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Preface

Dr. Irving Hill Blake's list of published titles is not a long one, but each paper was the result of thorough, painstaking accumulation of data and meticulous preparation for publication. Apart from two papers on the histology of the digestive tube of teleost fishes, all of his work was field oriented. It was concerned basically with the description of animal communities and their environments, in the early tradition of Victor Shelford under whom he took his doctorate in 1925 at the University of Illinois. Dr. Blake was enamored of the mountains at an early age, at first in the East, where he studied the ecology of Mt. Katahdin, Maine, and later in the West, where he taught briefly at Oregon State College (now University), the University of Idaho, and the University of Wyoming Summer Camp in the Medicine Bow Mountains. The love of the mountains and the American West which he shared with Mrs. Blake led to the purchase of a small mountain ranch near Lake George, Colorado, where they spent their summers for many years. They were making preparations for their annual trip to Colorado when Dr. Blake died suddenly on May 6, 1968, at the age of 80.

Dr. Abigail Kincaid Blake cooperated closely with her husband in his field studies throughout their married life. She made her major contribution in the area of the plant ecology of the communities which they studied, having taken a doctorate in botany in 1933 under Dr. John E. Weaver at the University of Nebraska. Thus, their work represented a melding of background and training under two of the great pioneer personalities in North American ecology.

The material presented in this paper has been unfortunately long delayed in publication, and much ecologically oriented work has been conducted in the Colorado Rockies since the summer of 1945 when most of the data presented were recorded. However, the Doctors Blake's work makes a unique contribution from a time when some of the study areas were in a near-primitive condition but have since been disturbed by grazing and flooding. It provides an appropriate complement to the recently published "Sociological studies of the alpine vegetation on Long's Peak" by Walter Kiener (University of Nebraska Studies, New Series 34, 1967).

Harvey L. Gunderson, Paul A. Johnsgard, and John F. Davidson have been consulted on the common and scientific names of animals and plants used in the manuscript, but except for minor changes, identifications and nomenclature originally employed by the authors have not been altered.

This paper is Contribution No. 395, Studies from the Department of Zoology, University of Nebraska.

THOMAS B. THORSON
Professor and Chairman
Department of Zoology

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The writers wish to express appreciation for the assistance of William A. Sheldon of Alma, who has permitted the use of his many years' observations on the birds and mammals of Mount Lincoln and vicinity. Thanks are due also to the University of Nebraska Research Council for a grant for student assistance in preparing and cataloging specimens.

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Introduction

During the short alpine growing season of 1945 the authors had the opportunity of studying conditions and biota on Mount Lincoln, Park County, Colorado, in an attempt to evaluate the ecological conditions and animal communities of the area. Of the large amount of taxonomic and ecological zoology published on the state, most has been in the field of autecology, and, except in the province of aquatic studies, little has appeared bearing on synecological relations, especially among invertebrates. The marked differences between the physiography, climatology, and biology of timberline, alpine, and other stations seemed to offer a field well worthy of investigation. Since the work was done, other factors have been introduced which have greatly altered the nearly primitive conditions encountered at the time of the investigation. One of the areas has been entirely destroyed by the formation of a water storage lake, and others have been affected through heavy summer grazing by bands of sheep.

The material published on the Mount Lincoln area is very limited. Cary (1911) was concerned with similar areas in other parts of the state, but apparently he did not work around the mountains at the head of the South Platte. The most detailed paper on the region is that of Patton and his collaborators (1912) which covers the physiography very completely. There are scattered references to the animal life of the vicinity in Coues (1874), Sclater (1912), Warren (1942), and elsewhere. The most complete published reports on the animal life of the region are those of Brewer (1871) and Allen (1872, 1876a, 1876b); the first of Allen's papers is the source of most of Coues' references to the Mount Lincoln avifauna. None of these papers deals with the invertebrates, save for comments by Brewer on the relative abundance of certain orders of insects.

Scope of Work

In our investigations of the animal ecology at high altitudes, limitations of time, equipment, and personnel made it necessary to confine the study mainly to three stations, one of which received far less attention than the other two. The areas considered of most importance were the sites of the timberline and alpine tundra

stations (Stations 1 and 2, respectively), both situated on the southeast slope of Mount Lincoln (Fig. 1). Each of these was equipped with a fairly complete set of meteorological instruments. These stations were visited weekly, sometimes oftener, when recording instruments were read and reset, and collections of animals were made. The most extensive collecting was of invertebrates, almost wholly arthropods. In addition, some trapping was done for small mammals. The station collections were supplemented by collecting done in similar habitats nearby. For purposes of comparison some collections and observations were made at the comparatively low altitude of Montgomery in the South Platte River valley (Station 3). The bird records are based on field observations, checked and supplemented by local observers, who also made some contributions to the list of mammals. In addition species were listed that are known historically to have been present but have now disappeared. The lists of animals do not profess to include the entire fauna but do represent all species collected and/or observed in the present study, supplemented by the records mentioned above.

Methods of Study

The collections of animals were made at each station when the weekly instrumental records were read. The usual procedure was net-sweeping, using fifty strokes of an insect-net with a diameter of 12 in. In timberline collecting, sweepings were made both over the low herbaceous vegetation and higher among the shrubby and low tree growths of that habitat; at the alpine station only the lower stratum of vegetation was present. Although the results are not strictly quantitative, attempts have been made to evaluate them numerically as far as possible. Because the same methods were employed in all collecting, it is felt that the results from different stations and on different dates at the same station are suitable for comparison. Net-sweeping was supplemented by investigation of selected areas of the ground cover and the upper 10 cm. of soil where the underlying rocks were at sufficient depth to permit this. In addition individual collecting was done, particularly of conspicuous and characteristic species whose habits prevented their usual inclusion in sweep collections; this was especially the case with strong-flying insects like Lepidoptera. Observations of altered behavior with the constant changes of mountain weather were made when possible.

Habitat factors measured included: velocity of wind, amount of evaporation, temperature of air (also of soil at the alpine sta-

tion) and relative humidity. Recording hygrothermographs, a recording soil thermometer, one three-cup and one four-cup anemometer, and both cylindrical and black and white spherical atmometers yielded records once a week. When possible these were supplemented by direct readings taken at the time of the collection of animals. A few light readings were obtained.

General Environment

The area of study on Mount Lincoln lies between five and ten miles west-southwest of Hoosier Pass, 11,541 ft. (Lackey, 1949), approximately 39° 30′ N. latitude, 106° W. longitude (Fig. 1). The nearest town is Alma, five miles south at the foot of the pass. A conspicuous feature of the general landscape is the South Platte River meandering out of the gorge deeply cut between Mount Lincoln and North Star Mountain of the Continental Divide. Where this last forms the dividing line between Park and Summit Counties and also the division between the head waters of the South Platte and those of the Blue River, there diverges from it the Park or Mosquito Range, of which line of peaks Mount Lincoln forms the northern end. Mount Lincoln (14,276 ft.) is really one of three summits forming a high mountain massif (Patton, *et al.*, 1912), the others being Mounts Bross (14,276 ft.) and Cameron (14,233 ft.). The last is closely associated with Mount Lincoln, and between their summits and that of Bross lies a deep glacial basin about a mile and a half in width, known as the Cameron Amphitheater, the scene of the alpine portion of this study. Quartzville Creek drains the Cameron Amphitheater and enters the Platte. Still farther south and occupying a lower bench on the slopes of Mount Bross is a small park with a number of beaver ponds, from which Moose Creek enters the Platte lower down. The close-lying mountains of the Park Range afford each other considerable protection at their massive lower levels. Above 11,000 to 11,500 ft. the eroded peaks emerge sharply, climatic exposure becomes severe, and trees disappear. The base from which the work was done was the "ghost town" of Montgomery, now submerged under an artificial lake, but the more detailed studies were made mainly at timberline above the old townsite of Quartzville and in the Cameron Amphitheater.

Stations

After preliminary surveys the alpine station (Sta. 2, Fig. 3) was set up on 19 July at an elevation of 13,100 ft., the timberline station (Sta. 1, Fig. 2) on 20 July at the Quartzville U.S.L.M., 12,200 ft. These points of study were about two miles apart. They were visited once a week regularly, oftener when practicable, until mid-September. After that date, until the stations were dismantled in late October, the schedule was frequently altered by snowfalls. Sometimes the trails were blocked; more often it would have been useless to attempt to find invertebrates in the cold and storm. Some collections and instrumental readings were taken in the South Platte valley on the site of the old town of Montgomery. This will be known as the valley station (Sta. 3, Fig. 4) in this paper, the altitude being 10,700 ft. The invertebrate collecting done here was much less complete and systematic than that at the higher stations, and the point was used mainly as a check for the altitudinal distribution of vertebrates. Under this heading were listed all occurrences below the high timberline bench of Sta. 1, including the Platte valley and the lower slopes of Bross and Lincoln as high as Moose Creek Park (ca. 11,100 ft.) on the headwaters of that stream.

Although the authors believe with Lutz (1922) that it is extremely difficult if not impossible to determine definitely the boundaries of the Biological Survey "life zones," especially in a local study, an attempt has been made to homologize the areas worked with that concept; this is mainly to make possible the use of Cary's careful data on the altitudinal distribution of vertebrates in Colorado and to apply them to the same species found to occur in the Mount Lincoln area. Based on Cary's "index plant" criteria, the following are tentatively suggested. There can be no question of the propriety of homologizing the Arctic-Alpine zone of Cary with the alpine tundra of the present study. It will be considered here that the timberline tract, as designated hereafter, covers the conditions given by that author as pertaining to his Hudsonian zone and that all regions in this study lying lower down are to be called Canadian. However, the boundaries between these last two are admittedly uncertain.

TIMBERLINE

The timberline station will be considered first as its records are more nearly complete. Also the conditions were more mesic for most types of life than those encountered at higher altitudes. While timberline has been altered and somewhat lowered in this region by activities of man, its present limits are fairly clear.

The station where the timberline instruments were located, while not the highest at which trees were found, was the last one where they grew to any size; only limited patches of low krummholz were found above. The trees were often relatively large specimens of Engelmann spruce and alpine fir; the usual understory of herbaceous plants is very scanty. Glades of alpine grasses break the forest, which changes to grassy tundra either abruptly or through dense thickets of subalpine willows. Above rise the rocky, barren upper slopes of Mount Lincoln on whose lofty surfaces the thin general cover of short sedges, grasses, and forbs is scarcely discernible from a distance. Small patches of spruce krummholz are scattered over the first few hundred feet of the ascent, while thick clumps of shrubby cinquefoil (*Potentilla fruticosa*) and low willows grow much higher. The last upright trees mark the upper boundary of an area some 500 to 600 yards in width; its upper slopes, fairly steep and partly forested, lead down to a gently sloping bench, whose lower portions are somewhat above 11,000 ft. altitude. This area, which is diversified by shallow ravines, is bounded below by steep, spruce-covered slopes, dropping nearly 1,000 ft. to the Platte valley, of which they form the western wall. To the south the drop into Moose Creek Park is less abrupt but forms on this side the lower boundary of the area where collections were made. The drainage is towards the South Platte through Quartzville and Moose Creeks.

Much of this benchland tract is covered with vegetation of the "park" type, consisting of firs, isolated or in small clumps, separated by considerable areas of subalpine grassland carrying seasonal forbs. The amount of grassland is increased by past cutting of timber, the stumps and discarded logs of which dot the open spaces and are partly overgrown with shrubby vegetation, especially wild currants. Apparently the virgin timber had attained full development before the old town of Quartzville flourished here eighty to a hundred years ago. Logs were cut extensively for timbers for gold and silver mines and for cabins. Within more recent years a few small mining projects have been prosecuted in the vicinity. Sheep-grazing has also occurred in August of some years.

While the timber clearing was not as complete as that often caused by fire, it exposed much of the area to the severity of mountain sun and winds so that the mass recovery of the spruce forest has not occurred. Some individuals of large size survived human occupation of their habitat. Saplings in favorable spots are maturing into normal stands of young spruce trees, forming windbreaks to the north and west, the direction of the prevalent winds down the mountain slopes. Where air currents cause winter-killing of tips of branches, a few patches have assumed the wind timber habit, closely crowded in the circumference of a few rods with individuals never exceeding 8 ft. in height or 4 in. in diameter. Both limber and bristle-cone pines have become more prominent in this windswept location. Willows have formed dense thickets, 6 to 8 ft. tall, very efficient in reducing wind and retaining snow. Extensive open spaces are occupied by huge tufts of mountain brome grass and by sedges, fescue, and wheat grasses and by scattered representatives of lupines, fireweed (*Epilobium* spp.), *Potentilla* spp., and *Senecio* spp.

The timberline instrument station (Sta. 1) was established on the upper margin of this bench at 12,200 ft. Scattered conifers maintained themselves for about 200 ft. to the west among outcropping rocks and ledges. They were terminated at a swampy depression that lay at the base of the definitely alpine upper slope of the mountain. On the north and east of the area of study, remains of old forest afforded considerable protection from wind and driving rain or snow. To the south the ground cover was low and herbaceous except for a few bristle-cone and limber pines a hundred feet or more distant.

The weather recording instruments were placed where the two natural dominants of the ecotone, Engelmann spruce and Idaho fescue grass, come in direct contact. The hygrothermograph shelter, the atmometers, and the anemometer were set in the open on scantily grassed soil overlying rock. Their position was within 5 to 10 ft. of a stand of thrifty young spruce.

The habitat factors measured in this situation are probably at the optimum for the development on Mount Lincoln of vegetation and delicate-bodied invertebrates. Some collecting was done throughout this general area, but the most intensive animal collections were made within a hundred yards of the instrument station at the actual timberline. They included animals from rock, in grass and sedges, in willow thickets, in isolated conifers, and in a deeply shaded stand of old spruce.

ALPINE TUNDRA

Maximum protection under alpine conditions was the basis of selection. The alpine station was placed near the head of the Cameron Amphitheater, a long valley cut by glacial action. It is a trough 12,500 to 13,100 ft. and higher, lying between the crests of Mount Lincoln on the north and Mount Bross on the south. To the west the valley is closed by the lofty ridge of Mount Cameron, which connects the adjacent spur of Bross and the south wall of Lincoln close below its peak. Towards Lincoln, precipitous walls, mainly cliff and loose gravel, rise 700 ft. and toward the west 500 ft. At the south, above the first 200 ft., the slope of Bross is gradual enough to support a continuous green cover of thin sedges and grass. The valley is open toward the east and slopes comparatively gradually eastward and southward toward Bross. A mile below its head the valley is entirely clear of the sheer wall of Lincoln and blends with the contours of the alpine slopes to the north. The main watercourse, Quartzville Creek, retreats to a deep ravine formerly carved on the side of Mount Bross by a glacial river.

While the precipitation and the surface area of the watershed are not sufficient to form a lake across the valley, a shallow pool lies at the foot of the Cameron ridge; in the earlier parts of the growing season boggy spots are frequent in the area, and streams flow along both the north and south borders, reduced by autumn to interrupted pools. The solidly packed snow of the winter storms melts slowly with the wetter snowfalls of the spring months and the rains of summer; all make contributions to the moisture. Well into August remnants of drifts cling along the walls of the amphitheater. They furnish diminishing trickles of water to the shrinking pond and streams, the mainly snow-fed sources of Quartzville Creek.

Glacial ice has disappeared relatively recently from the valley. The resistant granite and schists have disintegrated so little that only a scant amount of mineral soil has developed among boulders and smaller fragments. Consequently the floor is not uniform. Extensive ledges, close to the surface or openly exposed, alternate with depressions in which earth has accumulated to a depth of several inches or even a foot.

Vegetation consists most extensively of the alpine climax of grass-sedge with a number of scattered, conspicuously flowering forbs. Fescue grass (*Festuca ovina*), mountain bluegrasses (*Poa epilis* Scribner), and several sedges such as *Carex rupestris*, and in the areas of better soil *C. calciolepis*, occur widely. Characteristic

non-grasses include alpine sunflower (*Rydbergia grandiflora*, bistort (*Polygonum bistortoides*), alpine paintbrush (*Castilleja occidentalis*), the late-flowering king's crown (*Sedum rodanthum*), and miner's lettuce (*Lewisia pygmaea*), the last growing submerged in the early part of the season. Many forbs are suppressed by domestic sheep grazed across the region in August.

The weather recording instruments were placed near the middle of the amphitheater, within a quarter mile of the Cameron Ridge, which closes the head of the valley. They were set where enough gravelly soil covered the underlying ledge to permit some bracing of the supports and a scant burial of the sensitive unit of the soil thermograph. In this high-walled valley the habitat factors were presumably at the optimum for alpine biological development on the dry side of the mountain range. Animal collections were made on and over gravelly bare ground and rock, grass-sedge, forbs, and low shrubby cinquefoil, and also at pond and stream sides.

River Valley

This station was located in the upper South Platte valley, on the site of the "ghost town" of Montgomery. The valley was walled by steep, rocky slopes, the lower portions of which were covered with coniferous forest interspersed with clumps of much-stunted aspens or willows. The floor of the valley was a flood-plain of no great extent, forming a typical luxuriant mountain meadow of tall grasses, sedges, and forbs. This area is now covered by an artificial lake. Observations here were supplemented by others around the head of Moose Creek in a somewhat higher but similarly protected location. A thermograph was operated during a part of the study, and individual readings were taken of temperature, humidity, and air movement, particularly at the times and in the places where collecting was done. Collecting methods were the same as those employed at the upper stations and embraced flood-plain grassland and the bordering forest-covered slopes. Collections here, however, were only incidental as compared with those made at the upper stations.

Climate and Soil

Alpine weather records are meagre, but generalizations on mountain climate noted by Sherier (1933) apply to the upper slopes of Mount Lincoln. While the mean and maximum temperatures decrease regularly with the altitude, the minima depend largely on air drainage. Precipitation along the Continental Divide and probably along the tops of the Park ranges is of the Pacific type, much greater in winter as snow than in summer as rain. The characteristic tendency toward drought in June, noted by Sherier, is less significant because the soil at high altitudes is saturated at this season by melting snow.

Weather along the upper limit of the subalpine forest (the spruce-fir belt) is considerably more severe than at its lower edge, about 10,000 ft. in this part of Colorado. The growing season is shortened and is much more frequently visited by hail and snow. Averages of eight years' records of temperature and seventeen years of precipitation at Alma, 10,300 ft. altitude, give the best picture available of the local spruce-fir climate on the dry side of the high mountains.

Precipitation, at least on the eastern slope, shows much greater annual variation than temperature. Consequently it becomes the critical factor in distribution of such plants and animals as must have ample moisture in later summer, whether juicy fruits or soft-bodied insects.

Precipitation and the percent of it that is due to snowfall both increase with the altitude. The plains cities of Denver and Colorado Springs, directly east of the Front Range, have between 14 and 15 in. annually. Alma's average for seventeen years is 16 in. But the much lower temperatures at Alma keep the evaporation losses less, so that the 16 in. is more effective for the scarcely mesophytic vegetation.

Total precipitation along the upper levels of the coniferous belt may be estimated conservatively as about 22 in. (Breckenridge at 10,500 ft. on the wet slope below Hoosier Pass has 24 in.) The larger part of the timberline increase over that of Alma falls as snow, heaviest in March and April. Summer throughout the region is characterized by much fair dry weather in June,

followed by heavy rains of the shower type in July and August. While autumn and winter are seasons of light precipitation, much more snow falls at the higher levels.

Air Movements

Wind velocity was measured by standard aluminum cup anemometers placed permanently at each station. Readings covering periods of a few minutes duration were occasionally made with an "air-way" hand anemometer.

A four-cup anemometer was established at the timberline station, a three-cup instrument in the alpine amphitheater. Both were set so that the cups were one meter above the ground. This was considerably higher than the level of the other weather instruments. It afforded, however, a wind record nearer the average height at which flying insects were collected by sweeping and avoided interference by small mammals. This level, widely used by field ecologists, gave records directly comparable with those of other workers.

The anemometers were read whenever the stations were visited, yielding figures from which the average velocities in miles per hour were computed. The intervals between readings were usually six or seven days at the higher station, somewhat shorter at timberline. When storms after mid-September lengthened the intervals, the probability of more than one complete revolution of the recording dial had to be considered. Extremes were impossible to determine, as they were concealed by the more continuous periods of relative calm.

At the timberline station, wind was usually light. The prevailing west and northwest winds of the region and the strong south winds that sometimes blew upward from South Park were greatly reduced by the fringe of trees. The remnant of old forest at the east shut off the impact of the rather weak winds that not infrequently came from that quarter. From early August through the first week of September the average velocity was 2.5 to 3.5 mph. Later it was often a little above 5 mph., rising to 7 in prolonged periods of intermittent storms, dropping in the exceptionally mild second week of October to less than 3.

On the open slopes above timberline the wind blew strongly from the north in the morning. After midday the warm air rising from the Platte valley, south and east, was so widely diffused that it seldom constituted a discernible current. The Cameron Amphitheater where the alpine station was located was character-

ized by gusty winds. Usually they were from the north or from the northwest through a gap between the peak of Mount Lincoln and the lofty knife-edge of Mount Cameron. On many days the amphitheater was crossed by strong breezes alternating sharply between north and south, more rarely east and west. The average velocities were roughly three times as high as those at timberline, nearly 9 mph. until the end of August, through September as high as 12 to 15 mph. The October record was for less than a week. Before a later reading could be taken wind had wrecked the anemometer.

Evaporation

Evaporation was measured by porous cup atmometers so placed that the evaporating surfaces were from 18 to 25 cm. above the ground. This was higher than the sensitive units of the hygrothermographs; underlying rock rendered it impossible to sink the wooden boxes holding the reservoir bottles more deeply. Both cylindrical cups and paired black and white spheres were employed. So many replacements were necessary because of animal interference at first, and freezing at the end of the season, that frequently readings could not be obtained in duplicate. For a measure of insolation, paired black and white spheres were used at the alpine station during the last three weeks of August, and later at timberline, until they were wrecked by freezing. Evaporation was slightly less from the cylindrical type than from the white spherical when the two were placed together under apparently identical conditions of exposure. As the difference was less than 10%, sometimes as low as 5% when the coefficients were applied, the readings from both have been considered together.

The last ten days of July and the first ten days of August were very wet with many heavy rains and high humidity. Temperatures were high, winds generally low. Weekly evaporation losses at timberline were small, 15 cc. or under per day. They reached 20 to 30 cc. during most of the period of study. In very dry air and winds of autumn velocity during the second week of September they rose to 40 cc.

Alpine average daily losses exceeded those of timberline by about 5 cc. While the temperature averaged 10° F. lower during the day, except in rainy weather, the wind was three to four times as high as that at the lower station. A 24-hour reading at the end of August, with an average relative humidity of 50%, showed an evaporation loss of 37 cc.

INSOLATION

Insolation was measured by computing the differences in amount of evaporation between black and white spherical atmometers used in the evaporation studies. The paired instruments were close together and under practically identical conditions of exposure. Three weekly readings were obtained at the alpine station in middle to late August and two at timberline in early September.

While the method is open to criticism, it was the only one available. Separate day and night readings were not possible. The amount of evaporation due to wind could not be determined. This was not highly significant at one station alone, as the factor acted on both white and black spheres equally. The greater velocity at the alpine station induced a larger error in attributing the loss to insolation than at the sheltered timberline station. In this study the two records at the lower altitude were made in September, too late in the season to be fairly comparable with the August records from the alpine station.

The maximum record was at the alpine station from the readings of the week of August 17-24. Evaporation from the white sphere gave a 24-hour average of 24.2 cc., from the black 43.2 cc. Excess evaporation from the black sphere was 78.5% of total evaporation from the white. Day temperatures and saturation deficits (Table 9) averaged high, indicating more than the usual number of hours of sunshine. Relative humidity was somewhat low, as was also wind velocity. Insolation the preceding week was nearly as high, causing excess evaporation of 77%. The last week of August (24-31) showed a reduction to 43%. This may have been due to the more severe weather of the advancing season.

At the timberline station, insolation was measured during the first twelve days of September. Readings were taken on the seventh and twelfth. The period was one of much sunshine. Both readings gave practically the same average excess of water loss from the black sphere, 45%.

In conclusion, during clear weather in August radiant energy is intense enough near 13,000 ft. elevation to increase the evaporation from a completely absorbing moist surface by at least 80%; in early September, above 11,000 ft. along timberline, by 50%.

TEMPERATURE

Hygrothermograph records were obtained at the timberline station from July 20 until October 23 and at the alpine station from

July 19 until September 13, after which frequent penetration by blizzard snow and thawing and freezing rendered the recording instruments undependable. The instruments were housed in standard shelters built with louvered sides. With the instrument in the shelter the metal plate which responded to temperature changes was about 10 cm. above the ground.

The records taken at timberline broke naturally into two distinct groups. The first eight weeks, July 20 to September 14, constituted the last half of the growing season; the last six weeks, September 14 through October 23, autumn. A wet snowfall occurred on September 15, some four to five inches, and melted off in a few days. While there was a little warm weather after this date, notably in the first week of October, it was brief and scattered.

The temperature records of the alpine station covered only the eight weeks of July 19 to September 13. The mid-September storm struck many hours earlier along the upper levels of the mountain and was largely of the blizzard type. Snow penetrated the shelter house and instrument case, halting the recording levers. Repeated storms made subsequent records impossible. A maximum-minimum thermometer indicated during that period that the alpine maxima were about 12° F. lower than those at timberline, and the minima 3 to 5° lower.

A soil thermograph was maintained at the alpine station beside the hygrothermograph. Its sensitive unit was buried 10 cm. deep in the gravelly, rocky soil, practically against the underlying ledge. Its records were not finished until September 25, as snow did not enter the shelter of this instrument.

Daily temperatures in the accompanying tables have been computed from the readings on the charts at two-hour intervals. Summer averages based on the larger number of readings run a little lower than those computed from the maxima and minima, because the maxima deviate farther upward than the minima deviate downward from the true mean temperature.

For the period in which both stations were maintained, closing in mid-September, the timberline station showed a 24-hour mean temperature of practically 50° F., with a day mean of a little under 60° F. and a night mean of approximately 40° F. Comparison with maximum-minimum temperatures in an old spruce grove at timberline, July 27 to August 16, indicated that in summer the forest cover reduced maxima 10° F., minima 3-5° F. The alpine station had a 24-hour mean of 5° F. lower, with a day mean of

50° F., while the night mean was like that at timberline, 40° F. Night cooling in the alpine amphitheater was balanced by the cold air drainage at the lower station. Of more importance to the life that maintained itself in these areas were the maxima that condition daily activity. At timberline the mean maximum recorded was 67° F., the absolute maximum 75° F. The figures from the alpine station were 10 degrees lower.

The soil temperature of the loose, well-aerated gravel at the alpine station closely followed the air temperature after the first two weeks when the soil remained cold from saturation by heavy rains. Usually soil temperatures were less than 5° F. lower than those of the air. The mean and absolute maxima were 7° F. lower.

In conclusion summer daily maxima at the timberline station were in the middle sixties to the middle seventies; at the alpine station in the middle fifties to the low sixties. Subsequently, while exceptionally warm days occurred irregularly, timberline readings rarely reached 60° F., alpine rarely 50° F. With such low temperatures only species that can survive on brief, often interrupted periods of heat will persist.

Humidity

Relative humidity was measured by hygrothermographs, placed at each station in standard shelters so that the sensitive elements were at the 4-in. (10-cm.) level. Direct readings were made with a cog psychrometer. While it is scarcely possible for a recording instrument to adjust to all the rapid changes of a high mountain climate, the hygrothermograms give the best picture available. Temperature fluctuations too small and transitory to affect the metal heat unit are accompanied by alterations in relative humidity sufficient to cause response by the more immediately sensitive hygrometric unit.

Relative humidity was found to decrease with rise in altitude. Although it lacked the regular lowering that characterizes temperature, the 24-hour means showed a definite decline, with the least difference in the daytime values and the minima. A 10,300-ft. basis for comparison was furnished by the town of Alma, climatically in the spruce-fir belt, although man's occupation has resulted in replacement by lodgepole pine. Hygrograms for the corresponding periods at Alma in 1946 and 1947 indicated that the relative humidity was slightly higher (3 to 5%) than that of the timberline station at 12,200 ft., except for a very dry week at the end of July in 1947.

Relative humidity at timberline where tree growth is still of erect stature is comparatively high, 64% for the 24-hour mean during the period of study, with a day mean of 53% and a night mean of 76%. Heavy rains in late July raised the 24-hour weekly mean to 75%, with absolute maxima above 95%. More often the 24-hour mean was in the upper sixties, with day periods in the fifties and nights in the low eighties. The humidity in mid-September fell below 20% on three days only. Subsequently high winds, sometimes accompanied by snow, often produced large and abrupt changes, from 30% and below to the mid-nineties in three or four hours.

Beyond the shelter of trees the relative humidity was lower, the daily range less, and continuous minor fluctuations were more apparent. These changes were obviously due in part to increased wind. Another factor is the continual alteration in temperature of the streams of air that flow constantly up and down the slopes of high mountains. Strong insolation at varying angles heats the ground and air above it to many different temperatures. Shaded surfaces quickly lose heat in the rarified atmosphere. By noon valleys below send up warm air which produces clouds above the peaks. Resultant cooling starts downward currents, which mingle with the upward draughts along the surfaces of the slopes (Hahn, 1903).

At the alpine station (13,100 ft.) the mean 24-hour relative humidity recorded on the hygrothermograms was about 20% R.H. lower than that registered on the instrument at timberline. The 24-hour mean from July 19 to September 13 was 45 R.H., with day mean of 40% R.H. and night mean of 50% R.H. The rains and high relative humidity that opened the record at timberline did not occur at the alpine station. But after September 15 blasts of wind-driven snow repeatedly blocked the levers of the hygrothermograph inside its shelter. At both stations the second week of September was the driest of the season.

Soil

Soil at timberline is sandy loam. Sand content is 50% to 70%, often with well over 10% of gravel. Two distinct kinds are present. The azonal soil of the open grassland differs from the more mature type that has developed under cover of spruce. The former is a thin layer accumulated on rock surfaces. The depth is seldom over three or four inches, rarely six. The pH values are close to neutrality. Samples taken in August in an

unusually wet summer gave pH readings of 7.07 to slightly acid. Soil under the spruce cover is of the podsol type, with a layer of partly decayed organic debris above the mineral soil. The pH of August samples varied from 6.15 to 5.88. An October reading, near but not at the station, gave pH 5.1. The acid, poorly aerated soil, low in temperature, is unfavorable for insect life.

Soil at the alpine station resembles that of grassland at timberline. The glacial retreat left the high valleys of Colorado ranges occupied by ice until the last few thousand years. Since it disappeared a thin film of gravelly soil and a scant cover of hardy vegetation have developed a younger lithosol.

Animals

The animal life, following the changing meteorological conditions characteristic of alpine climates, showed considerable fluctuations from week to week, although the general trend of the populations was of course downward as the season advanced towards autumn. The alpine tundra collections were consistently smaller than the timberline ones, the two curves approaching each other only after September 13 when inclement weather had reduced the numbers of animals at both stations to a point where they were hardly significant. Starting with the high populations of the week of July 22-28, when collections were made in fair, warm and dry weather (Sta. 1 above 70° F. and below 25% R.H.; Sta. 2, 65° F. and also below 25% R.H.), there was a considerable decline during the two weeks following; Diptera were the prevalent groups at both levels. The sharpest decline was shown by the tundra population of August 4, which was taken during air temperatures of about 50° F. with R.H. of 55-57%. These declines followed cool, cloudy weather with heavy showers that left the ground soaked. The week of August 12–18 gave a slight further decrease in the timberline animals and a slight upward trend of the tundra group; the weather was fair, warm and somewhat dry (74° F. and 60° F. 35% R.H. and 36% R.H., respectively). Similar meteorological conditions continued during the week of August 19–25 although it was somewhat warmer at timberline; here there occurred an enormous upthrust of population, the highest encountered during the study. This increase was due mainly to the appearance of cicadellids in large numbers. The tundra population also increased but much more moderately. The following week populations declined sharply at timberline with Cicadellidae still the prevalent components there and Diptera at the tundra station. The week of August 26 to September 1, when these declines occurred, brought the beginning of autumnal conditions when, although the mornings might be comparatively warm and dry, sudden changes to colder weather with rain and/or hail came about midday, sharply altering the climatic and biological pattern. Here, as usual in mountain studies, the immediate effect of brief weather changes was very marked, surface-living invertebrates becoming

quiescent as warm, bright sun changed to dull and colder conditions.

The week of September 2–8 furnished some slight increase at Sta. 1, Sta. 2 remaining about the same; the prevalent forms were orthopterans (Acrididae) in both cases, with considerable numbers of dipterans at timberline. Even there temperatures remained above 70° F. for only a short time at midday, while on the tundra they stood at 56° F. or lower during the collecting periods. At the latter station, marked changes had taken place in the invertebrates; many winged species had disappeared altogether, and the ground-running forms were less conspicuous. However some little invertebrate life was active under stones and debris, where temperature was markedly higher than on the surface of the ground. The week following (September 9–16), with lowered temperatures (ca. 50° F.), populations continued to decline, orthopterans being the most numerous components. During the week of September 16–22 this order contributed to a small increase in the last tundra count made, although the temperature remained low, and winds were violent and gusty from N.N.W. A few miscellaneous insects were swept at timberline, but there was little surface life. Two other attempts were made to collect at timberline on October 4 and 6; in the first case, with a temperature of ca. 50° F., there was no evidence of invertebrates, and fifty sweeps netted nothing. On October 6 the same procedure yielded some mixed forms, mainly semi-torpid orthopterans; the day was fair and warm (64° F.), with the highest maximum temperature and the lowest relative humidity (ca. 20%) encountered during the month. Even as late as October 14 (56° F. and 48% R.H.) a few invertebrates were active to some extent on the surface of the ground; they included the wolf spider *Pardosa altimontis*, the grasshopper *Chorthippus longicornis*, the bug *Geocoris decoratus solutus*, and the ant *Formica neorufibarbis gelida*. Throughout the study, the faunal changes, especially at timberline and below, were less conspicuous and required more careful observation than the many floral changes made during the advancing season.

Invertebrates

Several invertebrate groups were represented only by unidentifiable material such as juvenile forms, cast skins, and the like. Thus, the named lists include no centipedes or millipeds and few acarinid records, although all these were present, and specimens of the erythraeid genus *Microtrombidium* were secured

under moist debris at Sta. 2. Phalangids were rare also; a single specimen of *Hololophus punctatus* was taken at the same place.

In this study no attempt was made to evaluate the aquatic life. However the terrestrial sweep collections sometimes contained winged adults of aquatic species where the work was done in the vicinity of standing or running water, both in the Cameron Amphitheater and in places below the timberline station. Small naiads of several mayflies were found on August 11 in rivulets running into Quartzville Creek. Adult females of *Baetis bicaudatus* appeared in late August sweeping at Sta. 2 and as late as September 18 at Sta. 3. This species occupies running waters under a wide variety of conditions; it was collected at 9,975 ft. from small swift streams in the Medicine Bow Mountains of Wyoming (Blake, 1945), and is often found at high altitudes. Our collections at 13,100 ft. may represent a high altitude record for the species. Females of the spring stonefly *Nemoura delicatula* appeared at the timberline station, and of the green stonefly *Alloperla pallidula* among the mountain meadow collections at Sta. 3. The former is common in the northward mountains throughout a wide variety of altitudes. Males and females of the northern caddisfly *Limnephilus emarginatus* were taken in flight over the mountain meadows of the valley habitat in the immediate vicinity of the South Platte River, from August 14 to September 2; previous records are Alaskan.

ARANEIDA

Spiders are well represented in most collections, the more numerous being wolf spiders of the genus *Pardosa,* especially at Sta. 2. On August 4 juvenile spiders of this group, probably *P. tristis,* were beginning to be abundant along with a few representatives of other families, especially the linyphiid *Linyphia marginata* and the argiopid *Tetragnatha,* probably *laboriosa.* Mature females of *P. tristis* with egg-sacs appeared later in the summer, more frequently in dry tundra areas. Another *Pardosa* common at the tundra station was *ourayensis,* which seemed more usually found in moist areas; females carrying egg-sacs were collected about the middle of August. Even in October the species was occasionally taken under debris. *P. altimontis* was found only at timberline where it was still abundant and active, in spite of low temperatures and occasional snow, as late as October 14. *P. mackenziana* appeared only in the Sta. 3 collections from Montgomery, where it seems to be partly aedificarian in habitat; the first examples, females with egg-sacs, were taken on August 6 and the last, running

actively on a snow-bank, September 30. This species was collected by the authors in the Medicine Bow Mountains of Wyoming where it occupied a wider range of habitats including wet meadows, rocky slopes, aspen subclimax, spruce-fir forest, plains grassland and especially lodgepole pine forest, in all involving an altitude range from 9,875 ft. down to 7,000 ft. elevation. Also confined to the valley station, as far as our Mount Lincoln collections show, was the drassid *Orodrassus coloradensis*; all those found in the old cabins at Montgomery were aedificarian. This species was found also in the Medicine Bow lodgepole pine and spruce-fir forests, especially the latter. Crab spiders were represented sparsely and only in the Sta. 3 list, as immature *Xysticus*.

ORTHOPTERA

Brewer (1871) found crickets very abundant from 12,000 to 13,000 ft., including several species and large numbers of individuals; these were not encountered in the present study. He was impressed by the numbers of grasshoppers at all altitudes, including the highest points visited. He noted enormous numbers of dead ones that had become chilled and perished from alighting on the snowbanks, so many as to cause a stench when the snow melted. Similar phenomena have been recorded in recent years. Early in August, 1869, he observed from the summit of Mount Lincoln immense numbers of these insects passing over, at a height of several hundred feet. In contrast with this, Chapman (1954) found comparatively few Orthoptera, of wingless types, about the summit of Squaw Peak in western Montana.

While the enormous numbers of short-horned grasshoppers encountered on Mount Lincoln by Brewer did not appear in our collections, these insects formed a prominent constituent of sweep collections at the two higher stations, and some of the same species were minor constituents in the population of the meadows in the valley location. All species determined were those to be expected in this region at such altitudes. Two species were characteristic of the timberline area, juveniles being conspicuous on August 4. *Chorthippus longicornis* was most abundant and was active up to September 1; by September 21 they had become fewer, and by October 6 the few on the surface were torpid. Specimens taken on October 14 were frozen under debris. At Montgomery (Sta. 3) this species was observed to have resumed activity on September 18, after the melting of the first snow. Alexander (1951) took juveniles and adults at timberline on Hoosier Pass and considered the species

as possibly resident above timberline. *Melanoplus oregonensis marshalli* appeared in all timberline sweeps from August 23 to October 6 and was also taken from a similar habitat near Hoosier Pass. It is reported by Alexander as resident of "alpine communities in the Mosquito Range." *Camnula pellucida* also occurred at timberline in limited numbers but was abundant in the valley collections; juveniles appeared about the middle of August. This species also showed renewed activity in sunny spots among vegetation after melting of early snowfall.

None of these species was collected at the tundra station, where the only acridid that was numerous was *Aeropedellus clavatus*, also taken from a tundra habitat near Hoosier Pass; the nymphs were abundant but mostly inactive on August 4. From that date onwards until September 22, the date of the last tundra collection, the species was a constituent of every population and made up the major portion of the last three collections. Both nymphs and adults retired under vegetation and remained inactive during the frequent intervals of cloudy skies, resuming activity under conditions of bright sunshine and little wind. On September 6 the animals were torpid, few appearing on the vegetation and showing the most activity on the sun-warmed areas of rock and gravel; by September 22 they had become active again and were fairly numerous on sunny sheltered slopes, even within a few inches of the snowdrifts surviving from the recent storm. Alexander took this alpine species at 11,400 ft. altitude on Niwot Ridge near the University of Colorado Science Lodge, and reports it on Sierra Blanca, 12,800 to 13,000 ft. He states that this species has the widest altitudinal range of any of the alpine acridids, 5,500 to 13,000 ft.

Hemiptera

Two leaf bugs, *Labops hesperius* and *Plagiognathus (laricicola?)*, made considerable contributions to population totals at timberline, but were not taken elsewhere. The lygaeid bug *Geocoris decoratus solutus* first appeared on the tundra July 26 and continued in increasing numbers until the end of August, being especially characteristic of the ground society although also swept from vegetation. Even to the end of the collecting it appeared in gradually smaller numbers until October 5, still active on bare, sun-warmed ground between clumps of plants. The species also appeared at timberline in very considerable numbers from July 27 to October 14, when some individuals running on the ground appeared to be copulating. Another lygaeid characteristic of the

two upper stations, with tundra records from August 11 (nymphs) to September 6, was *Nysius ericae*. The only other hemipteran at all conspicuous was the coreid *Alydus scutellatus,* which appeared only below timberline from August 23 to October 6 and never in large numbers. This may be an arctic-alpine form northerly, as it has been reported in the Rocky Mountains from 8,000 ft. up to timberline (Fracker, 1918), and our records carry it even higher.

HOMOPTERA

The members of this order that were conspicuous were cicadellids and aphids, especially the former. Psyllids were rarely taken, although *Aphalara loca* was taken at Sta. 2. Of the leafhoppers, the one most abundant at timberline was *Deltocephalus dorsti*; this species appeared first in the sweepings of August 23, when it made the major contribution to the high population of that date, and it was the prevalent form in the greatly reduced population of that station September 1. A week later it was still numerous, although actual dominance in numbers had been assumed by the orthopterans. Thereafter it did not appear, nor was it ever collected at the tundra station. Deltocephaline nymphs first appeared at the timberline station on August 10, reached a maximum about August 24, and then declined, a single specimen being taken on October 6.

On the tundra the prevalent leafhopper was definitely *Macrosteles fascifrons,* appearing first and in maximum numbers on July 26, when it contributed to the high population count of that date. Thence it declined in numbers rather regularly until September 13, when the last specimen was collected. *Hebecephalus occidentalis* was also prevalent on the tundra but less so than *Macrosteles fascifrons.* The only aphid taken in great numbers was *Aphis pseudovalerianae,* collected at Montgomery as a portion of an ant-aphis complexus swarming on fruit-bearing stalks of *Valeriana edulis,* the formicid components being referable to *Formica montana. A. neilliae* was also collected in the valley habitat, and *A. fabae* and several other plant-lice appeared in the timberline and tundra collections but none in significant numbers.

COLEOPTERA

Brewer found this order sparse, especially in phytophagous species, in comparison with his findings in the high Sierras of California. In the present study beetles did not make very large numerical contributions to the populations, but some species were

rather constant components. On dead, wind-broken trees at timberline there was much old scolytid work, but the insects themselves were not collected. Carabid beetles were particularly characteristic of the tundra habitat. Of these the most abundant was *Amara* (*Cyrtonotus*) *brunnipennis*, common running on the surface and under rocks and debris; it appeared from July 26 to September 6. Less common, but more noticeable from its activity late in the season, was *Amara* (*Celia*) sp., collected October 5 on the tundra and a few on the surface at timberline the day following. Another species found at both the upper stations was *Carabus taedatus patullicollis*, more frequently taken in the tundra collecting but sometimes below timberline and always hiding under debris. *Harpalus seclusus* occurred in some numbers under stones at a tundra area near Hoosier Pass. The carrion beetle *Thanatophilus coloradensis* was taken only at the tundra station but occurs at lower altitudes; numerous individuals were found working on the carcasses of small mammals not promptly removed from traps. Brewer recorded this also. Females of the melyrid beetle *Collops* (*hirtellus*?) were abundant and characteristic of the tundra habitat from the middle of July until the end of August; they were usually found running on the surface but were sometimes taken in sweeping. A larva, probably of this form, was collected under rocks on July 26; the species did not appear at timberline. The tumbling flower beetle *Anaspis seriacea* made a considerable contribution to the tundra population of August 18, but did not otherwise appear.

Lepidoptera

Brewer considered the lepidopteran fauna of the alpine Rocky Mountains to be much richer in species and individuals than that of the High Sierras. The insects ranged up to the highest points but especially on sunny slopes at 12,000 to 13,000 ft. Thus he found only very few butterflies about the actual summit of Mount Lincoln even on a sunny day in early August, while they were most numerous on the tundra below the rocky summits but above timberline. The lepidopteran material collected in the present study was limited both in quantity and quality by the difficulties of preparation under extremely unfavorable conditions and of transportation on pack animals over rough mountain trails. Some of the records are field determinations, checked with reports from similar Colorado areas but not based on identifications of well-mounted specimens.

The butterfly *Parnassius smintheus sayii,* listed by Holland (1931) as mountain-dwelling in Colorado, was not abundant; it was taken rather late in the season (September 6) from the tundra habitat. Pierids were more common; the western white butterfly *Pieris occidentalis* occurred at timberline from August 10 on, being last noted on October 6. It was less abundant there than at the tundra station, where it was the conspicuous butterfly from July 26 until September 22, being most common in flight during the first two weeks of August; by the early part of September it appeared in fewer numbers and none in flight except during brief sunny intervals. There were a few in the sun on September 13; after September 22 even stragglers disappeared. Keyser (1902), writing of this species on Gray's Peak, noted a "number of individuals . . . zig-zagging over the summit, and occasionally settling on the rocks right by the fields of snow." A few sulphur butterflies (*Colias*) appeared in September, the last seen in flight being on October 6. Satyrs were represented by the mountain butterfly *Oneis,* appearing in August at both stations but more characteristic of the higher; it is an arctic-alpine form. The most conspicuous nymphalid was the painted lady *Vanessa cardui,* appearing in flight on August 11 at both stations but more numerous at timberline and below; the last appearance was on September 13, accompanying warm sunlight. This species was also observed by Keyser on Gray's Peak. After the western whites, the most conspicuous tundra butterfly was the blue *Plebejus aquilo rustica* which occurred also at the lower station but in lesser numbers. It appeared first in the Platte valley on July 27 and not until later (ca. August 23–24) at the upper stations. At timberline it seemed to be rather characteristic of the mountain parks, being taken in flight until the middle of September. Thenceforward the numbers decreased, except for brief renewals during sunny periods, until September 23 when the last few torpid individuals appeared. But it was at the tundra station that the species was most conspicuous. From the date of its first appearance until the last week in September and from the upper border of timberline up to the tundra station itself, this butterfly was a constant constituent of the insect population; individuals were in flight during periods of bright sunshine and little wind but otherwise rested inactive, like many other alpine winged forms. The last specimen (September 23) was very torpid; when disturbed it flew only a few feet and immediately settled into shelter of vegetation. *P. saepiolus* appeared only in the valley collections of streamside meadow animals, where it was abundant

and characteristic. Arctiid moths were represented by *Halisidota* and phalaenid moths by *Euxoa rufula*, both from the lower stations only; the latter was active in flight as late as September 1.

For the reasons given above, very few microlepidopteran records were obtained. On October 6 unidentified members of the group were observed in flight among the already leafless aspens at Sta. 3. At this station the pyralid moth *Crambus lamellus* and the olethreutid moth *Epinotia* were taken, the latter numerous under favorable conditions until September 7.

Geometrids, tortricids and sphingids, collected in the vicinity of Sta. 1 proved unidentifiable.

DIPTERA

Chapman (1954), in his study of insects frequenting Squaw Peak (7,996 ft. alt. but much farther north), particularly emphasizes Diptera in dealing with frequency, numbers and activity of insects on the actual summit as compared with those of similar areas lower down. Apparently actual tundra areas were limited or absent, and timberline or scattered conifers extended up to the slide rock on the slopes below the summit. His results (except for taxonomic differences) would therefore appear to be comparable with timberline on Mount Lincoln rather than the tundra basin which formed the upper station of the present study. The Mount Lincoln dipterans were conspicuous elements in population counts, especially those made early in the study. Some species will be mentioned that, although they were not prevalent numerically, are considered of particular interest as altitude or other distributional records.

The widely distributed Nearctic crane fly *Erioptera* (*Symplecta*) *cana* was taken at the 13,100-ft. level, which probably constitutes an altitude record. A mosquito, *Aedes* (*cataphylla*?), was extremely abundant in biting swarms from July 7 through August 10; numbers and activity then decreased until August 23, after which it did not appear. Contrary to expectation the greatest numbers were at timberline and below, but during the height of activity these mosquitoes were in considerable numbers at tundra areas in Cameron Amphitheater and near Hoosier Pass. March flies, *Bibio monstri*, made significant contributions to the tundra populations of August 11 and 30, and were always present from July 26 until the latter date. The species was not taken at timberline, where *Bibiodes aestiva* appeared in smaller numbers about the middle of August. Brewer (1871) found biting flies particularly

abundant at 8,000 to 12,000 ft., at times driving his mules nearly frantic but disappearing when the sun went behind clouds. Chapman found Tabanidae one of the three characteristic families (the others being Syrphidae and Tachinidae) on the summit of Squaw Peak; they were mostly males. Two horse flies, *Tabanus rhombicus* and *T. sonomensis,* were abundant in flight at the timberline and valley stations from July 27 to August 23. During this period our horses were frequently much annoyed by the assaults of these insects. Dance flies (*Rhamphomyia*) appeared in some numbers at both upper stations, but more constantly on tundra; the dates limiting their appearance were July 26 and August 14. The long-legged fly *Scellus coloradensis* contributed to the tundra population of August 17 and appeared earlier in the timberline area. It has been taken from a number of Colorado locations and was described from a series of specimens collected at Trail Ridge Road, Rocky Mountain National Park, about 12,000 ft. altitude. *Dolichopus groenlandicus,* appearing in the Sta. 2 collections, has been recorded from Tennessee Pass, Colorado, a little above 10,000 ft. altitude.

The syrphid fly *Sphaerophoria nigritarsi,* described by Fluke from specimens taken in Pingree Park, appeared in the Mount Lincoln timberline collections. The heleomyzid flies, *Pseudoleria crassata* and *P. vulgaris,* were taken only occasionally at the tundra stations, but were constant constituents of the timberline populations from July 27 to August 23. The leaf-miner fly *Phytomyza minuscula* was taken during the middle part of August and only at the tundra station; it contributed to the population peak of August 24. The shore fly *Philygria debilis* was a constant constituent of tundra populations from July 26 to August 17, and a few appeared at timberline about the former date. The characteristic timberline ephydrid in the collections was *Lamproscatella sibilans,* appearing from August 10 to as late as September 7. Chloropidflies were conspicuous in most of the collections made at the upper stations between July 27 and August 30: *Meromyza pratorum* and *Mediza oscinina* were collected only at timberline, where the former made predominating contributions to the population peaks of July 27, August 10 and 18. *Oscinella frit* appeared in considerable numbers from both timberline and tundra areas and even as late as October 6 had not entirely vanished from collections made at the former station.

Dodge and Seago (1954) made a careful quantitative study of Sarcophagidae and other muscoid families on exposed summits in

the southern Appalachians. We found few of their numerous species in our study, partly no doubt from the large geographic interval and partly because we collected on alpine tundra rather than the bare—or nearly so—rocky eminences where both they and Chapman did much of their collecting. Our only species of those encountered by the former workers were *Ravinia querula, Calliphora livida, C. vomitoria, Paregle cinerella,* and of course *Musca domestica.* At timberline, *C. vomitoria* and *R. querula* were usually present and sometimes abundant, as was also the case at the valley station where *C. livida* was collected on September 13. Muscid flies of the genus *Hylemya* were prominent at the upper stations, especially *H. angusta* and *H. platura.* Both of these, as well as *H. neomexicana,* contributed to the high dipterous population of August 10 at timberline. The last also made a part of the population count at the tundra station on August 30. *H. angusta* and *H. platura* also appeared on the tundra occasionally, but never in the numbers found at timberline. The earliest date *Hylemya* was collected was July 27, the latest (on tundra) September 13. Other timberline muscids were *Paregle cinerella, Eupogonomyia borealis,* and *Lasiops septentrionalis;* of these only *E. borealis* was ever very abundant. Around the inhabited buildings at Montgomery the house fly *Musca domestica* was extremely numerous, and it occurred also around abandoned cook-shacks of mines at much higher elevations. The stable fly *Stomoxys calcitrans* was also present in the valley but was not collected above.

HYMENOPTERA

Sawflies were represented by larvae of *Nematus,* collected only at timberline. Among ichneumons the only ones at all prominent in the collections were *Hyposoter* and *Phygadeuon,* both of which appeared at timberline and the latter in the valley also. The braconid *Chelonus arculeatus* occurred at timberline but in small numbers. The torymid *Torymus* was taken in considerable numbers at timberline, the last specimen appearing on September 7; it was rare in the tundra collections. By far the most numerous hymenopterans in the collections were ants, mainly of forms to be expected at high elevations. At timberline the ant *Formica neorufibarbis gelida* appeared in various degrees of activity from July 20 to October 14. During most of the study the species was abundant running on the ground and in nests; these last were usually placed under stones and contained many pupae. As the season advanced surface activity lessened; by October 4 it was

reduced to crawling on the moist ground in sheltered places, sometimes within a few feet of residual snow. On October 18 the ants had all retired to nests under rocks and debris. Another *Formica* (*microgyna* group) was collected in winged form among sweepings from the mountain meadows at Montgomery. The only other ant at all numerous, although much less so than the foregoing, was the carpenter ant *Camponotus herculeanus modoc*; it was locally abundant at timberline and below as late as October 6. Various mining, leaf-cutter and other bees were collected, but the only one abundant in the collections was the bumble bee *Bombus fervidus*; it appeared erratically in the timberline collections.

In the interest of preserving a record, however incomplete, of Mount Lincoln invertebrates a list of arthropods collected at the various stations (mainly timberline and alpine tundra) is subjoined. These species were not considered sufficiently numerous or characteristic to be included in the lists of station prevalents. Many genera might have been added to this list, but it has been deemed unwise to extend it beyond forms for which specific determinations were available.

Vertebrates

It is not claimed that the list of vertebrates for Mount Lincoln is complete; it is likely that some forms, not observed in the present study but recorded by Cary (1911), Sclater (1912), Warren (1942), and others for similar habitats in Colorado, may occur in the area. However, the appended list contains all species taken or observed on the mountain. Most of these were birds and mammals; no reptiles were noted and only a few amphibians. "Axolotl" stages of the tiger salamander (*Ambystoma tigrinum*) occurred abundantly in beaver ponds as high as Moose Creek Park; adults were not observed. The species is said by Rodeck (1943) to be found "up to altitudes of 10,500 feet or higher," and has been collected from Estes Park. The mountain toad (*Bufo boreas*) was found among the wet grass of a small marsh at timberline, the highest amphibian record of the study; it also occurs in wet meadows lower down along Quartzville Creek and the South Platte River at Sta. 3. The only other amphibian observed was the three-lined tree frog (*Pseudacris nigrita triseriata*); tadpoles and adults were abundant, the local distribution being the same as that of the tiger salamander. Cockerell (1927) states that it extends "high into the mountains."

BIRDS

The mallard (*Anas platyrhynchos platyrhynchos*) breeds about beaver ponds in Moose Creek Park; Sclater (1912) gives only about 9,000 ft. as the maximum breeding altitude. The green-winged teal (*A. carolinensis*) has been observed in the same locality, where it breeds. This typically northern breeder is said by Keyser (1902) to breed "in mountains and upper parks"; the highest breeding record we have seen (Sclater) is 7,592 ft., but the bird has been recorded in migration at Breckenridge, Colorado (9,530 ft.).

The goshawk (*Accipiter gentilis atricapillus*) is a year round resident, nesting in the Canadian and Hudsonian zones; it is common above timberline in summer, and is the most common winter resident hawk, preying on grouse and snowshoe rabbits. The red-tailed hawk (*Buteo jamaicensis calurus*) is a resident, commonly seen in flight at all stations; an immature bird was noted at Montgomery. Swainson's hawk (*B. swainsoni*), considered a plains species, is included on the basis of a somewhat doubtful "flight" record below timberline; however, Keyser (1902) says "Common resident; breeds everywhere below 11,000 ft." The golden eagle (*Aquila chrysaetos canadensis*), a resident throughout the year, was observed in flight and hunting at all stations. It is also a carrion feeder, driving the ravens from the carcasses of dead sheep. The marsh hawk (*Circus cyaneus hudsonicus*) was more frequently seen hunting over the meadows at Montgomery, females being more usual; it was occasionally noted at higher levels. The prairie falcon (*Falco mexicanus*) was not common but was observed at all stations. The sparrow hawk (*F. sparverius sparverius*) was commonly seen everywhere and breeds at the lower levels.

The blue grouse (*Dendragapus obscurus obscurus*) is now very rare, although Allen (1876b) found it common. It is occasionally seen feeding on grasshoppers above timberline, but most of our records were from timberline downward and included a covey composed of hen and half-grown young. The white-tailed ptarmigan (*Lagopus leucurus altipens*) was observed on several occasions in Cameron Amphitheater. On June 27 the birds were apparently beginning to assume the summer plumage. On September 13 a bird was watched at close range, and the markings could be seen distinctly; the plumage change was well under way, and the general tone was much lighter than in summer. The bird was very inconspicuous against the background of gray and white rocks. Allen (1876a) says that in winter these birds descended to timberline, where in his time many were killed for food by the miners.

At present, during heavy winter storms, they come down as low as Alma, where they feed on willow buds during the day and burrow into snowdrifts at night.

The killdeer (*Charadrius vociferus vociferus*) is common in open places as high as Quartzville, generally near water; it breeds at Montgomery.

The common snipe (*Capella gallinago delicata*) was noted as migratory in the fall at the Montgomery station and even higher up on the Platte. The spotted sandpiper (*Actitis macularia*) is found around beaver ponds in Moose Creek Park and similar places. Allen (1876b) says "Common along the Platte to its source"; he found nest and eggs at Montgomery.

The mourning dove (*Zenaidura macroura marginella*) was observed on Mount Lincoln as high as Quartzville and breeding at the lower stations.

The great horned owl (*Bubo virginianus occidentalis*) was common, frequently heard and sometimes seen at timberline and below. The snowy owl (*Nyctea scandica*) is an occasional winter visitor, recorded from timberline downward.

The nighthawk (*Chordeiles minor henryi*) is common up to and even above timberline, and breeds in the valley area.

The broad-tailed hummingbird (*Selasphorus platycercus platycercus*) was seen far above timberline, hovering about thistle and other blossoms. Coues (1874) cites Allen as finding the species "in Park County, Colorado, where he saw it repeatedly among the flowers growing far above the timber-line of Mount Lincoln." It breeds to timberline, where Allen recorded a pair.

The hairy woodpecker (*Dendrocopus villosus monticola*) was frequent to timberline; it breeds at the lower stations. The northern three-toed woodpecker (*Picoides tridactylus dorsalis*) was observed rarely, but is said by Allen (1876b) to have been "Common up to timber line." Williamson's sapsucker (*Sphyrapicus thyroideus natalis*) was observed at Montgomery and stated by Allen (1872) to have been "Common to forest line." The red-shafted flicker (*Colaptes cafer collaris*) was breeding at Montgomery and around Quartzville, where it was frequently seen in pairs; it also feeds above timberline.

The horned lark (*Eremophila alpestris leucolaema*) was seen commonly on Mount Lincoln, and is said to nest abundantly on slopes above timberline; it winters in South Park. The birds are abundant around Alma during hard spring snows, and many are killed by cold and/or starvation.

The violet-green swallow (*Tachyneta thalassina lepida*) is found nesting in buildings up to timberline and even higher. The tree swallow (*Iridoprocne bicolor*) Allen (1876b) found "Common about Montgomery, and seen far above timber-line." The barn swallow (*Hirundo rustica erythrogaster*) was common at Montgomery, and to mountain tops in fair weather. The cliff swallow (*Petrochelidon pyrrhonota pyrrhonota*) was seen in small numbers by Allen, in company with tree swallows.

Allen observed the abundance of the gray jay (*Perisoreus canadensis capitalis*) in the vicinity of Mount Lincoln. It is a common resident breeder at the lower stations but was only rarely observed above timberline. Steller's jay (*Cyanocitta stelleri macrolopha*) was common at timberline and thence downward, where it breeds. The black-billed magpie (*Pica pica hudsonia*) was common in the lower areas and sometimes seen up to timberline or even above. The common raven (*Corvus corax sinuatus*) was occasional at all levels, but more often lower down; an unusually large flock of a dozen or more was noted near Montgomery on September 30. Clark's nutcracker (*Nucifraga columbiana*) is a common resident of the forested stations. The piñon jay (*Gymnorhinus cyanocephala*) is seen in occasional flocks as high as Mineral Park on Mount Bross, feeding on limber pine; it probably makes similar visits to adjacent Lincoln.

The black-capped chickadee (*Parus atricapillus septentrionalis*) is common up to the forest margin. The mountain chickadee (*P. gambeli gambeli*) is common and breeds at the lower stations; Allen collected fully grown young July 23.

The same worker recorded a single individual of the white-breasted nuthatch (*Sitta carolinensis nelsoni*); Sclater (1912) says it is found almost to timberline in summer. The red-breasted nuthatch (*S. canadensis*) is common in the evergreen forests up to timberline.

The American dipper (*Cinclus mexicanus unicolor*) was common and breeding at Montgomery; Coues (1874) cites Allen: "We met it . . . in the mountains up to the remotest sources of the South Platte, within a few hundred feet of timberline."

Several pairs of rock wrens (*Salpinctes obsoletus obsoletus*) were recorded by Allen (1876b) among rocks near timberline, and also above.

The brown thrasher (*Toxostoma rufum longicauda*) is rare, but occasionally seen in the upper forest.

The robin (*Turdus migratorius propinquus*) was common at

the two lower levels, where it breeds, and frequently observed far above. Allen found nest and newly-hatched young at timberline. The birds were seen last on September 18 at Montgomery. The hermit thrush (*Hylocichla guttata auduboni*) is stated by the earlier workers to have been common from Montgomery to timberline. The mountain bluebird (*Sialia currucoides*) was very common at the two lower stations; it nests to timberline and perhaps higher, sometimes in old buildings. Allen found the newly-hatched young at timberline, and they were observed in the present study at even higher levels. Flocks were often seen on the tundra in the late summer. The birds were flocking for migration by September 20 at Montgomery and disappeared soon after. Townsend's solitaire (*Myadestes townsendi townsendi*) was observed up to timberline.

The ruby-crowned kinglet (*Regulus calendula cineraceus*) was common up to timberline; female and new-fledged young were found by Allen.

The water pipit (*Anthus spinoletta alticola*) is a summer resident not met with except above timberline on the tundra, where it is an abundant and characteristic breeder. Coues (1874) says: "Although Mr. Allen did not actually find the nest, there is no question of his having determined that the bird breeds in the mountains of Colorado, for he found young scarcely able to fly, July 20, 1871, on Mount Lincoln, Park County, Colorado, among the snow-fields above timberline." In the present study a nest was seen, as well as the bird itself, on the upper waters of Quartzville Creek at about 12,500 ft. elevation. The nest and eggs, observed on June 27, agreed with the account of Audubon as cited by Coues. Babcock and Ashton (1930) list the bird as nesting up to 12,000 ft. The latest date pipits were observed was September 22.

The Bohemian waxwing (*Bombycilla garrula pallidiceps*) was observed rarely in large flocks at the forest stations.

The yellow warbler (*Dendroica petechia aestiva*) was a fairly common bird along streams up to timberline; it is a continuous summer resident and probably breeds. Audubon's warbler (*D. auduboni memorabilis*) was the most abundant warbler, breeding up to the limit of trees. It was seen around thistle heads on Mount Lincoln, probably seeking the insects which infest these blooms as well as the seeds themselves. The birds have been observed around Alma during the months of July, August, and September, eating the half-ripened seeds of the dandelion, pulling out the seed, clipping off the parachute and swallowing the fruit. Although

these birds are mainly insect-eaters, Beal (1907) found 9% of their food to have been weed seeds. As early as the first week in August of some years, flocks of several hundred have been observed around Alma preparing for migration; stragglers remain until the first snowfall. Townsend's warbler (*D. townsendi*) is a summer resident at the lower stations. MacGillivray's warbler (*Oporornis tolmiei monticola*) was common but inconspicuous; it was observed feeding about the timberline station and lower down, where it probably breeds. Wilson's warbler (*Wilsonia pusilla pileolata*) was most common in willow thickets, breeding from timberline downward. Coues (1874) cites Allen:

> the black-capped warbler (*Wilsonia pusilla*) is a common inhabitant of the subalpine and alpine districts of the Colorado Mountains, breeding from about 8,000 feet up to about timberline. In the dwarfed willows and other low shrubs that grow for some distance above the limit of trees, we found it by far the most numerous of all the insectivorous birds. It is here more plentiful even than at lower points, and hence may be regarded as an eminently alpine species. Although evidently breeding, we failed to discover its nests. It manifests great anxiety when its chosen haunts are invaded, and during our excursions at the above-described locality, we were almost constantly scolded by one or more pairs of these birds.

The American redstart (*Setophaga ruticilla tricolora*) was conspicuous but less common than the yellow warbler. Sclater (1912) calls it "hardly common." It was not seen above the Platte valley; Coues (1874) says: "In the mountains he (Allen) did not observe it above 8,000 ft."

The western meadowlark (*Sturnella neglecta neglecta*) occurs in mountain meadows on the lower slopes of Lincoln at least as high as Moose Creek Park, breeding at Montgomery and probably much higher. Brewer's blackbird (*Euphagus cyanocephalus*) is said by Allen (1876b) to have been "Common at Montgomery, and ranges to the tops of the mountains." The brown-headed cowbird (*Molothrus ater*) was seen around cattle in the upper South Platte valley; an egg was found in the nest of a Wilson's warbler near Quartzville. It no doubt breeds up to the level of Montgomery, and sometimes higher.

The evening grosbeak (*Hesperiphona vespertina brooksi*) was observed on Mount Lincoln but was not common; it was usually associated with flocks of pine grosbeaks, and was sometimes seen feeding on the cooks' dumps around mines above timberline. Allen found Cassin's purple finch (*Carpodacus cassinii*) common around Montgomery. The pine grosbeak (*Pinicola enucleator montana*) was very common in the timber on Mount Lincoln,

usually in small flocks. The red crossbill (*Loxia curvirostra stricklandi*) was also observed there. Until the end of the study, brown-capped rosy finches (*Leucosticte australis*) were the most abundant and characteristic tundra birds; they were often seen feeding, sometimes on seeds blown by the strong winds and lodged in remaining snowbanks. They nest on Mount Lincoln where Allen (Coues, 1874) "found it, in summer, 'common above the timberline . . . breeding among the snow-fields.' " They are often seen in pairs during the early part of the season. By late August the young were out of the nest, and birds in immature plumage were seen in flocks, now apparently collecting for downward movement. The birds are year-round residents of the region but practice local and vertical migration, large flocks coming down in winter to Alma and similar elevations to feed on bare ground. In severe weather telephone and light wire in Alma are loaded with them in hundreds, where they have been photographed and where the writers saw flocks of them in June during cold weather with light flurries of snow. A few were observed at the tundra station as late as October 5. The common redpoll (*Acanthis flammea rostrata*) is an occasional later fall and winter visitor. Allen (1876b) found the pine siskin (*Spinus pinus pinus*) "Common up to the limit of trees"; it breeds everywhere in the timber. He reports the savannah sparrow (*Passerculus sandwichensis nevadensis*) "Common in the valley of the Platte, and also numerous on the mountains above timber line." The vesper sparrow (*Pooecetes gramineus confinis*) he calls "Common, ranging considerably above timberline." The Oregon junco (*Junco oreganus mearnsi*) has been reported in migration. The gray-headed junco (*J. caniceps caniceps*) was found numerous in flocks at the lower stations, where it breeds; Allen saw it "ranging considerably above timber line." He reports the chipping sparrow (*Spizella passerina arizonae*) "frequent about Montgomery" and "more or less common up to the forest line." The white-crowned sparrow (*Zonotrichia leucophrys*) was common and breeding at all levels but more frequent lower down. Nesting appeared to have been completed by the middle of August, and a month later the flocks were banding for migration, feeding and seeking shelter in willow thickets during inclement weather. The last record was September 29, at the valley station. Allen says "Exceedingly numerous, even at a considerable distance above timberline." Lincoln's sparrow (*Melospiza lincolni alticola*) was a very common summer resident at all stations; it breeds up to timberline and was often noted far above on the tundra, usually in small flocks

either of young birds or, later in the season, bands for migration. The last record was September 13. Allen (cited by Coues, 1874) says

> an abundant summer resident in the mountains of Colorado, from about 8,000 feet to above the limit of trees. It is found chiefly in the vicinity of wooded streams and in moist or swampy thickets, being essentially a woodland bird. Its song is rather feeble, but pleasant and varied and generally uttered for a considerable period from some elevated point of the thicket. It is one of the few species that are as abundant at the timber-line as at lower points.

MAMMALS

The vagrant shrew (*Sorex vagrans obscurus*), widely spread in the western mountains, was taken at Alma and occurs much higher. It has been reported from Long's Peak (Warren, 1942).

The silver-haired bat (*Lasionycteris noctivagans*) was observed at twilight, in flight around Montgomery.

The Colorado pika (*Ochotona princeps saxatilis*) was seen and heard, always in slide-rock, at all levels on the trail above timberline, in the vicinity of Cameron Amphitheater and higher up; it was the abundant and characteristic mammal. The animals themselves, their droppings, and old "hay-piles" were observed on all visits to this station. Being noisy and tame, their behavior could often be watched at close range. New "hay-piles," made from alpine plants, began to appear early in August and from then on were conspicuous. The animals were still active as usual on October 26. Pikas were not, however, confined to the alpine rocky areas; they were common in rock piles around the old placers at Alma.

Nuttall's cottontail (*Sylvilagus nuttalli pinetis*) occurs up to timberline. The Rocky Mountain snowshoe rabbit (*Lepus americanus bairdi*) is common to the upper limit of trees and occasionally found above. The white-tailed jack rabbit (*L. townsendii campanius*) was more commonly observed above (and often far above) timberline on the open tundra; when found below timberline, the animals were in the open "parks." Individuals seen seemed very large, agreeing with local reports on the size of those killed. Warren reports "An extraordinarily large animal of this species was taken near Alma, Park County, in the winter of 1930."

The park marmot (*Marmota flaviventris luteola*) was occasionally encountered below timberline in the "park" openings, but was constant around the tundra station, damaging shelters and instruments. The animals were last seen September 13. The least Colorado chipmunk (*Eutamias minimus operarius*) was the most

conspicuous mammal in numbers and activity at the lower stations and was frequent at all elevations above timberline. Early severe storms of snow and cold in late September and October drove them to cover but they reappeared immediately after and sometimes during such weather. The last record was for October 28 at Quartzville. Anthony (1928) says "in Colorado, chiefly west of the Continental Divide from foothills to timberline." Richardson's ground squirrel (*Citellus richardsonii elegans*) was constantly found from timberline downwards, especially in open "parks." None were observed above timberline and none after the middle of September, when they apparently went into hibernation. The species is a comparatively recent invader, appearing in the vicinity of Alma about 1930. Warren (1942) says "It must have passed . . . Hoosier Pass, 11,460 feet, from Summit to Park County. . . . In Park County this ground squirrel is fairly common between Alma and Fairplay, and above Alma to the approach to Hoosier Pass." The golden-mantled ground squirrel (*C. lateralis lateralis*) was always found at timberline and below and was common at the lower stations. It was still active after the first snowfall. Gunnison's prairie dog (*Cynomys gunnisoni gunnisoni*) was observed at Montgomery as early as 1914, and apparently had always been there; it penetrated as high as Moose Creek Park and even Quartzville. The species was either exterminated or nearly exterminated by poison about 1945. The red squirrel or Fremont's chickaree (*Tamiasciurus hudsonicus fremontii*) was common and characteristic from timberline downwards throughout the study. Food storage of mushrooms and especially spruce cones in preparation for cold weather was first noted on August 24 and became constant after September 12. Large "kitchen-middens" of cone scales were found in the timber.

The mountain pocket gopher (*Thomomys talpoides fossor*) was common at all stations, where its fresh diggings were constantly seen. Fresh gopher work was found on September 12 at timberline, and old earth cylinders indicated that work continued all winter under the snow.

The Colorado beaver (*Castor canadensis concisor*) lived and bred at Sta. 3 and lower down along the Platte.

The tawny deer mouse (*Peromyscus maniculatus rufinus*), including specimens of various ages, was taken at all levels. It was still active after the late September snows, as shown by abundant tracks. The same applies to the Colorado bushy-tailed wood rat (*Neotoma cinerea orolestes*) whose "sign" and nests were found in rock clefts and around abandoned mining cabins, as described

by Warren for the vicinity of Alma. The mountain vole (*Microtus montanus fusus*) appeared at the two lower stations; the runways just under the snow appeared everywhere when melting occurred. The long-tailed vole (*M. longicaudus mordax*) lives up to timberline where its grass tunnels and holes were found in early September among the tall grasses, still green, along the edge of an intermittent brook. The Rocky Mountain muskrat (*Ondatra zibethicus osoyoosensis*) occupied suitable habitats as high as Moose Creek Park.

The house mouse (*Mus musculus domesticus*) has penetrated to the highest cook shacks on Lincoln, far above timberline.

The yellow-haired porcupine (*Erethizon dorsatum epixanthum*) ranged everywhere in the timber and sometimes above it.

The robber coyote (*Canis latrans lestes*) occurs at all levels; it was seen at Montgomery and its tracks and droppings appeared far above timberline. The animals were often heard from the camp below timberline at Quartzville. The gray wolf (*C. lupus youngi*) is reported as occurring formerly on Mount Lincoln and vicinity. The western red fox (*Vulpes fulva macroura*) is said to be numerous on the slopes of Mount Lincoln well above timberline and of course at lower levels as well.

The black bear (*Euarctos americanus subsp.*) has been occasionally observed at the lower stations. The grizzly bear (*Ursus horribilis bairdi*) was a former inhabitant. The type specimen (Hall and Kelson, 1959) was taken on the Blue River in Summit County, only a few miles away. Brewer (1871) considered it "quite common" in 1869, although he did not specify its occurrence on Mount Lincoln.

The Rocky Mountain marten (*Martes americana origines*) is found at all levels up to timberline and even above it. It was taken at Montgomery and seen on the headwaters of the Blue River just across the Divide. It is reported common and tame, scavenging around the miners' cabins. The ermine (*Mustela erminea muricus*) is very common up to and above timberline. Also common, although less so than the last, is the long-tailed weasel (*M. frenata nevadensis*), observed hunting among slide rock slopes. The black-footed ferret (*M. nigripes*) has been occasionally trapped at the lower station in the vicinity of Montgomery. The western mink (*M. vison energumenos*) is common on the upper South Platte River and its tributaries. The badger (*Taxidea taxus taxus*) is reported from all levels; diggings made in hunting ground squirrels were seen just below timberline in the open "parks." The striped

skunk (*Mephitis mephitis varians*) was observed from the valley nearly up to timberline.

The mountain lion (*Felis concolor hippolestes*) is occasional at all levels but of course is not common. The mountain bobcat (*Lynx rufus pallescens*) is found in the timber at higher elevations but not commonly observed above timberline; one young specimen was practically block-spotted on white, with little or no rufous tinge.

Local reports say that wapiti (*Cervus canadensis nelsoni*) are occasionally seen high up on the slopes of Mount Lincoln well above timberline and, of course, lower down. The black-tailed (mule) deer (*Odocoileus hemionus hemionus*) was often met at the lower stations, and the bucks are reported as occasionally seen on the upper slopes above timberline. Fresh tracks were abundant in the timber, and the animals themselves, usually does and young bucks, were frequently encountered during the study.

Bison (*Bison bison bison*) formerly ranged above timberline on Mount Lincoln, their skulls and horns having been frequently picked up. The presence of old bulls, perhaps herd outcasts, on the mountains above the limit of trees was noted by early observers (Ruxton, 1847). Brewer (1871) considered the animals exterminated for South Park and the adjoining mountains by 1869; he found skulls up to 11,000 ft., both in "parks" and forest. However, a few survived until 1897 in Lost Park (Warren, 1942). A few mountain sheep (*Ovis canadensis canadensis*) are seen on Mount Lincoln almost every year; they are reported, as might be expected, to occur high up on the rocky slopes, far above timberline. They are probably strays from the bunch in the Tarryall Mountains.

Summary

Four months, from June 27 to October 29, 1945, were spent in an ecological reconnaissance of Mount Lincoln (14,276 ft. alt.) in Park County, Colorado. Collections and meteorological records were made from three stations: timberline (11,200 ft.), alpine tundra (13,100 ft.) and river valley (10,700 ft.); the greater part of the work was concentrated on the two upper areas.

As might be expected, wind velocities at the tundra station, both maximum and minimum, were approximately three times as great as at timberline. Evaporation differences were less marked, probably because of the fact that at the time when weekly maxima and minima were registered for the timberline station corresponding readings were not available from the tundra. For comparable dates the 24-hour mean temperatures were 49° F. at the timberline station and 45° F. on the tundra, with an absolute maximum of 75° F. and an absolute minimum of 22° F. for the former and 66° F. and 23° F. for the latter, respectively. Some records made later with maximum and minimum thermometers, after weather conditions had rendered the recording instruments inoperative, were of course much lower. Soil temperatures with a recording instrument were taken only on the tundra, at a depth of 10 cm., with a 24-hour mean of 41° F., an absolute maximum of 59° F., and an absolute minimum of 24° F. Soil temperatures at timberline, based on individual readings of various depth, insolation, and vegetational cover, gave a mean of 53° F.; the highest temperature recorded was 66° F., the lowest 40° F. Relative humidity for corresponding periods was 63% 24-hour mean, 98% absolute maximum, and 10% absolute minimum for timberline, and 62%, 97%, and 24%, respectively, for tundra. Saturation deficit was, for comparable periods, 0.143 24-hour mean, 0.224 day mean, and 0.077 night mean at timberline, and 0.117, 0.157 and 0.081, respectively, on the tundra.

Two hundred and nineteen genera and species of invertebrates were identified, of which seventy-three were accorded "prevalent" status on the basis of numbers and constancy of occurrence. Of these, the timberline station contributed about 47% in contrast with the tundra's 27%; the more varied local conditions and

habitats and the less stressful climatic factors might be expected to effect this difference. The 26% of "prevalents" recorded for the river valley is certainly not comparable with the corresponding percentages from the other two areas. As has been stated, the amount of collecting done here was distinctly limited; had it been possible to work the valley with the frequency and completeness that were employed at the upper stations, it seems likely that not only would the total number of "prevalents" have been greatly increased but the population percentage from this station would have exceeded that from the tundra and probably also that from the timberline.

The vertebrates recorded from Mount Lincoln by collecting, observations, and published reports totalled 114 species, mostly birds and mammals, seventy-two of the former and thirty-nine of the latter. Only three amphibians were noted and no reptiles. The vertebrate inhabitants, longer and better known, were those that might have been expected. Of interest is the occurrence on open tundra at high altitudes of species whose centers of distribution are on the plains at lower elevations.

Based on the quasi-quantitative methods of collection employed, some conclusions may be drawn as to the seasonal societies of invertebrates, both as regards numbers and constituents; timberline counts always exceeded tundra counts, save at the end of the study. The general population trend downward from July to October was interrupted by some temporary increases; the most conspicuous of these (August 23, 24), affecting both upper stations but most marked at timberline, appeared to be the result less of environmental changes than of the sudden appearance of certain insect groups in vast numbers. In general, dipterans were the most important constituents during the early part of the study, cicadellids during the middle portion, and orthopterans towards the end.

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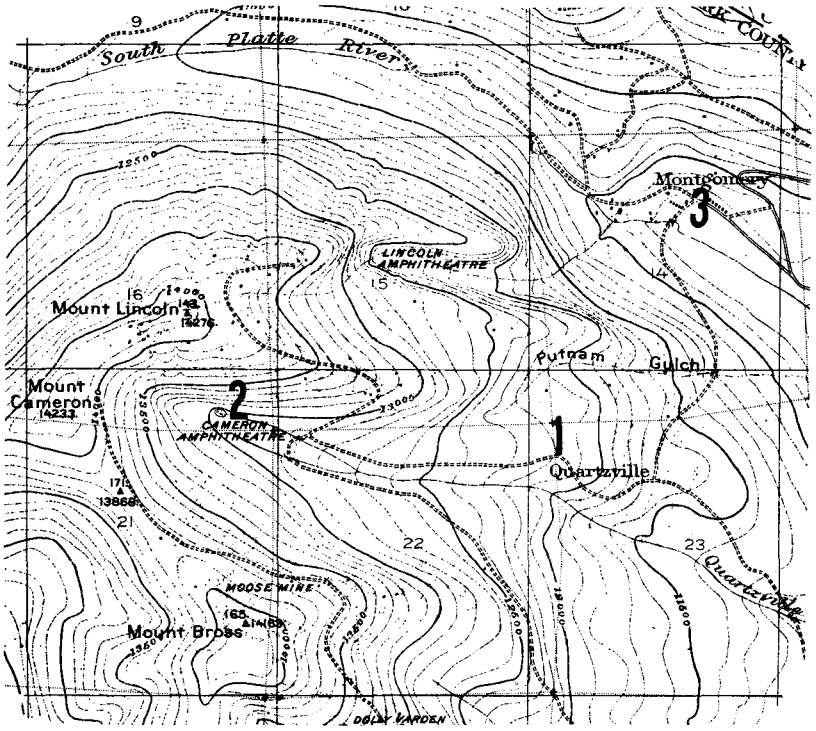

FIG. 1. Map of Mount Lincoln region, showing principal collection areas. (After Patton, Hoskin and Butler.)

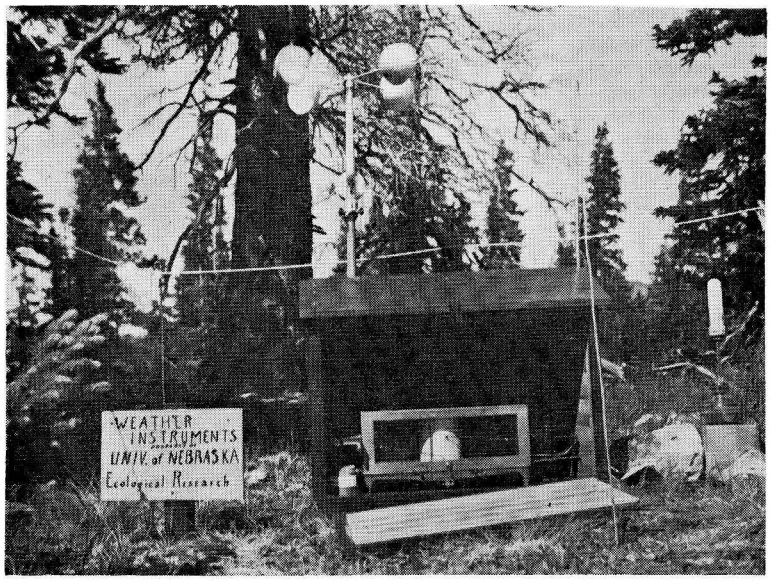

FIG. 2. Station 1 (timberline), 12,200 ft. altitude.

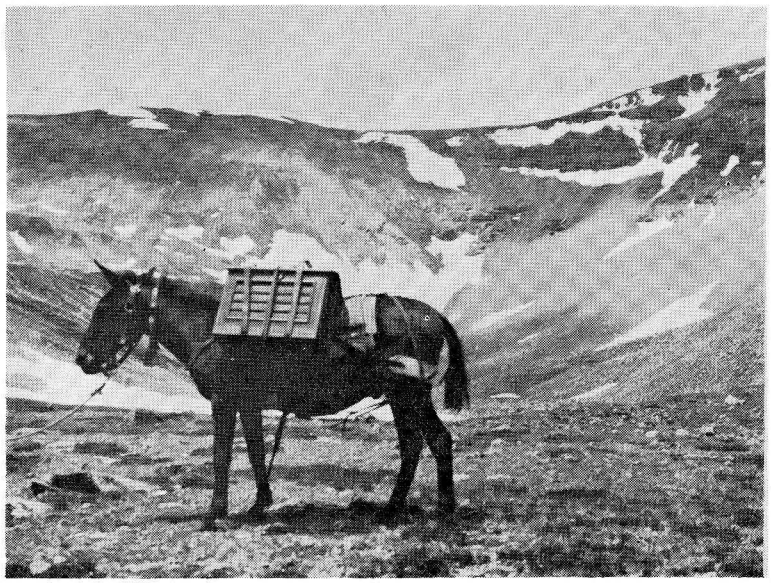

FIG. 3. Station 2 (alpine tundra), 13,100 ft. altitude.

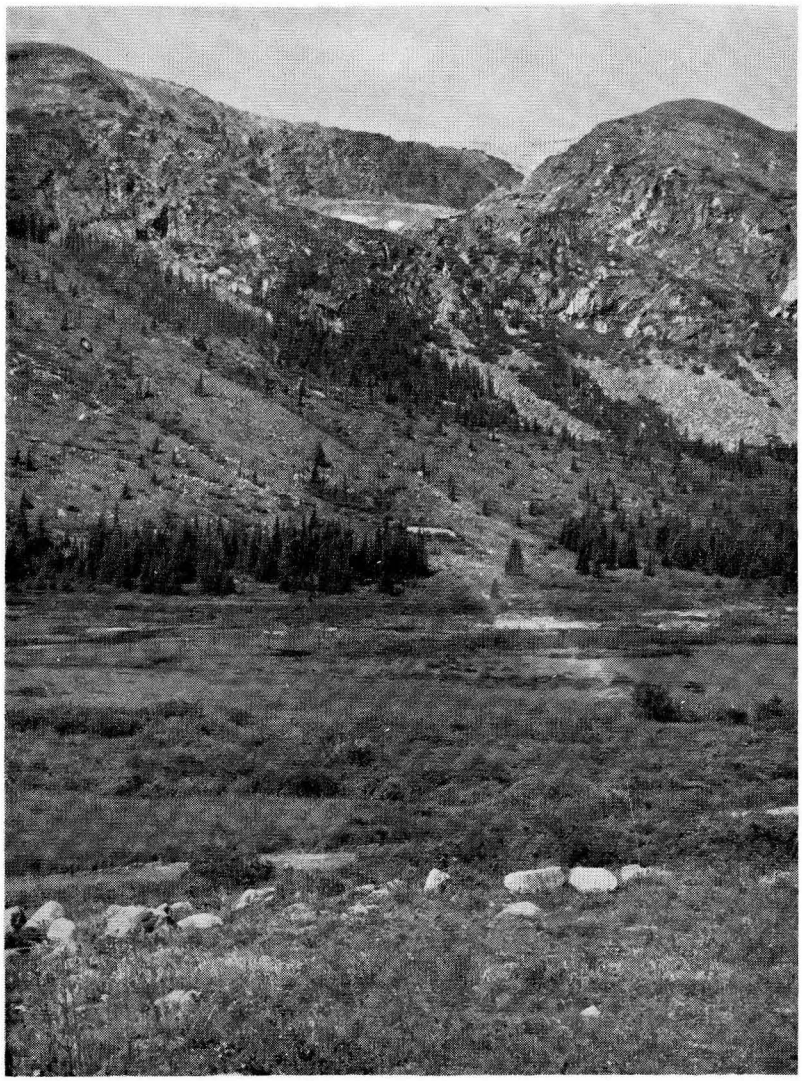

FIG. 4. Station 3 (river valley), 10,700 ft. altitude.

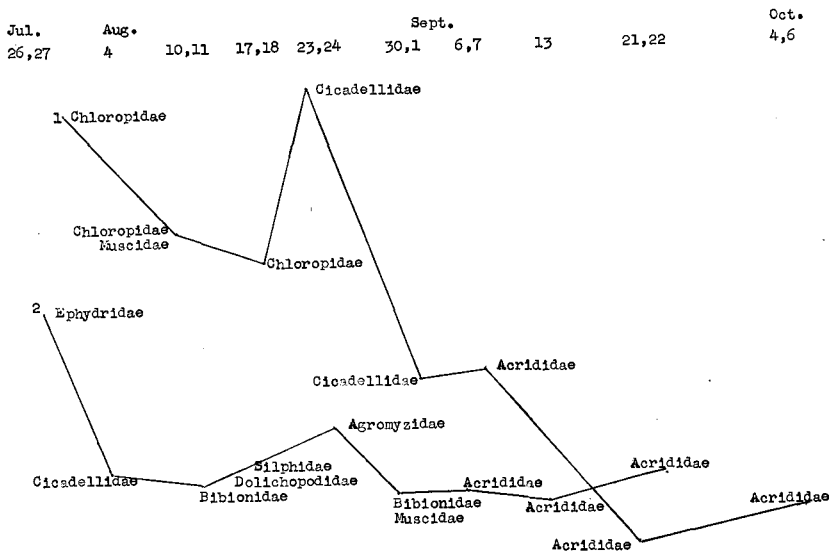

FIG. 5. Seasonal populations, with prevalents by families, for Stations 1 and 2. Consideration of genera and species involved is given in text.

TABLE 1

WIND VELOCITY DATA

Station 1, 11,200 ft.		Station 2, 13,100 ft.		
Dates	M.p.h.	Dates		M.p.h.
Aug. 5–10	3.5	Aug. 4–11		8.7
Aug. 10–16	2.7	Aug. 11–17		8.8
Aug. 16–18	2.2			
Aug. 18–23	3.8	Aug. 17–24		7.9
Aug. 23–25	2.7	Aug. 24–30		7.9
Aug. 25–30	2.8	Aug. 30–31		13.3
Aug. 30–Sept. 5	3.0	Aug. 31–Sept. 6		11.5
Sept. 5–7	2.4			
Sept. 7–12	4.9	Sept. 6–13	*(8.7)	14.9
Sept. 12–14	3.5			
Sept. 14–21	5.2	Sept. 13–22	*(6.2)	15.5
Sept. 21–23	3.7			
Sept. 23–Oct. 4	3.5	Sept. 22–Oct. 5	*(5.5)	13.0
Oct. 4–6	2.5			
Oct. 6–14	2.7			
Oct. 14–28	5.3			

*Direct readings.

TABLE 2

ATMOMETRY DATA

(Measured by cylindrical cups unless spheres are specified)

Station 1				Station 2			
Reading date	Sphere	C.c. per day	C.c. for week	Reading date	Sphere	C.c. per day	C.c. for week
July 27		13.0	91				
Aug. 3		15.8	112				
Aug. 10		10.8	79				
Aug. 16		28.8	202				
				Aug. 17	White	27.3	191
				Aug. 17	Black	48.2	333
Aug. 23		19.0	133				
				Aug. 24	White	24.2	169
				Aug. 24	Black	43.2	302
Aug. 30		18.0	126	Aug. 30	White	23.5	165
				Aug. 30	Black	33.6	235
				Aug. 31		*36.7	
Sept. 1		*24.0					
				Sept. 6		30.7	215
Sept. 7		26.4	185				
Sept. 7	White	28.8	202				
Sept. 7	Black	40.5	284				
Sept. 8		*9.0					
Sept. 12		*40.3					
Sept. 12	White	*42.2					
Sept. 12	Black	*61.4					
				Sept. 13		18.1	127
Sept. 23		*30.2					

*Five days or less.

TABLE 3

AIR TEMPERATURE DATA, STATION 1

(Degrees Fahrenheit)

Week	24-hr. Mean	Day Mean	Night Mean	Mean Max.	Abs. Max.	Mean Min.	Abs. Min.	Max. Range	Min. Range
July 20–27	51	59	42	69	75	39	33	42	22
July 27–Aug. 3*	51	59	43	70	75	39	35	38	21
Aug. 3–10	48	54	41	62	69	38	33	29	17
Aug. 10–17	49	58	40	67	71	37	33	38	23
Aug. 17–24	51	59	42	69	74	39	36	37	18
Aug. 24–31	48	55	40	64	69	38	33	31	20
Aug. 31–Sept. 7	52	61	42	71	73	39	35	40	26
Sept. 7–14	45	54	36	63	72	32	22	38	22
Sept. 14–21	39	46	31	56	65	28	21	37	5
Sept. 21–28	38	48	28	56	60	25	20	40	3
Sept. 28–Oct. 5	28	32	24	39	53	21	18	33	4
Oct. 5–12	42	49	32	61	67	29	26	37	24
Oct. 12–19	35	42	27	51	62	25	21	34	9
Oct. 19–23	26	31	21	40	56	17	9	43	11
July 20–Sept. 14	49	57	41	67	75	38	22	42	17
Sept. 14–Oct. 23	35	41	27	51	67	21	9	43	4
Period of study	43	50	35	60	75	32	9	43	4

*Six days or less.

TABLE 4

AIR TEMPERATURE DATA, STATION 2

(Degrees Fahrenheit)

Week	24-hr. Mean	Day Mean	Night Mean	Mean Max.	Abs. Max.	Mean Min.	Abs. Min.	Max. Range	Min. Range
July 19–26	49	54	44	65	66	42	40	25	19
July 26–Aug. 2	48	52	43	61	65	39	34	31	18
Aug. 2–9	43	47	39	55	60	38	36	19	13
Aug. 9–16	43	48	38	56	62	37	34	23	14
Aug. 16–23	45	50	39	58	63	36	34	27	15
Aug. 23–30	42	46	38	54	62	36	35	27	14
Aug. 30–Sept. 6	45	49	40	57	65	39	38	26	13
Sept. 6–13	40	44	35	50	56	32	23	23	17
July 19–Sept. 13	45	49	40	57	66	37	23	31	13
Sept. 13–22*	....	....	....	....	53	....	18	....	....
Sept. 22–Oct. 5*	....	....	....	....	48	....	13	....	....

*By maximum-minimum thermometer.

TABLE 5

SOIL TEMPERATURE DATA, STATION 1

(Degrees Fahrenheit)

Soil	Date	Time	Depth	Remarks	Air
60	Aug. 23	3:15 p.m.	5 cm.	In shade	70
66			3 cm.	In sun	
61	Sept. 1	11:30 a.m.–12 m.	3 cm.*		63
55			7 cm.	Among rocks	
55			5 cm.)	Under mature spruce	
52			8 cm.)		
66	Sept. 7	12 m.–1 p.m.	2 cm.*		68
51			8 cm.)	Upper 4 cm. duff	62
48			16 cm.)		
47	Sept. 8	10:30–11 a.m.	12 cm.)	Among rocks	57
45			14 cm.)		
52			5 cm.*	Under fescue clump	
52	Sept. 21	3:30–4 p.m.	5 cm.*	Under fescue clump	55
44			8 cm.*	Under young spruce	
48	Sept. 23	11:30 a.m.	5 cm.*	Under fescue clump	49
40			7 cm.*		

*Maximum depth of soil to underlying rock.

TABLE 6

SOIL TEMPERATURE DATA, STATION 2

(Degrees Fahrenheit)

Week	24-hr. Mean	Day Mean	Night Mean	Mean Max.	Abs. Max.	Mean Min.	Abs. Min.	Max. Range	Min. Range
July 19–26*	41	44	38	49	59	34	27	20	10
July 26–Aug. 2	43	46	40	51	58	35	34	23	9
Aug. 2–9	41	44	38	49	51	35	33	16	12
Aug. 9–16	42	46	38	51	55	35	31	22	12
Aug. 18–23*	43	47	38	52	56	35	32	21	16
Aug. 23–30	40	43	36	49	54	33	29	21	10
Aug. 30–Sept. 6	39	42	36	49	55	33	32	21	10
Sept. 6–13	37	40	34	47	50	30	26	19	13
Sept. 13–20	32	34	30	39	50	27	24	20	5
July 19–Sept. 13	41	44	37	50	59	34	26	20	11
July 19–Sept. 20	40	43	36	49	59	33	24	23	5

*Six days or less.

TABLE 7

RELATIVE HUMIDITY DATA, STATION 1

(Percentages)

Week	24-hr. Mean	Day Mean	Night Mean	Mean Max.	Abs. Max.	Mean Min.	Abs. Min.	Max. Range	Min. Range
July 20–27	75	62	88	93	98	39	22	72	39
July 27–Aug. 7*	69	58	80	90	96	31	15	75	40
Aug. 3–10	74	66	82	92	94	43	30	64	32
Aug. 10–17	66	49	83	92	95	33	30	65	55
Aug. 17–24	69	57	81	89	98	35	16	63	39
Aug. 24–31	64	52	76	85	95	37	27	58	40
Aug. 31–Sept. 7	58	46	69	77	94	26	24	65	40
Sept. 7–14	39	31	47	59	93	18	10	83	17
Sept. 14–21	55	45	64	74	96	31	19	71	14
Sept. 21–28	52	42	61	78	97	28	8	85	11
Sept. 28–Oct. 5*	71	65	77	87	96	46	13	73	18
Oct. 5–12	57	42	71	84	96	27	19	83	31
Oct. 12–19	72	65	78	85	99	46	25	67	27
Oct. 19–23*	59	51	67	85	96	35	22	72	47
July 20–Sept. 14	65	53	76	85	98	33	10	83	17
July 20–Oct. 23	63	52	73	84	99	34	8	85	11

*Six days or less.

TABLE 8

RELATIVE HUMIDITY DATA, STATION 2

(Percentages)

Week	24-hr. Mean	Day Mean	Night Mean	Mean Max.	Abs. Max.	Mean Min.	Abs. Min.	Max. Range	Min. Range
July 19–26*	33	29	36	46	54	16	9	45	20
July 26–Aug. 2	35	28	42	54	61	22	7	46	13
Aug. 2–9					No record				
Aug. 9–16	56	49	63	69	76	35	29	41	31
Aug. 16–23	54	49	59	73	81	30	15	58	31
Aug. 23–30	53	51	54	74	80	33	19	53	32
Aug. 30 Sept. 6	52	45	56	64	81	32	24	47	24
Sept. 6–13	33	30	36	48	82	18	12	69	10
July 19–Sept. 13	45	40	50	61	82	27	7	69	10

*Six days.

TABLE 9

SATURATION DEFICIT DATA

Week	Station 1			Station 2		
	24-hr. Mean	Day Mean	Night Mean	24-hr. Mean	Day Mean	Night Mean
July 19–26*	...	...	...	.240	.296	.183
July 20–27	.111	.190	.032	...	...	...
July 26–Aug. 2	...	...	...	.220	.279	.161
July 27–Aug. 3*	.138	.210	.056	...	...	...
Aug. 2–9	...	...	...		No record	
Aug. 3–10	.094	.142	.046	...	...	...
Aug. 9–16	...	...	...	.127	.170	.084
Aug. 10–17	.144	.246	.042	...	...	...
Aug. 16–23	...	...	...	.140	.184	.097
Aug. 17–24	.133	.215	.051	...	...	...
Aug. 23–30	...	...	...	.128	.152	.105
Aug. 24–31	.134	.208	.059	...	...	...
Aug. 30–Sept. 6	...	...	...	.150	.191	.109
Aug. 31–Sept. 7	.186	.289	.082	...	...	...
Sept. 6–13	...	...	...	.163	.201	.125
Sept. 7–14	.200	.288	.112	...	...	...
Sept. 14–21	.116	.170	.062	...	...	...
Sept. 21–28	.126	.194	.058	...	...	...
Sept. 28–Oct. 5*	.046	.063	.029	...	...	...
Oct. 5–12	.127	.201	.052	...	...	...
Oct. 12–19	.062	.093	.031	...	...	...
Oct. 19–23*	.055	.073	.036	...	...	...
July 20–Sept. 14	.143	.224	.061	...	...	...
July 19–Sept. 13	...	...	...	.167	.210	.123
July 20–Oct. 23	.120	.185	.077	...	...	...

*Six days or less.

TABLE 10

PREVALENT INVERTEBRATES OF TIMBERLINE HABITAT, STATION 1

Scientific Name	Common Name	Other Stations
Pardosa altimontis Chamberlin & Ivie	Wolf spider	
Chorthippus longicornis (Latr.)	Short-horned grasshopper	3
Melanoplus oregonensis marshalli (Th.)	Short-horned grasshopper	
Labops hesperius Uhl.	Leaf bug	
Plagiognathus (*laricicola* Kngt.?)	Leaf bug	
Nysius ericae (Schill.)	Lygaeid bug	2
Alydus scutellatus V. D.	Leaf-footed bug	
Deltocephalus dorsti Oman	Leafhopper	
Deltocephalus (*artemisiae* (G. & B.)?)	Leafhopper	
Psammotettix sp.	Leafhopper	
Sorhoanus uhleri (Oman)	Leafhopper	
Cabrulus tener (B. & T.)	Leafhopper	
Amara (*Celia*) sp.	Ground beetle	2
Anaspis sericea Mann.	Tumbling flower beetle	
Colias sp.	Sulphur butterfly	
Oeneis sp.	Mountain butterfly	2
Epinotia sp.	Olethreutid moth	
Aedes (*cataphylla* Dyar?)	Mosquito	2
Bibiodes aestiva Mel.	March fly	
Tabanus rhombicus O. S.	Horse fly	
Pseudoleria crassata Garr.	Heleomyzid fly	
Pseudoleria vulgaris Garr.	Heleomyzid fly	
Lamproscatella sibilans (Haliday)	Shore fly	
Meromyza pratorum Meigen	Chloropid fly	
Madiza oscinina Fallén	Chloropid fly	
Psalidopteryx sp.	Tachina fly	
Ravinia querula (Wlkr.)	Metopiid fly	
Calliphora vomitoria (L.)	Metopiid fly	
Hylemya angusta Stein	Muscid fly	2
Hylemya platura (Meigen)	Muscid fly	2
Hylemya neomexicana Mall.	Muscid fly	2
Eupogonomyia borealis (Mall.)	Muscid fly	
Paregle cinerella (Fallén)	Muscid fly	
Lasiops septentrionalis (Stein)	Muscid fly	
Nematus sp.	Sawfly	
Hyposoter sp.	Ichneumon	
Phygadeuon sp.	Ichneumon	3
Chelonus arculeatus Ashm.	Braconid	
Torymus sp.	Torymid	2
Formica neorufibarbis gelida Whlr.	Ant	
Formica montana Em.	Ant	3
Camponotus herculeanus (L.)	Carpenter ant	
Bombus fervidus (F.)	Bumble bee	

TABLE 11

PREVALENT INVERTEBRATES OF TUNDRA HABITAT, STATION 2

Scientific Name	Common Name	Other Stations
Microtrombidium sp.	Acarinid	
Pardosa tristis (Thorell)	Wolf spider	
Pardosa ourayensis Gertsch.	Wolf spider	
Baetis bicaudatus Dodds.	Small mayfly	3
Aeropedellus clavatus (Th.)	Short-horned grasshopper	
Geocoris decoratus solutus (Montd.)	Lygaeid bug	1
Macrosteles fascrifrons (Stal)	Leafhopper	
Hebecephalus occidentalis B. & T.	Leafhopper	
Errhomus montanus (Baker)	Leafhopper	
Amara (Cyrtonotus) brunnipennis DeJean	Ground beetle	
Carabus taedatus patulicollis Casey	Ground beetle	1
Thanatophilus coloradensis Wick.	Silphid beetle	
Collops (hirtellus Lec.?)	Soft-winged flower beetle	
Parnassius smintheus sayii Edw.	Parnassian	
Pieris occidentalis Reak.	Western white	1
Plebius aquilo rustica (Edw.)	Lycaenid butterfly	1
Bibio monstri James	March fly	
Rhamphomyia sp.	Dance-fly	1
Scellus coloradensis Harmston & James	Long-legged fly	1
Phytomyza minuscula Goureau	Leaf-miner fly	
Philygria debilis Lw.	Shore fly	1
Oscinella frit (L.)	Chloropid fly	1

TABLE 12

PREVALENT INVERTEBRATES OF VALLEY HABITAT, STATION 3

Scientific Name	Common Name	Other Stations
Orodrassus coloradensis (Emerton)	Drassid spider	2
Xysticus sp.	Crab spider	
Pardosa mackenziana (Keyserling)	Wolf spider	
Alloperla pallidula Bks.?	Green stonefly	
Camnula pellucida (Sc.)	Short-horned grasshopper	1
Lygus sp.	Leaf bug	
Aphis pseudovaleraneae G. & P.	Aphid	
Aphis neilliae Oest	Aphid	
Pachyta lamed (L.)	Long-horned wood-boring beetle	
Limnophilus emarginatus Bks.	Caddisfly	
Plebeius saepiolus (Bvd.)	Lycaenid butterfly	
Euxoa rufula (Sm.)	Phalaenid moth	
Crambus lamellus Thunberg	Pyralid moth	
Tabanus sonomensis O. S.	Horse fly	
Villa fulviana (Say)	Bee fly	
Protophormia terrae-novae	Metopiid fly	
Calliphora livida Hall	Metopiid fly	
Eucalliphora lilaea (Wlkr.)	Metopiid fly	
Musca domestica L.	House fly	
Stomoxys calcitrans L.	Muscid fly	
Camponotus herculeanus modoc Whlr.	Carpenter ant	
Formica (microgyna?)	Ant	

TABLE 13

MISCELLANEOUS ARTHROPODS FROM MOUNT LINCOLN

Scientific Name	Common Name	Station
Homolophus punctatus Bks.	Harvestman	2
Dictyna compta Ivie	Hackle-band spider	1
Ebo latithorax Keyserling	Crab spider	2
Linyphia marginata Walckenaer	Sheet-web spider	2
Tetragnatha (laboriosa Hentz?)	Orb-weaver	2
Melanoplus kennicotti subsp. (Sc.)	Short-horned grasshopper	2
Nemoura delicatula Claassen	Stonefly	1
Taeniothrips vulgatissimus (Haliday)	Thrips	1
Anthocoris musculus (Say)	Flower bug	1
Labops hirtus Kngt.	Leaf bug	1
Lygus elisus V. D.	Leaf bug	2
Stenodema vicinum (Prov.)	Leaf bug	1
Lygaeus lateralis Dall.	Lygaeid bug	1, 2
Athysanella acuticauda (Baker)	Leafhopper	1
Lemellus bimaculatus (G. & B.)	Leafhopper	1
Macrosteles major (Dorst)	Leafhopper	1
Parabolocratus major Osborn	Leafhopper	1
Scleroracus cacheolus (Ball)	Leafhopper	2
Aphalara loca Cald.	Jumping plant louse	2
Aphis fabae Scropoli	Aphid	2
Macrosiphum granarium (Kby.)	Aphid	1
Cymindis unicolor Kby.	Ground beetle	1
Harpalus seclusus Casey	Ground beetle	1
Nebria suturalis Lec.	Ground beetle	2
Dasytes (hudsonicus Lec.?)	Soft-winged flower beetle	1
Hippodamia convergens Guer.	Ladybird beetle	2
Chaetocnema subviridis Lec.	Leaf beetle	1
Entomocelis americanus Brown	Leaf beetle	2
Galeruca rudis Lec.	Leaf beetle	1
Trichalophus alternatus (Say)	Snout beetle	2
Euphydryas anicia Dbldy. & Hew.	Nymphalid butterfly	2
Erioptera (Symplecta) cana (Walk.)	Crane fly	2
Simulium decorum Walk.	Black fly	1
Bibio xanthropus palliatus McAtee	March fly	1
Dolichopus groenlandicus Zett.	Long-legged fly	2
Tomosvarvella similis (Hough)	Big-headed fly	1

TABLE 13—*continued*

MISCELLANEOUS ARTHROPODS FROM MOUNT LINCOLN

Scientific Name	Common Name	Station
Tomosvarvella sylvatica (Meigen)	Big-headed fly	1
Sphaerophoria nigratarsi Fluke	Syrphid fly	1
Chamaemyia aridella (Fallén)	Chamaemyiid fly	1
Chlorops genarum Beck.	Chloropid fly	1
Diplotoxa pulchripes Lw.	Chloropid fly	2
Oscinella incerta Beck.	Chloropid fly	1
Leptocera acutangula (Zett.)	Dung fly	2
Peleteria cornigera Curran	Tachinid fly	1
Coenosia anthracina Mall.	Muscid fly	1
Coenosia atrata (Walk.)	Muscid fly	2
Coenosia errans Mall.	Muscid fly	2
Hydrophoria alaskensis Mall.	Muscid fly	1
Hydrotaea pilitibia Stein	Muscid fly	1
Hylemya cerealis (Gill.)	Muscid fly	1
Hylemya cinerella (Fallén)	Muscid fly	1
Hylemya echinata (Séguy)	Muscid fly	1
Hylemya femorata mss.	Muscid fly	2
Hylemya garretti Huck.	Muscid fly	1
Lasiops brevitarsis (Mall.)	Muscid fly	1
Lasiops subrostratus (Zett.)	Muscid fly	2
Lispocephala rubricornis Zett.	Muscid fly	1
Neodexiopsis ovata (Stein)	Muscid fly	2
Pegomya intersecta (Meigen)	Muscid fly	2
Pogonomyia metatarsata (Stein)	Muscid fly	2
Agathis tibiator Prov.	Braconid	1
Apanteles flaviconchae Riley	Braconid	1
Aphidius propinquus (Ashm.)	Braconid	2
Meteorus vulgaris (Cress.)	Braconid	1
Copidosoma bakeri (How.)	Encyrtid	1,2
Melanips bilineatus (Kieffer)	Figitid	1
Leptothorax canadensis Prov.	Ant	1,2
Megachile melanophaea Sm.	Leaf-cutter bee	1,3

TABLE 14

VERTEBRATES FROM MOUNT LINCOLN

Species	Occurrence		
	Sta. 1	Sta. 2	Sta. 3
Ambystoma tigrinum (Green), Tiger salamander			CB
Bufo boreas Baird & Girard, Mountain toad	B		B
Pseudacris nigrita triseriata (Wied), Three-lined tree frog			CB
Anas platyrhynchos platyrhynchos L., Mallard			SB
Anas carolinensis Gmelin, Green-winged teal			SB
Mergus merganser americanus Cassin, Common merganser			SB
Accipiter gentilis atricapillus (Wilson), Goshawk	CRB	CS	CRB
Buteo jamaicensis calurus (Cassin), Red-tailed hawk	CRB	C	CRB
?Buteo swainsoni Bonaparte, Swainson's hawk	*		
Aquila chrysaetos canadensis (L.), Golden eagle	R	R	R
Circus cyaneus hudsonius (L.), Marsh hawk	*		CS
Falco mexicanus Schlegel, Prairie falcon	*	*	*
Falco sparverius sparverius L., Sparrow hawk	CSB	*	CSB
Dendragapus obscurus obscurus (Say), Blue grouse	RB	*	RB
Lagopus leucurus altipens Osgood, White-tailed ptarmigan	W	RB	W
Charadrius vociferus vociferus L., Killdeer			CSB
Capella gallinago delicata (Ord), Common snipe			M
Actitis macularia (L.), Spotted sandpiper			CSB
Zenaidura macroura marginella (Woodhouse), Mourning dove	SB		SB
Bubo virginianus occidentalis Stone, Great horned owl	CRB		CRB
Nyctea scandica (L.), Snowy owl	W	W	W
Chordeiles minor henryi Cassin, Common nighthawk	CS	*	CSB
Selasphorus platycercus platycercus (Swainson), Broad-tailed hummingbird	CSB	*	CSB
Dendrocopus villosus monticola (Anthony), Hairy woodpecker	CRB		CRB
Picoides tridactylus dorsalis Baird, Northern three-toed woodpecker	C		C
Sphyrapicus thyroideus natalis (Malherbe), Williamson's sapsucker			*
Colaptes cafer collaris Vigors, Red-shafted flicker	CRB	*	CRB
Eremophila alpestris leucolaema Coues, Horned lark	*	CSB	*
Tachyneta thalassina lepida Mearns, Violet-green swallow	CSB	SB	CSB
Iridoprocne bicolor Vieillot, Tree swallow		*	CS
Hirundo rustica erythrogaster Boddaert, Barn swallow	*	*	CS
Petrochelidon pyrrhonota pyrrhonota (Vieillot), Cliff swallow			*
Perisoreus canadensis capitalis Ridgway, Gray jay	CRB	*	CRB
Cyanocitta stelleri macrolopha Baird, Steller's jay	CR		CRB
Pica pica hudsonia (Sabine), Black-billed magpie	*	*	CRB
Corvus corax sinuatus Wagler, Common raven	*	*	*
Nucifraga columbiana (Wilson), Clark's nutcracker	CRB		CRB
Gymnorhinus cyanocephala Wied, Piñon jay	*		*
Parus atricapillus septentrionalis Harris, Black-capped chickadee	C		
Parus gambeli gambeli Ridgway, Mountain chickadee	CB		CB
Sitta carolinensis nelsoni Mearns, White-breasted nuthatch	C		C

TABLE 14—*continued*
VERTEBRATES FROM MOUNT LINCOLN

Species	Occurrence		
	Sta. 1	Sta. 2	Sta. 3
Sitta canadensis L., Red-breasted nuthatch	CR		CR
Cinclus mexicanus unicolor Bonaparte, American dipper			RB
Salpinctes obsoletus obsoletus (Say), Rock wren	RB	*	
Toxostoma rufum longicauda (Baird), Brown thrasher	*		*
Turdus migratorius propinquus Ridgway, Robin	CSB	*	CSB
Hylocichla guttata auduboni (Baird), Hermit thrush	CSB		CSB
Sialia currucoides (Bechstein), Mountain bluebird	CSB	SB	CSB
Myadestes townsendi townsendi (Audubon), Townsend's solitaire	SB		SB
Regulus calendula cineraceus Grinnell, Ruby-crowned kinglet	CSB		CSB
Anthus spinoletta alticola Todd, Water pipit		CSB	
Bombycilla garrula pallidiceps Reichenow, Bohemian waxwing	*		*
Dendroica petechia aestiva (Gmelin), Yellow warbler	CSB		CSB
Dendroica auduboni memorabilis Oberholser, Audubon's warbler	CSB	*	CSB
Dendroica townsendi (Townsend), Townsend's warbler	*		*
Oporornis tolmiei monticola Phillips, MacGillivray's warbler	*		CSB
Wilsonia pusilla pileolata (Pallas), Wilson's warbler	SB		SB
Setophaga ruticilla tricolora (Müller), American redstart			*
Sturnella neglecta neglecta Audubon, Western meadowlark	*		SB
Euphagus cyanocephalus (Wagler), Brewer's blackbird	*	*	CSB
Molothrus ater (Boddaert), Brown-headed cowbird	CSB		CSB
Hesperiphona vespertina brooksi Grinnell, Evening grosbeak	*	*	RB
Carpodacus cassinii Baird, Cassin's purple finch			C
Pinicola enucleator montana Ridgway, Pine grosbeak	*		*
Loxia curvirostra stricklandi Ridgway, Red crossbill	*		
Leucosticte australis Ridgway, Brown-capped rosy finch	W	CRB	CW
Acanthis flammea rostrata (Coues), Common redpoll			W
Spinus pinus pinus (Wilson), Pine siskin	CRB		CRB
Passerculus sandwichensis nevadensis Grinnell, Savannah sparrow		C	C
Pooecetes gramineus confinis Baird, Vesper sparrow	CS	C	CS
?*Junco oreganus mearnsi* Ridgway, Oregon junco			WM
?*Junco caniceps caniceps* (Woodhouse), Gray-headed junco	CRB	C	CRB
Spizella passerina arizonae Coues, Chipping sparrow	*		*
Zonotrichia leucophrys (Forster), White-crowned sparrow	CSB	CSB	CSB
Melospiza lincolni alticola (Miller & McCabe), Lincoln's sparrow	CSB	CSB	CSB
Sorex vagrans obscurus Merriam, Vagrant shrew	*	*	C
Lasionycteris noctivagans (Le Conte), Silver-haired bat			*
Ochotona princeps saxatilis (Bangs), Colorado pika	*	C	*
Sylvilagus nuttalli pinetis (J. A. Allen), Nuttall's cottontail	*		*

TABLE 14—*continued*

VERTEBRATES FROM MOUNT LINCOLN

Species	Occurrence		
	Sta. 1	Sta. 2	Sta. 3
Lepus americanus bairdi Hayden, Rocky Mountain snow-shoe rabbit	C	*	C
Lepus townsendii campanius Hollister, White-tailed jack rabbit	C	*	C
Marmota flaviventris luteola A. H. Howell, Park marmot	C	C	*
Eutamias minimus operarius Merriam, Least Colorado chipmunk	C	*	C
Citellus richardsonii elegans (Kennicott), Richardson's ground squirrel	C		C
Citellus lateralis lateralis (Say), Golden-mantled ground squirrel	C		C
Cynomys gunnisoni gunnisoni (Baird), Gunnison's prairie dog	*		*
Tamiasciurus hudsonicus fremontii (Audubon & Bachman), Red squirrel (Fremont's chickaree)	C		C
Thomomys talpoides fossor A. A. Allen, Mountain pocket gopher	C	C	C
Castor Canadensis concisor Warren & Hall, Colorado beaver	*		C
Peromyscus maniculatus rufinus (Merriam), Tawny deer mouse	*	*	*
Neotoma cinerea orolestes Merriam, Colorado bushy-tailed wood rat	C	C	C
Microtus montanus fusus Hall, Mountain vole	*		*
Microtus longicaudus mordax Merriam, Long-tailed vole	C	*	*
Ondatra zibethicus osoyoosensis (Lord), Rocky mountain muskrat			*
Mus musculus domesticus Rutty, House mouse	*	*	*
Erethizon dorsatum epixanthum Brandt, Yellow-haired porcupine	C	*	*
Canis latrans lestes Merriam, Robber coyote	*	*	*
Canis lupus youngi Goldman, Gray wolf	F	F	F
Vulpes fulva macroura Baird, Western red fox	C	C	C
Euarctos americanus subsp., Black bear	*		*
Ursus horribilis bairdi Merriam, Grizzly bear	F	F	F
Martes americana origines (Rhoads), Rocky Mountain marten	C	C	*
Mustela erminea muricus (Bangs), Ermine	C	C	C
Mustela frenata nevadensis Hall, Long-tailed weasel	C	C	C
Mustela nigripes (Audubon & Bachman), Black-footed ferret			*
Mustela vison energumenos (Bangs), Western mink			C
Taxidea taxus taxus (Schreber) (*montana* Schantz), Badger	*	*	*
Mephitis mephitis varians Gray, Striped skunk	*		*
Felis concolor hippolestes Merriam, Mountain lion	*	*	*
Lynx rufus pallescens Merriam, Mountain bobcat	C	*	C
Cervus canadensis nelsoni V. Bailey, Wapiti	*	*	*
Odocoileus hemionus hemionus (Rafinesque), Black-tailed (mule) deer	C	*	C
Bison bison bison (L.), Bison	F	F	F
Ovis canadensis canadensis Shaw, Mountain sheep		*	

Asterisk signifies occurrence, sometimes occasional; B, breeding; C, common; F, former inhabitants; M, in migration; R, resident; S, summer; W, winter.

A NOTE ABOUT THE AUTHORS

Irving Hill Blake was born at Augusta, Maine, on February 15, 1888. He earned his A.B. degree at Bates College in 1911, his A.M. at Brown University in 1912, and Ph.D. at the University of Illinois in 1925. He served as Assistant at Brown University, 1912–1913; Instructor at Oregon State College, 1913–1916, and at Syracuse University, 1916–1918; Associate Professor at the University of Maine, 1918–1925, and at the University of Idaho, 1925–1926; and Professor of Zoology at the University of Nebraska, 1926–1956. He was Chairman of the Department of Zoology from 1946 to 1953, and was Professor Emeritus from 1956 until his death on May 6, 1968. Following are his published papers:

A comparison of the animal communities of coniferous and deciduous forests. 1926. Ill. Biol. Monog. 10(4):1–149.

Studies on the comparative histology of the digestive tube of certain teleost fishes I. A predaceous fish, the sea bass (*Centropristes striatus*). 1930. Jour. Morph. and Physiol. 50(1):39–70.

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Studies on the comparative histology of the digestive tube of certain teleost fishes III. A bottom-feeding fish, the sea robin (*Prionotus carolinus*). 1936. Jour. Morph. 60(1):77–102.

An ecological reconnaissance in the Medicine Bow Mountains. 1945. Ecol. Monog. 15:207–242.

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