maxima in temperatures for all probes. Maximum temperatures and hours above 0°C occur mainly in mid-December or between mid-December and early January. Weather conditions were particularly bad at the time December observations were made at L. Péwé and Marble Point, which affected the actual temperatures thus somewhat obscuring actual time of seasonal maxima.

This finding, of maximum seasonal temperatures occurring in mid-December of the 1963/64 season, is contrary to the finding recorded by Wise, Fearon & Wilkes (1964), from re-

Table 1. Diurnal maximum, minimum, and mean air temperatures (°C) with hours above 0°C, for Probe 1 (1 m) and Probe 4 (stone-surface) during 24-hr observation periods at 6 localities.

Locality	Date	Probe 1				Probe 4			
		Max.	Min.	Mean	Hours above 0°C	Max.	Min.	Mean	Hours above 0°C
Observation Hill	8/9.XI.63	−6.6	−13.5	−9.8	0	+0.4	−11.0	−7.5	1
	22/23.XI.63	−3.0	−7.8	−6.2	0	+4.0	−7.5	−3.2	6
	10/11.XII.63	+4.0	−3.0	−0.2	11	+7.9	−2.1	+4.6	23
	7/8.I.64	−3.3	−6.4	−5.0	0	+4.0	−4.9	−1.5	6
	3/4.II.64	+0.5	−11.1	−4.3	1	+9.2	−8.6	−0.7	5
Lake Penny	11/12.XI.63	+2.2	−7.6	−4.1	1	+7.3	−8.0	−1.0	12
	25/26.XI.63	−1.3	−6.0	−4.2	0	+3.5	−5.0	−1.9	8
	10/11.XII.63	+4.8	−3.4	−0.1	11	+10.9	−3.8	+5.0	19
	8/9.I.64	−0.3	−7.0	−4.5	0	+4.8	−5.5	−2.2	6
	7/8.II.64	−1.5	−6.0	−4.3	0	+4.2	−8.1	−3.6	3
Lake Péwé	12/13.XI.63	−0.2	−8.0	−4.5	0	+12.8	−10.0	−1.6	10
	11./12.XII.63	−2.5	−8.2	−6.0	0	−1.2	−6.0	−4.5	0
	9/10.I.64	−2.0	−10.3	−7.2	0	+9.0	−5.1	0.0	11
	6/7.II.64	0.0	−7.7	−4.9	0	+1.7	−9.3	−4.7	3
Marble Point	13/14.XI.63	−0.2	−11.0	−5.5	0	+9.6	−11.8	−2.8	9
	14/15.XII.63	+2.3	−7.8	−2.5	5	+6.3	−7.0	0.0	15
	11/12.I.64	+1.5	−7.6	−3.5	1	+7.7	−6.1	+0.1	9
	9/10.II.64	−2.7	−8.2	−6.2	0	+2.7	−8.7	−4.7	2
Flatiron	15/16.XI.63	−1.0	−8.2	−5.0	0	+4.5	−7.3	−2.2	6
	15/16.XII.63	+1.6	−3.7	−1.0	8	+10.0	−1.5	+3.1	19
	14/15.I.64	+1.1	−4.2	−2.5	1	+8.9	−2.0	+2.4	17
	12/13.II.64	+1.8	−8.0	−4.5	1	+7.0	−9.4	−2.7	7
Lake Bonney	18/19.XI.63	−1.5	−8.1	−4.6	0	+2.8	−8.6	−3.0	5
	17/18.XII.63	+5.0	−2.0	+1.2	13	+12.8	−0.9	+4.3	18
	15/16.I.64	+2.4	−2.9	−0.6	9	+8.2	−1.6	+2.3	17
	14/15.II.64	0.0	−11.0	−6.1	0	+2.1	−12.2	−5.5	3

Table 2. Diurnal maximum, minimum and mean soil temperatures (°C) with hours above 0°C, for Probe 2 (surface) and Probe 5 (surface) during 24-hr observation periods at 6 localities.

Locality	Date	Prode 2				Probe 5			
		Max.	Min.	Mean	Hours above 0°C	Max.	Min.	Mean	Hours above 0°C
Observation Hill	8/9.XI.63	+0.4	−10.9	−6.7	1	−4.0	−12.0	−9.3	0
	22/23.XI.63	+4.7	−8.3	−2.3	7	+3.7	−8.7	−3.6	4
	10/11.XII.63	>+10.0	−1.0	>+4.9	23	>+10.0	−0.6	>+4.1	23
	7/8.I.64	+4.9	−4.2	−0.7	7	+6.3	−4.4	−0.6	8
	3/4.II.64	+8.0	−5.0	−0.3	7	+6.2	−5.7	−1.6	6
Lake Penny	11/12.XI.63	+7.0	−7.8	−0.2	12	+7.2	−8.3	−0.3	12
	25/26.XI.63	+8.8	−4.2	−0.1	10	+7.6	−4.3	−0.2	12
	10/11.XII.63	+13.8	−2.8	+5.8	18	+13.3	−3.2	+5.8	18
	8/9.I.64	+5.3	−3.3	−0.9	6	+6.2	−3.5	−0.9	6
	7/8.II.64	+1.2	−8.5	−4.5	3	−5.0	−8.4	−6.6	0
Lake Péwé	12/13.XI.63	+6.3	−10.0	−3.3	6	+8.8	−10.5	−1.6	11
	11/12.XII.63	−0.8	−4.9	−2.4	0	−0.3	−4.4	−2.6	0
	9/10.I.64	+8.0	−3.7	+1.2	12	+4.3	−2.3	0.0	10
	6/7.II.64	−3.1	−7.8	−5.7	0	−4.4	−7.2	−6.0	0
Marble Point	13/14.XI.63	+8.3	−12.2	−3.6	7	+5.7	−13.4	−3.8	10
	14/15.XII.63	+8.4	−4.0	+2.9	16	+7.7	−4.5	+1.2	15
	11/12.I.64	+16.0	−4.7	+3.9	14	+6.7	−2.3	+1.3	10
	9/10.II.64	+5.3	−8.4	−4.0	4	+3.6	−8.7	−4.9	3

Flatiron	15/16.XI.63	+7.0	−7.0	−0.5	10	+3.2	−6.2	−1.2	11
	15/16.XII.63	+16.0	−0.6	+5.1	19	+9.6	+0.2	+4.6	24
	14/15.I.64	+10.6	−1.0	+4.5	21	+7.5	0.0	+3.7	23
	12/13.II.64	+3.0	−7.5	−2.6	6	+2.3	−7.6	−4.2	3
Lake Bonney	18/19.XI.63	+6.0	−8.3	−2.2	9	+3.9	−7.4	−2.6	6
	17/18.XII.63	+14.4	−0.1	+6.3	23	+15.0	−0.2	+5.4	20
	15/16.I.64	+9.7	−0.7	+3.8	18	+12.4	−1.7	+3.1	15
	14/15.II.64	+4.5	−12.8	−5.1	7	+4.0	−12.0	−4.9	7

Table 3. Diurnal maximum, minimum, and mean under-stone temperatures (℃), with hours above 0℃, for Probe 3 and Probe 6 during 24-hr observation periods at 6 localities.

Locality	Date	Probe 3				Probe 6			
		Max.	Min.	Mean	Hours above 0℃	Max.	Min.	Mean	Hours above 0℃
Observation Hill	8/9.XI.63	−2.7	−11.2	−8.2	0	−2.2	−11.8	−9.0	0
	22/23.XI.63	+1.7	−7.2	−3.3	3	+3.7	−8.0	−3.4	5
	10/11.XII.63	+6.8	0.0	+3.5	23	+6.5	+0.1	+3.4	24
	7/8.I.64	+1.7	−3.8	−0.8	8	+5.1	−4.9	−0.4	8
	3/4.II.64	+2.6	−4.4	−0.6	8	+4.3	−4.4	−0.8	10
Lake Penny	11/12.XI.63	+8.0	−7.3	0.0	14	+7.1	−7.2	−0.3	12
	25/26.XI.63	+8.8	−3.9	+0.3	12	+7.6	−4.2	−0.1	12
	10/11.XII.63	+12.0	−2.6	+6.0	20	+13.3	−2.1	+5.6	18
	8/9.I.64	+6.9	−3.1	−0.4	6	+6.2	−3.3	−0.4	7
	7/8.II.64	+0.8	−8.2	−4.4	3	−5.6	−8.2	−6.9	0
Lake Péwé	12/13.XI.63	+7.4	−9.0	−1.6	10	+4.6	−9.0	−1.7	11
	11/12.XII.63	−0.3	−4.2	−2.1	0	0.0	−4.1	−1.7	0
	9/10.I.64	+5.7	−0.3	+1.7	17	+3.8	−1.8	+0.3	14
	6/7.II.64	−1.7	−7.6	−5.3	0	−4.0	−6.9	−5.9	0
Marble Point	13/14.XI.63	+9.5	−11.6	−1.8	10	+6.8	−12.4	−3.5	9
	14/15.XII.63	+5.2	−4.0	+1.0	14	+3.7	−2.2	+1.2	15
	11/12.I.64	+13.1	−4.6	+3.2	16	+7.0	−1.0	+1.9	12
	9/10.II.64	+2.6	−7.4	−3.9	4	−0.5	−8.5	−5.9	0
Flatiron	15/16.XI.63	+5.3	−6.2	−0.9	11	+7.3	−6.4	−0.5	11
	15/16.XII.63	+12.0	0.0	+4.7	22	+9.7	0.0	+4.4	23
	14/15.I.64	+9.0	0.0	+4.2	22	+8.8	+0.1	+3.7	24
	12/13.II.64	+3.0	−7.5	−2.5	9	+3.8	−7.6	−2.6	10
Lake Bonney	18/19.XI.63	+4.7	−7.8	−2.0	10	+5.7	−7.7	−1.8	9
	17/18.XII.63	+14.8	0.0	+6.5	23	+7.0	+1.4	+4.3	24
	15/16.I.64	+13.0	−0.3	+4.6	19	+8.0	+0.9	+4.1	24
	14/15.II.64	+3.1	−11.4	−4.7	6	+0.3	−9.7	−4.5	4

Table 4. Diurnal maximum, minimum, and mean soil temperatures (℃), with hours above 0℃, for Probe 7 (1 cm deep) and Probe 8 (5 cm deep) during 24-hr observation periods at 6 localities.

Locality	Date	Probe 7				Probe 8			
		Max.	Min.	Mean	Hours above 0℃	Max.	Min.	Mean	Hours above 0℃
Observation Hill	8/9.XI.1963	—	—	—	—	—	—	—	—
	22/23.XI.63	+3.7	−8.0	−3.1	5	+0.4	−7.3	−4.0	2
	10/11.XII.63	+7.9	−1.0	+4.5	23	+4.0	−0.9	+1.5	22
	7/8.I.64	+1.5	−4.1	−1.2	7	+1.3	−3.6	−1.5	2
	3/4.II.64	+2.3	−6.0	−1.3	5	−0.1	−4.6	−1.9	0
Lake Penny	11/12.XI.63	+7.0	−7.0	−1.2	11	+4.8	−6.0	−1.3	10
	25/26.XI.63	+3.8	−4.5	−1.4	8	+4.0	−3.9	−0.8	9
	10/11.XII.63	+9.6	−1.9	+3.5	18	+8.4	−0.3	+3.6	20
	8/9.I.64	+0.5	−4.1	−2.4	5	+1.2	−3.4	−1.8	3
	7/8.II.64	−4.9	−8.0	−6.3	0	−4.7	−7.8	−6.2	0

Lake Péwé	12/13.XI.63	+6.3	−8.5	−1.4	10	+3.3	−8.5	−2.8	7
	11/12.XII.63	−1.0	−3.8	−2.6	0	+0.1	−2.0	−0.7	1
	9/10.I.64	+7.0	−3.4	+0.6	10	+3.8	−1.4	+1.1	15
	6/7.II.64	−1.0	−8.3	−5.4	0	−2.3	−7.2	−5.5	0
Marble Point	13/14.XI.63	+9.0	−12.2	−2.0	10	+4.6	−10.4	−3.3	9
	14/15.XII.63	+6.8	−4.4	+1.5	15	+4.4	−3.0	+0.7	14
	11/12.I.64	+10.2	−4.0	+2.0	11	+9.2	−1.5	+3.1	14
	9/10.II.64	+4.8	−7.5	−4.0	3	+0.7	−5.5	−3.3	3
Flatiron	15/16.XI.63	+4.8	−5.5	−1.6	9	[1]+2.0	−5.7	−1.8	7
	15/16.XII.63	+9.9	0.0	+4.4	21	[1]+10.8	+0.3	+4.8	24
	14/15.I.64	+7.0	−2.4	+1.9	17	[1]+8.2	+0.3	+3.9	24
	12/13.II.64	+3.6	−9.5	−3.7	4	[1]+3.7	−7.1	−2.2	8
Lake Bonney	18/19.XI.63	+4.7	−8.3	−2.1	10	+1.8	−6.6	−2.4	7
	17/18.XII.63	+14.2	−0.2	+6.1	23	+10.8	+1.8	+5.4	24
	15/16.I.64	+10.6	−0.9	+3.7	17	+6.7	+1.3	+4.2	24
	14/15.II.64	+3.5	−12.2	−5.1	5	+0.9	−9.9	−4.9	2

[1] At end of season Probe 8 found to be 4 cm deep instead of 5 cm.

Table 5. Diurnal maximum, minimum and mean soil temperatures (°C), with hours above 0°C, for Probe 9 (10 cm deep) and Probe 10 (15 cm deep) during 24-hr observation periods at 6 localities.

Locality	Date	Probe 9				Probe 10			
		Max.	Min.	Mean	Hours above 0°C	Max.	Min.	Mean	Hours above 0°C
Observation Hill	8/9.XI.63	—	—	—	—	—	—	—	—
	22/23.XI.63	−3.0	−7.1	−5.6	0	−5.1	−7.3	−6.3	0
	10/11.XII.63	+0.4	−2.7	−0.3	9	−0.9	−3.9	−1.8	0
	7/8.I.64	−0.8	−4.2	−2.8	0	−1.7	−4.0	−3.3	0
	3/4.II.64	−1.0	−4.0	−2.1	0	−1.5	−4.0	−2.4	0
Lake Penny	11/12.XI.63	+0.7	−6.9	−3.2	1	−2.9	−8.0	−5.2	0
	25/26.XI.63	+0.7	−3.1	−1.9	4	−1.7	−4.3	−3.1	0
	10/11.XII.63	+2.3	−0.1	+1.3	20	+1.1	−0.9	+0.1	11
	8/9.I.64	0.0	−3.6	−2.3	0	−1.3	−4.0	−3.0	0
	7/8.II.64	−5.3	−8.3	−6.7	0	−6.8	−7.8	−7.2	0
Lake Péwé	12/13.XI.63	−0.2	−8.0	−4.2	0	−2.0	−8.2	−5.1	0
	11/12.XII.63	+0.8	−2.1	−0.4	8	+1.0	−2.0	−0.2	15
	9/10.I.64	+2.3	−0.2	+0.9	19	+1.7	0.0	+0.9	23
	6/7.II.64	−2.0	−7.3	−5.3	0	−3.8	−6.4	−5.4	0
Marble Point	13/14.XI.63[1]	+4.3	−10.2	−3.4	10	[2]+0.4	−9.3	−4.4	3
	14/15.XII.63	+0.7	−3.2	−0.9	3	−0.5	−3.6	−1.7	0
	11/12.I.64	+6.9	−1.0	+2.7	16	+4.6	−0.3	−2.2	18
	9/10.II.64	−0.7	−4.8	−2.9	0	−1.3	−4.1	−2.7	0
Flatiron	15/16.XI.63	+1.7	−5.3	−2.0	4	[3]−1.5	−4.9	−3.0	0
	15/16.XII.63	+9.7	+1.2	+4.5	24	[3]+9.6	+1.2	+4.5	24
	14/15.I.64	+6.8	+1.3	+3.7	24	[3]+7.0	+1.0	+3.9	24
	12/13.II.64	+0.9	−5.0	−1.8	5	[3]+1.7	−6.0	−2.1	5
Lake Bonney	18/19.XI.63	+1.7	−6.5	−2.8	2	−0.3	−4.9	−3.3	0
	17/18.XII.63	+8.0	+1.5	+4.7	24	+7.8	+2.2	+4.5	24
	15/16.I.64	+6.7	+1.3	+3.5	24	+5.6	+1.4	+2.9	24
	14/15.II.64	−1.2	−8.5	−4.8	0	−2.8	−6.8	−4.5	0

[1] Probe 9 at 5 cm depth (same as Probe 8) instead of 10 cm. [2]Probe 10 at 10 cm depth instead of 15 cm.

[3] On 15.I.64 Probe 10 was found to be partially pulled out of ground (?by skua). At end of season Probe 10 found to be 5 cm deep instead of 15 cm.

Table 6. Diurnal maximum, minimum and mean stone temperatures (°C), with hours above 0°C, for Probe 11 (lower surface) and Probe 12 (upper surface) during 24-hr observation periods at 6 localities.

Locality	Date	Probe 11				Probe 12			
		Max.	Min.	Mean	Hours above 0°C	Max.	Min.	Mean	Hours above 0°C
Observation Hill	8/9.XI.63	—	—	—	—	—	—	—	—
	22/23.XI.63	+3.4	−7.6	−3.3	5	+6.3	−8.3	−3.2	5
	10/11.XII.63	+7.2	+0.3	+3.8	23	>+10.0	−3.2	>+4.7	20
	7/8.I.64	+3.4	−4.1	−1.2	7	+4.9	−5.1	−0.1	7
	3/4.II.64	+4.2	−4.6	−1.1	7	+7.2	−7.6	−1.5	6
Lake Penny	11/12.XI.63	+7.0	−7.4	−1.0	11	+5.8	−8.2	−1.0	12
	25/26.XI.63	+6.8	−4.0	−0.4	8	+5.9	−4.4	−0.9	10
	10/11.XII.63	+11.3	−2.2	+4.9	18	+11.0	−3.9	+5.0	19
	8/9.I.64	+3.2	−3.3	−1.1	6	+4.8	−3.5	−1.0	7
	7/8.II.64	0.0	−8.0	−5.9	0	−0.3	−8.3	−6.1	0
Lake Péwé	12/13.XI.63	+8.0	−8.5	−0.9	12	+8.3	−10.3	−0.9	11
	11/12.XII.63	−0.8	−5.3	−3.8	0	−1.2	−7.6	−5.0	0
	9/10.I.64	+7.5	−2.0	+2.0	17	+6.5	−6.5	−1.2	7
	6/7.II.64	−3.8	−8.0	−6.4	0	−2.4	−9.9	−6.6	0
Marble Point	13/14.XI.63	+14.0	−12.2	−0.3	12	+8.2	−12.5	−1.9	10
	14/15.XII.63	+7.6	−4.0	+1.9	14	+9.2	−6.2	+1.8	16
	11/12.I.64	+9.5	−3.0	+2.1	12	+9.2	−5.2	+2.0	9
	9/10.II.64	+2.5	−6.8	−3.6	3	+4.2	−9.5	−5.3	2
Flatiron	15/16.XI.63	+4.9	−6.4	−1.6	9	+4.7	−7.5	−1.9	10
	15/16.XII.63	+10.0	−0.3	+4.2	19	+9.5	−1.6	+3.3	17
	14/15.I.64	+8.5	−0.8	+3.8	21	+7.6	−2.0	+1.8	19
	12/13.II.64	+3.3	−7.9	−2.8	6	[1]+10.2	−9.9	−3.9	5
Lake Bonney	18/19.XI.63	+5.1	−7.6	−2.4	10	+5.0	−9.0	−2.6	10
	17/18.XII.63	+14.8	−0.3	+5.8	20	+11.2	−1.3	+4.2	17
	15/16.I.64	+14.0	−0.7	+4.2	17	+11.8	−1.8	+2.8	15
	14/15.II.64	+3.2	−11.9	−5.0	5	+3.7	−13.4	−6.2	5

[1] Tape missing-Probe 12 exposed-temp. not accepted as highest for season.

sults of the previous, 1962/63, season, and the conclusion then drawn that the time of maximum Collembola numbers considerably precedes the time of maximum temperatures. However the present findings are considered most accurate as, in the earlier season, observations were not made near mid-December except at Granite Harbor on 7.XII.1962. For the most part, the December 1962 Granite Hbr readings were, in fact, the maximum for the 1962/63 season in that area.

HUMIDITY AND SOIL WATER

Relative Humidities of air in the surface soil, measured by hygrometer, are given in Table 8, results being much as recorded for the 1962/63 season. There is a diurnal effect of humidities in indirect relationship to the diurnal pattern of temperatures (Table 9) but there is no marked seasonal effect.

Percentages of soil water, measured by a Speedy Moisture Tester, are also given in Table 8. Seasonal patterns of soil water percentages are indicated but there is an averaging effect on the figures in consequence of the melting of ice in the Tester as is also the case with the diurnal pattern (Table 9) which should be in direct relationship to the ground temperatures if measuring free water. Thus the percentage of soil water recorded at any

Table 7. Dates of seasonal maxima of diurnal maximum, minimum, and mean temperatures, and of hours above 0°C, for 6 localities in 1963/64 season.

Probes		1	2	3	4	5	6	7	8	9	10	11	12
Locality	Temps.												
Observation Hill	Max.	10. XII	10. XII	10. XII	3. II	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII
	Min.	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII
	Mean	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII
	Hours above 0°C	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	0	10. XII	10. XII
Lake Penny	Max.	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII
	Min.	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	8. I
	Mean	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII
	Hours above 0°C	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII	10. XII
Lake Péwé	Max.	6. II	9. I	9. I	12. XI	12. XI	12. XI	9. I	9. I	9. I	9. I	12. XI	12. XI
	Min.	6. II	9. I	9. I	9. I	9. I	9. I	9. I	9. I	9. I	9. I	9. I	9. I
	Mean	6. II	9. I	9. I	9. I	9. I	9. I	9. I	9. I	9. I	9. I	9. I	9. I
	Hours above 0°C	0	9. I	9. I	9. I	12. XI	9. I	(12. XII (9. I	9. I	9. I	9. I	9. I	12. XI
Marble Point	Max.	14. XII	11. I	11. I	13. XI	14. XII	11. I	11. I	11. I	11. I	11. I	13. XI	(14. XII
	Min.	11. I	14. XII	14. XII	11. I	11. I	11. I	11. I	11. I	11. I	11. I	11. I	(11. I
	Mean	14. XII	11. I	11. I	11. I	11. I	11. I	11. I	11. I	11. I	11. I	11. I	11. I
	Hours above 0°C	14. XII	14. XII	11. I	14. XII	14. XI	14. XII	14. XII	(14. XII (11. I	11. I	11. I	14. XII	11. I 14. XII
Flatiron	Max.	12. II	15. XII	15. XII	15. XII	15. XII	15. XII	15. XII	15. XII	15. XII	15. XII	15. XII	15. XII
	Min.	15. XII	15. XII	(15. XII (14. I	15. XII	15. XII	14. I	15. XII	(15. XII (14. I	14. I	15. XII	15. XII	15. XII
	Mean	15. XII	15. XII	15. XII	15. XII	15. XII	15. XII	15. XII	15. XII	15. XII	15. XII	15. XII	15. XII
	Hours above 0°C	15. XII	14. I	(15. XII (14. I	15. XII	15. XII	14. I	15. XII	(15. XII (14. I	(15. XII (14. I	(15. XII (14. I	14. I	14. I
Lake Bonney	Max.	17. XII	17. XII	17. XII	17. XII	17. XII	15. I	17. XII	17. XII	17. XII	17. XII	17. XII	15. I
	Min.	17. XII	17. XII	17. XII	17. XII	17. XII	17. XII	17. XII	17. XII	17. XII	17. XII	17. XII	17. XII
	Mean	15. I	17. XII	17. XII	17. XII	17. XII	15. I	17. XII	17. XII	17. XII	17. XII	17. XII	15. I
	Hours above 0°C	17. XII	17. XII	17. XII	17. XII	17. XII	(17. XII (15. I	17. XII	(17. XII (15. I	(17. XII (15. I	(17. XII (15. I	17. XII	17. XII

Table 8. Diurnal maximum, minimum, and mean relative humidity % (Hygrometer) and soil water % (Speedy Moisture Tester), during 24-hr observation periods at 6 localities.

Locality	Date	RH % (Hygrometer)			Soil Water % (Speedy Moisture Tester)		
		Max.	Min.	Mean	Max.	Min.	Mean
Observation Hill	8/9.XI.63	98	31	55.2	1.5	0.1	0.9
	22/23.XI.63	79.5	33.5	60.7	5.75	0.7	3.1
	10/11.XII.63	—	—	—	—	—	—
	7/8.I.64	100	77	87.0	6.8	2.2	4.5
	3/4.II.64	100	83	95.6	6.5	2.4	4.1
Lake Penny	11/12.XI.63	66	29	43.1	4.6	0.1	0.8
	25/26.XI.63	70	42.5	59.8	2.4	0.1	0.3
	10/11.XII.63	66	23.0	37.2	6.2	0.5	2.5
	8/9.I.64	100	65	92.3	6.0	0.2	2.6
	7/8.II.64	100	100	100.0	3.2	0.3	1.7
Lake Péwé	12/13.XI.63	63	43	54.8	1.55	0.1	0.4
	11/12.XII.63	98	80.5	92.3	10.2	0.5	1.9
	9/10.I.64	100	52	68.7	4.2	1.65	2.8
	6/7.II.64	100	100	100	4.4	0.75	2.0
Marble Point	13/14.XI.63	77	38	56.4	4.7	0.2	1.3
	14/15.XII.63	70	46	57.5	6.9	2.3	5.4
	11/12.I.64	100	40	70.3	6.3	0.95	3.0
	9/10.II.64	100	61	84.9	3.5	0.8	1.7
Flatiron	15/16.XI.63	100	35.5	59.2	0.6	0.1	0.2
	15/16.XII.63	66.5	18.4	38.1	4.35	0.3	1.3
	14/15.I.64	86	38	56.1	—	—	—
	12/13.II.64	63	29	40.3	4.4	0.4	1.6
Lake Bonney	18/19.XI.63	74	47	60.5	0.3	0.0	0.1
	17/18.XII.63	62	15.1	37.3	0.5	0.0	0.2
	15/16.I.64	73	35.5	51.7	—	—	—
	14/15.II.64	71	33	56.1	0.8	0.2	0.5

one time may not be the percentage of free water in the soil. As ground temperatures are below zero at the beginning and end of the summer season, and as they drop below zero at night there must in fact be seasonal and diurnal patterns but within the periods of melting, both seasonal and diurnal, the amounts of free water in the soil vary considerably within each locality.

In Table 8 the figures for soil water % may indicate that moisture is higher at Observation Hill, where mites occur, than elsewhere; figures for soil water % and maximum RH % indicate that moisture is less at L. Bonney, where no arthropods occur, than elsewhere.

Results from cobalt thiocyanate papers are presented in Table 10 to indicate the range of humidities gained by this method. It is not possible to obtain diurnal or seasonal maxima and minima. These figures appear to confirm that soil moisture was higher at Observation Hill and lower at L. Bonney, than at other sites.

The available moisture is very important to animal life in Antarctica and further work is required to determine the best and most accurate method of measurement. It would seem that temperatures and moisture on the surface of stones where Collembola occur, and also in the interstitial air of the soil, need to be studied in greater detail and with greater accuracy in order to get a better understanding of the Antarctic insect environment.

Table 9. Soil temperatures (0°C) (Probe 2), soil relative humidity % (Hygrometer) and soil water % (Speedy Moisture Tester) during 24 hrs at L. Péwé, 12/13.XI.1963.

Time of day	Soil temps. (Probe 2)	RH%	Soil water %
1814	−0. 1	52. 0	1. 0
1900	−3. 3	53. 5	0. 4
2000	−1. 5	56. 0	0. 2
2100	−6. 5	57. 0	0. 3
2200	−6. 0	59. 0	0. 4
2300	−6. 5	60. 0	0. 2
2400	−9. 0	60. 5	0. 55
0100	−9. 5	62. 0	0. 9
0200	−9. 5	62. 0	0. 2
0300	−10. 0	63. 0	0. 15
0400	−9. 5	63. 0	0. 4
0500	−9. 5	63. 0	0. 3
0600	−5. 2	61. 0	0. 3
0700	−5. 0	60. 0	0. 3
0800	−4. 9	58. 0	0. 5
0900	−3. 2	56. 5	0. 3
1000	−1. 3	52. 0	0. 2
1100	−0. 3	46. 5	0. 1
1200	+2. 2	46. 5	0. 65
1300	+2. 5	44. 0	0. 1
1400	+3. 0	43. 0	1. 55
1500	+5. 8	46. 0	0. 4
1600	+6. 3	48. 5	0. 3
1700	+1. 3	43. 5	0. 2

SOIL FACTORS

A series of studies were made on Antarctic soil material in conjunction with distributional and ecological studies on the Collembola and mites found in the S. Victoria Land area.

Much of the work was done in the Biological Laboratory at McMurdo Station using a Hellige-Truog Combination Soil Tester, but these results are not reported here. Some samples were taken to New Zealand and tested using standard soil testing equipment at Lincoln College.

The soil samples were collected from the actual sites the insects or mites occurred in. Where no arthropods were present, samples were taken from corresponding places.

Physical characters: Many of the surface areas of the soil material are desert pavements, the larger sized stones on top providing a "wind break" sheltering the smaller, more easily blown particles. The texture of the soil material is coarse (McCraw 1960), though small sized particles, even to clay size do occur (Blakemore & Swindale 1958). Insects and mites can penetrate the coarse soils.

In areas of patterned ground, cracks outlining polygons in the soil often fill with ice or snow. This phenomenon sometimes gives rise to soil conditions moist enough to support insect life.

Chemical characters: Antarctic soil is usually both alkaline and saline. This is due largely to the dryness of the environment, precipitation being so low in many areas that the salts liberated by rock weathering form a deposit on the rock surfaces.

Soil biology: In S. Victoria Land no higher plants occur, only algae, lichens, mosses,

Table 10. Relative humidity % (cobalt thiocyanate papers) at 6 localities.

Locality	Date-Time of day	RH% (cobalt thiocyanate papers)					
Observation Hill	7/8.I.64	Under thin stone	Under thick stone	Under stone	In soil surface	In soil surface	Under thin stone
	1530–1810	98[1]	90	98	98	98	98
Lake Penny	25/26.XI.63	Under stone	5 cm deep loose stones	In small stones	2.5cm deep in loose gravel	6 mm deep in loose gravel	Under rock with Collembola
	1400–1600	46	62	50	62	45.25	45.25
	8/9.I.64	Under stone	Under stone	Under stone	Under stone	6 mm deep in soil	25 cm deep in soil
	1415–1615	76	81	76	87	99	93
	7/8.II.64	Under stone	Under stone	Under stone	Under stone	6 mm deep in soil	2.5 cm deep in soil
	1620–1820	83.5	83.5	71.5	60	77.5	83.5
Lake Péwé	9/10.I.64	Under stone	Under stone	Under stone	Under soil	6 mm deep in soil	2.5 cm deep in soil
	1330–1535	95	89	95	95	95	95
	6/7.II.64	Under stone	Under stone	Under stone	Under stone	6 mm deep in soil	2.5 cm deep in soil
		84.5	80	66.5	53.5	60	93.5
Marble Point	11/12.I.64	Under stone	Under stone	Under stone	Under stone	6 mm deep in soil	2.5 cm deep in soil
	1340–1715	95	89	89	83	95	95
	9/10.II.64	Under stone	Under stone	Under stone	Under stone	6 mm deep in soil	2.5 cm deep in soil
	1330–1530	86.5	81	75.5	81	86.5	81
Flatiron	14/15.I.64	Under stone with Collembola	6 mm deep in soil	2.5 cm deep in soil			
	1100–1300	84.5	50	84.5			
	1700–1900	80	53	73.5			
	2300–0100	66.5	73.5	80			
	0500–0700	73.5	80	80			
	1100–1300	76	34	57.5			
	12/13.II.64	Under stone	Under stone	Under stone	Under stone		
	1415–1615	75.5	86.5	70	81		
		Under stone	Under stone	Under stone	Under stone	6 mm deep in soil	2.5 cm deep in soil
		79	84.5	79	84.5	79	90.5
Lake Bonney	15/16.I.64	Under stone	6 mm deep in soil	2.5 cm deep in soil			
	1910–2100 hrs.	49	49	49			

[1] All percentages corrected for temperature.

Table 11. pH values of 4 samples each from 6 localities.

Locality	pH values				mean
Observation Hill	8.0	8.7	8.6	8.1	8.35
Lake Penny	7.8	7.9	8.4	8.3	8.10
Lake Péwé	8.8	8.7	9.4	9.3	9.05
Marble Pt	9.8	9.8	9.6	9.7	9.725
Granite Hbr	7.9	7.7	8.3	8.4	8.076
Lake Bonney	8.1	8.1	8.1	8.0	8.075

Table 12. Percentages of water soluble salts in 2 samples each from 6 localities.

Locality	% Sol. Salts		Mean
Observation Hill	0.04	0.008	0.024
Lake Penny	0.03	0.002	0.016
Lake Péwé	0.05	0.004	0.027
Marble Pt	0.26	0.022	0.141
Granite Hbr	0.02	0.002	0.011
Lake Bonney	1.25	0.91	1.08

fungi and bacteria are found. Of the terrestrial algae, *Chlamydomonas, Chlorella, Nostoc* and several other genera all typical of temperate soils have been identified (Flint & Stout 1960). Bacteria have also been demonstrated, both being present due to contamination by man and his animals, and occurring naturally in the soil (Boyd & Boyd 1963 a, b.).

Fungi are possibly of some importance, especially in chalikosystem (Janetschek 1963). *Penicillium* & *Aspergillis* have been demonstrated for some S. Victoria Land areas, and also some N fixing organisms, as *Azotobacter*, as have some N cycle reactions (Boyd & Boyd 1963a) ; no fixation has yet been demonstrated however.

pH and salt content of soils: pH values from soil samples treated in New Zealand with a pH meter (Metson 1956), are given in Table 11. As the pH levels of areas where arthropods occur overlap by some margin the areas where they do not occur, pH cannot be regarded as providing an index to distribution. This agrees with results presented by Wise, Fearon & Wilkes (1964), from work done in the same vicinity.

Water soluble salts were measured in soil samples treated in New Zealand by resistance bridge (Metson 1956) and results are presented in Table 12. Percentages of salts are much higher at L. Bonney, where arthropods do not occur, than elsewhere, but this does not necessarily mean that salts are exerting a direct effect. There is an indirect effect through food supply and as salts have not been leached away, such an area may be too dry to support life, except possibly lichens. The level of salt concentration in the soil may prove useful as an index of possible occurrence of arthropods.

TEMPERATURES AND ARTHROPOD ACTIVITY

In Table 13 times of the day, for which under-stone temperatures were recorded above 0°C by Probes 3, 6, and 11, are related to times of collembolan and mite activity.

Times given are within 24-hr observation periods and are observed times not necessarily indicating the whole period when temperatures were above 0°C, or animals were active, on any one day. When setting up an observation site, activity was sometimes recorded before acceptable temperatures were recorded and such instances are noted in the table.

Table 13. Times of day under-stone temperatures above 0°C, and Arthropods active, at 5 localities.

Locality	Date	Times of day[1] under-stone temperature above 0°C. Probe 3	Probe 6	Probe 11	Times of day Collembola active	Times of day Acarina active
Observation Hill	8.XI.63	0[2]	0	—		1330 -1545
	9.XI.63	0	0	—		0[3]
	22.XI.63	0	0	1500		1445[4]
	23.XI.63	1200-1400	1100-1400	1100-1400		1015 -1400
	10.XII.63	1100-2400	1100-2400	1100-2400		1000[4]-2000
	11.XII.63	0100-0600 0800-1000	0100-1000	0100-0600 0800-1000		 0800 -1000
	7.I.64	1100-1500 1700	1100-1600	1100-1500		1000[4]-1800
	8.I.64	0900-1000	0900-1000	0900-1000		0730 -1000
	3.II.64	1400-1600 1800-2200	1300-2200	1300-1900		1300 -2200
	4.II.64	0	0	0		0
Lake Penny	11.XI.63	1500-2100	1500-1900	1500-1900	1500 -1805	
	12.XI.63	0800-1400	0800-1400	0800-1400	0800 -1400	
	25.XI.63	1200-1800	1200-1800	1200-1600	1108[4]-1300 1600	
	26.XI.63	0700-1100	0700-1100	0800-1100	1000	
	10.XII.63	1000-2200	1000-2200	1000-2200	1000 -2100	1000 -
	11.XII.63	0300-0900	0500-0900	0300 0600-0900	0700 0900	
	8.I.64	0	0	0	1700[4]	
	9.I.64	1200-1700	1100-1700	1200-1700	1300 -1500	
	7.II.64	0	0	0	0	
	8.II.64	1100-1200 1500	0	0	1400 -1500	
Lake Péwé	12.XI.63	1700-1814	1700	1700-1814	1700	
	13.XI.63	0900-1700	0800-1700	0800-1700	1200 -1600	1000 -
	11.XII.63	0	0	0	0	
	12.XII.63	0	0	0	0	
	9.I.64	2200-2300	2200-2300	2200		2100[4]
	10.I.64	0700-2100	0800-1900	0700-2100	0600- 1600	
	6.II.64	0	0	0	0[5]	
	7.II.64	0	0	0	0	
Marble Point	13.XI.63	0	0	0	0[6]	
	14.XI.63	0700-1600	0800-1600	0700-1800	1100[6]	
	14.XII.63	1300-2100	1300-2200	1300-2100	1200[4]-1300	
	15.XII.63	0800-1200	0800-1200	0800-1200	0900 -1200	0900 -
	11.I.64	1300-2400	1300-2400-	1300-2400	1200[4]-1600	1200[4]-1600 0200
	12.I.64	1100-1200	0	0	0	
	9.II.64	1600-1900	0	1600-1800	1500 -1600	1700
	10.II.64	0	0	0	0	
Flatiron	15.XI.63	1300-1900	1300-1900	1300-1800	1400	
	16.XI.63	0900-1200	0900-1200	0900-1200	1200	0900-
	15.XII.63	1700-2400	1700-2400-	1700-2300	1600[4]	
	16.XII.63	0300-1600	-0100 0300-1600	0500-1600	0900 -1600	
	14.I.64	1100-2400-	1100-2400-	1100-2400	1100- 1900	
	15.I.64	-0100 0400-1000	-0100-1000	0400-1000	0600- 1000	
	12.II.64	1400-1900	1400-1900	1400-1700	1500	
	13.II.64	1100-1320	1000-1320	1200-1320	1000 1200	1000-

[1] Periods given are observed periods not necessarily whole period when temperatures above 0°C and Collembola or Acarina active, on any one day. [2] 0 in Probe columns denotes that temperatures were recorded but did not rise above 0°C. [3] 0 in arthropod columns denotes animals present but inactive. [4] Active but probe temperatures not available for the same time. [5] Collembola taken into tent became active in temperatures above 0°C so not in diapause. [6] Collembola not found at site but within 100 m to SW.

Table 14. Under-stone temperatures (°C) 3 probes, before, during, and after Arthropod activity (Acarina at Observation Hill, Collembola elsewhere), at 5 localities.

Locality	Date	Temp. at hr before activity			Temp. at hr of activity			Maximum temp. during activity			Temp. at last hr of activity			Temp. at hr after activity		
	Probe:	3	6	11	3	6	11	3	6	11	3	6	11	3	6	11
Observation Hill	8.XI.63	−9.8	−8.0	—	−4.7	−4.9	—				−2.7	−2.2	—	−5.2	−5.1	—
	22.XI.63				−0.3	+1.7	+0.8							−2.6	−2.7	−2.8
	23.XI.63	−2.3	−1.2	−1.5	−1.2	0.0	−0.1	+1.7	+3.7	+3.4						
	10.XII.63							+6.8	+6.5	+7.2	+6.2	+5.8	+4.6	+4.9	+4.2	+4.5
	11.XII.63	0.0	+0.1	−0.3	+2.0	+0.8	+2.7									
	7.I.64							+1.3	+2.8	+1.7	−0.1	−1.2	−1.0	−0.5	−1.8	−1.8
	8.I.64	−1.7	−1.5		−1.0	−0.5										
	3.II.64	−4.4	−3.8	−4.1	−1.8	+0.3	+0.6	+2.6	+4.3	+4.2	+0.1	+0.1	−2.2	−0.2	−1.0	−3.2
Lake Penny	11.XI.63										+4.3	+4.0	+3.0	+3.0	+2.3	+1.6
	12.XI.63	−2.5	−2.8	−3.3	+1.0	+1.3	+0.3									
	25.XI.63										+2.0	+1.3	+1.0	+0.9	+0.5	−0.2
	26.XI.63	+4.6	+3.0	+1.8	+4.6	+4.0	+3.8							+4.0	+3.3	+2.1
	10.XII.63							+12.0	+13.3	+11.3	+5.2	+4.2	+3.7	+4.9	+3.3	+3.3
	11.XII.63	+3.9	+3.3	+1.9	+6.0	+5.5	+4.5									
	8.I.64													−0.2	−0.1	−0.4
	9.I.64	+0.9	+3.2	+0.3	+4.9	+4.8	+2.2	+6.9	+6.2	+3.2	+5.8	+5.4	+3.0	+4.8	+4.9	+2.7
	8.II.64	−0.5	−6.1	−5.0	−0.7	−6.2	0.0				+0.8	−5.8	−4.2	−0.3	−5.6	−3.7
Lake Péwé	12.XI.63										+0.8	+0.2	+1.0	+0.3	−0.2	+1.0
	13.XI.63	+3.6	+3.6	+6.3	+5.2	+4.6	+7.4	+7.4		+8.0	+4.0	+1.4	+3.0	+4.6	+1.8	+1.8
	10.I.64	−0.3	−1.8	−1.2	−0.1	−1.2	−0.1	+5.7	+3.8	+7.5	+3.2	+0.1	+4.1	+3.0	+0.1	+3.6
Marble Point	14.XII.63										+3.7	+2.7	+6.7	+3.0	+2.7	+5.7
	15.XII.63	+0.3	+0.1	+3.3	+1.9	+0.9	+4.0									
	11.I.64							+13.1	+7.0	+9.5	+11.0	+6.3	+7.7	+10.9	+6.6	+7.9
	9.II.64										+2.6	−0.5	+2.5	+1.7	−0.6	+2.3
Flatiron	15.XI.63										+1.3	+1.8	+0.25	0.0	+1.8	+0.8
	16.XI.63	+4.3	+7.3	+4.5	+5.3	+6.9	+4.9									
	15.XII.63													+12.0	+9.5	+8.9
	16.XII.63	+3.9	+3.8	+3.2	+5.6	+5.8	+5.5									
	14.I.64							+9.0	+7.1	+8.5	+5.9	+5.0	+5.7	+4.0	+3.0	+2.3
	15.I.64	+0.9	+0.7	+0.7	+1.6	+1.2	+1.8									
	12.II.64	+0.3	+0.5	+0.4	+1.4	+2.0	+1.0							+1.3	+2.0	+0.8
	13.II.64	−3.7	−2.6	−3.7	−1.4	+0.1	−1.7									

All other records of activity times outside recorded probe times indicate activity at or below 0°C. Activity was judged immediately a stone was upturned, a quick look usually being all that was necessary to determine whether anything was moving or not. If collembolans or mites are in an inactive diurnal period, usually a noticeable time passes before they become active through disturbance or exposure.

It is noticeable that mites are frequently active at temperatures below 0°C. Mites are not generally present under the same stones as Collembola so are not generally recorded at collembolan sites. Normally mites are active when collembolans are, but the reverse does not always apply.

Despite the facts that sunlight was available for 24 hr a day and under-stone temperatures above 0°C sometimes occurred late at 'night' or all 'night', collembolan activity did not occur before 0600 hrs or after 2100 hrs and usually not before 0900 hrs or after 1600 hrs. Thus a diurnal rhythm is demonstrated.

In Table 13 the only recorded occurrence of collembolan activity (L. Péwé, 10.I.64), outside periods of under-stone temperatures above 0°C, occurred when 2 probes recorded −0.1°C and 1 probe −1.2°C. As two stones were so close to 0°C, it is likely that the stone under which collembolans were active was just above 0°C, or the record may be observererror. General activity that day started at 0900, after temperatures had risen above freezing point.

Information on actual under-stone temperatures before, during, and after, collembolan and mite activity is presented in Table 14.

One interesting effect often noticed in this and other seasons is an early morning rise in temperature while the site is still in shadow. An example of this is given in Table 15. It would seem to result from radiation reflected from surrounding snow-fields and/or sea-ice. This effect was briefly recorded for Hallett by Pryor (1962) and has been noted there by me (K. A. J. W.). There is no subsequent direct effect from this on the activity of insects but there may be a preliminary effect in decreasing the difference between temperatures of soil in exposed and shadowed areas early in the day.

Table 15 further shows the normal pattern of morning temperature increase and collembolan activity. Only the degree of these is affected by the cloud, sun, and wind factors. The time-lag of temperature-changes, as depths increase, is demonstrated from Probes 7 (1 cm), 8 (5 cm), 9 (10 cm), 10 (15 cm). In this particular case, collembolan activity would only occur less than 10 cm from the surface as at 10 cm (Probe 9) temperatures did not rise above freezing point.

Referring to Table 13 above it can be seen that collembolan activity at the four sites was just starting in early to mid-November and was almost over by mid-February. A few afternoon temperatures were taken at L. Penny on 9.XI.63 when soil temperatures (Probe 2) rose to +1.8°C. and under-stone temperatures (Probe 3) to −1.1°C. Active Collembola were found on that day. At the end of the season, on 22.II.1964, ground temperatures at L. Penny did not reach 0°C. and only inactive Collembola were found. If we take the total observed period from 9.XI.63 (first at L. Penny) to 13.II.64 (last at Flatiron) as being the total period of activity for that season then Collembola were active over 96 days, or for 26.3 % of the year. The observed hours of collembolan activity for each site over the whole season are totalled and the equivalent number of

Table 15. Morning-early afternoon temperatures (°C) in soil and under a stone in relation to cloud, sun, wind, and Collembola activity at L. Penny, 12.XI.1963.

Time of day	Cloud	Sun	Wind	Probe 2 (surface)	Probe 3 (under-stone	Probe 7 (1 cm deep)	Probe 8 (5 cm deep)	Probe 9 (10 cm deep)	Probe 10 (15 cm deep)	Collembola activity
0000	1/8	Shadow[1]	0–1[3] WSW	−7.5	−6.1	−6.2	−5.0	−4.2	−5.0	inactive
0100	3/8	Shadow	6–10 SW	−7.8	−7.3	−7.0	−5.8	−5.1	−5.8	
0200	7/8	Shadow	4–8 ENE	−5.8	−6.1	−6.1	−6.0	−5.7	−6.1	
0300	8/8	Shadow	0–4 SE	−6.1	−6.1	−6.0	−5.8	−5.8	−6.9	
0400	8/8	Shade[2]	Calm	−5.2	−5.2	−5.4	−5.2	−5.7	−6.8	
0500	8/8	Shade	0–1 N	−4.4	−4.8	−5.1	−5.1	−5.8	−7.0	
0600	8/8	Shade	0–2 NW	−5.0	−4.0	−5.6	−5.9	−6.9	−8.0	inactive
0700	8/8	Pale Sun	0.2 NW	−1.5	−2.5	−3.9	−4.6	−6.0	−7.3	inactive
0800	4/8	Sun thru cloud	1–2 NE	+0.9	+1.0	−1.6	−2.6	−4.9	−6.6	inactive
0900	4/8	Sun	0–2 N	+5.7	+3.8	+0.5	−1.8	−4.9	−6.9	some active
1000	6/8	Shade	0–2 N	+2.8	+3.1	+0.8	−0.5	−4.0	−6.7	some active
1100	7/8	Shade	0–5 N	+4.0	+3.9	+1.0	+0.9	−2.5	−5.0	many active
1200	7/8	Shade	0–2 NW	+4.0	+3.8	+0.9	+0.5	−3.0	−6.0	active
1300	6/8	Sun thru thin cloud	5 NNW	+4.2	+4.1	+1.8	+1.0	−3.0	−5.9	active
1400	3/8	Sun thru thin cloud	3–5 N	+6.5	+6.6	+5.2	+3.0	−1.9	−4.8	active

[1]Shadow—strong shadow cast by mountain or smaller topographic feature or boulders.
[2]Shade—lighter shadow or diffuse light because of cloud.
[3]Wind speed in knots.

Table 16. Numbers of hours of observed Collembola activity, and of the soil and under-stone temperatures above 0°C, at 4 localities; with equivalent numbers of hours for a 96-day season, and % hours of activity in a year and in periods available for activity.

Locality	Probe	Dates					Total hours	No. of 24-hr periods of observation	Equivalent No. of hrs for 96-day season	% hrs activity in 96-day season, of No. hrs in year	96-day season: % hrs activity of No. hrs temps. above 0°C
L. Penny		11–12. XI.63	25–26. XI.63	10–11. XII.63	8–9. I.64	7–8. II.64		5			
No. of hrs of Collembola activity		11	5	14	4	2	36		691	7.9%	
No. of hrs temps. above 0°C.	2	12	10	18	6	3	49		941		73.4%
	3	14	12	20	6	3	55		1056		65.4%
	11	11	8	18	6	0	43		826		83.6%
L. Péwé		12–13. XI.63		11–12. XII.63	9–10. I.64	6–7. II.64		4			
No. of hrs of Collembola activity		6		0	11	0	17		408	4.6%	
No. of hrs temps. above 0°C	2	6		0	12	0	18		432		94.4%
	3	10		0	17	0	27		648		62.8%
	11	12		0	17	0	29		696		58.6%
Marble Point		13–14. XI.63		14–15. XII.63	11–12. I.64	9–10. II.64		4			
No. of hrs of Collembola activity		1		6	5	2	14		336	3.8%	
No. of hrs. temps. above 0°c.	2	7		16	14	4	41		984		34.1%
	3	10		14	16	4	40		960		35.0%
	11	12		14	12	3	41		984		34.1%
Flatiron		15–16. XI.63		15–16. XII.63	14–15. I.64	12–13. II.64		4			
No. of hrs of Collembola activity		2		9	14	3	28		672	7.7%	
No. of hrs temps. above 0°C.	2	10		19	21	6	56		1344		50.0%
	3	11		22	22	9	64		1536		43.7%
	11	9		19	21	6	55		1320		50.9%

hours of activity for a 96-day season are given in Table 16. These results suggest that periods of collembolan activity during a year are very short. However, in comparing the numbers of hours of collembolan activity (Table 16) with the numbers of hours the soil (Probe 2) and under-stone temperatures (Probes 3, 11) were above 0°C., (extracted from Tables 2, 3, 6), it is found that numbers of hours of activity for a 96-day season were a much higher percentage of the numbers of hours available for activity (i. e. numbers of hours soil and under-stone temperatures were above 0°C.). Probe 11 is included as it was taped on in contact with the under-side of stones and may give the best comparison of activities and temperatures as all collembolan activity was judged on specimens clinging or walking on the under-sides of similar stones. The data presented in Table 16 also indicates a comparable monthly pattern of collembolan activity and soil and under-stone temperatures. When temperatures drop or rise from one month to another then activity drops or rises in accordance.

COLLEMBOLA NUMBERS AND SIZE-RANGES

Counts of Collembola, *Gomphiocephalus hodgsoni*, were made in 1 m^2 quadrats, as regularly as possible. Results are given in Table 17 which presents numbers of large (above 0.75 mm in length) and small (below 0.75 mm in length) Collembola together with the largest sizes of the large and smallest sizes of the small. Although incomplete for the season, the figures do give some comparison between areas at one locality and between localities. What pattern there is, in numbers, is not so clear cut as in results from the previous season (Wise, Fearon & Wilkes 1964). The first series (Table 17) from L. Penny is complete and shows a pattern with the maximum numbers in mid-December which coincides with the time of maximum temperatures (see Table 7 above). However, one series for L. Péwé shows a maximum in mid-November and some high counts appear in both January and February for Flatiron. It is suggested that, although general seasonal trends may be expected, the irregular distribution of Collembola in Antarctic soils and the irregular weather conditions tend to mask or to alter the seasonal pattern in collembolan numbers. In the 1963/64 season weather was particularly bad during December at the time of observations.

The size separation of large and small at 0.75 mm separates the smallest from the others, being less than half-size. The complete size range (Table 17) is 0.4–1.2 mm, the Collembola being all collected in the field from stones or the soil under stones and preserved in alcohol; subsequent measurements were made with a microscope and eye-piece micrometer. Considering the numbers of small and large Collembola together with the size-ranges of each group, there is no growth pattern apparent at any of the localities. There always seem to be a few small and comparatively many more large Collembola present. If the species were to overwinter entirely in the egg stage it could be expected that there would be large numbers of small Collembola at the beginning of the season and few, if any, adults; but that is not the case.

By direct observation in the field the impression is gained that there is fairly sudden outbreak of active large Collembola at the beginning of the season.

In an attempt to assess population of the soil, a series of samples was collected throughout the season, in cans of the same size. The initially round beverage-cans were beaten

Table 17. Numbers and size ranges of *Gomphiocephalus hodgsoni* Carp. in 1 m^2 quadrats, at 4 localities.

Locality	Date	Quadrat Large	Quadrat Small	Quadrat Large	Quadrat small	Quadrat Large	Quadrat Small	Quadrat Large	Quadrat Small
Lake Penny	12.XI.63	16[1] (1.2)[2]	0						
	25.XI.63	157 (1.2)	22[3] (0.5)[4]	270 (1.2)	34 (0.5)	93 (1.1)	13 (0.5)	4 (1.0)	2 (0.6)
	11.XII.63	185 (1.1)	46 (0.4)						
	9.I.64	19 (1.1)	3 (0.5)	28 (1.1)	2 (0.5)	17 (1.1)	6 (0.6)	11 (1.1)	1 (0.7)
	8.II.64	2 (0.9)	0	0	0	5 (1.0)	0	1 (0.7)	0
Lake Péwé	13.XI.63	10 (1.1)	0	128 (1.2)	17 (0.6)				
	13.XII.63			20-size not known					
	10. I.64			10 (1.1)	3 (0.6)	50 (1.1)	19 (0.4)	6 (1.1)	1 (0.5)
	6.II.64	0	0	1 (0.9)	0	0	0	1 (0.9)	1 (0.4)
Marble Point	19.XI.63	5 (0.9)	5 (0.7)						
	15.XII.63								
	11.I.64	10 (1.2)	0	18	0	63 (1.2)	0	95 (1.2)	2 (0.6)
	10.II.64	2 (1.1)	0	0	0	0	0	0	0
Flatiron	15.XI.63	6 (1.0)							
	16.XII.63	0	0	38 (1.2)	5 (0.4)				
	14.I.64	62 (1.1)	6 (0.4)	94 (1.2)	20 (0.4)	516 (1.1)	24 (0.4)	24 (1.1)	4 (0.6)
	12.II.64	24 (1.1)	1 (0.4)	1 (1.1)	0	16 (1.1)	0	185 (1.1)	16 (0.5)

[1] No. of specimens larger than 0.75 mm.
[2] Size of largest specimen; indicating for this entry a size range of 0.75–1.2 mm for the 16 specimens.
[3] No. of specimens smaller than 0.75 mm.
[4] Size of smallest specimen; indicating for this entry a size range of 0.5–0.75 mm for the 22 specimens.

Table 18. Numbers and size ranges of *Gomphiocephalus hodgsoni* Carp. in tin samples, at 4 localities[1].

Locality	Date	Sample		Sample		Sample		Sample	
		Large	Small	Large	Small	Large	Small	Large	Small
Lake Penny	10.XII.63	0	0	0	0	0	0	0	0
	9.I.64	3 (0.9)	1 (0.4)	1 (0.9)	0	0	0	0	0
	8.II.64	0	1 (0.5)	9 (1.2)	1 (0.4)	0	0	0	0
Lake Péwé	13.XII.63	0	0	0	0	0	0	0	0
	11.I.64	4 (1.1)	0	0	0	0	0	0	0
	.II.64	0	0	0	0	0	0	0	0
Marble Point	15.XII.63	0	0	0	0	0	0	0	0
	12.I.64	5 (1.2)	0	33 (1.6)	2 (0.6)	0	0	57 (1.5)	1 (0.6)
	12.II.64	0	0	8 (1.2)	0	0	0	14 (1.2)	0
Flatiron	16.XII.63	22 (1.4)	3 (0.6)	0	0	0	0	0	0
	15.I.64	12 (1.2)	0	13 (1.3)	0	1 (1.3)	0	0	0
	13.II.64	16 (1.2)	3 (0.4)	59 (1.3)	2 (0.6)	1 (0.7)	1(0.6)	7 (1.2)	0

[1] Data presented as in Table 17.

Table 19. Numbers and size ranges of *Gomphiocephalus hodgsoni* Carp. in whole colonies, each under 1 stone[1], at 4 localities.[2]

Locality	Date	Stone		Stone		Stone		Stone	
		Large	Small	Large	Small	Large	Small	Large	Small
Lake Penny	9.XI.63	1 (1.1)	0						
	11.XI.63[3]	60 (1.1)	4 (0.7)						
	12.XI.63	67 (1.2)	1 (0.6)	3 (0.9)	0	65 (1.2)	7	6 (1.2)	0
	10.XII.63	99 (1.0)	46 (0.4)						
Lake Péwé	13.XI.63	31 (1.0)	1 (0.6)	20 (1.1)	0				
	10.I.64	14 (1.1)	1 (0.6)						
Marble Pt.	14.XII.63[4]	802 (1.2)	6 (0.6)						
	15.XII.63	76 (1.2)	3 (0.7)	202 (1.2)	1 (0.4)	29 (1.2)	0		
Flatiron	15.XI.63	84 (1.1)	0	45 (1.1)	12 (0.4)				
	16.XI.63	264 (1.0)	39 (0.4)	79 (1.1)	8 (0.5)				
	16.XII.63	420 (1.1)	17 (0.3)						

[1] Stones generally about 8×8× 2.5 cm.
[2] Data presented as in Table 17.
[3] Stone 13×10×2.5 cm.
[4] Stone 10×8×5 cm.

to an oblong cross-section; subsequently the can was pushed along in soil so that a flat sample was obtained with as little disturbance as possible. The cans were then kept flat, each sealed in a plastic bag, and transported to the laboratory for extraction of the Collembola by flotation or Berlese funnel. The former method is more practical with Antarctic soils devoid of humus. Negative results are included in Table 18 to emphasize the difference between under-stone (Table 17) and soil (Table 18) habitats. There is again no evidence of small Collembola being predominant at any time.

On some occasions whole colonies of Collembola were collected from the under-side of stones approximately $8 \times 8 \times 2.5$ cm. Larger stones and small boulders sometimes carried two or more distinct colonies. Collection of whole colonies was sporadic and was not intended to provide a seasonal pattern. The results in Table 19 show a wide range of collembolan numbers. Of particular interest are the figures for Marble Pt which, if considered with the figures in Table 17, may indicate maximum numbers in December at that locality. At the Flatiron, high numbers occurred both in November and December. There is the same pattern of sizes as in Tables 17, 18.

INVESTIGATIONS ON OVERWINTERING OF *GOMPHIOCEPHALUS HODGSONI* CARP.

On 22 February 1963, I (K. A. J. W.) carried out some sampling at L. Penny, assisted by K. P. Rennell who revisited the area on 17 March and again, after overwintering at McMurdo Station, on 9 September 1964, when he collected further samples.

Collembola were not readily found on 22 February, 1 specimen seen was 4.5 cm below soil surface on the side of a stone, and on another stone 2 small colonies occurred 2.5 cm and 1 cm below soil surface. All specimens were inactive. Counts and size-ranges are given in the first entry of Table 20. Two tin samples of soil from under stones were also taken and results from subsequent flotations are recorded in Table 20.

Table 20. Numbers and size ranges of *Gomphiocephalus hodgsoni* Carp. on stones and in soil samples from L. Penny, 22.II.64.

Collection Data		Large[1]	Small[1]	Total numbers
Under stones		7 (0.9)	5 (0.6)	12[2]
Soil under stones—tin sample		18 (1.3)	1 (0.7)	19[2]
Soil under stones—tin sample		10 (1.1)	0	10[2]
Soil from 2.5–10 cm below original soil surface	Sample 8	2 (1.2)	0	2[2]
Soil under stone with exuvia—to depth of 4 cm	Sample 9	9 (1.2)	7[3] (0.4)	16
Soil under snow-drift	Sample 10b	1[4] (1.1)	0	1
Soil under snow-drift	Sample 10c	3[5] (1.2)	0	3
Soil under snow-drift	Sample 10dz	2[4] (1.2)	0	2

[1] Data presented as in Table 17—large, above 0.75 mm; small, below 0.75 mm.
[2] All specimens dark.
[3] Specimens young and fresh.
[4] Specimens partly disintegrated.
[5] 2 specimens partly disintegrated.

In an effort to find out whether Collembola may migrate into, or survive in, sheltered areas of the soil, two series of samples were taken, one across a crack edging a soil polygon and one across the width of a snow-drift.

The polygon crack was 30 cm wide, so 3 (30 cm)^2 areas were measured out in a 90 cm strip with the middle square across the crack. Samples 1, 2, 5, 8 were taken in the square on one side, Samples 6 and 7 in the crack, Samples 3 and 4 on the other side of the crack. Positive results are given in Table 20.

Sample 9, taken elsewhere, was of soil under a stone bearing collembolan exuviae, and it is also recorded in Table 20.

A 30 cm wide strip across a 180 cm wide snow-drift was cleared of snow, and the soil marked into 6 (30) cm squares, labelled a-f from one side of the drift to the other. The stones on each square were examined, 1 collembolan being found under a stone 20$\times$ 20 cm in square C at the middle of the snow-drift.

Then a sample of soil and small stones was taken from each square in a layer from 0 to 5 cm deep (Samples 10a-f) and finally another set of samples (Sample 10az-fz) was taken in the same squares from a layer 5-10 cm deep. Positive results are given in Table 20.

Samples 1, 3, 6, being stones, were subsequently microscopically examined, in the laboratory, for eggs and collembolans; all were negative for both collembolans and eggs. The remaining samples (soil), were treated by flotation for collembolans, the water being subsequently seived for eggs; of 24 soil samples only 7 were positive for collembolans (Table 20) and 1 positive for eggs (Sample 9).

Sample 9, being soil from under a stone near the usual quadrat area, proved to be most interesting as it yielded 49 collembolan eggs and 7 young, fresh-looking collembolans, some of the latter being only 0.4 mm and apparently recently hatched. This is the first record of *Gomphiocephalus hodgsoni* eggs, and occurring at this time of the year they have special significance. It is worth noting however that collembolans of 0.4 mm in length occurred in various months of the summer season (Tables 17, 18, 19) which confirms that eggs were hatching throughout the season, except, perhaps, at the very beginning.

On 17 March no samples were taken but Rennell set maximum and minimum thermometers, measuring -10.8°C and -17.2°C. respectively, on the ground under a small wooden box.

On 9 September, towards the end of the winter, Rennell collected 6 samples of soil from under stones bearing collembolan exuviae. The maximum and minimum thermometers read -4.9°C. and -42.2°C. respectively.

Samples 1-4 were held at -20°C overnight then treated by flotation, Samples 1 and 3 being positive for collembolans but all were negative for eggs. Samples 5, 6 were held at -2°C for one week before flotation, Sample 5 being positive for collembolans but both were negative for eggs. Sample 5 also yielded an active tardigrade and 2 active nematodes, while Sample 6 yielded 1 active nematode.

Positive collembolan results are given in Table 21. It is seen that there is an almost complete lack of small young collembolans.

There is still no definite proof of what actually occurs during the winter and this is another aspect which requires more sampling at regular intervals. It would seem that eggs are hatching in February and that 'large' collembolans are present at both the begin-

Table 21. Numbers and size ranges of *Gomphiocephalus hodgsoni* Carp. in soil samples from L. Penny, 9.IX.64.[1]

Collection Data	Large	Small	Total
Soil under stone with exuviae Sample 1	16 (1.2)	0	16[2]
Soil under stone with exuviae Sample 3	5 (1.2)	0	5
Soil under stone with exuviae Sample 5	21 (1.2)	1[3] (0.4)	22

[1] Data presented as in Table 20.
[2] Specimens partly disintegrated.
[3] Young, but not entirely fresh-looking.

ning and end of winter. No large concentrations of collembolans were found in the two sheltered niches investigated in late February 1964. It is considered that summer populations, for the most part, die out with the onset of winter, but small colonies (such as in Sample 9 above) survive in tiny niches where conditions are just sufficient to support life. The collembolans may survive in any stage (small or large) in which they were arrested by the continued depression of temperatures below 0°C.

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