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THE OCCURRENCE OF ORTHOPTERA AT HIGH ALTITUDES, WITH SPECIAL REFERENCE TO COLORADO ACRIDIDAE¹

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Among the most abundant animals at high altitudes are the grasshoppers. In the alpine zone of the Colorado Rockies these apparently exceed all other kinds of insects—in numbers of individuals if not in numbers of species. The statement that insects of complete metamorphosis predominate at high altitudes, whereas the “warmth-loving” Orthoptera are less well adapted to the cold of such regions (Hesse 1924; Erhard 1931), seems to be based on observations of conspicuous rather than abundant forms. The butterflies and beetles of high altitudes are perhaps better known than are the Orthoptera, as suggested by the summary of Holdhaus (1929), and the butterflies are certainly more conspicuous. Furthermore, more species of Coleoptera and Lepidoptera than of Orthoptera undoubtedly do occur at high altitudes, but the same relationship holds at low altitudes. On the other hand, if we consider numbers of individuals, disregarding numbers of species, we may safely say that grasshoppers are often the predominant insects at high altitudes, just as stated by Prenant (1933). They are certainly among the most significant ecological units of the alpine zone.

There seems to be no a priori reason for the statement that insects with complete metamorphosis are poorly adapted to the cold of high altitudes. The statement is not supported by the known facts of distribution. In the Alps, Collembola occur at higher altitudes than any other insects (Erhard 1931). Hemiptera as well as Orthoptera occur in considerable numbers in alpine regions. Some primitive insects are actually dependent upon cold for survival. *Grylloblatta*, for example, cannot long survive at temperatures

above approximately 60° F. (Walker, 1937), and its optimum temperature seems to be close to 39° F. (Mills and Pepper 1937). One of the Acrididae, an unnamed species from Mount Everest, appears to hold the high altitude record for an established insect species. Major Hingston (1925), who made observations on natural history while a member of the 1924 Everest Expedition, found early nymphs of a grasshopper at 18,000 feet above sea level, the limit of vegetation. Uvarov (1925) was unable to name these and stated that they were representatives of an undescribed species. In the same paper, Uvarov described a new genus of wingless grasshoppers, *Dysanema*. Appropriately enough, he named the two new species in this genus *irvinei* and *malloryi* after A. C. Irvine and G. Mallory, the two members of the Expedition who lost their lives in the final assault on the summit. The two species of grasshoppers occurred at altitudes of 15,000 and 16,000 feet on Mount Everest. Where vegetation occurs at such altitudes in any part of the world we may reasonably expect to find Orthoptera. Altitude, as such, is not a barrier.

Orthoptera have been recorded from alpine regions all over the world. Good general summaries of their occurrence have been given by Scudder (1898), Chopard (1928), and Uvarov (1928). In addition, some discussion of their occurrence has been combined with the excellent general accounts of alpine animal ecology by Hesse (1924) and Erhard (1931).

Most of the records of high altitude occurrence are, of course, scattered through taxonomic accounts of collections made in mountainous regions. Unfortunately, the importance of complete data—even with reference to altitude alone—

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was not recognized by early collectors, localities being designated by such vague expressions as Tibet, Colombia, or Rocky Mountains. The information on high altitude Orthoptera is naturally more complete from the mountains of Europe and North America than elsewhere. We were particularly fortunate in the United States in that the first great student of Orthoptera in this country, Samuel H. Scudder, was an ardent mountain climber. Limited collections, however, and individual variations led to an early multiplicity of names that seems more complex than in the taxonomy of lowland species. Mountain climbing is strenuous, too, and the accumulation of representative collections from scattered alpine areas is a long-time process.

TYPES OF ORTHOPTERA REPRESENTED

Not all groups of Orthoptera are well represented at high altitudes. Some, however, appear to be particularly well adapted to the cold conditions of the alpine zone. The Grylloblattidae, for example, are associated in general with cold, damp situations. They have been found in the mountains of western Canada and northwestern United States, among rocks at the edge of snow-fields, in areas covered with snow much of the year. Some of the Tetrigidae, likewise, are tolerant of cold, damp situations, and occur in the alpine zone.

Species which are quite active at night, as are many Gryllidae and Tettigoniidae, are absent from alpine regions. Nor are they likely to occur even as accidental visitors, because wind movements in mountains are usually downward at night. Crickets appear to be absent from high altitudes, at least in the Holarctic Region. The diurnal Tettigoniidae, however, are represented by several high altitude species, in the Old World as well as in the New. In this country we have several species thoroughly adapted to alpine conditions. *Anabrus simplex* Haldeman, the Mormon "cricket," completes its life cycle in Colorado at altitudes up to 13,000 feet

above sea level (at least as far north as Mount Evans). *Acrodectes philopagus* Rehn and Hebard, another decticine, was described from specimens collected near and at the summit of Mount Whitney (California), 14,500 feet, the highest mountain in the United States (Rehn and Hebard 1920). One of the cave-crickets, *Ceuthophilus alpinus* Scudder, was collected above timber line on Mount Lincoln, in Colorado (Scudder 1898). All of the forms just mentioned are flightless; wings, if present, are much abbreviated.

The majority of the alpine Orthoptera, some of which have wings of normal length, are members of the family Acrididae. Undoubtedly, hundreds of species in this family will eventually be known from the alpine regions of the world, where they occur as well-adapted resident insects. The activity of the American species with which I am familiar, at air temperatures below 50° F., is convincing evidence of efficient physiological adaptation to cold temperatures. The high altitude species are obviously better adapted to cold than are those of low altitudes, even when closely related taxonomically.

ECOLOGICAL CATEGORIES OF HIGH ALTITUDE SPECIES

When a flightless insect as large as the average decticine (or even a small grasshopper, for that matter) is found regularly at a given altitude we may consider this reliable evidence that it is established at such an altitude, i.e., that it is able to complete its life cycle at that altitude. On the other hand, among the numerous species of fully-winged grasshoppers recorded from alpine regions we must distinguish carefully between those that are native to the altitudes in question and those that are accidental or casual in occurrence. Since grasshoppers are primarily diurnal in activity, and since diurnal air movements in mountainous regions are predominantly upward, we find that a large number of species at high altitudes are accidental. A combination of flight ability, which need not be great, and favor-

able wind currents is undoubtedly responsible for the arrival of such accidental visitors. The possibilities of passive dispersal of this sort have been summarized by Holdhaus (1929). In commenting upon the same phenomenon, Chopard (1938) has pointed out that this high degree of vagility is not necessarily accompanied by a high per cent of establishment in new areas. In other words, we are apparently dealing with species that annually repeat on a large scale their invasions of the alpine region, but which, lacking the necessary preadaptation, have not yet become established there. Several of the species attributed to the alpine zone in Colorado, in particular *Melanoplus mexicanus mexicanus*² and *Melanoplus occidentalis*, are apparently in this category. It is important, therefore, to know something of the life histories of long-winged species that occur at high altitudes. Without this information it is not possible to determine whether a species is present as a resident or merely as an accidental visitor.

In the ecological classification suggested by Hesse (1924), three types of alpine animals are recognized, eualpine, tychoalpine, and xenoalpine. Belonging to the first category are those that are exclusively alpine; to the second belong those that extend into the alpine zone from below and are able to complete their life cycles in the higher zone; in the third group are those that invade the alpine zone but are unable to establish themselves there.

This classification was devised for the fauna of the Alps, a mountain mass isolated from northern regions by intervening lowlands. It is not appropriate in the Rocky Mountains, however, for in the Rockies the populations of alpine species in southern latitudes are in more or less continuous geographic contact with populations of the same or closely related species at lower altitudes to the north. There are no eualpine species in the mean-

ing of Hesse's term; a species which appears to be eualpine in the southern part of its range may not be alpine at all farther north. All our characteristic alpine species would be considered tychoalpine according to Hesse's classification. This, however, implies that they are related to species of the adjacent lowlands, whereas their affinities are with low altitude species which occur farther north. Xenoalpine or accidental species do occur in numbers, however, and these undoubtedly occur in mountains of all regions.

A satisfactory ecological classification of the alpine fauna of the Rocky Mountains appears to require only two categories. We must distinguish between species which can complete their life cycles in the alpine zone and those that reach the zone but cannot become established at that altitude. The former are characteristic of the zone; they are here designated "resident alpiners." The numerous species which invade the alpine region from below but cannot become established are the "accidental alpiners."

HIGH ALTITUDE GRASSHOPPERS IN COLORADO

Since the summer of 1931 I have been interested in the altitudinal distribution of Colorado grasshoppers. Collections at altitudes from the plains (5,000 feet) to over 13,000 feet above sea level have been made in northern Colorado throughout this period. These collections were chiefly in the Boulder region, but occasional trips have been made into the mountains of other parts of the state. Personal observations were supplemented during the season of 1949 by extensive collections made by H. A. Fehlmann, graduate student at the University of Colorado, in the alpine zone of the Culebra, Sangre de Cristo, and Mosquito Ranges. Published records have been used to supplement personal observations and those of Mr. Fehlmann. In spite of the apparent extensive coverage, however, there are still large areas of alpine country in Colorado where grasshoppers have not been collected.

² Author names of Colorado Acrididae are given only in the list near the end of the paper.

The present report is limited to a discussion of grasshoppers (Acrididae) of the alpine zone. This is the mountain zone which occurs above timber line. Timber line in Colorado is at an altitude of about 11,000 feet in the northern part of the state, at about 12,000 feet in the Culebra Range and other mountains of southern Colorado. The Acrididae referred to are all listed in the last section of this paper, preceding the Summary.

A geographic study of the distribution of species waits upon additional collections and taxonomic reexamination of some of the high altitude groups. Large series covering the entire range of each species should be collected. Meanwhile, the recognition of the ecological category to which each species thus far collected belongs may prove of value.

The method of recognizing a winged species as a resident alpine is relatively simple if local life history studies are available. If a species is collected above timber line in the adult condition, and the flightless nymphs of the same species are found in the same locality, it is considered characteristic of the alpine zone. If, on the other hand, an adult grasshopper is collected above timber line without juveniles of the same species we must ask its source. If one knows from observations at lower altitudes that it is just appearing as an adult some five thousand feet lower down the assumption is clear that it has been transported upward. If we follow this species through the season at different altitudes we are able to determine its maximum range of altitude as a resident. If it occurs anywhere above that range it is accidental.

The special case of *Melanoplus mexicanus mexicanus* is highly informative, particularly since it has been referred to as an alpine form on the basis of adult specimens alone (Hebard 1935, 1936). The species is highly vagile, and has repeatedly been taken in numbers above timber line. One striking observation illustrates the real nature of this occurrence. On July 18, 1948, I found nu-

merous adults of this species frozen in the surface of a snow bank at about 12,200 feet altitude on the east side of Mount Audubon (Colorado). These grasshoppers had fallen on the snow not many hours or days before, because the snow bank had not yet receded to its size in the preceding autumn. The alpine species in the adjacent area were still juveniles, not having reached the adult condition, while *M. m. mexicanus* was already a common adult on the plains seventeen miles due east and seven thousand feet lower down. The adults in the snow bank had undoubtedly flown or been carried on rising air currents to the high altitude.

A more complete demonstration is afforded by the record of collections during 1949, as these collections were made to determine the time of development at different altitudes. Early juveniles of *M. m. mexicanus* were collected on the plains and as high as 7,600 feet by the last of May, and these were adult by the first of July. Juveniles were taken as early as the third week in June at 8,500 feet, but the first adults did not mature at that altitude until about the first week of August. The highest elevation at which juveniles were collected was 9,800 feet. Juveniles appeared there as early as the first of August, but the first adults associated with last instar nymphs were not collected until after the first of September. As late as October 1, juveniles and adults were both still present at 9,800 feet, but cold weather had already set in at that altitude. Meanwhile, on September 8, an adult female of this species was collected by H. A. Fehlmann at an altitude of 12,300 feet on Mount Evans. This grasshopper may have come all the way from the plains; in any case it must have originated from an altitude at least 2,500 feet lower than that at which it was collected.

Other high altitude records of this species in Colorado give additional evidence that *M. m. mexicanus* is not typical of the alpine zone. On July 13, 1936, an adult male and three adult females were

collected above timber line, at 11,400 feet, on Niwot Ridge (near Science Lodge, University of Colorado mountain laboratory). On July 20, the same year, three males and eight females, all adults, were collected above timber line on Mount Audubon, one of the females being collected on the cold rocks of the wind-blown summit, at 13,300 feet above sea level. H. A. Fehlmann collected adults during August 1949, from alpine areas above 12,000 feet on Trinchera Peak (Culebra Range), Greenhorn Mountain, West Spanish Peak, Sierra Blanca, Pike's Peak, and in the Mosquito Range west of Alma, Colorado. On Greenhorn Mountain, which is quite close to the plains southwest of Pueblo, thirteen adults were taken above 12,000 feet on August 3 and twenty-six on August 25. No juveniles were collected in any of these alpine areas, nor have I found any records of juveniles taken above timber line in this region. Furthermore, we do know that *M. m. mexicanus* is capable of flying or being carried many miles (Munro and Sangstad (1938)). The evidence seems clear that it is an accidental alpine.

The evidence with reference to *Melanoplus occidentalis* is not so clear. It has been found above timber line on numerous occasions, and was listed by Hebard (1929, 1935, 1936) as an alpine species in Colorado and New Mexico. On July 13, 1936, I collected eight males and two females, all adult, above timber line on Niwot Ridge. A single adult male was collected by Robert J. Niedrach on August 10, 1933 at 13,600 feet on Mount Evans. I have no records, however, of juveniles above timber line, nor have I seen such records in the literature. Furthermore, the species is highly vagile (La Rivers 1948). The evidence available thus far points, therefore, to recognition of this species as a purely accidental alpine grasshopper, which is not established above timber line.

Other species occasionally listed as alpine in distribution include *Melanoplus bivittatus* and *Melanoplus femur-rubrum*.

The former completes its life cycle up to about 9,500 feet, but juveniles are scarce at that altitude. *M. femur-rubrum* apparently does not occur much above 8,000 feet in the juvenile condition. Both these species are collected not infrequently above timber line, where they are of course accidental.

Arphia conspersa, since of boreal affinities, is a species that we might expect to find established in the alpine zone. Adults are found above timber line (Hebard 1929), but in the Boulder region I have not collected juveniles above approximately 9,800 feet. In favorable spots this species may be able to complete its life cycle above timber line, but at present I am inclined to consider its occurrence at such altitudes accidental.

Another one of the Oedipodinae listed by Hebard (1929) as alpine in Colorado is *Camnula pellucida*, but Hebard failed to list any alpine collecting localities. I have not collected this species above timber line but have taken both juveniles and adults from 6,000 to 10,000 feet. In favorable areas this species may be able to complete its life cycle above timber line. It should not at present be considered alpine, however.

One other macropterous species of uncertain status, *Chorthippus longicornis*, may upon further collecting prove to be a resident alpine. Adults have been taken above timber line, but this species is so highly restricted in habitat that a special search will have to be made at the right time and place before we can be sure that it does complete its life cycle above timber line. It does complete its life cycle in wet patches of sedges up to about 10,500 feet in the Boulder region, and my son and I have collected juveniles and adults on Hoosier Pass (11,500 feet), just at timber line.

One of the interesting aspects of the occurrence of accidental species above timber line is the observation that at certain times, apparently during quite warm weather, abnormally large numbers of these may be taken in a single day. I

have previously referred twice to collections made July 13, 1936 on Niwot Ridge, near Science Lodge. Niwot Ridge, which at its eastern end extends only a few hundred feet above timber line, carries the tundra farther east than at any other place in northern Colorado. It is an alpine ridge extending in an east-west direction, its eastern end less than fourteen miles from the plains. On the day mentioned there occurred the most extensive invasion of the alpine tundra by lowland species of which I have record. The collection above timber line on that date included adults of the following species: *Aulocara elliotti* (4 males, 11 females); *Aeropedellus clavatus* (1 male); *Amphitornus coloradus* (1 male, 1 female); *Metator pardalinus* (2 males, 1 female); *Melanoplus bivittatus* (8 males, 2 females); *M. mexicanus mexicanus* (1 male, 3 females); *M. dodgei dodgei* (5 males, 2 females); *M. occidentalis* (8 males, 2 females); *M. packardii* (2 males, 3 females); *Hesperotettix viridis viridis* (1 female). Two of these species were typical alpiners, *Aeropedellus clavatus* and *Melanoplus dodgei dodgei*. Eight juveniles of the former and seven of the latter were collected. On the other hand, no juvenile specimens of any of the other eight species were collected. They were all accidentals.

Among the observations made during the summer of 1949 by H. A. Fehlmann, at least one such unusual collection was noted. One or two accidental species were collected at almost every alpine collecting locality, but the most striking collection was made on Sierra Blanca, at 12,800 to 13,000 feet, on August 24, 1949. On that date adults of the following accidentally occurring species were collected: *Dissosteira carolina* (2 males, 2 females); *Melanoplus femur-rubrum* (5 males, 6 females); *M. mexicanus mexicanus* (1 male); *M. packardii* (1 male). Juveniles as well as adults of three resident alpine species were collected. These were *Aeropedellus clavatus*, *Melanoplus dodgei bohemani*, and *M.*

borealis monticola. What weather conditions are associated with these invasions of high altitudes by lowland species we do not know, but the invasions are necessarily associated with rising air currents.

Among the grasshoppers with fully developed wings at least three species in the front range of the Colorado Rockies are resident alpiners. These are: *Melanoplus alpinus*, of the northern Colorado mountains; *M. borealis monticola*, of the mountains of southern Colorado; and *Xanthippus corallipes altivolus*, with a wider north-south range than either of the other two species. The last of these forms has somewhat reduced wings, those of the female occasionally being too short to support sustained flight, but both species of *Melanoplus* have moderately long wings. I have collected many juveniles of *M. alpinus* and *X. c. altivolus* in the alpine zone in the mountains west of Boulder, Colorado. With H. A. Fehlmann I collected juveniles of *M. b. monticola* in the Culebra Range in July 1949, and during August of the same season he collected both juveniles and adults of this species on Greenhorn Mountain, on Sierra Blanca, in the northern Sangre de Cristo Mountains, and as far north as Pike's Peak. These three species are the only fully winged grasshoppers normally present in the alpine zone along the eastern range of the Rockies in Colorado.

A fourth macropterous form, *Melanoplus bruneri*, appears in the alpine zone of mountains in the central part of the state. This was recorded from an "alpine environment" near Gothic by Hebard (1929), two adult males and a juvenile female having been collected by Mary J. Brown. Under the name *Melanoplus excelsus* it was recorded from above timber line on Mount Lincoln by Scudder (1898).

Melanoplus borealis stupefactus is a brachypterous subspecies of *M. borealis* that occurs in the alpine zone of New Mexico and in the mountains west of the San Luis Valley and as far north as Gothic (Hebard 1935). I find no definite record of its occurrence above timber line

in Colorado, but there is a questionable record mentioned by Scudder (1898) under the name *Podisma stupefacta*.

The majority of the resident alpine species in Colorado are short-winged. *Aeropedellus clavatus*, of wide latitudinal range, appears to have the widest altitudinal range of any alpine species, completing its life cycle in the Boulder region at all altitudes from 5,500 to 13,500 feet. The short-winged *Melanoplus dodgei* complex, for which I use the nomenclature of Hebard's Colorado paper (1929), is represented by the small alpine subspecies in northern Colorado (*M. d. dodgei*) and a larger subspecies (*M. d. bohemani*) above timber line in the southern mountains of the state. Hebard, in a later paper (1935), recognized *bohemani* as a distinct species. I have retained the earlier name, however, as it indicates what appears to me to be a close relationship with *M. d. dodgei*.

Melanoplus oregonensis marshallii is another brachypterous form, its tegmina and wings being shorter even than those of *M. dodgei*. It occurs in alpine communities in the Mosquito Range and as far north as Loveland Pass. It occurs north of Loveland Pass below timber line. *Melanoplus kennicotti nubicola*, which has been recorded from a few alpine areas in the central part of the state, is unquestionably alpine, but its geographic distribution is not yet well understood.

I have collected juvenile and adult *Melanoplus fasciatus* a short distance above timber line in the Boulder region, and, for that reason, have listed the species as a resident alpine. However, it is possible that it should be considered accidental on the tundra in spite of the fact that it is relatively short-winged. It is ecologically associated with the forested portions of the mountains, and is able to complete its life cycle up to and within the dwarf forest at timber line. Even juveniles, at least in the later instars, could hop the short distance from the forest to the tundra areas where they have been collected.

In any particular alpine area of the front range the community of resident alpine grasshoppers appears to include not more than three species at the same time. *Xanthippus corallipes altivolus* is the only species that over-winters in the juvenile condition above timber line, and, consequently, it is the only species that becomes adult before mid-summer. In the latitude of Boulder, adults mature at 11,000 feet as early as the last week of June. By the middle of July, *Aeropedellus clavatus* and *Melanoplus dodgei* are adult. Both of the macropterous melanopli, *M. alpinus* and *M. borealis*, become adult toward the end of the season, about the middle of August, but while *A. clavatus* and *M. dodgei* are still present. Adults of *Xanthippus* have disappeared by that time, though juveniles hatch as early as the last of August from eggs laid the same season. Since the two macropterous melanopli do not occur in the same locality, the usual combination of species is: *A. clavatus*, *M. dodgei*, and either *M. alpinus* (in the north) or *M. borealis* (in the south). Neither of the last two species is necessarily present, however. If *Melanoplus oregonensis marshallii* is present, *M. dodgei* appears to be absent. Thus we have as the typical alpine grasshopper population the wide-spread *A. clavatus*, a short-winged species of *Melanoplus*, and a long-winged species of *Melanoplus*, all of these following an early season form, the over-wintering *Xanthippus corallipes altivolus*.

COLORADO ACRIDIDAE COLLECTED IN THE ALPINE ZONE

The following is a list of all species of Acrididae known from above timber line in Colorado. Most of these have been collected by the writer. Some were collected by H. A. Fehlmann in his 1949 expedition. If the only records available are his, the names are followed by the initials H. A. F. in parentheses. Some names are based on published records only. The sources for these are indicated by reference to the literature list, likewise in parentheses following the names.

Those Acrididae that are resident alpine species, completing their life cycles above timber line, are indicated by an asterisk preceding the name. Species not so marked are considered of accidental occurrence.

Acridinae:

- **Aeropedellus clavatus* (Thomas)
- Ageneotettix deorum* (Scudder)
- Amphitornus coloradus* (Thomas)
- Aulocara ellioti* (Thomas)
- Chorthippus longicornis* (Latreille)
- (May be a resident alpine species)

Oedipodinae:

- Arphia conspersa* Scudder (Hebard 1929)
- Circotettix rabula altior* Rehn
- Dissosteira carolina* (Linnaeus) (H. A. F. collection)
- Metator pardalinus* (Saussure)
- Spharagemon collare* (Scudder)
- Trachyrhachis kiowa* (Thomas)
- **Xanthippus corallipes altivolus* (Scudder)

Cyrtacanthacrinae:

- Hesperotettix viridis viridis* (Thomas)
- **Melanoplus alpinus* Scudder
- M. bivittatus* (Say)
- **M. borealis monticola* Scudder
- M. borealis stupefactus* (Scudder)
- (Scudder 1898; questionable)
- **M. bruneri* Scudder
- **M. dodgei dodgei* (Thomas)
- **M. dodgei bohemani* (Stål)
- **M. fasciatus* (F. Walker) (May be accidental)
- M. femur-rubrum* (DeGeer) (H. A. F. collection)
- **M. kennicotti nubicola* (Scudder)
- (Scudder 1898, as *Podisma nubicola*)
- M. mexicanus mexicanus* (Saussure)
- **M. mexicanus spretus* (Walsh) (Extinct; juveniles reported by Scudder 1898)
- M. occidentalis* (Thomas)
- **M. oregonensis marshallii* (Thomas)
- M. packardii* Scudder

It should be noted that of the total number of twenty-eight species and sub-

species collected above timber line in Colorado only eleven (approximately 39%) may be considered characteristically alpine in distribution, and one of these (*Melanoplus mexicanus spretus*) is now extinct.

SUMMARY

1. Orthoptera of several families occur at high altitudes. The Acrididae are represented by the largest number of species. In numbers of individuals they are among the most numerous insects at high altitudes. Their abundance leads one to question the statement that insects with complete metamorphosis are better adapted to alpine climatic conditions than are those with incomplete metamorphosis.

2. High altitude Orthoptera of the Rocky Mountains of Colorado are of two ecological groups, resident alpiners and accidental alpiners. The former can complete their life cycles above timber line. Accidental alpiners occur in the alpine zone only as adults, flying or being borne to the alpine areas on air currents. The majority of species of Acrididae recorded from alpine areas of Colorado are accidentals. Only eleven (approximately 39%) of the twenty-eight recorded species and subspecies are resident alpiners.

3. *Melanoplus mexicanus mexicanus*, *M. occidentalis*, and several other species previously recorded as alpine grasshoppers are not resident species but accidental visitors. The resident alpine species of Colorado are: *Aeropedellus clavatus*, *Xanthippus corallipes altivolus*, *Melanoplus alpinus*, *M. borealis monticola*, *M. bruneri*, *M. dodgei dodgei*, *M. dodgei bohemani*, *M. fasciatus* (may be accidental), *M. kennicotti nubicola*, *M. mexicanus spretus* (now extinct), *M. oregonensis marshallii*. None of these is confined, except locally, to the alpine zone.

4. In any given alpine area along the eastern ridge of the Colorado Rockies the grasshopper population may include an early summer species which over-winters as a juvenile (*Xanthippus corallipes altivolus*), *Aeropedellus clavatus* and a short-

winged *Melanoplus* in mid-summer, and a long-winged *Melanoplus* in late summer. Apparently two species of brachypterous melanopli or two species of macropterous melanopli do not occur at the same time and place.

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