The grasshopper campaigns of 1917-1924 : entomology at war
by Richard Wojtowicz

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Arts in History
Montana State University


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Date 18 July 1989

To Dianna, my spouse of infinite patience;
Lottie and Joseph, my parents;
John, my entomologist brother;
Pierce Mullen, Billy G. Smith, and Robert Rydell,
my Graduate Committee.

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# ABSTRACT

Montana experienced the most destructive grasshopper outbreaks since 1903 during the period 1917 through 1924. Intervening years of agriculturally favorable weather, cheap land, good market prices, and few insect and disease problems encouraged many would be farmers to move into the state.

From 1917 through 1924, the Montana State Entomologist and associates in entomology at the federal level intervened decisively to stave off ruin for many Montana farmers. Deploying a variety of techniques they were able to prevent losses which would have driven some farmers into economic ruin. Data indicate that without their efforts greater economic loss would have occurred. Calculations of savings versus expenditures consistently established a positive balance in favor of scientific entomology. In this period efforts on the part of the Montana State entomological team made an important difference and contributed to the survival of state agriculture.

# CHAPTER 1

## INTRODUCTION

The consequences of Sarajevo affected the United States in various ways, though most Americans could not even pronounce the city's name or point it out on a map. For three years American business, industry, and agriculture had profited from the carnage along the shifting fronts of Europe and Asia Minor. Food and hardware had to come from somewhere and the isolationist U.S. served as a horn of plenty for armies and nations preoccupied with killing. But 1917 brought America into a struggle no longer confined to "over there." The United States now became the arsenal of democracy, and the cornucopia for a starving world.

At the same time an ancient enemy, quiescent for nearly a decade and a half, suddenly multiplied its numbers and again began ravishing the fruits of field and range. This enemy spoke no decipherable language and held no arguable ideologies. Evolutionally, they lived closer to the genesis of life on earth than their adversary, Homo sapiens, and possessed a less adaptive intelligence. In spite of occupying this lower rung on the chain of being, the humble grasshopper proved its mettle in the Montana

resurgent outbreaks between 1917 and 1924. Years of setbacks and partial victories faced the state entomological forces headquartered in Bozeman, Montana, under the overall supervision and direction of the State Entomologist, Robert A. Cooley.[1]

From 1917 through 1924, Montana agriculture experienced its worst grasshopper infestations since the turn of the century. Mild weather had encouraged the settlement of marginal lands in the state and engendered hopes for prosperity. But when drought conditions returned, beginning in 1917, many farmers confronted decreased productivity, low profits, high prices for goods, and spreading grasshopper outbreaks. Marginal lands also meant a tenuous chance for economic survival. Banks and other businesses, dependent on Montana agriculture, failed along with the farms. Grasshopper destruction grew steadily worse from 1917 through 1920, but paled in comparison with its intensities from 1921 through 1924. An individualist and often non-cooperative spirit among many Montana farmers gave way to the dictates of a situation which no person could hope to fight alone.

Cooley had developed an organization to meet insect pest crises and responded to the grasshopper outbreaks by putting it into action. He nurtured his organization to meet the call for efficient control of insect depredations on Montana agriculture. Financial, political, social, and

scientific obstacles sometimes constrained and set back the evolution of the entomology organization. But as the scientific basis of insect control allowed them to provide increasingly reliable control measures, Cooley and his compatriots created a social, political, and scientific mechanism to accomplish their goals. The grasshopper outbreaks of 1917 through 1924 provided a stimulus for further maturation of this entomology organization.[2]

About 160 species of grasshoppers occupied the various habitats of Montana. However, only a half dozen of these species caused significant agricultural damage to range and croplands during outbreak years. Four of this half dozen predominated in reports of the Montana Experiment Station and the State Entomologist's Office. In order to appreciate some of the various actors in this drama, one must first examine pertinent facts concerning the general biology and ethology of grasshoppers and several specific points about the handful of harmful Montana species.[3]

The climate of Montana generally allows grasshoppers only one complete life cycle (generation) per year. This cycle passes from the egg, through four to six nymphal stages (depending on the species), to the adult, then full circle again to the egg. This limited lifespan still provides sufficient time for the gradual growth of successive grasshopper generations until ideal weather, food

availability and other environmental factors enable them to reach outbreak proportions.

Adult grasshoppers deposit their eggs from midsummer through early fall at a depth of from one to two inches in the soil. A secretion, accompanying egg laying, glues these egg clusters and particles of soil together to form egg pods, providing protection from some predation and inclement weather. The various grasshopper species lay different numbers of eggs per pod and "choose" different types of egg laying sites. The majority of females lay from 200 to 400 eggs in areas which evolutionally have ensured high nymphal survival rates, usually around grass root zones and in undisturbed soils. Undisturbed, and usually weedy, areas like roadsides, headlands, rangeland and field margins provide ideal conditions for the success of grasshopper reproduction.[4]

During the autumn, eggs begin their initial development, but soon the chill of winter checks their progress as the cold soil imposes a state of suspended animation upon them. Protected by their pod structure and the insulating soil during the winter, the eggs hatch over a four-to-six-week spring period after the soil warms to 60° F. and precipitation stimulates egg growth. Larvae often hatch en masse after a soaking rain, although the rate and time of hatching depends in large part on the particular species involved. The stage of development reached during the fall

influences the variability in the time of hatching as well. Most eggs hatch between mid-May and mid-June.[5]

When the nymphs emerge, they begin consuming nearby green vegetation. However, grasshoppers eat plants selectively (again falling out according to species)--unless scarcity of their preferred diet leads them to feed on less desirable flora. Undeveloped wings, called wing pads, and a smaller overall body size distinguish nymphs from adult grasshoppers. As noted earlier, nymphs pass through four to six instars or stages, the length of which depends on weather conditions, food availability and other factors for growth. The most rapid development occurs under warm but dry conditions. Molting enables nymphs to pass from instar to instar as they grow and develop. During molting, the cuticle or outer skin splits along suture lines on the head and thorax, allowing the nymph to wriggle out of the old shell and expand its replacement skin.[6]

The grasshopper reaches its adult stage upon completion of the final molt. From late July through October adult grasshoppers emerge with fully developed wings and attain sexual maturity within two weeks. After mating, the females lay eggs for about three weeks. Adults feed ravenously and may migrate in search of food when population pressures mount and food supplies decline at their present location. Both nymphal and adult populations move about from field margins into fields and between fields. The

adult stage, with its greater mobility, represents an opportunity for increased crop invasion and destruction. Additionally, the mature grasshopper better withstands the onslaughts of disease, predation, weather, and chemical treatments.[7]

Grasshoppers particularly savor small grains, although they consume corn, alfalfa, clover, soybeans, flax, and other crops. Grasshoppers cause damage mainly through seedling destruction and progressive defoliation of older vegetation. They may injure crops beyond the estimations set by merely counting the numbers of invading pests by feeding on particularly susceptible parts of a plant. Shattered kernels and severed heads of small grains testify to such attacks. The failure of vegetable and legume seed crops demonstrates the grasshoppers taste for plant blossoms. Vegetation which provides grazing for domestic and wild animals suffers similar depredations during grasshopper outbreaks. Defoliation damage or immediate feeding destruction of the plant makes it unavailable for other feeders. Twenty-five to 75 grasshoppers per square yard, considered a heavy infestation, may result in the removal of all vegetation in an area as the grasshoppers indulge in a feeding frenzy, compounded by sheer numbers. Wind and water erosion may soon follow the complete denudation of the soil surface, bringing about "dust bowl" conditions similar to those in the U.S. during the 1930s.[8]

Predators and parasites serve major roles in controlling the populations of grasshoppers and moderating or ending serious outbreaks. Currently many entomologists believe that grasshoppers reach crisis proportions due more to the conjunction of favorable weather and bountiful food supplies than the failure of moderators of the ecosystem to fulfill their "missions."[9] However, once grasshoppers reach numbers well beyond the capacities of predators and parasites to control them, these elements of the ecosystem have little impact on controlling an outbreak.

While avoiding the technicalities of a detailed morphological description of the four major species of grasshoppers involved in the Montana outbreaks between 1917 and 1924, some points about each species require a brief review. The importance of these selected biological and ethological facts will become more evident as the grasshopper control campaigns and the entomologists' forays into predictive science for the years following major infestations are considered.

The adult Camnula pellucida (Scudder)--known commonly as the Roadside, Warrior, Yellow-Winged, or Clear-Winged grasshopper--sports a yellow to brown body and front wings. Large brown spots further differentiate this insect from the other three grasshoppers under consideration. The entomologists and agriculturalists of British Columbia referred to C. pellucida as the Roadside grasshopper due to

its habit of ovipositing (egg-laying) in the undisturbed soils of bare, dry roadsides. This grasshopper also commonly uses exposed, particularly overgrazed open ranges. Thus, human actions producing near ideal reproductive environments largely contributes to the rise of invasive populations of C. pellucida.[10]

C. pellucida congregates in limited areas if hatching occurs in critical threshold numbers. This concentration elicits changes in behavior during the first two instars, whereby the insect becomes increasingly gregarious and demonstrates migratory tendencies. C. pellucida also may exhibit the effects of these population pressures on behavior during later stages of development. The change from their normal solitary demeanor, when individuals tend not to wander, inspired some western states, including Montana, to refer to C. pellucida as the "warrior grasshopper." Under the aforementioned influence of overcrowding on their behavior, the adults may fly in diffuse swarms for short distances and females may travel long distances to communally oviposit in sod to create egg beds. Entomologists consider C. pellucida partly gregarious. As "hoppers" or nymphs this species prefers feeding on Gramineae (Poaceae), which include grain crops. C. pellucida is the major pest of pasture and rangeland.[11]

A second major grasshopper pest of the early twentieth century in Montana, the greenish yellow or olive Melanoplus

bivittatus (Say) or the Two-Striped grasshopper, receives its name from two yellow stripes extending from its head to wing tips. Assuring a sufficient food supply for its progeny and itself, the female regularly lays its eggs in sod or weedy terrain adjacent to favored crops. Confined mainly to the arid West, M. bivittatus concentrates on irrigated lands. Seeking humidity, the Two-Striped grasshopper frequents lowlands, woodland margins, and shaded mountain slopes.[12]

Cultivated habitats also attract M. bivittatus. They tend to select land which the agriculturalist has cultivated and then abandoned for several seasons. Like C. pellucida, the Two-Striped grasshopper prefers ovipositing in compacted soils. On the other hand, M. bivittatus often lays eggs in stubble which farmers leave after harvesting grain crops. Rapidly increasing in numbers when the conjunction of favorable circumstances permit it, the Two-Striped grasshopper devours cereal and other crops, including alfalfa.[13]

Melanoplus mexicanus atlanis (Riley),[14] the Lesser Migratory grasshopper, thrives in bunch-grass prairie and in open grasslands of short grass and compact sandy soils--a favorite environment for egg laying. However, the adaptability of M. m. atlanis enables it to exploit a wide variety of habitats. Adults characteristically possess reddish-brown, or dark olivaceous bodies with a black

pattern. Hoppers and adults tend to display solitary behavior. If overcrowding occurs, the adults may form loose swarms and migrate when the swarms reach a critical density. Females oviposit in grain stubble, alfalfa, weedy idle land and rangeland.[15]

Considered extremely dangerous to the health of agriculture due to its migratory behavior under outbreak conditions, the Lesser Migratory grasshopper repeatedly bore comparison to Melanoplus spretus (Walsh), the Rocky Mountain Locust. During the 1880's M. spretus devastated the farmlands of the West and mid-West, exceeding anything settlers had experienced in the Eastern United States or Europe. Only the locust plagues of Africa and the Middle East provided points for analogy. American and European entomologists speculated upon M. m. atlanis as an environmentally induced disguise for M. spretus. Physical differences appeared "small and relative" and observers demonstrated the instability of some characteristics. Systematists felt that M. spretus, like the locust found elsewhere in the world, represented the swarming phase of the same insect of which M. m. atlanis embodied the solitary state. According to the continued argument, drastic changes in the environment brought about by more extensive agricultural development furnished the major explanation for M. m. atlanis no longer emerging in the M. spretus migratory phase. Regularly in the midst of another M. m. atlanis

outbreak, speculation proliferated as to the interchangeability of the Rocky Mountain Locust and the Lesser Migratory grasshopper as species.[16]

Aulocara elliotti (Thomas), the Bigheaded grasshopper, caused much less grief and destruction between 1917 and 1924 then did the three previously described grasshoppers. However, it materialized often enough in contemporary documents to deserve mention. With a general grayish brown body shade, A. elliotti adults display a flash of deep blue on the hind tibia as they propel themselves forward. The disproportionately large head relative to the rest of its body accounts for the common name, Bigheaded grasshopper. The female oviposits between range plants in bare spaces. Normally feeding on rangeland grasses, A. elliotti sometimes attacks small grains and enters the fray with the other more persistent species.[17]

These enemies of agriculture reduced the independence of farmers both financially and intellectually. Rugged individualism in the face of such destructive forces invariably led only to failure, despair and abandonment of a life's work. It did little good to fight the pests in one's own field if neighbors did nothing in theirs, since grasshoppers moved so easily from field to field, especially at the adult winged stage. Proper organization and treatment required outside expertise.[18] Montana's entomo-

logical organization served this purpose for the state's agricultural community.

This organization consisted of Montana State College's Department of Entomology and Zoology (hereafter referred to as the Department of Entomology), the Experiment Station, and the State Entomologist's Office--all headquartered in Bozeman. The Eighth Montana Legislative Assembly appointed Cooley, as Experiment Station entomologist and head of the Department of Zoology and Entomology, the State Entomologist in 1903.[19] This network involved the Extension Service through its communication with and use of the Service's county agents.[20] The Montana Experiment Station developed insect control methods through research and experimentation carried on within the scope of the Department of Entomology's duties--information which the State Entomologist supplied to agents, farmers, and the general public. After collecting information on conditions around the state, the State Entomologist communicated with county agents and other leaders to organize campaigns for battling insect outbreaks and keep them abreast of prices for and sources of necessary supplies. Cooley assigned most of these duties to the Assistant State Entomologist. The organization also cooperated closely with the newly instituted State Department of Agriculture as per the Session Laws of 1921.[21]

The State Entomologist's Office encompassed many duties. Cooley confronted emergency insect situations and assisted in the prevention of a large number of less important losses." As the sounding board for problems in Montana, he kept the Department of Entomology informed as to the needs for particular lines of research. By 1911, the State Entomologist served on the State Board of Entomology as a member and secretary. This State Board oversaw anything affecting "the health of man and domestic animals." Neither the State Entomologist nor the State Board of Entomology positions provided compensation beyond Cooley's salary in the Department of Entomology, except for traveling, laboratory, and office expenses, and the salary of an assistant. The County Insect Pest Law of 1921 further required the State Entomologist to investigate any reported insect infestations to determine if a county should organize a campaign and use the law as a funding mechanism. The Insecticide and Fungicide Act of the same year required Cooley to check agricultural poison shipments for adulteration and mislabeling while the Pest and Plant Quarantine Law placed additional burdens on the office. Finally, the State Entomologist published an annual report covering insect problems of the year, including new insects found in Montana.[22] When an insect crisis struck--like the grasshopper outbreaks--Cooley neglected many of his less immediate responsibilities.

Cooley took great pride in this entomological organization. He pointed out that other states had separated the State Entomologist's Office from other duties and educational institutions. But in Montana, for the sake of efficiency and economy, the State Entomologist spread his duties among the Experiment Station, the Department of Entomology, and his own office. This arrangement avoided the duplication of the Entomology Department's 2,000 volume library, its 90,000 specimen insect collection, microscopes, cameras, various other equipment, and office spaces.[23] In his final report for the 1917-1924 grasshopper period, Cooley reflected on this organization, concluding that,

> The triangular combination of a centralized state office, a county pest act, and a system of county agents, provides an effective organization for this service and has resulted in the saving of millions of dollars to the farmers of the state of Montana.[24]

These "millions of dollars" would mean salvation for many Montana farmers.

The state entomological organization of Montana--led by R. A. Cooley in his capacities as State Entomologist, head of the Entomology and Zoology Department of Montana State College and its division in the Montana Experiment Station at Bozeman, and including the U.S.D.A. Bureau of Entomology in Billings and the Extension Service--played the primary role in the control and final eradication of grasshoppers in Montana between 1917 and 1924. Natural

controls, including weather, parasites, predators, and disease, rapidly lost their dominance over the grasshoppers and left the tasks of grasshopper population limitation to human interventions. As natural controls reached a point of negligibility during these years, the state entomological organization stepped into the breach to assure the ascendancy of Montana agriculture. Furthermore, through these interventions, Montana's entomological organization ensured the survival of many Montana farmers who otherwise would have failed.

The thesis is organized in a chronological fashion. The next chapter describes the slow increase in grasshopper troubles from 1917 through 1920 and the gradual dominance of human intervention over the grasshoppers as natural controls failed. The first inklings of major trouble appeared in 1917, followed by 1918, a year of respite. But 1919 produced another reversal and increased problems. By 1920 Cooley and his organization planned for continued problems and the need for a strengthened and fully funded effort.

Chapter 3 deals with the clear failure of natural controls to keep grasshopper populations within bounds during 1921. Though predators and parasites appeared in abundance, they could not deal with the abnormal masses of grasshoppers. In response, the State Entomologist's Office turned increasingly to the poison bait method of control,

improving the formula and the timing of treatments for greater efficiencies. When the difficulties of funding became apparent, passage of the County Insect Pest Law of 1921 provided a mechanism for purchasing supplies and equipment for the grasshopper campaigns. The State Entomologist began pressing for increased funding when levels were too low to meet insect emergencies and gain maximum savings for farmers.

Chapter 4 considers 1922--the worst of the eight-year period. With increased pressures on personnel and funds, counties faced legal spending limitations. Meanwhile, Cooley stressed the inadequacies in funding for personnel, office expenses, and traveling necessary for his own office. Counties decried the weaknesses in the funding procedures of the County Insect Pest Law and joined with Cooley in advocating changes. The State Entomologist's Office expanded the scope of survey work to provide information to farmers and the legislature of 1923.

Chapter 5 discusses the mixed news for state entomology forces. The 1923 state legislature slashed the State Entomologist's Fund from $3900 to $450 because of a technicality in the 1903 law which originally had authorized the allocations. As a result, Cooley freed A. L. Strand of his duties as Assistant State Entomologist and depended on correspondence and federal personnel to control the outbreaks. Though still a bad year, 1923 had fewer and less

extensive outbreaks than 1922. The year ended with the Grasshopper Conference held in Great Falls during August. Its resolution committee developed plans to approach the federal government for assistance.

The final chapter addresses 1924, the last year of the grasshopper outbreak. With inadequate allocations from the legislature, Cooley turned to the private sector for assistance. Montana banks supplied a revolving fund for his office to be repaid by legislative allocations during each session. Railroads allowed a half-rate for grasshopper bait supplies shipped along their lines. Still, no one would accept the position of Assistant State Entomologist because of the precarious nature of funding. Despite these and other difficulties, Montana's entomologists helped many farmers to survive the insect plague.

## NOTES

1. Robert A. Cooley received his degree from Massachusetts State College. His official positions at Montana State College included: Professor, Zoology and Entomology, 1899-1923; Experiment Station Zoology and Entomology, 1899-1906; Experiment Station Entomologist, 1906-1937; Professor, Entomology, 1923-1931; and Consulting Professor, Entomology, 1931-1937. He also served as the head of the Zoology and Entomology Department, the Entomology and Zoology Department, and the Entomology Department until 1930, and as a member of the State Board of Entomology and the State Entomologist during the period 1917 to 1924.

2. A. Hunter Dupree, Science in the Federal Government: A History of Policies and Activities (Baltimore: The Johns Hopkins University Press, 1985), p. 158; A detailed description of what the state entomology entailed follows particulars on the major grasshopper species involved in the outbreaks.

3. Bob Gillespie and Ron Wight, Crop & Rangeland Grasshopper Management Guide, Tech Bulletin 85-2 (Helena, MT: Montana Department of Agriculture, [n.d.], p. 3.

4. Gillespie and Wight, Grasshopper Management Guide, p. 6; Robert E. Pfadt, "Insect Pests of Small Grains," in Robert E. Pfadt, ed., Fundamentals of Applied Entomology, 4th ed. (New York: Macmillan Publishing Company, 1985), p. 257.

5. Gillespie and Wight, Grasshopper Management Guide, pp. 6-7; Pfadt, "Insect Pests," in Pfadt, ed., Fundamentals, p. 259; B. P. Uvarov, Locusts and Grasshoppers: A Handbook for Their Study and Control (London: The Imperial Bureau of Entomology, 1928), p. 39.

6. Pfadt, "Insect Pests," in Pfadt, ed., Fundamentals, p. 259; Gillespie and Wight, Grasshopper Management Guide, p. 4.

7. Gillespie and Wight, Grasshopper Management Guide, p. 4; Pfadt, "Insect Pests," in Pfadt, ed., Fundamentals, p. 259.

8. Pfadt, "Insect Pests," in Pfadt, ed., Fundamentals, p. 255.

9. Ibid., p. 260.

10. Ibid., p. 258; Uvarov, Locusts and Grasshoppers, p. 293.

11. Uvarov, Locusts and Grasshoppers, p. 293; Pfadt, "Insect Pests," p. 259.

12. Pfadt, "Insect Pests," pp. 258, 259; Uvarov, Locusts and Grasshoppers, pp. 299-300.

13. Uvarov, Locusts and Grasshoppers, pp. 299-300.

14. Entomologists often shortened this trinomial designation for the Lesser Migratory grasshopper to Melanoplus atlanis.

15. Uvarov, Locusts and Grasshoppers, pp. 294-297; Pfadt, "Insect Pests," in Pfadt, ed., Fundamentals, pp. 257, 259.

16. Uvarov, Locusts and Grasshoppers, pp. 294-297.

17. Pfadt, "Insect Pests," in Pfadt, ed., Fundamentals, pp. 257-259.

18. John T. Schlebecker, "Grasshoppers in American Agricultural History," Agricultural History 27, no. 3 (July 1953): pp. 92-93.

19. In 1917 the Zoology and Entomology Department entered its eight year stint as the Entomology and Zoology Department. When this aggregate of academics occupied Lewis Hall upon its completion in 1924, Entomology and Zoology split asunder. R. A. Cooley headed the new Department of Entomology and Professor Spaulding took charge of Zoology. These years coincide with the grasshopper outbreak. See "History of the Department of Zoology & Entomology, Montana State University," pp. 5-6, File "Entomology and Zoology Research," Drawer "Departmental Histories," Montana State University Archives, Bozeman, Montana.

20. The Department of Entomology had no division within the Extension Service as it did in the Experiment Station. See "Experiment Station Report of the Entomology Department," [n.d.], File "Summary of Work Reports, 1920-1925," Acc. 00016, Box 1 of 15, Montana State University Archives, Bozeman, Montana.

21. F. B. Linfield, "Twenty-Fifth Annual Report For the Fiscal Year Ending June 30th, 1918," February 1919, p. 159, in Agricultural Experiment Station, Montana: Bulletins and Circulars, vol. 18, Montana State University Archives, Bozeman, Montana; "State Organization for the Control of Insect Pests," in "Report of Grasshopper Conference Held at Great Falls, Montana, August 32, 1923," File "Grasshopper Conference, Great Falls, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; A. L. Strand to Dorothy Lampen, 26 February 1921, File "Insect Control (General) 1921-1922, 1930-1949," Acc. 00016, Box 4 of 15, Montana State University Archives, Bozeman, Montana; "Experiment Station Report of the Entomology Department," [n.d.]; R. A. Cooley, "Montana Insect Pests for 1923 and 1924: Being the Twentieth Report of the State Entomologist of Montana," January 1925, Bulletin 170, p. 10, in Agricultural Experiment Station, Montana: Bulletins and Circulars, vol. 21, Montana State University Archives, Bozeman, Montana.

22. Cooley, "Montana Insect Pests for 1923 and 1924," Bulletin 170, pp. 7-10; R. A. Cooley, "Fourteenth Annual Report of the State Entomologist of Montana," December 1916, Bulletin 112, p. 61, 62, in Agricultural Experiment Station, Montana: Bulletins and Circulars, vol. 16, Montana State University Archives, Bozeman, Montana; Linfield, "Twenty-Fifth Annual Report," pp. 134, 162; R. A. Cooley, "Eighteenth Annual Report of the State Entomologist of Montana," January 1921, Bulletin 139, pp. 11-12, in Agricultural Experiment Station, Montana: Bulletins and Circulars, vol. 19, Montana State University Archives, Bozeman, Montana.

23. Cooley, "Fourteenth Annual Report," Bulletin 112, p. 61; Cooley, "Montana Insects for 1923 and 1924," Bulletin 170, p. 12; F. B. Linfield, "The Work of the Montana Experiment Station: Thirty-First Annual Report, July 1, 1923, to June 30, 1924," February 1925, p. 33, in Agricultural Experiment Station, Montana: Bulletins and Circulars, vol. 21, Montana State University Archives, Bozeman, Montana.

24. Cooley, "Montana Insects for 1923 and 1924," Bulletin 170, pp. 9-10.

# CHAPTER 2

## TRANSITION: NATURAL TO HUMAN CONTROLS

Events of the years 1917 to 1920 demonstrated the gradual shift from the natural suppression of grasshoppers in Montana with little active participation by state entomologists to the growing need for intervention by the State Entomologist's Office and its interwoven fabric of the state entomological organization. R. A. Cooley and his forces accepted the challenge of saving Montana agriculture from the swelling waves of voracious insects. But even after the first four protracted years of struggle, Montanans had not suffered the worst that grasshoppers could provide nor had Montana entomology won its greatest victories against this six-footed bane of farmers.

### 1917: Resurrection

In autumn 1916, county agents, agriculturalists, and other observers notified the State Entomologist's Office that abnormal numbers of grasshoppers had infested the Flathead Indian Reservation during the summer. Melanoplus atlanis did the most damage in scattered areas of the state "climbing the full-grown grain stalks and cutting off the heads" and slightly injuring "newly seeded winter wheat."

Montana's Assistant State Entomologist, H. L. Seamans, surveyed the area of the reports in mid-April of the following year.[1] He promptly discovered grasshopper eggs and physical remains of the previous season. Recognizing the potential for trouble, the State Entomologist's Office in Bozeman notified county agents in neighboring counties to prepare for an outbreak.[2] Cooley reconstituted the organizational machinery in 1917, which would fight the grasshoppers for the next eight years and ward off the total collapse of agriculture in Montana. Luckily, a combination of natural controls and artificial interventions directed by the State Entomologist's Office prevented major damage in 1917.

Western Montana witnessed the feared outbreak in 1917. In the opinions of farmers and the state's entomologists it suggested the grasshopper plagues of pioneer days. Below normal precipitation and abnormally high summer temperatures created ideal breeding conditions for grasshoppers. County agents reported large grasshopper concentrations in Flathead, Sanders, and Missoula Counties in a 70 mile area from Stevensville to Flathead Lake. The infestation soon spread to other parts of the state. Other large areas of trouble appeared in Cascade, Chouteau, Blaine, Phillips, Valley, Sheridan, and Richland Counties. Farmers and agents also reported damage through western Gallatin and southern Broadwater Counties. The pioneer outbreaks had

involved Melanoplus spretus, the extinct Rocky Mountain Locust, which scoured large areas clear of crops and native vegetation for a series of years in the latter half of the nineteenth century. But the twentieth-century visitation of other species, the most widespread and damaging in over twenty-five years, consumed crops and defoliated orchards and native trees. Urban dwellers also watched helplessly as vegetable plots and prized landscaping disappeared beneath hordes of hungry insects.[3]

In some areas of the infestation nearly all green vegetation served as nourishment for the armies of grasshoppers. Through the passing season and the pressures of crowding, these invaders attained their winged forms and flew to fresh feeding areas, generalizing the outbreak beyond its earlier locus. Immigration replenished the numbers of grasshoppers which control crews had not long before managed to destroy. It seemed that if only the agricultural community persevered and defeated this plague, most farmers would overcome this setback and prosper, but the weather failed to cooperate. Many crops saved by the insect control programs fell before the equally devastating drought.[4]

World food demands, exacerbated by World War I European manpower and cropland destruction, dictated increased attention to the wastage of agricultural products. As one of the guardians of agriculture in Montana, Cooley acknowl-

edged the role of entomology in general and of his office in particular in assuring the continuing supply of food and fiber. World food shortages and the fact that at least ten percent of agricultural yield fell to insect pests each year stressed the need to limit feasting by these uninvited guests.[5]

The county agents served as the major contacts for the State Entomologist's Office in accomplishing its duties in controlling insect pests. The daily field work necessary in implementing recommendations fell on the shoulders of these agents. Familiarity with conditions in their assigned areas and closer working relationships with local people positioned county agents better to assist farmers. The State Entomologist's Office sent assistants to give lectures and demonstrations of control techniques and provided current information on sources and prices of materials for poisons and other insect control supplies.[6]

Assistants from the State Entomologist's Office remained in the field for two months working with county agents and farmers. On May 30, Seamans resigned his position as Assistant State Entomologist to accept a field assistantship with the U.S. Bureau of Entomology. A. L. Strand, who graduated in the entomology curriculum of Montana State College in 1917, assumed Seamans's vacated post on June 1st.[7] To meet further demands for manpower during the crisis, Cooley employed two senior entomology

students, C. L. Corkins and Kenneth M. King. The State Entomologist Fund of $2,700 failed to meet the needs of the 1917 grasshopper outbreak and the Chancellor of the University furnished an additional $1,000 after Cooley appealed for additional funds.[8]

At the federal level, Montana enjoyed the cooperation and assistance of the Bureau of Entomology, a division of the U. S. Department of Agriculture. During June and July of 1917, C. W. Creel, the supervisor of the Forest Grove Entomological Station in Oregon, and his assistants helped the state entomological forces of Montana to battle the grasshopper menace. When farmers proved unwilling to treat their own property if vacant and public lands remained untreated, the Federal government funded treatment on some of the public lands. This action prevented much reinfestation by migrating grasshoppers.[9]

State entomologists failed to identify the species of grasshoppers in the 1917 outbreak beyond the point of the genus, Melanoplus. The Rocky Mountain Locust of fifty years earlier received the brunt of accusations since the 1917 species shared similar migratory habits and comparably large wings. Admitting to his bafflement, Cooley asserted that even if this species proved technically different from Melanoplus spretus, "there is [still] much reason to [fear] that it may be capable of quite as much damage as was done in the old days."[10]

New and old methods of grasshopper control commingled in the 1917 campaign. Local conditions and the state of the art dictated the choice of particular techniques. Major factors determining the method included the extent of the infestation, the crop type, farmer cooperation, availability of materials, and accessibility of labor and time. Approaches to attacking the problem included grasshopper-catching machines, cultural controls, poisoned bran mash, and other minor methods.[11]

With grasshopper-catching machines farmers trapped live grasshoppers for later use as poultry feed. Farmers perceived the machines as less expensive than other techniques and providing a usable byproduct. The cheaply built cage-like device measured about sixteen feet in width. Farmers drew it with a pair of horses, one on either side, through a grasshopper infested field. As the disturbed insects leapt before the advancing machinery, they struck a tin sheet attached to the front, fell into a trough and collected in a large bin area at the rear. Usable in low-growing crops, it proved unacceptable in ripening grains, corn, and well developed seed alfalfa because of the damage it caused to the vulnerable plants. Rough terrain precluded its use in many other areas.[12]

The State Entomologist's Office touted the usefulness of the catching-machine's byproduct--tons of dead grasshoppers.[13] Basing recommendations on the experiments of J. S.

McHargue of the Kentucky Experiment Station, which demonstrated the 75 percent protein rating of dried grasshoppers, Cooley's office advised farmers to take advantage of a rich resource otherwise discarded. Such protein ration stimulated chicken "egg production to the highest degree." Since prolific egg laying depressed summer markets farmers could "collect and dry grasshoppers during the summer months and feed them to poultry during the winter," thereby earning higher egg prices. Thus the farmer "[paid] for his machine, [made] a good wage for himself and team, and [prevented] grasshoppers from destroying his crops." Through the aid of the State Entomologist's Office farmers sold surpluses of dried grasshoppers to others requiring winter feed. This apparatus faded in popularity with professional entomologists and agents as they acknowledged the greater efficiencies of other methods which killed more grasshoppers or prevented them from reproducing easily. For the moment, Cooley and his entomologists recommended a combination of the catching machines and poison baits.[14]

Cultural control methods comprised another method of battling grasshopper proposed to farmers by the State Entomologist and county agents. Plowing, harrowing, disking--all classified as cultural treatments--destroyed eggs before they developed and hatched. The Montana experiment station, on the advice of Cooley and others, recommended disking the ground or working it with a spring-tooth harrow

"lengthwise, crosswise, and cornerwise" three inches down in October or November. If plowing in the late fall or early in the spring, they increased the recommended depth to six inches. In this way, entomologists hoped that the egg pods suffered breakage, scattering, and exposure to surface weathering and predation.[15]

However, state entomologists also noted the impracticality and futility of the cultural method in many Montana situations. "Large areas of dry, hilly ground, open range, and unused private or government land" prevented the use of cultural controls due to jurisdiction problems and added expenses. They provided breeding grounds during grasshopper outbreaks from which they continuously migrated onto treated lands under the right conditions. Sparse settlement of Montana tracts dictated focusing on grasshoppers at the nymphal and adult stages rather than attempting to prevent outbreaks at the egg stage on a sufficiently broad scale.[16]

In the opinions of the State Entomologist's Office, the Experiment Station, and the Department of Entomology, poisoned baits provided the most successful and promising method for controlling grasshoppers at the nymphal and adult stages. The formula for the poisoned bran mash in 1917 consisted of bran, Paris green or white arsenic, salt, cheap molasses or syrup, lemons or oranges, and water. The poisoned bran killed nymphal and adult grasshoppers and

allowed the treatment of crops susceptible to damage by the catching-machinery. But at thirty-five to fifty cents per treated acre, many farmers found the treatment too expensive in hard times. Farmers often objected to the expense and care needed to apply the poison bran properly. To alleviate part of the cost complaints, the Bozeman office suggested subscription lists for donations to insect campaigns. However, a few contributors often paid the lion's share of costs.[17]

Farmers who could afford the costs found they could spread large amounts of the poisoned mash more quickly from the rear of wagons. Often lined up alongside one another in a spirit of cooperation, the workers overlapped the spread areas of adjacent fields and covered a greater area more completely in less time. Automobiles served the same purpose as the modern equivalent of the wagons. Even with such strategies, the State Entomologist's Office advised against attempting to treat all vacant lands. Instead, Cooley and his assistants counseled farmers to find and poison the grasshoppers when they concentrated in green areas during dry periods following the spring rains. This included areas along creeks, draws, and waterholes where the vegetation thrived in moister microclimates. Through observation of the behavior of grasshoppers during various parts of the day, the state entomological authorities suggested that workers distribute the poison from three to

five in the afternoon and between daylight to eight in the morning. They noted that grasshoppers fed best after the sun had warmed them in the morning and a few hours before evening. Entomologists thus increased the bait's efficacy by making sure farmers spread it at the proper feeding times.[18]

The demands for collective action against the grasshopper infestations--especially with the poison bait method--dictated the organization of farmers and communities. The State Entomologist's Office assigned an employee to enter a troubled area first to gather information on existing conditions, grasshopper abundance, and damage. At meetings called by the county agents, farmers and other concerned citizens learned from the agent and an entomologist sent from Montana State College about the grasshopper's life history, the area's present situation, and a comparison of conditions in other districts. Committees comprised of farmers and townspeople often arranged for the purchase, mixing, and distribution of the poisoned bait.[19]

Farmers and other applicators of the poison bran mash often doubted its efficacy when they could see no immediate results. Therefore, the State Entomology Office published details on what would happen after treating an area. The poison worked slowly, taking five or six days. By the second full day, grasshoppers usually stopped feeding but continued to move about for three or four days before

dying. Observers might not find large numbers of dead grasshoppers since the poisoned ones sought damp, shaded places before dying. Birds, other animals and insects also carried dead grasshoppers off for food. The farmer had to judge the success of poisoning by the numbers of living grasshoppers remaining, though grasshoppers from adjacent untreated areas might skew the numbers and convey a false perception that the initial treatment failed. Fifty to 75% of grasshoppers died from a proper first application. A second treatment after four or five days raised the fatality rate to 80 or 90%.[20] By providing more details about what farmers should expect, officials hoped to limit discouragement and to maintain support for the program by the public.

Poisoned bran mash also served as the ideal solution to grasshopper attacks on orchards. The grasshoppers ate the leaves and bark, causing abnormal development and stunted growth. The department encouraged shaking the insects from young trees after broadcasting the poison mash on the ground. Consuming the mash before returning to the trees, the grasshoppers died within a day or two.[21]

County agents and the State Entomologist's Office constantly reminded people that the grasshopper bait contained poison--either arsenic or Paris green. During the 1917 campaign, many horses, hogs, and poultry consumed the bran mash and died. After investigation, the State Entomologist

decided that carelessness contributed to all the accidents. Seven hogs died because of a mixup in feed sacks on one farm. On others, horses nosed open tied sacks of poison mash and feasted on their last meals.[22]

Other methods, not requiring community organization or specialized equipment, served the needs of some agriculturalists. Grasshopper swarms in weed patches, vacant city lots, and along roadsides died in controlled burns. Young hoppers gathered beneath old straw after hatching also met death by flame. Grasshopper aversion to excessively wet areas suggested the use of irrigation as a control. Finally, the state agricultural authorities believed that large flocks of turkeys and chickens consumed many grasshoppers so they encouraged poultry raising as a hedge against undue damage.[23]

No single artificial intervention gained absolute favor from Bozeman entomologists. Each approach had its uses Poison bran mash provided the best results in ripening crops and under conditions where the grasshopper catching-machine could not physically operate or would damage maturing crops. But the poison bait proved less viable under wet, cool conditions when grasshoppers slowed and fed less readily and the poison lost its potency quickly. Fire treatments succeeded against grasshoppers only in their nymphal and adult stages since they normally oviposited too deeply for farmers to kill their eggs. Cultural methods

faced the same constraints as the catching machine; irregular topography and rocky soils prevented plowing, harrowing and disking in many areas of Montana. Dry land farmers normally had no access to irrigation, so they had to depend on the other approaches. Flocks of poultry might provide farmers an agricultural alarm clock, but they quickly satisfied their avian appetites in a major grasshopper outbreak without significantly limiting insect numbers. Thus, in 1917 Montana entomologists had not settled on any one primary method to battle an old foe of humanity.

Natural controls also played a role in the 1917 outbreak. Blister Beetles, Epicauta maculata (Say) and Epicauta pennsylvanica, fed on grasshopper eggs and appeared in large numbers with the grasshoppers. In and around the area of Flathead County, flesh flies, Sarchophaga, laid their young on the bodies of adult grasshoppers. After feeding on these adults, which died in the process, the young emerged as adult flesh flies. Numerous dead grasshoppers testified to the presence of this parasite.[24]

To predict the prospects for 1918, the entomologists of the state college advised farmers and county agents on methods of surveying for grasshopper eggs. Depending upon where grasshoppers had been numerous in the 1917 season, farmers should examine the soil around the roots of grass, clover, and alfalfa. In bare soil the observer scraped away the surface to a depth of two inches. If he or she

discovered one or more egg masses per square yard over an extensive area, the locale might expect grasshopper problems the following season. During May and June of the following year farmers watched for hoppers of around a quarter inch. If they found them in abundance, farmers prepared to battle them as they attained the injurious stage. In addition, the observer reported the presence of many eggs or hoppers to the State Entomologist in Bozeman. Cooley would then send someone to inspect the area and recommend appropriate control measures.[25]

As an added precaution, Cooley sent his assistants to the regions where significant damage had occurred during the year to survey for grasshopper egg-laying activity. On the basis of the species of grasshopper eggs and the extent of egg-deposition discovered, he could establish whether Montana should expect a repeat of grasshopper troubles in 1918. When no eggs materialized during the extensive survey, Cooley confidently predicted no major outbreak for 1918.[26] But, grasshoppers had played out only the first round of an eight-year struggle. Interventions in the outbreak areas by agents and other county leaders under direction from the State Entomologist's Office, natural parasites, and the arrival of colder weather all combined to control grasshoppers in 1917--not a particularly bad year in retrospect.

## 1918: Pause and Hope

Cooley and the state entomological organization learned quickly from the destructive grasshopper experiences of 1917. Early in 1918, they attended closely to evidence of mass hatching, especially in areas which had suffered the heaviest damage the previous year. The Entomology Department took advantage of the prior outbreaks by refining methods of control, particularly the use of poisoned bran. At the same time pressures and demands arising from the war dictated the general directions for national agriculture. The U.S. and Canada served as the breadbasket for Europe. This required an emphasis on practical results and left less time for basic research--maximization of food production over satisfaction of mere intellectual curiosity. Montana farmers tried to meet the increased market needs and take advantage of the higher food prices by increasing the acreage planted--acreage now increasingly threatened by the fellow travelers, grasshoppers and drought.[27] For the second year, the state entomological services worked in tandem with natural enemies of the grasshopper to control scattered outbreaks and head off losses and financial ruin for many Montana farmers.

Research lagged behind the pace of other years. Investigations bore only indirectly on the world war as the department focused entomological research and outreach

activities on methods of increasing agricultural production. The necessity of applying existing knowledge to increase crop yields and the shortage of staff personnel, as they received notice for war service, decreased support for long term studies. Student numbers dwindled as young Montanans answered the call of the "war to end all wars" and female students stayed home to fill in for military-bound brothers. In response, Montana State College temporarily furloughed faculty and reduced departmental budgets, further eroding the possibility of completing projects. In the autumn of 1918, the Spanish influenza struck station workers and necessitated the abandonment of offices and laboratories, and the transformation of the College agricultural building into a temporary hospital.[28]

Yet Montana entomologists managed to accomplish significant work despite these obstacles. They contributed to the life history studies of various insects in general and assembled disparate information on grasshoppers in particular. Field workers applied this knowledge in control measures to improve agricultural production and to contribute, in their own ways, to the war effort and the advancement of their science.[29]

Representatives from the State Entomologist's Office inspected areas reporting grasshopper damage, finding it less severe then the 1917 outbreak. Unlike other years between 1917 and 1924, Cooley compiled no outbreak map for

the 1918 season, emphasizing his perception of a lull or a probable end to the trouble. June, the hottest month of the year, provided low precipitation, warm winds, and dry days and promised grasshopper problems. However, July and August guaranteed a successful wheat crop with a return to normal precipitation. Some areas witnessed the return of the poorly identified Melanoplus, which the office again compared to the Rocky Mountain Locust. However, Camnula pellucida (Yellow-Winged or Warrior locust), Melanoplus bivittatus (Two-Striped locust), and Aulocara elliotti (the Bigheaded grasshopper) caused the majority of damage.[30] Although the Yellow-Winged grasshopper inflicted significant damage in the Bitter Root Valley of Ravalli County, it did not migrate. Observers also reported unidentified grasshopper species in Rosebud, Madison, Fergus, Sweetgrass, Meagher, and Cascade Counties. The unspecified Melanoplus reappeared in southern Broadwater and eastern Gallatin Counties, where it consumed thousands of wheat acres. J. R. Parker,[31] Assistant Station Staff Entomologist, and Cooley surveyed the area in September but found neither traces of the adult grasshoppers nor signs of egg-laying.[32]

The State Entomologist's Office compiled and distributed the looseleaf bound book, Standard Control Methods, Insect Pests of Montana, to county agent offices in order to impose some degree of uniformity on the advice of agents

to farmers and further increase the strength and efficiency of the state entomology organization. Through this book, the department also sought to assist agents in insect pest identification. Based on the collective experience of department entomologists, the book attempted to bridge the gaps in the county agents' knowledge of a specialized science. With occasional updates, the department retained its currency of information. According to Standard Control Methods, county agents should recommend the standard methods of treatment for the state as described in the text, after they positively identified an insect. The Department of Entomology would classify questionable insects, but they found it necessary to remind agents to "never send insects in letters." The Committee on Insect Pests, formed to deal with the increasing likelihood of trouble, expected the county agents to report any serious outbreaks to the College's department of entomology. When practical, the office sent one of its own men or a representative of the federal Bureau of Entomology to ascertain the situation and organize a campaign and demonstrations of control methods.[33]

The U.S.D.A. Bureau of Entomology continued its cooperation with Montana's entomological services in the second year of the grasshopper war. The Food Production Act provided funds for the Bureau to supply field extension entomologists in association with agricultural colleges and

experiment stations. Through this agreement, two Bureau entomologists specializing in insects of cereal and forage crops served in Montana under the direction of the State Entomologist.[34]

Personnel problems also plagued the grasshopper fight. Cooley found it necessary to recommend to F. B. Linfield, Director of the Experiment Station, that he not remove Parker from grasshopper work in the future.[35] Parker had left his research work from March through August, 1918, in order to conduct extension work in rodent control and entomology at the behest of F. B. Linfield. This included the critical period for insect damage. Much valuable time passed, since the spring months served as the best time for Parker to progress in his grasshopper experiments. He lost a month of this time anyway due to a bout with scarlet fever. On the other hand, Parker expressed his excitement at the prospects for proving himself in entomology and asked J. A. Hyslop, Extension Entomologist of the Bureau of Entomology in Washington, D.C., about promising projects he could pursue. Hyslop directed Parker's attention back to the needs of grasshopper control, based on the experiences of the previous year's outbreaks.[36]

The pressure on the State Entomologist's Fund, in no small part due to the grasshopper troubles, forced Cooley to accept an arrangement with the Bureau of Entomology. Through this agreement Strand, the Assistant State Entomol-

ogist, temporarily left his position and served as a field assistant with the Bureau out of Bozeman. Strand continued along lines of work similar to his duties as assistant to Cooley until the military inducted him in June, 1918. The loss of Strand and others had forced the movement of Parker out of his usual research work as assistant station entomologist during the crucial period in grasshopper troubles. As the war continued to draw away his staff, Cooley lamented that "before long Parker and I will be the only ones left here in the entomological force." Cooley even considered the prospect of enlisting some of his better entomology students in departmental work to fill the personnel vacuum. The department also looked upon women as a potential source of entomologists and workers. Thus, Cooley, as head of the Entomology-Zoology Department of the College, submitted articles to Montana newspapers outlining opportunities for women as scientists, biological illustrators, library researchers, and laboratory technicians--all with a strong focus on entomological science. The war-spawned personnel shortages had opened opportunities for women in entomology. These prospects ended with the war and the return of male staff members.[37]

Along with the continuing difficulty of maintaining staff in the entomological organization, Cooley foresaw no expansion in the scope of responsibilities for the coming two years. The events of each year determined the focus of

the office and the department and the spending from the State Entomologist's Fund. An outbreak of destructive insects triggered investigations in the field and work in the laboratories at Bozeman as the organization went into action to head off the worst of the damage.[38]

The State Entomologist credited parasitic flies (Sarcophaga spp.) with stemming the tide of the grasshopper outbreak of 1917 and even more so in 1918. As a result grasshoppers inflicted little damage in Flathead, Missoula, and Sanders Counties--the area which had received the brunt of the infestation and agricultural losses in the previous year. These flies also prevented a major outbreak in Gallatin and Broadwater Counties.[39]

However, entomologists did not leave the suppression of the 1918 grasshopper outbreak entirely to natural enemies. Under the supervision of county agents and others working though the office in Bozeman, farmers spread poison bran mash and crisscrossed fields with catching-machines in the most heavily infested sections of the state. Beyond crop damage, some farmers complained about grasshoppers eating their binder twine before hired hands could stack the grain. Bozeman advisors recommended a strong "Kreso Dip" to discourage the insects' omnivorous appetites.[40]

Noting the high cost for the ingredients in the poison bran, researchers at the college attempted to remedy the situation. Farmers viewed the expense as the major reason

for not using the poison method. Lemons sold for $12 per case in 1918--too expensive to waste for attracting insects. Amyl acetate (banana oil) seemed promising as a substitute. In field tests near McIntire, W. B. Mabee found amyl acetate equal to lemons, while H. L. Seamans thought it had failed to attract as well in his Fort Benton trials. In desperation, others tried vinegar without success. Beer had also crossed the entomologists' minds, but Cooley felt "it may be best to put the arsenic and beer together before we allow the latter out of our sight."[41]

By the end of 1918, the entomology department had collected valuable equipment and source materials to carry out its mission more efficiently. The insect collection, important in identification and teaching, contained 80,000 specimens, while the entomology library held 550 volumes and 800 pamphlets. Cooley made his 5,000 books and pamphlets available to the department for research. In addition, the department subscribed to twenty different zoology and entomology journals. Numerous drawings, prepared by departmental personnel, depicted "enlargements of insects and parts of insects" for the edification of students and farmers. Cooley worried that all this valuable material could vanish in a fire within twenty minutes. The collected knowledge of Montana insects, representing years of dedicated research, would instantly disappear with the firetrap that housed it. He added the need for a new home

for entomology to his agenda--belying his earlier plans for no expansion in the work of the State Entomology Office.[42]

Along with aggressive control measures by farmers, agents, and county leaders under the direction of the state entomology organization, the parasitic flies (Sarchophaga) dealt a fatal blow to multiplying numbers of grasshoppers. Parasites limited the amount of insect damage to crops over 1917 and 1918 and prevented grasshoppers from reaching "plague" proportions. Reported outbreaks during 1918 fell below those of 1917 and required less intervention, still paid for on an individual subscription basis.[43]

Thus, 1918 does not clearly demonstrate the necessity for nor the success of the state entomology organization's interventions. World War I had created increased demands for food and fiber at the same time it siphoned away money and personnel who supported agriculture through their labors. Fortunately, the lower grasshopper damage in 1918 required less attention than in 1917, so the entomological organization could get along with fewer people. The State Entomologist and other observers credited parasitic flies for maintaining low grasshopper levels and alleviating a potentially serious outbreak in Montana. Cooley took this relatively calm interval to educate the department's contacts in the field about insect problems and the need for a strong organization to meet insect emergencies. Somewhat alleviating the shortage of personnel and helping to inform

farmers on insect situations, the federal Bureau of Entomology cooperated closely with the State Entomologist's Office. In efforts to make the poison bran method of grasshopper control more acceptable to farmers, station researchers began substituting amyl acetate for the more expensive lemon attractants, though nothing definitive resulted from this limited testing with amyl acetate. Finally, the accumulation of a valuable insect collection, library, and other resources enabled the state entomological organization to more easily identify insect pests and use the latest information on treatments to assist the agricultural community of Montana.

The latter half of the 1917-1924 period provides greater evidence for the state entomology organization's part, with its more conscientious accounting procedures and records of expenditures and savings--a requirement brought about by the need for better financing of the intensifying grasshopper campaigns at the state and county levels. The events of 1919, the turnaround year in terms of outbreak severity, brought these money problems to the fore.

## 1919: Plowshares into Swords

Montana farmers benefited little from higher agricultural prices, generated by the demands of the world war years--years when patriotism demanded "[borrowing] money, [to] buy more land, grow more wheat, [and] produce more

meat and wool." The temptation of large profits induced many to gamble with climate and pests by farming marginal lands. A third consecutive drought year, 1919 was the driest of the last forty years. High temperatures and a general lack of rain characterized the critical summer season. What the drought failed to destroy, grasshoppers ravenously consumed as insects profited from human folly.[44] Cooley redoubled the efforts of state entomology through his positions in the Experiment Station, the Department of Entomology, and the State Entomologist's Office--and with the cooperation of the Bureau of Entomology and the Extension Service--to challenge the grasshoppers' increasing dominance over the fate of state agriculture and contributed to the salvation of Montana farmers from financial ruin. With Cooley's increased pressure on the legislature for additional funding and the decreasing effectiveness of parasites and other natural controls to equilibrate grasshopper populations at low damage levels, 1919 represents a year of change for this eight year period--a change for the worse.

Three species participated in the 1919 infestations, but a major actor--Melanoplus atlanis--took no encore for the season. Camnula pellucida, the Warrior or Yellow-Winged grasshopper, attacked grain fields in ten Montana counties. It also appeared in significant numbers in most other parts of the state, including Gallatin, Missoula, and

Beaverhead Counties. C. pellucida became such a serious problem that the State Entomologist's Office concentrated personnel in fighting this pest and assisting farmers in proper methods of control. When the traveling fund finally gave out, the office had to forsake further direct personal assistance and rely on the mails, telegraph, and telephones to work through county agents and other designated agricultural and county leaders. Cooley noted this financial weakness in the system and struggled to improve funding, personally lobbying whomever he felt had any influence.[45]

Along with the usual suspects from the two previous seasons, another species reappeared. The Bigheaded grasshopper, Aulocara elliotti, had last caused major problems in 1903. Great numbers reemerged in 1919 accompanied by a normally minor species, Eritetix tricarianata, which provoked concerns in the eastern part of the state. Parker and Strand encountered numerous Bigheaded grasshoppers while surveying for alfalfa weevils in Beaverhead, Gallatin, and Madison Counties. A. elliotti, a true grass-feeding species and one of Montana's worst range pests, devastated thousands of acres of pasture and range before control measures stemmed the tide.[46]

Melanoplus atlanis,[47] the Lesser Migratory grasshopper, remained unreported in 1919, giving it a respite from incriminating comparisons with Melanoplus spretus, the Rocky Mountain Locust. Cooley and Parker believed that the

parasitic flies (Sarchophaga) which had seemed to control M. atlanis in the outbreaks of 1917 and 1918 had eliminated it as a threat in 1919. However, this same parasitic fly failed to control the Bigheaded and the Yellow-Winged grasshopper infestations of the current year, precipitating Cooley to pessimistically report that "grasshopper difficulty will be continued through several years."[48]

To battle the species that nature failed to control, the State Entomology Office relied increasingly on the poison bait method. But the expense for materials, questionable efficacy, and laborious preparation of the poisoned bran mash discouraged many farmers from fully cooperating with control programs. After field testing various mixtures, station entomologists announced changes in three formula ingredients, which they felt advanced the poison bait's effectiveness and alleviated many criticisms. First, they substituted finely ground arsenic at 10 cents per pound for Paris green which cost 50-to-75 cents per pound. The poisoning properties of the arsenic equaled or exceeded those of Paris green. Second, since citrus fruits like lemons and oranges traditionally cost dearly at all times of the year, workers sought and found a substitute attractant in amyl acetate. The amyl acetate sold for five cents per ounce and in field tests attracted grasshoppers much more effectively. As a liquid it also transported easily and required less work in preparation than lemons

and oranges, which farmers first had to cut and grind. Finally, station personnel discovered that the effectiveness of the formula did not suffer from the elimination of molasses, another very costly, messy and bulky material to ship and move.[49] Increased usage of the poisoned bran method in the following years clearly demonstrated the success of these developments in significantly reducing the earlier farmer resistance.

In his review of 1919, Cooley expressed his concerns about meeting the expectations of the agricultural community from the State Entomology Office, the Experiment Station, and the Entomology Department. The paucity of funding could not possibly cope with all requests and satisfy all assigned tasks. Strand already worked throughout the year to provide information about various insects, particularly their identification and control, in answer to numerous inquiries. The summer months occupied Strand with traveling around Montana for survey work, demonstrations, and the organization of local farmers for control activities. During the winter months Strand spoke at farmers' meetings and county agent conferences and spent additional time "preparing information on insect control, making portable exhibits of insect life history, and developing the collection of state insects."[50]

In 1919, the Assistant State Entomologist received a salary of $2,000 from a total State Entomologist Fund

appropriation of $3,300. The remaining $1,300.00 paid for "traveling expenses, student labor, scientific journals and supplies." As noted earlier, the State Entomologist's Office had to stop field work in many areas during the outbreak due to lack of traveling funds. A $5,000 special appropriation passed the Montana Senate but died in the House. Thus the year ended with a warning from Cooley that the legislators, farmers and other interests of Montana could not expect full assistance from his office without appropriate funding. He repeated this theme to little avail throughout the grasshopper years of the twenties.[51]

A year of change, 1919 demonstrated the growing importance of the state entomology organization in the control of grasshoppers. Although Sarchophaga parasitic flies had eliminated the threatened resurgence of the Lesser Migratory grasshopper in 1919, it could not suppress the emergence and growth of the Bigheaded grasshopper, the Yellow-Winged grasshopper, and Eritetix tricarianata. Weather conditions also cooperated with the grasshoppers, not the farmers.

Crop and grassland damage escalated from the depredations of the three dominant species of 1919, dictating that Cooley's entomology organization step in to alleviate the worst of the situation. By changing some of the ingredients in the poison bait, the State Entomology Office saved over $4,100--this figure representing savings from just the substitution of amyl acetate for lemons and oranges.

Cooley pointed out that this one saving outstripped the total amount in the State Entomologist's Fund. Lacking reliable information for the total savings realized in 1919 for all crops in Montana due to timely intervention by his office, Cooley used the Centennial Valley area as an example of probable statewide results. Normally the hay crop in the Valley accrued some $150,000 dollars for farmers. In 1918 they lost the entire crop without intervention by the State Entomologist. In 1919 Cooley "conservatively" estimated a saving of $100,000 in the Centennial Valley alone and "several millions of dollars" throughout Montana "due to prompt control measures" initiated by the State Entomologist's Office.[52] Montana farmers agreed with the need for timely intervention whenever natural controls failed to save crops. The state entomology organization complied with demands of the agricultural community as the crisis deepened and sought adequate funds for the years following this watershed year.

## 1920: Taste of the Future

Cooley and his staff believed the crisis would persist--drought and grasshoppers in tandem. Referring to the weather record, which encompassed the period stretching back into the nineteenth century, he argued that this should not have happened, not three and more years of drought in succession. A cold, wet April and early May

with normal precipitation from May through June replenished soil moisture levels insufficiently to compensate for the years of shortage. As localized dry conditions continued stunting or killing crops outright and the world demand for American farm products plummeted, prices of agricultural goods fell to near prewar levels. Nature's afflictions superimposed themselves on the financial complications arising from the post-war agricultural depression. Montana farmers endured increasing freight rates coupled with low market prices for whatever they managed to harvest.[53] Then, grasshoppers struck again, as Cooley had predicted in 1919. With the accumulated experience of previous years, the state entomology organization quickly moved into action and headed off the worst potentials of 1920. Natural controls provided even less assistance for Montana agriculture than the years since 1917.

As 1920 witnessed the most severe grasshopper troubles of the past three seasons, a practical decision faced the State Entomologist's Office and its associated organization--whether to recommend the use of amyl acetate to the county agents in the poisoned bran mash as an attractant substitute for lemons. The midst of a crisis seemed like an inopportune time to experiment with something still not totally accepted by farmers who had just become accustomed to the old formula. However, the results of tests carried out in 1919 provided support for an affirmative decision.

Its success as a substitute in the campaigns against Melanoplus atlanis and Camnula pellucida led the State Entomologist to recommend its immediate use to county agents. The success rates of the poison bran mash with lemons versus a mixture with amyl acetate finally convinced agents and farmers of amyl acetate's superiority. The 1920 campaign added further credibility to the change. Parker wrote that the poisoned bran mash, with its alternative ingredients of crude arsenic and amyl acetate, had achieved better results this year than in any of the previous three. Recommendations to farmers and agents now included fewer other techniques to control the grasshoppers. They added to the arsenal in normal years, but now Montana dealt with an emergency.[54]

Montanans needed a consistently more trustworthy method for fighting grasshoppers in the most widespread outbreak it had faced in years. Observers reported infestations in every corner of the state. Once again, the Yellow-Winged grasshopper, Camnula pellucida, had overwhelmed many areas and represented the dominant species of 1920. It affected the western counties, especially Beaverhead, Flathead, and Missoula Counties, the locations of the majority of its egg beds in 1919 and 1920. This provided the Department of Entomology an opportunity for additional experimentation and observation of this species. Entomologists gathered information on egg-laying and hatching and

recorded observations on the seasonal behavior of nymphs and the migration patterns of adults. The department's researchers noted how C. pellucida grouped into colonies to oviposit and migrate from the egg-laying sites to feeding areas and back. From this data they determined they could best poison the Yellow-Winged grasshopper and prevent the most crop damage as the insects hatched in and emerged from the egg beds. The Lesser Migratory (Melanoplus atlanis) and the Two-Striped (Melanoplus bivittatus) grasshoppers predominated in eastern Montana outbreaks, but Cooley reported no similar studies conducted on these species.[55]

Farmers also reported unusual numbers of minor species. The Large Lubber grasshopper, Brachystola magna (Gir.), the largest of Montana's grasshoppers, demonstrated its previously unsuspected ability to multiply its population several times within a short period. The State Entomologist's Office handled nearly ten times the normal number of inquiries on this species. However, the Large Lubber caused damage only on a very local basis.[56]

The troubles of the previous years left farmers and agents skittish. When thousands of grasshoppers hatched during late February in northeastern Montana, reports flooded the Bozeman office. The two species involved, Stirapleura decussata and Hippiscus pardalinus, panicked farmers who saw the hatches as an omen of more destruction to come that summer. In response, the State Entomologist's

Office reassured the farmers that these particular insects would not reach destructive numbers. Later events supported this analysis. But the normally destructive grasshopper species ravaged the area instead.[57]

Turning to the necessities of supporting his major non-departmental contacts at the scenes of the outbreaks, Cooley recognized that he could not expect county agents to maintain the knowledge levels of professional entomologists. The many demands on an agent's time--beyond the need to assist in the control of various insect pests --clearly required the state entomology organization to supply the expertise which the agents lacked. Different years usually presented various new and unfamiliar insect problems. In order to more fully fulfill consultation duties to agents, farmers and other parties, the State Entomologist expressed the necessity for funding a second assistant in his office, a need made more apparent in the next four years.[58]

Along with the information from Bozeman, agents required the tools to carry out their mission. They gathered the necessary information on grasshoppers through bulletins, circulars, memoranda, letters, phone calls, telegrams, and visits of entomologists from the Bozeman office. Frequent agent conferences around the state also supplied them with facts and figures to accomplish their missions. Cooley's office provided the agents with the latest infor-

mation on available techniques of control, particularly the poison bait method. Station staff continued to enhance the efficiency of the poison bran mash formula. In the first full season of use, they found amyl acetate superior as an attractant compared to lemons. Used more extensively in 1920, amyl acetate saved $2,000 in materials and reduced labor by decreasing mixing times. Furthermore, blending the arsenic and salt with wet ingredients rather than dry bran saved the farmers more time and expense. The latter innovation also prevented skin poisoning of laborers, an occasional problem with the older dry mixing method.[59]

In an obvious effort to assure future increases in funding for his office and organization, Cooley publicized the accomplishments of 1920. In this worst of the four grasshopper years to date, crews poisoned 36,790 of the 140,000 seriously infested acres in eighteen Montana counties. This saved 44,055 acres of crops including unpoisoned adjacent crops. The total savings amounted to $643,475. At the same time, however, the office lacked reliable information on losses incurred in locales which had not carried on extensive campaigns. Losses ranged from 16.9 to 47.1 percent in the areas acknowledged by Cooley. Farmers may have expected upwards of 100% crop destruction by grasshoppers if they had not treated their fields. With such imposing numbers, the State Entomology Office hoped to garner increased funding from the upcoming legislature in

1921, particularly when it could accomplish more--so Cooley argued--at higher spending rates.[60] He still had to convince Montana's legislators, businessmen and farmers of entomology's progressive value whenever "cost-free" natural controls failed against insect pests.

NOTES

1. Howard L. Seamans served as Assistant State Entomologist, 1916–1917; Extension Service Special Field Agent in Entomology, 1918–1919; Instructor in Entomology and Zoology, 1919–1921; and Entomology Department Assistant with the Experiment Station, 1920–1921. He then accepted an entomology position with the government of Alberta.

2. R. A. Cooley, "Fourteenth Annual Report of the State Entomologist of Montana," December 1916, Bulletin 112, pp. 55–57, in Agricultural Experiment Station, Montana: Bulletins and Circulars, vol. 17, Montana State University Archives, Bozeman, Montana; R. A. Cooley, "Fifteenth Annual Report of the State Entomologist of Montana," February 1918, Bulletin 124, p. 203, in Agricultural Experiment Station, Montana: Bulletins and Circulars, vol. 17, Montana State University Archives, Bozeman, Montana.

3. R. A. Cooley, "Sixteenth Annual Report of the State Entomologist of Montana," December 1918, Bulletin 126, p. 44, in Agricultural Experiment Station, Montana: Circulars and Bulletins, vol. 18, Montana State University Archives, Bozeman, Montana; Cooley, "Fifteenth Annual Report," Bulletin 124, pp. 195, 204, 207; R. A. Cooley, J. R. Parker, and H. L. Seamans, "Grasshopper Control in Montana," February 1918, Circular 76, p. 119, in Agricultural Experiment Station, Montana: Circulars and Bulletins, vol. 17, Montana State University Archives, Bozeman, Montana; F. B. Linfield, "Twenty-Fourth Annual Report for the Fiscal Year Ending June 30, 1917," February 1918, pp. 146, 245, 263, in Agricultural Experiment Station, Montana: Circulars and Bulletins, vol. 17, Montana State University Archives, Bozeman, Montana.

4. Cooley, "Fifteenth Annual Report," Bulletin 124, p. 204.

5. Linfield, "Twenty-Fourth Annual Report," p. 242; Cooley, "Fifteenth Annual Report," Bulletin 124, p. 202.

6. Cooley, "Fifteenth Annual Report," Bulletin 124, p. 205.

7. Augustus Leroy Strand served as an assistant in the Entomology Department, 1917-1918; Extension Service Special Field Agent in Entomology, 1918-1919; and Assistant State Entomologist during the period discussed through 1923.

8. Linfield, "Twenty-Fourth Annual Report," p. 247; Cooley, "Fifteenth Annual Report," Bulletin 124, pp. 191, 202-203; Cooley, "Sixteenth Annual Report," Bulletin 126, p. 42.

9. Cooley, "Fifteenth Annual Report," Bulletin 124, pp. 206-207.

10. Cooley, et al., "Grasshopper Control," Circular 76, p. 120; Linfield, "Twenty-Fourth Annual Report," pp. 245, 247; Cooley, "Fifteenth Annual Report," Bulletin 124, p. 195.

11. Cooley, et al., "Grasshopper Control," Circular 76, p. 125.

12. Cooley, et al., "Grasshopper Control," Circular 76, pp. 135, 140, 142; Linfield, "Twenty-Fourth Annual Report," p. 247.

13. According to Schlebecker, one bushel contains 7,000 grasshoppers (species unknown)--a feast fit for a rooster. See John T. Schlebecker, "Grasshoppers in American Agricultural History," Agricultural History 27, No. 3 (July 1953), p. 89.

14. Linfield, "Twenty-Fourth Annual Report," p. 247; Cooley, et al., "Grasshopper Control," Circular 76, pp. 141-142, 143.

15. Cooley, et al., "Grasshopper Control," Circular 76, pp. 124-125.

16. Ibid.

17. Cooley, et al., "Grasshopper Control," Circular 76, p. 125, 146-147; Schlebecker, "Grasshoppers," Agricultural History 27, No. 3 (July 1953), p. 90.

18. Cooley, et al., "Grasshopper Control," Circular 76, pp. 132-134.

19. Cooley, "Fifteenth Annual Report," Bulletin 124, p. 205.

20. Cooley, et al., "Grasshopper Control," Circular 76, p. 134-135.

21. Ibid., p. 145.

22. Ibid., pp. 130-131.

23. Ibid., p. 145.

24. Cooley, "Fifteenth Annual Report," Bulletin 124, pp. 201, 208; "News Paragraphs, Entomology Department, Montana State College," File "Insect Control (Misc., Notes, & Discussion), 1918-1948," Acc. 00016, Box 5 of 15, Montana State University Archives, Bozeman, Montana.

25. Cooley, et al., "Grasshopper Control," Circular 76, pp. 123-124.

26. Cooley, "Fifteenth Annual Report," Bulletin 124, p. 208.

27. Cooley, "Sixteenth Annual Report," Bulletin 126, p. 28; R. A. Cooley to F. B. Linfield, 4 September 1918, File "Departmental Affairs (General), 1918-1946," Acc. 00016, Box 1 of 15, Montana State University Archives, Bozeman, Montana; F. B. Linfield, "Twenty-Fifth Annual Report For the Fiscal Year Ending June 30, 1918," February 1919, pp. 115, 116, in Agricultural Experiment Station, Montana: Bulletins and Circulars, vol. 18, Montana State University Archives, Bozeman, Montana.

28. Linfield, "Twenty-Fifth Annual Report," p. 115; R. A. Cooley to J. [M.] Hamilton, 27 May 1918, File "Departmental Affairs (General), 1918-1946," Acc. 00016, Box 1 of 15, Montana State University Archives, Bozeman, Montana; J. M. Hamilton to the Heads of Departments, 3 July 1918, File "Departmental Affairs (General), 1918-1946," Acc. 00016, Box 1 of 15, Montana State University Archives, Bozeman, Montana.

29. Linfield, "Twenty-Fifth Annual Report," pp. 160-162.

30. Entomologists use the term "locust" in reference to a grasshopper which tends to migrate.

31. John Robert Parker served as Assistant Experiment Station Entomologist, 1910-1916; Experiment Station Entomology Department Assistant, 1916-1923; and Associate Professor of Entomology, 1923-1925. He was in charge of Grasshopper Research at the Bureau of Entomology's facility in Bozeman from 1930 to 1954.

32. Cooley, "Sixteenth Annual Report," Bulletin 126, pp. 23, 28, 29; Linfield, "Twenty-Fifth Annual Report," pp. 110, 174.

33. Cooley, "Sixteenth Annual Report," Bulletin 126, pp. 40-41, 42; "Report of Committee on Insect Pests," December 1918, File "Insect Control (Misc., Notes, & Discussion), 1918-1948," Acc. 00016, Box 5 of 15, Montana State University Archives, Bozeman, Montana.

34. Cooley, "Sixteenth Annual Report," Bulletin 126, p. 43.

35. Frederick B. Linfield served as the Director of the Montana Agricultural Experiment Station from 1904 through 1937 and as Dean of the College of Agriculture in 1913.

36. Cooley to Linfield, 4 September 1918; Linfield, "Twenty-Fifth Annual Report," p. 110; H. L. [Seamans] to A. L. Strausz, 22 June 1918, File "Montana Department of Horticulture, 1918-1921," Acc. 00016, Box 1 of 15, Montana State University Archives, Bozeman, Montana; "News Paragraphs, Entomology Department, Montana State College [1918]," File "Insect Control (Misc., Notes, & Discussion), 1918-1948," Acc. 00016, Box 5 of 15, Montana State University Archives, Bozeman, Montana; J. R. Parker to J. A. Hyslop, 21 February 1918, File "U.S. Bureau of Entomology, 1918-1921," Acc. 00016, Box 4 of 15, Montana State University Archives, Bozeman, Montana; Jim Hyslop to J. R. Parker, 1 March 1918, File "U.S. Bureau of Entomology, 1918-1921," Acc. 00016, Box 4 of 15, Montana State University Archives, Bozeman, Montana; Cooley, Sixteenth Annual Report," Bulletin 126, pp. 42-43.

37. Cooley, "Sixteenth Annual Report," Bulletin 76, pp. 42-43; "News Paragraphs [1918]"; R. A. Cooley, "News Notes: Women in Entomology," 26 August 1918, File "Insect Control (Misc., Notes, & Discussion), 1918-1948," Acc. 00016, Box 5 of 15, Montana State University Archives, Bozeman, Montana.

38. Cooley, "Sixteenth Annual Report," Bulletin 126, p. 43.

39. Ibid., pp. 20, 28-29.

40. "News Paragraphs [1918]."

41. Ibid.

42. R. A. Cooley to F. B. Linfield, 4 September 1918.

43. Cooley, "Sixteenth Annual Report," Bulletin 126, p. 20.

44. F. B. Linfield, "Twenty-Sixth Annual Report for the Fiscal Year Ending June 30, 1919," February 1920, pp. 7-8, 42, in Agricultural Experiment Station, Montana: Bulletins and Circulars, vol. 18, Montana State University Archives, Bozeman, Montana; Joseph Kinsey Howard, Montana: High, Wide, and Handsome (New Haven: Yale University Press, 1943), p. 210.

45. R. A. Cooley, "Seventeenth Annual Report of the State Entomologist of Montana," December 1919, Bulletin 133, pp. 3, 9, in Agricultural Experiment Station, Montana: Bulletins and Circulars, vol. 18, Montana State University Archives, Bozeman, Montana.

46. Cooley, "Seventeenth Annual Report," Bulletin 133, pp. 3, 9-10.

47. R. A. Cooley, J. R. Parker, and others often referred to Melanoplus mexicanus atlanis by the shorter binomial designation Melanoplus atlanis. By the 1930s, entomologists referred to this species as Melanoplus mexicanus mexicanus.

48. Cooley, "Seventeenth Annual Report," Bulletin 133, pp. 9-10.

49. Linfield, "Twenty-Sixth Annual Report," pp. 27-28; R. A. Cooley to F. B. Linfield, 8 October 1919, File "Summary of Work Reports, 1920-1925," Acc. 00016, Box 1 of 15, Montana State University Archives, Bozeman, Montana.

50. Cooley, "Seventeenth Annual Report," Bulletin 133, p. 14.

51. Ibid.

52. Cooley to Linfield, 8 October 1919.

53. F. B. Linfield, "Twenty-Seventh Annual Report for the Fiscal Year Ending June 30, 1920," February 1921, pp. 7, 9, 46, in Agricultural Experiment Station, Montana: Bulletins and Circulars, vol. 19, Montana State University Archives, Bozeman, Montana; James Whorton, Before Silent Spring: Pesticides & Public Health in Pre-DDT America (Princeton, New Jersey: Princeton University Press, 1974), p. 129.

54. J. R. Parker, "Improvements in the Methods of Preparing and Using Grasshopper Baits," February 1922, Bulletin 148, p. 6, in Agricultural Experiment Station, Montana: Bulletins and Circulars, vol. 19, Montana State University Archives, Bozeman, Montana.

55. R. A. Cooley, "Eighteenth Annual Report of the State Entomologist of Montana," January 1921, Bulletin 139, pp. 4, 13, in Agricultural Experiment Station, Montana: Bulletins and Circulars, Montana State University Archives, Bozeman, Montana; Linfield, "Twenty-Seventh Annual Report," pp. 28-29; Parker, "Improvements in Grasshopper Baits," Bulletin 148, p. 6; "Annual Report of Entomology Department, Experiment Station, 1920-1921 (For the University), File "Summary of Work Reports, 1920-1925," Acc. 00016, Box 1 of 15, Montana State University Archives, Bozeman, Montana.

56. Cooley, "Eighteenth Annual Report," Bulletin 139, p. 13.

57. Ibid., p. 5.

58. Ibid., pp. 3-5.

59. Ibid., pp. 28-29.

60. Cooley, "Eighteenth Annual Report," Bulletin 139, p. 3; R. A. Cooley to James B. Cullison, 20 October 1921, File "Insect Pest Survey Reports, 1921-1922," Acc. 00016, Box 5 of 15, Montana State University Archives, Bozeman, Montana.

# CHAPTER 3

## 1921: OLD TROUBLES AND A NEW LAW

Real income from farm produce decreased, while the cost of living continued to increase. Railroad freight rates ran fifty percent higher than before the war, adding to the burdens. Farm acreage plummeted from 50 to 25 percent of its former value.[1]

Crop yields improved incrementally over the 1920 season but much of the state still suffered from drought; as F. B. Linfield, director of the Experiment Station in Bozeman, observed "there are some sections of the State where crop yields are too uncertain for dependence on grain growing solely for the farm income." Above normal summer temperatures and below normal precipitation created deteriorating soil moisture conditions.[2] Moreover, grasshoppers continued as a major problem for farmers. The state entomological organization increased its level of involvement as natural controls again failed to stem the tide of insects.

After five seasons of steadily worsening grasshopper troubles, R. A. Cooley seemed on the verge of despair. He believed Montana would always suffer from grasshopper outbreaks no matter how much money or manpower were dedicated

to eradicating them. The four species of grasshoppers causing the vast majority of the problems inhabited the state as native species. Normally occurring only in relatively small numbers, ideal conditions of weather, breeding areas, and food sources provided the stimuli for population explosions, migratory movements, and serious damage. The recent unrelenting drought provided an opportune period for an outbreak. Furthermore, with the sparse and widespread settlement of Montana and its large amounts of accompanying waste and vacant lands, humans could not practically and completely eradicate these most troublesome grasshopper species. The State Entomologist could only hope for adequate control and alleviation of the worst of the depredations.[3]

The usual suspects reappeared on the scene. Nearly all the agricultural counties suffered formidable grasshopper troubles in 1921. Warrior grasshoppers, Camnula pellucida, predominated in the outbreaks of Flathead, Sanders, Missoula, and Beaverhead Counties where their egg beds encompassed many miles of land. Beaverhead County's Centennial Valley benefited from the campaign of 1920, though it still required some repeated intervention. Its outbreak in 1921 yielded to less intense control measures. Central Montana also endured the ravages of the Warrior along with the Lesser Migratory (Melanoplus atlanis) and the Two-Striped (Melanoplus bivittatus) grasshoppers.[4]

Melanoplus atlanis dominated the infestations in eastern Montana, occurring in such large numbers that crop survival demanded large scale organized control measures in nearly all of the counties. A practically unbroken concentration of grasshoppers, fifty and more miles wide, reached from Dawson County south to Fallon County. Farmers saved much of the crop but nevertheless the lack of a more extensive campaign resulted in serious damage. The thinly settled territory provided an abundance of vacant lands on which the Lesser Migratory grasshopper readily bred. By late summer, southeastern Montana witnessed a devastation of range grasses to such an extent that the damage mimicked the losses from extreme drought. Stockmen faced ruination as their cattle wandered aimlessly over the once rich feeding grounds and owners wondered how to pay their debts when faced with little or no profit. Accompanying M. atlanis in the eastern and central Montana outbreaks, Melanoplus bivittatus, the Two-Striped grasshopper, accounted for far less damage, but enough to deserve mention as one of the three major species of 1921. Large scale infestations wreaked havoc in a large area north of the Yellowstone River from Stillwater through Yellowstone and Musselshell and into Rosebud Counties.[5]

The State Entomologist's Office and its on site representatives described the campaign west of the continental divide and on some of the eastern slopes as more effective

than in the eastern part of the state. Since the Warrior grasshopper, the major culprit of the western infestation, concentrated in limited areas for egg-laying, observers easily counted the numbers of eggs per unit area and predicted outbreaks for the upcoming season. The clustering of individuals during hatching also enabled field workers to spread poison bait at an optimal time for maximum results, so many nymphal grasshoppers died before they produced much damage or could mature, migrate, and breed.[6]

East of the continental divide, M. atlanis, the Lesser Migratory grasshopper, laid its eggs in less well defined areas. Investigators thus could predict an upcoming outbreak with little precision for the following year. Since these insects hatched en masse over a great deal of territory, more expense and labor went into fighting the infestation. This grasshopper tended to swarm during the adult stage and spread to late crops of winter rye and wheat faster than workers could locate and poison them. Swarms from southeast Montana devoured fields as they flew to the northern counties in 1921 and 1922. Mild October weather brought reports of M. atlanis still actively feeding --unusual for so late in the season. A. L. Strand recommended poisoning them with the bran mash formula, since if the grasshoppers ate the crops they would also readily eat the poison--and pass on to more heavenly rewards. Observers in the northwestern counties reported northern and

northwestern flights of the Lesser Migratory grasshopper (Melanoplus atlanis). Abundant in these counties just weeks earlier, they promised future problems for Montana and greater concerns for Montana's Canadian neighbors in 1922.[7]

Once again, the natural predators and parasites of grasshoppers emerged in abundance. Montana entomologists rated the effectiveness of the various grasshopper enemies in descending order as flesh flies (Sarchophagidae), blister beetles (Meloidae), fungus disease (Empusa grylli), and red mites (Trombidium). Though county agents, farmers, and other writers proclaimed the plenitude of the various enemies and hoped they would eventually stifle the outbreak, the State Entomologist's Office warned that natural enemies should not be depended on to complete the job. Strand advised careful observation for early grasshopper damage and the immediate use of poison bran mash whenever damage levels warranted.[8] Yet, a variety of parasites and predators did assist to control the grasshopper explosion of 1921.

Maggots of a gray-backed flesh fly, Sarcophaga kellyi, preyed on grasshoppers east of the continental divide, but only a small area benefited from their assistance in western Montana. State entomologists regarded the flesh fly as the most important of grasshopper enemies, accounting for the grasshoppers cyclic appearance and disappearance. Bee

fly larvae (Bombyliidae) fed on the eggs of the Warrior grasshopper in many of the districts as did the larvae of blister beetles--especially Epicauta maculata (Say) and Lytta nutalli (Say). As adults, the blister beetles caused minor damage to alfalfa crops and home gardens but the State Entomologist's Office regarded it as more beneficial than harmful, because of its depredations on the grasshoppers.[9]

R. B. McKee, the Flathead county agent, mailed red mites found on grasshoppers to Bozeman for identification as a possible natural control. Strand recognized these samples as Trombidium, which he claimed sucked the bodily fluids of nymphal grasshoppers and fed voraciously on grasshopper eggs. However, in Montana, entomologists had never witnessed any effective control of grasshoppers by the red mites. These red mites often appeared on the wings and necks of their victims during the summer months. Other agents sent the larvae of Tachinid wasps as testimony to their labors in the infestation. Tachinids laid their eggs in the bodies of living grasshoppers. The young hatched and grew, consuming their host as the Tachinid developed and emerged to continue the reproductive cycle. Farmers and agents detected their presence and handiwork, perennially hoping these natural allies would do the job alone at no cost to the agricultural community.[10]

But none of the natural predators and parasites could take the place of human intervention in saving crops from the grasshoppers. Since predators, parasites, and diseases failed to control grasshopper populations during periods of damaging infestations to the satisfaction of economically-oriented Montana entomologists and agriculturalists, the State Entomologist's Office recommended increased poisoning campaigns as the most effective weapon. Experiments proceeded on various aspects of the poison bran mash. By 1921, crude white arsenic and amyl acetate had completely replaced Paris green and citrus fruits respectively in the formulation. Easier preparation and handling and comparable savings in money expended on materials convinced observers of the value of the changes. Lemons for the 1921 campaign would have cost $28,000 while amyl acetate expenses totaled only $3,600. In addition, workers transported a five gallon can of amyl acetate much more easily than the required 17 cases of lemons, which then required cutting and grinding before mixing with the other ingredients. This saved time and expense at various stages of preparation.[11] Only partially satisfied with the increased efficiencies, farmers and agents sought further modifications to create an even less expensive formula.

Some proposed to supplant bran with sawdust. The State Entomologist's Office made it clear that in circumstances where it successfully substituted for bran, the

workers had used only old, well-rotted sawdust. Even so, the sawdust tended to dry much more rapidly than bran and rapidly lost its attractiveness for feeding grasshoppers. At less than $1.50 per hundred weight, wheat bran remained cheap enough to employ in the formula without resorting to sawdust. However, a mixture of sawdust and bran proved as effective as bran alone. The office strongly advised against using sawdust alone in the formula, especially when the proven and dependable bran mixture promised a surer rescue for valuable crops.[12]

The poisoned bran mash formula became unassailable for a period. No new proposals for modifications of the basic recipe entered the debate. But enterprising individuals recognized profit potential in the grasshopper troubles. James Reynolds, for example, proposed a machine for spreading the poison bait. Though not yet built, the horse-drawn machine would "spread the poison into the field 15 or 20 feet and would average 20 miles a day around the fields." Strand told Reynolds that some farmers already spread the bait with the few seeding machines found in Montana. The "inventor" could make money only if he sold the machines over a wide enough territory. Since grasshopper outbreaks occurred only occasionally, long term profits seemed unlikely and only in large scale campaigns of a non-emergency nature.[13]

With the poison bait formula temporarily ensconced, investigators turned to the timing of application to improve its efficiency. Earlier advice had championed distribution of the poisoned bran mash in the late afternoon or early morning, and some advice had even ranged from sunrise to sunset. Following this recommendation farmers had satisfactory results. Spreading the bait in hot dry weather, however, occasioned waste and inefficiency since the mash quickly dried and became unattractive to feeding grasshoppers. In addition, June and July thundershowers usually struck in the late afternoon or at night, soaking and washing away much of the bran mash and diluting its poisonous qualities. Though treatment during clear, warm weather avoided this problem, the bait tended to dry out before the period of maximum grasshopper feeding. Entomologists had considered the early morning as best since they believed that spreading the bait after the grasshoppers became active disturbed them too much for feeding. Past experiences of Montana entomologists influenced them to recommend treatment just as grasshoppers became active during the first hour, since they maintained the grasshoppers did not feed heavily immediately after increasing their activity levels. With confidence J. R. Parker claimed "during the period of maximum feeding the great majority of all the grasshoppers present will at once feed heavily upon" the recently broadcast poisoned bran mash.[14]

For the majority of applicators who could not idly wait for the grasshoppers to become active, Parker suggested putting out the poisoned bran mash between ten in the morning and noon on clear sunny days when the grasshoppers could feed on the mash before it dried. During the hottest part of the day, grasshoppers climbed vegetation to distance themselves from intense ground temperatures and did not feed. Large acreages required more time for treatment, so 9 a. m. to 3 p. m. provided acceptable results, though not as good. Farmers should avoid the hours of noon to 2 p. m. if possible since this hottest part of most days dried the bait too quickly. In extremely hot weather, acceptable times included as early as 7 a. m. and as late as 4 p. m. As a final precaution Parker instructed workers to avoid treatments on cool, cloudy days when grasshoppers remained inactive.[15]

Parker based his advice on observations of grasshopper behavior during various parts of the day and under different weather conditions. The largest kills occurred from late morning applications on warm sunny days. As the temperature dipped in the late afternoon, young grasshoppers gathered together until thoroughly warmed the following morning when they again became active and fed. Feeding took place between 8 a. m. and 6 p. m. except on the hottest or coolest days. From 8 to 9 a. m. grasshoppers ate "sparingly" and increased feeding levels from 9 to 10 in

the morning. Between 10 a. m. to noon, eating reached its maximum and decreased thereafter until it ceased at around 6 p. m. Parker saw this greater precision in describing feeding times as a valuable tool in making the bran more effective and avoiding the needless waste of materials and labor.[16]

With the rapidly increasing use of the poison bait method, accidental poisoning remained a concern of farmers and agents. County agents recommended the wet method of mixing the formula as quicker and making a better mixture. Additionally, it avoided the danger of inhaling dry arsenic dust. In 1921, at least two county agents reported suffering from poisoning while handling the arsenic during repackaging from barrels to smaller containers. One agent described the symptoms as feeling "under the weather" and that the poisoning "caused the skin on my face to peal [sic] off."[17]

Concerns also continued over accidental poisoning of animals by the poisoned bran mash. Warden Hodges of the National Bison Range objected to treatment for grasshoppers on the Range because of reported poisoning of cattle and poultry in other areas. He lodged an objection with the U.S.D.A. Bureau of Biological Survey that "it would kill the birds and also antelope." Furthermore, by spreading the mash on the moist grass "the buffalo, elk, and deer are liable to be affected." With such testimony in hand the

Biological Survey's chief, E. W. Nelson refused his permission unless a representative of the Agricultural Experiment Station, in company with the warden of the Bison Range, first made an assessment of the necessity for treatment. He then would sanction poisoning of the grasshoppers only if a representative of the Bureau oversaw operations at all times during any campaign.[18]

Further examinations of the situation on the National Bison Range quickly muted these initial concerns. Warden Hodges examined the area and declared that he found no grasshoppers concentrating or signs of egg-laying. To reassure the State Entomologist, Chief Nelson suggested that E. W. Pollinger, as a representative of the Station, accompany the warden to verify the warden's conclusions. Nevertheless, Nelson did "not care to have [poisoning] undertaken unless there was a real necessity for it." The Bureau of Biological survey further offered to allot funds for treatment on the Range since the Bureau wanted to cooperate "to prevent the destructive workings of pests, whether of insects or of rodents or predatory animals."[19]

Beyond the Bison Range's objections, bee keeping enjoyed popularity for pollinating certain crops and honey production. Naturally, beekeepers showed concern over the possible harm of grasshopper poisoning to their hives. Strand advised not allowing the poisoned bran mash to sit in containers to ferment and attract the bees. Otherwise,

he believed that little chance existed for the bees to die from consuming the mash already carefully spread over the fields. However, in offering these reassurances alone, Strand based his counsel on opinion rather than citing any supporting scientific studies of the issue.[20]

Certain farmers also expressed their anxieties about using the poisoned bran mash because of the dangers of accidental poisoning and the expenses added to their already precarious finances. But the State Entomologist relentlessly sang the praises of poisoning over other methods, particularly the grasshopper catching machines. These machines, they argued, only served well in very limited situations such as along field margins through which grasshoppers moved into crops. On grains which already had formed heads and kernels, the catchers only caused loss of much of the crop through mechanical damage. Besides, the machines caught tons of grasshoppers when control in such an outbreak year required the destruction of hundreds of tons. When asked where farmers could examine an operational grasshopper machine the State Entomologist's Office could not provide the information.[21] Advisers in Bozeman recommended only one method of control other than poisoning--cultural.

The cultural method demanded more attention to grasshopper behavior by the farmers. Egg-laying congregations or discovery of egg beds on later inspection surveys pro-

vided the basic information required by farmers to know where to disk in the autumn or plow in the spring to expose the eggs to weathering and natural enemies. Critical timing of cultural treatment and the impossibility of using it on certain terrains and in bad weather reinforced the State Entomologist's opinion that spreading the poisoned bran mash whenever numerous grasshoppers appeared harmful provided the best guarantee for success. The State Entomologist recommended a solely non-poison bait alternative only for something like binder twine damage. Twine soaked in a solution of kreso dip, coal oil, or crude oil, quickly changed the dietary preferences of the most ravenous grasshopper.[22]

The passage of the popularly termed County Insect Pest Law of 1921 sponsored by State Senator Frank A. Hazelbaker, Great Falls, marked a high point in the fight against the grasshopper and other pests. Hazelbaker did not consult the State Entomologist before writing and introducing the bill; Cooley first heard of its existence in a newspaper article and merely suggested correction of a typographical error. His network must have had some weak intelligence links with the legislature. Passed in early March, it gave local communities the power to tax themselves in the event of local pest outbreaks. Previously, subscriptions among farmers, banks, and farm organizations paid for battling

insects and other problems on a desultory basis, depending on who cared enough to contribute.[23]

The County Insect Pest Law provided for the appointment of people by county commissioners to lead insect campaigns under the overall direction of the State Entomologist in Bozeman. The designated leaders received compensation for their work and the total cost of the campaigns fell to individual counties which drew up warrants for payment against the Insect Pest Fund. Counties also purchased necessary materials and equipment for insect campaigns under the same procedure. County commissioners paid the outstanding warrants in the succeeding year by levying a tax on all property in the county up to one-half mill on each dollar of assessed valuation. This money went only to the Insect Pest Fund to pay off the warrants. The term Insect Pest referred to grasshoppers, cutworms, pale western cutworms, army worms, chinch bugs, and "any other insect generally recognized as a destroyer of grain, hay and horticultural crops."[24]

While the new law quickly proved a valuable source of funding, it also hurt feelings, engendered political infighting and renewed farmer hostility toward the organization in Bozeman. The new Montana Department of Agriculture absorbed the State Board of Horticulture and reduced its funding when the depressed state economy called for cutbacks. Moreover, the legislature amended the County Insect

Pest Law (Chapter 227) to permit expenditures for horticultural pest control. According to this law the State Entomologist would supervise any persons employed in this endeavor. Thus the Chief Horticulturist would have lost some of his supervisory power to the State Entomologist in Bozeman. Charles C. Davis, the Agricultural Commissioner of Montana, requested and received a deputization from Cooley so that the "present local inspectors" would "continue to work under the direction of [the] Division of Horticulture." County funds financed these workers, so they fell within the ken of Chapter 227.[25]

Commissioner Davis then discussed the grasshopper situation on the Flathead Indian Reservation with officials at Bozeman and asked for the recommendation of a reliable person to take charge of the campaign. Cooley suggested that W. E. Pollinger, who had served as Missoula County Agent in the past, would provide an ideal candidate for initiating successful organization and control. After consulting with Cooley and J. C. Wood, Chief of the Division of Horticulture, Davis authorized Wood to release Pollinger for duty in Missoula County the first week of June. Wood gave the order, assuring Davis that this would not affect the spraying program. Three weeks later, Wood expressed the "imperative necessity" that Pollinger return to his duties in the Division of Horticulture to direct a spraying campaign for other insects. Cooley responded to

Commissioner Davis in a confidential letter that he had no substitutes for Pollinger nor funds to cover another person, so Wood would have to fix things up with the county himself.[26]

In tendering his resignation as Chief of the Division of Horticulture, Wood protested the placement of insect control work under the supervision of the State Entomologist. Under the County Insect Pest Law, Wood's office would "function merely as an intelligence bureau for the purpose of forwarding orders from the Montana state experiment station." The plaudits for good work would have gone to Bozeman while the blame for failures came to Wood and his division. Commissioner Davis countered that horticultural work remained under the supervision of the State Department of Agriculture, not under the State Entomologist's Office. Chapter 227 of the 1921 session laws entered the equation only under emergency conditions and permitted expenditures by the counties to fight insect pests in orchards and other field environments. Deputization by the State Entomologist left the decision making powers in the hands of the Department of Agriculture and its Division of Horticulture. Wood resigned despite the explanations of Davis and others. Orchardists bemoaned their loss of a longtime ally in Wood. One inveighed against the ongoing "effort to place all of the farming and

fruit growing business in the hands of men at the State College."[27]

Despite some problems engendered by the new County Insect Pest Law, Cooley expressed satisfaction with its overall accomplishments. It enabled many counties which in the past had not been able to carry out satisfactory grasshopper campaigns to fund them in 1921. Twenty-five of the fifty-four Montana counties had used the law.[28]

This law stated that the person appointed to run a campaign acted "under the direction of the State Entomologist." Most county agents and others assigned by the counties to run campaigns in the absence of county agents--people like county clerks and community leaders --believed that this meant all campaigns required the approval of the State Entomologist before proceeding. So they worried that a county campaign might fail to receive approval, though the agent and commissioners had initiated it under emergency conditions. The State Entomologist reassured them that the law bestowed no veto power on his office. He merely wished to examine the need for a particular campaign and answer questions related to methods of control, organizational procedures, the problems of uncultivated lands, and other concerns--"to make the law a very effective one and see that it continues to be so year after year."[29]

To meet financial needs of the grasshopper campaigns, the counties tried modifying their applications of the County Insect Pest Law. Some attempted to pass on half the cost of additional poison directly to the farmers instead of levying the tax for the entire amount. The State Entomologist disagreed. Others supplied financing for the poison as long as the farmers supplied the labor. Cooley found this acceptable and recommended that the counties instruct the farmers to mix and spread the poison "not only on their own lands but on highways and public lands, without charging for labor."[30]

In counties without agents or other representatives to organize campaigns, or where publicists failed to reach all farmers, individuals cried out for help. In a few cases the State Entomologist directed them to county agents for assistance. With no local functioning organization, farmers had to organize among themselves or purchase the ingredients for control measures individually. Despite the best intentions of the State Entomologist's Office, they informed desperate farmers that they could not supply free poison.[31] They struggled for objectivity in the face of heartrending letters:

> The Grass Hoppers [sic] are eating my crop. I'm informed that the Goverment [sic] will furnish posin [sic]. If the Goverment does not furnish free of cost and would send me the posin I will pay for it as soon as I can. I'm unable to buy the posin at the present time. Please ans [sic] soon. In another three week [sic] they will have all of my crop.[32]

Tax-poor counties went to the spending limit of one half mill and gave up the work, leaving farmers to fend for themselves. The tendency of most Montana farmers to adopt a wait and see attitude added to the problems of state advisors who recommended prevention rather than reacting to emergency situations. When the trouble struck, they initially acted almost instinctively as individualists before accepting the need to organize. The State Entomologist's Office recognized the danger and warned its field agents that "it is necessary to push the work early in the season and not wait for the farmers to act individually."[33]

The County Insect Pest Law made no provisions for treatments on federal public lands, which included national forests and the Indian Reservations. Fortunately in 1921, as in other years, the federal government recognized the problem and provided funds for grasshopper control in these areas. Congress appropriated $240,000 for all affected public lands and the Department of Indian Affairs contributed $300 for control work on western Montana reservations. This diminished some dangers of reinfestation on treated farms by grasshoppers coming in from untreated public lands.[34]

Chapter 227 solved many of the problems of financing at the local level but the legislature expected the State Entomologist to encompass the added responsibilities of the law with no increase in the State Entomologist's Fund.

This small appropriation enabled Cooley to employ only one assistant, Strand. Early in the 1921 campaign the office exhausted its fund and was unable to send representatives to answer calls for assistance until the new fiscal year budget began July 1 or the counties paid travel expenses. The explosion in the numbers of requests continued unabated. As Strand interpreted the law, the legislature expected the State Entomologist to send a person to survey a county calling for aid, consult with the county agent, and decide whether the county should use the law for a campaign. With little help and a small budget, Cooley hoped for relief from the federal Bureau of Entomology in the eastern part of the state.[35]

During the 1921 season Montana counties spent a total of $94,735 on grasshopper control efforts, using 3,373 tons of bait. Under the direction of the State Entomologist's Office and the interlacing state entomological organization, farmers treated 296,227 acres of infested land. Cooley estimated that the 1921 efforts saved $503,112 in crops, which otherwise would have been lost to the grasshoppers.[36]

The difficulties of 1921 ended on a happy note for Cooley as construction workers laid the foundation for Lewis Hall, which included roomier entomology offices and laboratories. Increased popularity of biology in general and entomology in particular required proper facilities for

research and teaching. With the new, expanded laboratories, the Department of Entomology and Zoology could more easily meet its responsibilities to the College, students, the state, and the Experiment Station.[37]

Thus, the disparities between farm income and costs widened in 1921. Almost every Montana agricultural county confronted grasshopper infestations, which further increased costs and lowered incomes. Predators and parasites provided some natural control but failed to preclude the need for intervention by the state entomology organization. The reduction of material costs for the poison bran mash bait and more precise timing for applications increased its acceptance among Montana farmers. By 1921, the poison bait method had become the treatment of choice. Grasshopper campaigns added to the basic cost of farming--an increased burden during a period of economic hardship. In response, Senator Hazelbaker's County Insect Pest Law furnished counties and farmers with a vital funding weapon. The federal government also supplied some funds for the treatment of its lands which bordered croplands. The year had accorded a major test for Cooley's entomological organization, which had averted considerable crop losses from the grasshoppers and had gained valuable experience in responding quickly to a rapidly developing, adverse insect situation.

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# CHAPTER 4

## 1922: SCALING THE PEAKS

In 1922 Montana faced another year of below normal precipitation and above normal summer temperatures. Grasshopper depredations steadily worsened. Both problems --weather and insects--shaped the realities of a new natural order. Farmers and their Montana State College advisors faced the dictates of this new order. The post-war depression continued with low farm prices. But most farmers battled the grasshoppers despite financial constraints and uncertain prospects.[1]

Even as farmers increasingly despaired and some abandoned their farmsteads for other areas and occupations, Linfield sounded a note of optimism mixed with short-term pessimism. He counseled those who felt a strong attachment to the land to stick with agriculture despite the difficult times. Farm depressions came and went. Linfield blamed the increased use of machines for overproduction and agricultural price erosion. He claimed that those who remained eventually would find themselves among fewer producers and in a better position to take advantage of increased demand and prices for farm products.[2] But the threats posed by the continuing grasshopper outbreaks made prospects bleak

even for the most determined yeomen. The year shaped up as the climax of the grasshopper trouble for the period 1917 to 1924, though grasshoppers slowly decreased in numbers over the remaining two years. Once again, Montana turned to the State Entomologist and the state entomology organization for salvation.

Experiences of the previous five years sensitized farmers and agents to normally unnoticed natural events. The Fallon County agent grew excited at the appearance of numerous grasshopper nymphs in March. He feared damage beginning even earlier than in 1921. A. L. Strand informed the agent that the grasshoppers belonged to the group Hippiscus. They hatched during the hot days of late summer and overwintered in Montana in the nymphal stage, enabling them to move about and feed before other species hatched in May and June. But Hippiscus seldom occurred in sufficient numbers to cause serious crop damage and usually dispersed before spring crops grew to critical stages.[3] By reassuring those who reported common but relatively harmless grasshopper species, the State Entomologist's Office likely reduced much repetitious and panicked correspondence from agents and farmers. This allowed the College's entomologists to concentrate more fully on the serious grasshopper threats which rapidly developed.

Once again the Lesser Migratory grasshopper, Melanoplus atlanis, prevailed among the destructive species in

the northwestern United States. In Montana it concentrated its destruction along the Yellowstone Valley from Park to Rosebud Counties, an area dominated by Melanoplus bivittatus in previous outbreaks. Soon after M. atlanis, M. bivittatus--the Two-Striped grasshopper--suddenly increased and added to the damage. Every Yellowstone River County from Sweet Grass to the North Dakota border organized campaigns in the face of this common economic threat. Camnula pellucida, the Clear-Winged grasshopper, hatched in greater numbers in the western than in the eastern section of the state and dominated damage reports from that area. Adding to the pressure from the regulars, Bruner's Grasshopper, Melanoplus bruneri (Scudder), injured grains in the Shield's Valley area of Park County, the first record of damage by this species in Montana.[4]

Reviewing the information obtained through grasshopper egg surveys, the State Entomologist's Office predicted another serious outbreak in 1922, especially if the weather also favored grasshopper development. County agents relayed reports of millions of grasshoppers hatching in early spring, but after closely examining conditions in the areas they reassured the Bozeman office that farmers had exaggerated the scope of local hatches. Nevertheless, agents warned that ideal environmental factors favored more serious concentrations of grasshoppers in short order. Farmers initially worried more about the large numbers of crickets

appearing in the spring than about the grasshoppers, although Strand advised agents that crickets had never inflicted serious agricultural damage in Montana in the past. Instead, he counseled agents and farmers to turn their attention to further signs of a grasshopper resurgence instead. Strand experimented with different formulations of the poisoned bran mash to use against the crickets near Camas and Hot Springs, so J. R. Parker asked Strand to send his most effective concoction to the correspondents.[5]

Subsequent events actualized the feared comeback. Attempts to confine a major grasshopper outbreak to the Marias River country failed as the insects migrated to outlying territory north over Toole County. Lands along the northern Rocky Mountain Front served as additional loci for grasshopper hatches. Chouteau County reported "alarming numbers" of nymphs and expected serious damage if agents and the county failed to act. However, the county agent assured the Bozeman office that he had enough grasshopper poison supplies to begin a campaign when necessary. Continued dry conditions in the Marias and Teton River drainages enabled further widespread infestations in those regions. Eastern sections of the Great Northern Railway marked areas of outbreak worse than in 1921. Although Northeastern Montana witnessed decreases in grasshopper numbers from the previous year, enough caused damage to require extensive campaigns in two counties.[6]

Later in the season, grasshoppers concentrated on irrigated lands as drought conditions desiccated vegetation on range and vacant lands. Ravalli County, the site of extensive grasshopper damage in previous seasons, enjoyed a year of respite. However, the county agent noted late season damage to fall wheat before frost and the settling-in of colder weather, evidence, he believed, that the following year would require substantial assistance from the State Entomologist.[7]

Rain fell more abundantly in mid-1922 in certain sections of the state, bringing mixed blessings and false promises. North, east, and west of Great Falls crop prospects appeared brighter than any season since 1916, the final year of an earlier seven year period of unusually favorable rainfall. Only grasshoppers jeopardized a return to prosperity. Bankers with investments in a successful crop expressed confidence that the season's plentiful moisture and selective grasshopper bait applications assured a turnaround in Montana agricultural prospects. They saw no reasons to fear grasshoppers in 1922.[8]

Cooley agreed with assessments of the beneficial effects of the regular precipitation. The grasshoppers fed on the prolific non-crop vegetation made available through the regular rainfall and tended to invade and damage standing grain crops less. Nevertheless, Cooley told farmers and agents to stay alert and distribute poisoned bran mash

when necessary. Strand pointed out that as long as the weather remained moist, grasshoppers fed on and remained in the succulent grasses of vacant lands. But, problems arose when dry weather pushed these grasses into dormancy and forced the grasshoppers to move into the croplands. Parker added that the wet weather decreased grasshopper numbers by killing off newly hatched individuals with fungal and other infections. However, he reminded, a day or two of rain followed by dry, warm, and sunny conditions affected grasshoppers very little. In the face of these precautionary counsels, some agents recognized the need to intervene quickly whenever necessary and not to count on weather to reverse a bad situation.[9]

The rains also created difficulties. Parker found his automobile travels along Montana's rutted, rural roads extremely arduous. At one point Parker wrote the Bozeman office that hard rains and threatening skies forced him to reconsider starting out on a July survey. He dreaded getting stuck in the mud and camping under such miserable conditions and chose to wait until conditions improved. Even county agents, much more knowledgeable about the terrain of their assigned territories, found the mud and ruts too much to endure. They also delayed plans to travel to investigate reported grasshopper infestations and mass hatches. Besides making it difficult to travel, the rain drove up treatment costs by wasting valuable materials and

time. Intermittent showers made the poisoned bran mash less effective. When the workers spread the bait in the morning, while the weather looked less threatening, afternoons brought heavy thunder showers which covered the bait and diluted the arsenic's potency.[10] Thus, the wet weather promised better crop yields but stifled efforts to maximize the harvest by fighting the grasshoppers waiting to invade.

To meet the season's threats, Cooley used his scarce personnel resources in the most efficient ways possible. Strand and Parker, associate professor, traveled Montana from community to community to conduct surveys and recommend actions to the appropriate local authorities. Demands for assistance often outstripped the abilities of these men to respond. Occasionally, they delayed visits and surveys. Taking advantage of non-departmental expertise, Strand directed H. S. Brossard, the Yellowstone County agricultural agent, to Stewart Lockwood, newly arrived in his position with the U. S. Bureau of Entomology at Billings. Lockwood had much experience with the control of grasshoppers in North Dakota. Strand hoped that Lockwood could assist Yellowstone County without sacrificing his valuable studies and research out of the Billings office. Labor and financial shortages sometimes necessitated one county agent covering two or more counties, which created problems in surveying for insects and communicating with farmers and county leaders.[11]

Lack of a county agent or a farm organization forced farmers to plan individual actions. If the State Entomology Office could spare men to survey and offer advice on treatment and organization, farmers usually could expect success. If not, the battle usually had a less desirable outcome. The farmers, sometimes lacking information from a county agent, often failed to appreciate the potential threat of the grasshoppers. During the height of demand for assistance, Cooley and his staff had to refuse several requests for help. Limited funds prevented hiring more employees to cover all the infested territories. The Bozeman office then advised agents to rely on their past experience with grasshoppers and fight them as best they could.[12]

Treatment of public lands also remained a perennial problem. Displeasure with work on Indian Reservation lands generated criticisms of agents. One correspondent, who had asked for intervention by the Department of Interior, described the county agent in Pryor as just "[drawing] his salary and [riding] in the car the [government] furnishes him." Parker responded that he had heard the Department of Interior supplied some poison for government lands and advised the farmer to contact his county agent again for more information. The agent could not give each farmer individual attention because of the widespread nature of the grasshopper outbreak in Big Horn County. In corre-

spondence with Parker, the Big Horn County agent explained that the farmer who had written typified the uncooperative nature of those in the area, refusing even to collaborate with next door neighbors in the campaign. The superintendent of the Crow Reservation furnished funds to fight grasshoppers on the federal lands--funds available only if the farmers pulled together. In the Helena National Forest, lack of a county agent to cover the area added to the difficulties of surveying and treating public lands. Financial constraints delayed the dispatch of an entomologist to examine the situation and assist the forest supervisor.[13]

As the major method for communication from widespread areas of the state, the mails brought increased criticism of the County Insect Pest Law of 1921 and addressed other problems arising from the grasshopper troubles of 1922. Uncooperative county boards of commissioners delayed the acquisition of supplies until grasshopper damage had approached intolerable levels and the period had passed when treatments would have had the greatest success. Most counties made no provisions for holding over supplies from a previous year and did not compel uncooperative farmers, railroad and land companies to treat their properties. Counties could not absorb the costs of fighting the grasshoppers on state and federal lands. Instead they often decided to do little or nothing. In past years the federal

government provided some funds for Indian lands to poison grasshoppers. Montana did not do likewise for its state lands and Strand saw "no chance in the world" for a change in attitude in the near future.[14]

The County Insect Pest Law of 1921, in its second full year of operation, generated numerous complaints from county officials, farmers, and agricultural agents. They did not so much dislike the idea of such a law as recommend changes to improve it, after having had an opportunity to try it for a season. The State Entomologist's Office recognized many of these problems and took action to amend the law during the next legislative session. County commissioners objected to the provision which required them to pay for supplies with registered warrants--a provision which had attempted to circumvent restrictions on deficit spending. They maintained that surplus county funds enabled them to pay cash for materials at lower cost than using outstanding warrants. This would decrease the total cost of a campaign for those counties able to afford that approach. Cooley agreed and supported an amendment which authorized the counties to use general funds when available. He also noted that parties selling arsenic and bran had grown increasingly reluctant to accept registered warrants in lieu of cash payments.[15]

Additional complaints and suggestions arose from the County Agents Conference on Insect Pest Control held on

October 3rd at Malta. County agents expressed the need for a higher levy in the amended version of the law. Other correspondents echoed the necessity of an increased levy, particularly for counties where low valuations on property provided insufficient funds for a proper campaign. Strand responded by writing a proposed revision of the law which included the recommendations of the county agents and other concerned parties, especially with regards to flexible funding.[16] In these ways, the State Entomologist's Office accommodated the problems and concerns of agricultural constituencies and protected programs which needed protection.

The 1922 grasshopper campaign witnessed the continuation of some old economic problems and the appearance of new ones. The state legislature had authorized funds primarily for research, experimentation, supervision of the entomology organization, and control of insect campaigns. Cooley expected that under the County Insect Pest Law, the counties should appropriate funds necessary to carry out campaigns by taxing county property owners. No Montana legislature would agree to foot the bill for a statewide campaign. Unfortunately some counties could not afford to fund the necessary work. In such situations Cooley felt that when the banks would not or could not carry county warrants, financially interested businessmen, millers and

others had to step in to meet the crisis. Their survival also depended on the success of agriculture in Montana.[17]

In the face of financial duress, cooperation within and between counties enabled farmers to put on more effective insect campaigns. Some counties with excess supplies of poison sold it to farmers at cost and arranged bank financing when landowners could not afford to pay cash. Other counties sold leftover bran at cost and provided farmers with arsenic, molasses, and banana oil (amyl acetate) at cost. County officials and agents often believed that farmers would make more efficient use of the grasshopper poison formula if they had to cover part of the price themselves. Northern Montana farmers, dissatisfied even with this approach, asked why Montana did not give them the grasshopper poison free of charge as was done in Alberta. Strand wondered "who . . . would pay the bill."[18]

Further complications threatened to drive up the cost of supplies. Suppliers objected to receiving warrants from the counties, which came due in two years, rather than obtaining cash within thirty days or less. Companies threatened that future prices would reflect the waiting period necessary before full payment. Local suppliers raised prices on molasses products based on non-payment of 1921 bills. Creditors threatened less future willingness to give the best prices possible for vital materials.[19]

The State Entomologist's Office also bemoaned its low funding levels compared to its sweeping duties. Using county agents as his initial informants and primary communicators, Cooley provided farmers with support. He attempted to furnish men to initiate the work of grasshopper control after county commissioners agreed to support a county campaign. Cooley and his employees issued emergency circulars and notices on new injurious insects; demonstrated various control measures; identified insects to use more species-specific control methods; provided source and price information on insect control supplies; kept agents up to date on the latest treatments for pests; and corrected misinformation on insect control among agents and the farm population. In turn, agents kept the State Entomologist's Office apprised of general insect conditions, results of field trials for various control strategies, information on insect life histories and occurrence, and reports of crop losses caused by insects. Although only twenty-six counties had their own agents, these officials assisted in control measures in adjacent counties as well. As these agents gained experience and proficiency in caring for the problems in their counties, the State Entomologist's Office concentrated on assisting counties without agents, making more efficient use of limited personnel resources. But Cooley could not accomplish all this without additional funds.[20]

By 1922 the State Entomologist's Fund contained $3,900. From this amount, Cooley covered salaries, traveling expenses for himself and his staff, and the cost of numerous incidental items. According to Cooley this severely limited his ability to provide personnel to assist counties and communities in organizing for insect outbreaks. More counties would utilize the financial benefits of the County Insect Pest Law if he could send more men out to explain its provisions and mechanisms. Acknowledging that Montana would seek to retrench its finances during the coming year, Cooley nevertheless recommended an appropriation of from $10,000 to $15,000 for the State Entomologist's Fund in 1923--a request which may have precipitated a reexamination of the State Entomologist's Law and Fund, and led to a drastic decrease in the appropriation. He further argued that although entomology received a large sum of money, "as time goes on it will be necessary to spend more and more for the control of these major pests."[21] Cooley, however, failed to convince politicians and other non-specialists.

This year also brought the usual complement of grievances about effectiveness, suggestions for improvement, and sales proposals for the poison bait method of grasshopper control. Maneuvering to gain a portion of the profits stemming from the grasshopper outbreaks, some manufacturers suggested experimentation with their products and by-

products for improvement of the grasshopper poison formula. Eastman Chemical Corporation of Rochester, N. Y., encouraged experiments with wood product distillates and oils. Since amyl acetate cost only $2.00 per ton of bran treated, Strand countered that the potential savings could not justify such experimentation.[22]

Montana State entomologists often boasted how the demonstration of amyl acetate's efficacy in Montana, beginning in 1919, had strongly influenced its use by other western states. Noting its potential leadership position in the west, manufacturers and dealers tried convincing Montana's State Entomologist's Office that refined arsenic of 99% purity should replace crude arsenic in the grasshopper formula. Strand disagreed and continued recommending crude arsenic. The Anaconda Copper Mining Company had discontinued the manufacture of crude arsenic during the preceding year and raised the prices on refined arsenic. Naturally these companies and suppliers peddled whatever they could make the most profit selling. Parker argued that the coarser and heavier crude arsenic coated the particles of bran more thoroughly than the refined product and poisoned the grasshoppers more effectively. In the end, Strand directed inquiries for arsenic purchases to the U. S. Smelting Refining and Mining Company in Midvale, Utah, from which crude arsenic cost less than Anaconda's, including shipping. He believed that competition among

manufactures of arsenic would drive the prices even lower for the next season.[23]

Manufacturers also solicited the Bozeman office for ideas on how much molasses the various counties might use for grasshoppers in 1922. Local companies explained that otherwise they would sell molasses for other purposes. Strand explained that the State Entomologist's Office had no way of predicting future use and would have to settle for the same amounts that suppliers had set aside the previous season. Barrel shortages for shipments caused molasses shortfalls among the counties and increased costs. In response some agents substituted flour, sugar, and water mixtures. Strand responded that though he had never encountered the formula before, farmers might use it as an emergency stand-in for molasses. He added that the molasses acted to retain moisture in the bait and presented a better adhering surface for the arsenic granules. The sweetness of the syrup in his opinion did not add or subtract from the effectiveness of the bait formula. He also sought ideas for better shipping methods for molasses to reduce wastage and thus the cost. Rather than depend entirely on the Great Western Sugar Company at Billings for molasses stocks, Strand notified the British Molasses Company of New York that counties would buy from them if they could compete with the price from Billings.[24] It seems they would or could not.

Besides costs, farmers continued worrying about the use of the poison bait on lands dedicated to cattle production. Cooley reassured agents and their clients that hay and straw from treated fields would not poison cattle as long as the workers had properly scattered the grasshopper bait initially. Nevertheless, some farmers chose not to treat their lands, rather than risk losing valuable stock. They based their decisions on cattle loss by neighbors and other stockmen in their counties. Scientifically backed advice lost out to rumor and cattle deaths blamed on the bait but caused by other factors like poisonous range plants. Winter kills of stock also resulted from causes other than the grasshopper bait, since its viability diminished rapidly over a short time period.[25]

Other than attempts to find molasses substitutes, grasshopper fighters also continued mixing sawdust with bran in proportions of half and half. Strand advised that farmers should employ it only in an emergency, using old rotted sawdust and equal amounts of bran. Parker warned that the mixture provided poorer results than straight bran without shorts. With relation to these and other supplies, individual farmers proposed stocking up on the necessary ingredients early in the season. Strand wrote that if workers found large numbers of grasshoppers present or migrating into an area in late summer and during the fall, then a moderate stock of arsenic and banana oil would

enable the county to begin a sizable control campaign on a timely basis.[26] Otherwise stocking up on supplies unnecessarily froze already strapped funds.

Farmers sometimes faulted the effectiveness of the poison bait method. In most cases investigators found problems with materials and techniques rather than the basic formula of the grasshopper poison. One farmer near Clyde Park described how he carefully followed the instructions of the county agent but nevertheless,

> After eating heartily of the bran the hoppers [seemed] to chirp and hop and strut about in a manner to remind one of nothing so much as a delegation of College Proffessors [sic] at a Farm Bureau picnic.[27]

This farmer's distrust of the entomologists in Bozeman echoed its earlier manifestations during the 1921 Department of Horticulture affair.

Other cases of failure and dissatisfaction--some brought to the State Entomologist's attention by concerned business organizations dependent on agriculture--related to weather, misunderstandings about the actions of the poison and the proper time for treatment. The weather decreased the effectiveness of the poison when late afternoon thunder showers squandered the morning's labor by covering the scattered bait and diluting arsenic concentrations. Answering those who grieved about the slowness of the poison, Strand advised farmers that unlike strychnine in gopher bait, arsenic worked slowly--taking 24 hours to show evidence of working and two or three days to give final re-

sults. Additionally, some counties failed to carry out poisoning until mid-season, too late for the greatest efficacy and crop savings--again a flaw in technique and method.[28]

Other than incorrect treatment, variants in the accepted formula also caused difficulties. A farmer near Bridger described his bait as consisting of a "mixture of 100 lbs bran, four pounds arsenate, 3 [ounces] banana oil and four lbs salt with twelve gallons water and two gallons syrup." The formulation failed to kill a single grasshopper unless a bag accidentally fell from the wagon on top of one. In reply, Strand faulted the use of lead arsenate rather then crude arsenic. Druggists sometimes sold lead arsenate, containing only 25% arsenic, instead of crude or white arsenic with 80 to 99% arsenic content.[29]

Methodological arguments concerned whether more effective poisoning resulted from spreading the poison bait in strips rather than broadcasting it as evenly over the field as possible. Unlike previous examples of distrust, farmers posing this question placed a great deal of faith in the State Entomologist. Their county agent wrote that "a word from you [Cooley] will settle it because they are all strong boosters of yours and to them your word is law." Responding for Cooley, Parker maintained that grasshoppers appeared to move toward the scent of banana oil only fifteen to twenty feet away at most. When sown in strips the

poison could dry and lose its attractiveness to the grasshoppers before they managed to smell the bait. A second treatment, a week after the first, covered areas missed during the first application when farmers should have followed proper recommendations for a general widespread distribution.[30]

For farmers who wondered how late in the season it paid to use the poison method, Cooley advised treatment only if the grasshoppers caused significant damage and if the farmer could save remaining crops economically. Unless grasshoppers infested an area in great numbers during the autumn, Parker advised farmers to plant as usual and apply poison only where grasshoppers produced significant damage.[31]

Implement companies also attempted to promote the mechanization of grasshopper poisoning in mixing and spreading. Western Implements Limited of Regina proposed a demonstration of their machines at the County Agent Conference in January, 1923. But Strand informed them that high import duties and the machinery costs made their use prohibitive to financially strapped farmers. He suggested to one agent that agents might get ideas on how to build the machine after seeing it in operation.[32] In a lighter vein, W. C. Cook, another State College entomologist, noted the

effects grasshoppers had on his experiments with another insect:

> We have lots of hoppers around here, and will probably use around a half a ton of bran on the station farm here before the end of the season. I have had to poison my plots once, and will have to repeat the dose, as the hoppers are not leaving anything for my [cut] worms to eat.[33]

Agents and farmers sought counsel on other methods of dealing with grasshopper depredations. In large part they pursued less expensive techniques than poisoning, since many of the farmers could not afford the price of poison bait materials. However, Strand described fall cultivation as less of an option in Montana than in other states with gentler terrain. In Montana grasshoppers tended to lay their eggs where rocks and steep sloping conditions prevented extensive applications of cultural methods.[34] With discouragement of simpler approaches, farmers perennially called for biological warfare to permit nature to carry out the major portion of grasshopper control, at no cost to themselves.

Bozeman entomologists addressed various inquiries about infecting grasshoppers or infesting them with parasites. Parker explained that scientists had given up trying to inoculate grasshoppers with diseases by the beginning of the century. In 1902 entomologists experimented with artificially spreading fungal disease among grasshoppers. They failed in both Kansas and Montana, where Cooley took charge of the attempts, using a fungus

which attacked grasshoppers in South Africa. Observers found that the native American disease spread readily, but only naturally and under damp conditions. They could not initiate its diffusion in dry warm weather. Instead of spreading the disease through disease soaked swabs, or whatever writers pictured entomologists doing, some correspondents wanted infected grasshoppers with instructions on how to contaminate others in the fields. One farmer wrote that he had "a healthy lot of hoppers" and would "like to give them the flu," perhaps reflecting on the recent rampages of Spanish influenza among humans. A farming wife wondered whether poisoning grasshoppers also killed parasites, which might have attacked them anyway. Strand could not unequivocally answer her but suggested that poisoned grasshoppers quickly became inactive, whereas the flesh fly, a chief parasite, only attacked moving grasshoppers.[35]

Strand often repeated the same denials about existing or imminently developing methods of infecting grasshoppers with disease or infesting them with parasites. He explained the aforementioned difficulties involved in spreading disease among insects. The same difficulties arose with predators and parasites of grasshoppers. Entomologists more easily controlled introduced pests when they imported their natural enemies from native areas. Since grasshoppers and their enemies had evolved together in Montana and had developed a relative stability in their

population ratios, Strand saw little hope for initiating successful biological control techniques, limited especially by the state of scientific knowledge. He stressed the hopelessness of massive biological intervention and diverted the "rural imagination" among the farmers with an article in the Montana Farmer, published in Great Falls. In this piece, Strand argued against putting faith in miracles of germ warfare, but instead relying on tried and true methods--namely the poison bait.[36]

Grasshopper catching machines remained an attractive option for some farmers, though the State Entomologist's Office de-emphasized them in its advice to agents and farmers. Parker mailed an instructional bulletin describing the construction of a catching machine but informed the recipient that poison bran mash cost less in materials, time, and labor. So, compared to the earlier outbreak period, before the improvements in the poison bait formula, the catching machine no longer offered a genuine option in a serious outbreak. Unless specific situations required using the machine, it wasted precious time. In responses to similar inquiries, Strand pointed out that since 1918, when the extension service had published the grasshopper catching machine bulletin, additional experience with the poison bran formula had demonstrated its superiority in combating wide scale outbreaks.[37] Within four years advice from Bozeman to Montana's far-flung agriculturalists had

shifted from relatively equal emphasis on mechanical, cultural, and chemical means of grasshopper control to a predominantly chemical approach.

By 1922, the State Entomologist's Office also regarded fire as only a minor technique for grasshopper control. Parker noted that burning accomplished little, unless a fire burned hotly and for a sufficient period to heat the soil to a depth of two inches, where most grasshopper eggs developed.[38] Late in the season farmers tended to use a combination of control methods. They poisoned in winter wheat fields, burned along fence-rows, and disked and plowed wherever possible.

Nevertheless, favorable autumn weather, with low precipitation and mild temperatures, promised a resumption of problems in 1923. Disappointing a correspondent who had hoped for miraculous intervention from the weather, Strand wrote that rains which came late in the season could slow further egg-laying by grasshoppers but would have little or no effect on eggs already in the ground. Parker noted the inaccurate assumptions of a Record-Herald correspondent who had claimed that abundant moisture would prevent grasshopper eggs from hatching. Parker described how eggs had even hatched upon the return of favorable weather after inundation along lake shores. He added that many sections of the state had already reported deaths of grasshoppers from a spreading bacterial infection even before adults managed to

lay many eggs. Along with the recent rains he hoped this infection could end the season's damage without further artificial interdictions.[39]

In addition to infections and rain, farmers hoped that grasshoppers' other natural enemies would relieve them of the burdens of control work. Excited reports of red mites attacking grasshoppers near Lewistown and elsewhere compelled the president of the First National Bank in Lewistown to relate stories of hoppers found without wings and with their bodies partially eaten. Strand replied that a couple newspaper articles had come to his attention reporting the work of the mites. But he described these accounts as "perverted" since the mites never attacked grasshoppers internally but only on the thorax and wings. In abundance, the red mites at most weakened and reduced the fertility of the adult grasshoppers. As Parker observed red mites "seldom cause [grasshoppers] great annoyance, and rarely are they abundant enough to kill a grasshopper." Grasshopper deaths probably occurred from other factors, such as fungal infection or flesh flies, but not red mites.[40]

Agriculturalists also placed their hopes in other traditional insect enemies of grasshoppers. Strand assured county agents and others that blister beetle larvae destroyed many grasshopper eggs through predation. However, adult beetles also fed on various crops. Parker described Nuttall's blister beetles invading gardens and eating wild

lupines. He noted how the blister beetles fed on grasshopper eggs, then to a smaller extent on alfalfa, potato vines, and garden vegetables.[41] Still, Bozeman entomologists advised that the beneficial work of the blister beetles usually outweighed their minor damage.

The State Entomologist's Office dealt with several problems arising during the 1922 season, but also present to some degree during all the campaigns between 1917 and 1924. Agents had handled situations beyond insect depredations. Bozeman entomologists did not expect them to identify all the harmful pests when many benign species also inhabited the same areas. A 1922 outbreak of crickets confused farmers and agents. One agent mailed a sample of young crickets which he identified as grasshoppers, though area farmers disagreed, labeling them crickets. Strand agreed with the farmers and requested adult specimens when available.[42]

Financial problems reappeared to obstruct timely campaigns. The farmers had little spare cash; they expected counties to carry out the work of fighting grasshoppers. Estimates for the cost of treatment ranged from twenty to forty cents per acre. But in some cases county commissioners "deemed it inadvisable" to pay for a county wide campaign and left it to farmers. County agents knew that farmers would put out little poison because of the costs. Cooley also warned that this approach usually failed in a

widespread outbreak because poor and disorganized participation crippled a campaign's effectiveness. He could offer no other options if both the farmers and the county commissioners refused to finance the work.[43]

Farmers often despaired of exerting effort or pouring money into what they perceived as a hopeless situation. Grasshoppers covered the countryside in several counties and ate fields down to the ground, so farmers did nothing. In some cases, even though county commissioners seemed prepared to help, farmers did not cooperate among themselves--rugged individualism led to financial ruin. On other occasions farmers continued expressing their concern when county campaigns failed to reach their localities. Sometimes concerned Montanans deemed the situation so perilous that they requested the Governor to convene a special session of the state legislature to deal with the grasshopper crisis. He refused.[44]

The State Entomologist's Office conducted surveys during and after the 1922 grasshopper campaign to better grasp the extent of damage and effectiveness of the organization in fighting the outbreak. Cooley, in agreement with other departmental entomologists, believed that complete location of grasshopper egg beds in Montana remained an unattainable goal. Returning to an argument about similar problems in treatment, Cooley referred to the vast distances and isolated areas of Montana which made both

exhaustive treatments and surveys impossible. Agents mailed egg samples which enabled the State Entomologist to determine the condition of eggs and thereby the likelihood of another large outbreak. Strand described the characteristics of healthy and parasitized eggs for county agents and farmers so they could tell whether to expect trouble. He stated, "Healthy eggs in the spring are plump and filled with a liquid." Parasitized eggs appeared as empty shells and "those which have been affected by exposure to air are shriveled and dried." To further educate agents on the particulars of entomology, Strand recommended Sanderson and Peairs' Insect Pests of Farm, Garden and Orchard which sold for $4.50, a considerable sum for a low-paid county agent in 1922 Montana.[45]

Success in locating grasshopper egg beds varied among surveyors. Stewart Lockwood accompanied the Yellowstone County agent and reported finding few eggs and no large concentrations during May. By June the agricultural instructor in the Geraldine Public Schools relayed reports of "alarming numbers" of eggs and requested an investigator from Bozeman. In October, county agents reported few egg pods. Flesh fly and blister beetle larvae infested many of the discovered eggs. Parker also solicited information on collectible eggs of Melanoplus atlanis and Camnula pellucida for use in his 1923 work toward his Ph.D. at the University of Minnesota.[46]

In other efforts to assemble data, Strand mailed a request to all county agents to trace the important grasshopper infestations of 1922 on county maps. He added that the State Entomologist needed the information for his annual report covering 1921-22, which he hoped would educate the upcoming legislature on future state entomological needs. Strand also asked agents for objections to and suggestions in improving the County Insect Pest Law. Since county agents did not serve all the counties, the final maps lacked complete data, though some of this information also came from county clerks and recorders. Strand sent a copy of the completed state map, which included the data received for Montana, to Lockwood who found it valuable in his own studies with the Bureau of Entomology--part of the interaction which improved the success rate in the grasshopper campaigns.[47]

The State Entomologist's Office also solicited details of the 1922 campaign among the counties. Strand asked various questions including whether the county used the county insect pest law; county money used beyond the pest law; tons of bran used; the approximate acreage treated; the number of mixing demonstrations held; the number of field demonstrations held; the number of hopper catchers used; and the number of negative reports--where farmers reported grasshoppers but inspection of an area revealed none. Through this data, Cooley hoped to improve both the

entomological organization's performance and the efficiency of fighting future outbreaks at the local level in every Montana county. Comparing maps of 1922 with 1921, observers also noted that treatment during 1921 had reduced recurrences of grasshoppers in 1922 within the treated areas.[48]

Intervention by the State Entomologist's Office and associated offices thus played a major role in saving crops from grasshopper attacks in 1922. Entomologists reduced the panic among farmers who had little past experience with grasshopper damage by patiently leading them through various steps from surveying to organizing to treating and monitoring results. Many farmers consequently harvested a substantial crop where they had at first expected a total loss. In his annual report Cooley disclosed that farmers had treated over 700,000 acres of infested Montana lands. This translated into a crop saving of more than $2,500,000 at a cost of $185,000 for poison bait materials. In some counties where treatment deflected the grasshoppers from crops, yields still suffered from drought stress--losses not necessarily accounted for in the crop savings estimates.[49] Though the peak outbreak season occurred in 1922, two of the four worst grasshopper infestation years of this period still remained.

Thus, 1922 gave the state entomology organization its share of defeats and victories. Increased precipitation

had promised increased crop growth and some limitations on grasshopper numbers, but not enough to stem the troubles immediately. Muddy conditions also made traveling and surveying more difficult. The limited personnel available to the State Entomologist's Office, adequate for normal insect years, delayed more timely intervention during the grasshopper emergency. After their second year of experience with the County Insect Pest Law, counties requested permission to use available county funds rather than depend solely on outstanding warrants. They also suggested an increase in the allowable half-mill levy. Mounting grasshopper campaign expenses forced cooperation among counties and between counties and farmers. At the state level, Cooley sought expanded funding for the State Entomologist's Office; the emergency demands of 1922 had demonstrated the impossibility of properly meeting a crisis situation with normal appropriations. Suppliers of materials for grasshopper control found 1922 a lucrative year for marketing their wares. Yet, shortages of materials and price increases forced the State Entomologist's Office to suggest substitutes. Expanded survey work before, during, and after the grasshopper season enabled the state entomology organization to concentrate its forces in trouble areas and prepare for the expected threats of 1923.

NOTES

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2. Ibid., p. 10.

3. A. L. Strand to J. O. Hembre, 28 March 1922, File "County Agents--Correspondence, A-M, 1922," Acc. 00016, Box 4 of 15, Montana State University Archives, Bozeman, Montana; A. L. Strand to J. O. Hembre, 4 April 1922, File "County Agents--Correspondence, A-M, 1922," Acc. 00016, Box 4 of 15, Montana State University Archives, Bozeman, Montana.

4. R. A. Cooley, "Grasshoppers, Cutworms, and Other Insect Pests of 1921-1922: Nineteenth Report of the State Entomologist of Montana," December 1922, Bulletin 150, pp. 10, 27, in Agricultural Experiment Station: Bulletins and Circulars, vol. 20, Montana State University Archives, Bozeman, Montana; "Insect Pests of the Year," File "Insect Control (General) 1921-1922, 1930-1949," Acc. 00016, Box 4 of 15, Montana State University Archives, Bozeman, Montana; R. A. Cooley to Leroy M. Gilbert, 21 July 1922, File "Grasshopper Control Campaign, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; A. L. Strand to Stewart Lockwood, 1 June 1922, File "Grasshopper Control Campaign, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

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12. O. A. Wilseen to State Experimental Station, Bozeman, 26 June 1922, File "Grasshopper Control Campaign, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; R. A. Cooley to W. F. Cashmore, 26 July 1922, File "Grasshopper Control Campaign, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

13. A. Masterson to Bureau of Agriculture, Bozeman, 20 June 1922, File "Grasshopper Control Campaign, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; J. R. Parker to A. Masterson, 24 June 1922, File "Grasshopper Control Campaign, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; J. R. Parker to L. B. Ryman, 24 June 1922, File "County Agents--Correspondence, N-Y, 1922," Acc. 00016, Box 4 of 15, Montana State University Archives, Bozeman, Montana; L. B. Ryman to J. R. Parker, 26 June 1922, File "County Agents--Correspondence, N-Y, 1922," Acc. 00016, Box 4 of 15, Montana State University Archives, Bozeman, Montana; A. H. Abbott to A. L. Strand, 10 June 1922, File "Grasshopper Control Campaign, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; [Unknown] to A. H. Abbott, June [n.d.],

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18. Chas. H. Ruzicka to A. L. Strand, 29 June, 1922, File "County Agents--Correspondence, N-Y, 1922," Acc. 00016, Box 4 of 15, Montana State University Archives, Bozeman, Montana; [I.] B. Noble to A. L. Strand, 21 July 1922, File "Grasshopper Control County Surveys, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; A. L. Strand to H. L. Seamans, 18 May 1922, File "Grasshopper Control Campaign, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

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22. A. L. Strand to Frank J. Bohan, 28 October 1922, File "Grasshopper Control Campaign, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

23. J. R. Parker to H. N. Lyon, 7 June 1922, File "Grasshopper Control Campaign, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; A. L. Strand to C. B. Lyon & Bro., Inc., 12 May 1922, File "Grasshopper Control, Grasshopper Bait Supplies, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; J. R. Parker to Geo. C. Jackson, 7 June 1922, File "Grasshopper Control, Grasshopper Bait Supplies, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; A. L. Strand to O. A. Wilseen, 29 June 1922, File "Grasshopper Control Campaign, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; A. L. Strand to Chas. H. Ruzicka, 16 December 1922, File "County Agents--Correspondence, N-Y, 1922," Acc. 00016, Box 4 of 15, Montana State University Archives, Bozeman, Montana.

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25. R. A. Cooley to W. P. Stapleton, 5 August 1922, File "County Agents--Correspondence, N-Y, 1922, Acc. 00016, Box 4 of 15, Montana State University Archives, Bozeman, Montana; A. W. Warden to A. L. Strand, 5 May 1922, File "County Agents--Correspondence, N-Y, 1922," Acc. 00016, Box 4 of 15, Montana State University Archives, Bozeman, Montana; A. L. Strand to A. W. Warden, 10 May 1922, File "County Agents--Correspondence, N-Y, 1922," Acc. 00016, Box 4 of 15, Montana State University Archives, Bozeman, Montana.

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27. Justin D. Lovely to C. A. Arnet, 6 July 1922, File "Grasshopper Control Campaign, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

28. Leonard to State Agricultural College, 22 June 1922; E. R. Leonard to J. R. Parker, 30 June 1922, File "Grasshopper Control Campaign, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; Peterson to Strand, 15 July 1922; A. L. Strand to C. A. Arnet, 13 July 1922, File "Grasshopper Control Campaign, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; A. L. Strand to C. L. Corkins, 12 August 1922, File "Grasshopper Control Campaign, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

29. S. A. Carlson to The U.S. Experiment Station, Bozeman, 8 July 1922, File "Grasshopper Control Campaign, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; A. L. Strand to S. A. Carlson

12 July 1922, File "Grasshopper Control Campaign, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

30. W. H. Buckingham to R. A. Cooley, 11 June 1922, File "Grasshopper Control Campaign, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; J. R. Parker to B. A. Mumpower, 26 July 1922, File "Grasshopper Control Campaign, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; Parker to Buckingham, 15 June 1922.

31. R. A. Cooley to Walter F. Brown, 5 August 1922, File "Grasshopper Control Campaign, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; J. R. Parker to J. E. Monroe, 14 September 1922, File "Grasshopper Control Campaign, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

32. Jos. Cunningham to Stewart Lockwood, 30 November 1922, File "Grasshopper Control Campaign, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; A. L. Strand to Stewart Lockwood, 6 December 1922, File "Grasshopper Control Campaign, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; Strand to Ruzicka, 16 December 1922.

33. W. C. Cook to J. R. Parker, 27 June 1922, File "Cook, W. C., Asst. Ent. (Corresp.) 1921-1922," Acc. 00016, Box 4 of 15, Montana State University Archives, Bozeman, Montana.

34. A. L. Strand to H. N. Kauffman, September 1922, File "County Agents--Correspondence, A-M, 1922," Acc. 00016, Box 4 of 15, Montana State University Archives, Bozeman, Montana.

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37. J. R. Parker to J. T. Brown, 22 July 1922, File "Grasshopper Control Campaign, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; A. L. Strand to L. E. Newlon, 5 May 1922, File "Grasshopper Control Campaign, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

38. J. R. Parker to J. E. Border, 25 August 1922, File "Grasshopper Control Campaign, 1922," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

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# CHAPTER 5

## 1923: BATTLING, SLASHING, AND CONFERRING

Drought conditions decreased during the final months of 1922. By the spring and summer of 1923 precipitation levels stood above normal and temperatures returned to historical averages. Deflationary stresses pressed less heavily on Montana's farm economy and justified additional expenditures toward the ongoing grasshopper campaigns. Amid the easing natural burdens, F. B. Linfield lamented the ongoing effects of distant markets, situated 1,000 to 3,000 miles from Montana's croplands. The cost of spanning these distances raised the prices of Montana farm products and in turn increased the costs of manufactured items coming into the state. The inflated freight rates arising from demands of the world war, increased costs of eastern manufactured goods, and lower agricultural prices had stunted Montana's economic growth throughout these grasshopper years. Thus, even a smaller grasshopper outbreak, compared with 1922, created additional crippling burdens for farmers already debt stressed and at the mercy of the free enterprise system.[1]

Like 1922, the year 1923 mixed successes with failures in the grasshopper battles. Many farmers tilled their

lands at the edge of economic survival. The Montana legislature dealt a major blow to the State Entomologist and the overall organization of insect pest control by slashing the State Entomologist's Fund over a fine point in the law, which had limited the Fund to $500 per year. On the other hand, the Great Falls' Grasshopper Conference of August, 1923, brought together a large number of specialists in insect control. It refocused governmental, private, and academic authorities on the problems much of the West faced with recurring grasshopper outbreaks and diminishing economic wherewithal to fight the menace. Despite the financial stranglehold and the second worst year of the grasshopper threat, the State Entomologist of Montana and the state entomological organization waged a successful fight and documented their savings for all to see--particularly state legislators.

Familiar actors reemerged for their seemingly endless encore. The Lesser Migratory (Melanoplus atlanis), Two-Striped (Melanoplus bivittatus), and Roadside (Camnula pellucida) grasshoppers appeared in varying numbers during the 1923 season--a period which R. A. Cooley characterized as "more severe" than the previous year. Results of the jointly sponsored State Department of Agriculture and Bureau of Entomology egg bed survey promised a repetition of Lesser Migratory grasshopper troubles in 1924, unless the weather or poisoning intervened. Predators and dis-

eases did not seriously enter the equation, a reflection on their decreased effects during an extensive outbreak. Since the Lesser Migratory grasshopper consistently dominated the damage reports, J. R. Parker questioned whether an egg bed survey could adequately predict future troubles. He reminded Cooley that this particular species laid its eggs in a widespread area, not in concentrated pockets as did the Two-Striped and Roadside grasshoppers. Thus, Melanoplus atlanis, prevalent in the season's outbreak and the most widespread species in the state, demanded the greatest resources of time, labor, and money to control.[2]

Camnula pellucida, much less abundant than M. atlanis, concentrated its depredations primarily in eastern Montana. However, Cooley also expected damage from C. pellucida in 1924. Melanoplus bivittatus attacked crops in some areas along the Yellowstone River but Cooley expected less severe infestations in the following year, due to timely poison treatments and the prevention of oviposition.[3]

A mild autumn encouraged the late appearance of nymphal grasshoppers which panicked several farmers, concerned for their winter wheat and other overwintering crops. The Bureau of Entomology's Stewart Lockwood quickly wrote a memorandum addressed to all the county agents in Montana to allay unfounded fears. He "checked this up" and found none of the grasshoppers economically important. Lockwood added that "they are not the species which we have had to contend

with this summer."[4] Much of the job of entomology in Montana involved heading off disinformation and irrational fears.

In June, Cooley wrote to Parker, studying in Minnesota for his Ph.D., that grasshoppers appeared more numerous and caused more damage than in all his experience in Montana. Parker responded that so many grasshoppers would "wake up the people to the fact that their is some use for an entomologist" and suggested lining up individuals to pressure the next legislature for funds. Parker also requested Melanoplus atlanis adults for producing eggs in the fall, which he needed for his doctoral research.[5] Since no concentrated egg beds of this species existed, he had decided to breed the grasshoppers to obtain the needed eggs.

To measure the extent of the outbreak Cooley mailed a questionnaire in the spring to all county agents, whether he had heard from their areas in the past or not.[6] The responses indicated that irrigated croplands, growing more lusciously and quickly than drylands, had attracted numerous grasshoppers which hatched along the irrigation ditch banks. Additionally, grasshoppers returned more abundantly where farmers failed to poison them in 1922 and attacked crops less in areas treated the previous year. In sections with few settlers and abundant grasshoppers on open

prairie, agents hoped to control the situation by treating crops only as the need arose.[7]

As part of the campaign to enlist the support of the federal government in dealing with the recurring grasshopper problems, Cooley described to Senator Burton K. Wheeler areas which had become unsafe for croplands during the past seven years. Stressing that Montana's grasshoppers spread into surrounding states and the southern Canadian provinces, Cooley argued how the problem had become a federal and international responsibility. Individual states could no longer handle grasshoppers without federal assistance.[8]

Without an Assistant State Entomologist since June, Cooley traveled about Montana himself to appraise the extent of outbreaks. In the western part of the state, he witnessed "grasshoppers coming out of the air, flying into four-story windows and being chased by birds in the air." When he visited northern Montana in August, observers told him the grasshoppers had flown to the west. The situation again reminded him of the Rocky Mountain Locust outbreaks of fifty years before. Commenting on a letter from Cooley who reported the migrations in Montana, E. H. Strickland, chief of the entomology service in Alberta, credited the "somewhat exceptional winds" for limiting the grasshopper flights from Montana into the province. Having reached the point of "closing practically all mixing stations" in Alberta after a successful campaign season, Strickland

confided Canadian concerns of late migrations from Montana before oviposition had ceased. Canadian representatives to the Great Fall's Grasshopper Conference again voiced their hopes that Montana authorities would better control grasshoppers so that fewer migrated from Montana "nurseries" to inflict damage in Alberta and Saskatchewan.[9]

Cooley failed to report specific counties and areas where particular grasshopper species had caused problems in the outbreak of 1923. However the 1923 map with approximate sizes and locations of serious infestations appears in his Twentieth Report.[10] Grasshoppers had concentrated in a large area covering half of Toole and Chouteau Counties, with an arm of destruction leading across Liberty and into Hill Counties. A spotty band of lesser outbreaks led from this massive concentration east to the North Dakota border. Based on Cooley's reports of migration sightings, the Lesser Migratory grasshopper probably predominated in this area north of the high-line in 1923.[11] Widespread outbreaks damaged crops in southwestern and central Montana and along the Yellowstone River from Carbon through Yellowstone and into Rosebud Counties.

Personnel problems worsened in 1923 as the legislature gutted the appropriation for the State Entomologist's Fund and Parker left for advanced education. Adding to the workload of Cooley's office, J. A. Hyslop, the entomologist in charge of the Insect Pest Survey of the U.S.D.A. Bureau

of Entomology, had requested timely reports of insect outbreaks in Montana. Hyslop hoped to apply this information to calculations under the Grain Futures Act for tracing price effects on grains in interstate commerce. Cooley pleaded a lack of funds and personnel for his laxity in meeting Hyslop's request.[12]

Parker researched temperature and humidity affects upon Camnula pellucida and Melanoplus atlanis at the University of Minnesota as he labored toward his Ph.D. He had left Montana and begun his studies by October 1922, expecting to miss the entire grasshopper season of 1923. H. T. Fernald of the Massachusetts Agricultural College recommended a Master of Science for Parker on the basis of his course work in Massachusetts and Parker's paper based on his Montana researches on amyl acetate.[13] In approving Parker's sabbatical leave for his studies, Cooley had remarked that Parker's work on his Ph.D. would continue at the Montana Experiment Station upon his expected return in October 1923--Parker would not lose touch nor would the Experiment Station forfeit valuable investigations. Cooley stressed in his letter to Linfield that,

> it is desirable that our men of Mr. Parker's sort be given an opportunity to pursue advanced study and he will bring back to this Experiment Station not only the net results of this particular piece of research but a widened experience and a broader outlook for work in the future.[14]

All too typical legislative activities in 1923 led to crippling cuts in the State Entomologist's Fund and the

termination of A. L. Strand. The State Entomologist's Fund of 1903 allocated $500 for travel by the State Entomologist who received his salary compensation only from the Montana Agricultural College and Experiment Station. Over the intervening years, the legislature had voted additional funds until the total State Entomologist's Fund had reached $3,900 by the 1921-22 biennium. After reexamining the language of the state entomology funding law, which limited the total allocation to $500 per annum, the Committee on Boards and Commissions decided that the State Entomologist had been spending money "illegally" and reduced the sum back to its initial $500 level. On another of its traditional cost-cutting binges, the Montana citizen-legislators slashed another ten percent, leaving Cooley with $450 to run his entire operation.[15]

Cooley reluctantly freed Strand of his duties since his salary had comprised a major part of the fund. During the previous two years Strand had focused his efforts on the grasshopper campaigns and carried out his duties from the office by mail, telegraph and telephone, and had traveled in the field to assist counties, agents and farmers on an individual basis as long as funds were available. Upon Strand's loss, Cooley had to conduct the business of the State Entomologist strictly from the Bozeman office, making generous use of mimeographs and bulletins for county agents and other local campaign leaders. Demands for assistance

from the State Entomologist continued to increase throughout the 1923 campaign. Strand accepted a position as Assistant Extension Entomologist at Pennsylvania State College as Cooley solicited funds for a full time assistant, who would devote most of his time to State Entomology Office duties, and for "a few temporary assistants during the active grasshopper season." The Montana legislature expected the State Entomologist to maintain the quantity and quality of his intervention without providing the proper funding levels. Cooley's requests for over $9,000 for the State Entomologist's Fund may have backfired. State and county governments operated under extreme financial restrictions during the 1923 campaign. County agents acted in counties who had them while counties without agents applied few control measures.[16]

The State Entomologist's Office concentrated on the poison bran bait method in the grasshopper outbreak of 1923. W. C. Cook, Assistant Professor in the Entomology Department, experimented with esters and alcohols as attractants for flies, moths, and grasshoppers. Cooley described Cook's work as an attempt "to discover those broad fundamental principles in the relation of insects to chemical substances" and hoped this would lead to greater effectiveness in battling insect pests in general and grasshoppers in particular.[17]

Lockwood at the Bureau of Entomology continued providing valuable information to the State Entomologist concerning poison bait ingredients and their efficacy in the grasshopper poison formula. On the matter of substituting sawdust for bran, Lockwood noted that mixing half bran and half sawdust worked almost as well as whole bran but a bait made up entirely of sawdust compared extremely unfavorably. Farmers who used straight sawdust in the formula practiced a false economy since this made the bait nearly useless. Lockwood also conducted experiments at the Billing's Laboratory with beet and sorghum molasses and amyl acetate. When used alone, sorghum molasses attracted grasshoppers best, with amyl acetate coming in second and beet molasses third. However, amyl acetate mixed with either of the molasses products outperformed any of the three alone.[18]

Parker wrote to Cooley from Minnesota reiterating his opinion that molasses functioned primarily as an agent for moisture retention. Cooley must have received this counsel with relief since by the beginning of the season he discovered molasses in short supply and at unreasonable prices. Compounding the difficulties, Billings' Great Western Sugar Company had sold molasses, supposedly reserved for grasshopper bait, to stockmen for feed. Faced with shortages and high prices, agents and farmers began using a sugar-flour syrup mixture instead of the molasses with satisfactory results.[19]

The State Entomologist's Office and county agents also addressed other issues of the grasshopper poison bait method. Complaints about poisoned livestock had continued. Before leaving in June, 1923, Strand had authored the circular "Poison Grasshoppers--Not Live Stock" for the Experiment Station. In it he outlined the correct materials for the bait mix--their quantities and qualities--and the correct scattering methods to prevent concentrations of bait which could kill cattle. Poisonings usually resulted from carelessness in mixing and scattering and improper storage of left over poison bran. In addition, county agents recommended that farmers should mix the bait at community gatherings--so that farmers could learn the correct methods for mixing--unless special circumstances warranted handing out the ingredients to individual farmers for their own mixing. Mixing demonstrations by county agents totaled 138 during 1923 with 2,177 farmers in attendance. Four-hundred and thirty farmers attended 30 field demonstrations presented by county agents.[20]

By 1923 the ability of various Montana county and state governmental entities to manage the added expenses of battling the grasshopper outbreaks reached crisis proportions. Insects and drought contributed to numerous crop failures for some farmers who teetered on the precipice of financial ruin. Farmers abandoned homesteads and moved out of the country--a large proportion of these migrated to

Canada. Counties coped by selling most of the materials at cost to the farmers. They circumvented the provisions of the County Insect Pest Law by not using it. The massive extent of the grasshopper outbreak and the likely cost of fighting it properly incurred opposition among taxpayers to any extensive organization. Taxpayer attitudes discouraged county commissioners and Farm Bureaus from championing a more efficient campaign.[21]

Other counties used the County Insect Pest Law but charged farmers directly for the cost of some materials and passed on others to the taxable lists. Some county agents accepted a strategy of treating only the worst infested areas and only where farmers willingly cooperated. Counties which may have desired to carry out a full blown campaign within the provisions of the Pest Law legally could not because they had reached the limit of their bonded indebtedness. At the beginning of 1923, Cooley praised Frank A. Hazelbaker, the state senator who had written the County Insect Pest Law in 1921. He described the law as part of the triad which had successfully controlled the grasshoppers since 1921, the other members being the county agents and the State Entomologist's Office. He did not mention the Bureau of Entomology or the Department of Entomology for unknown reasons. Following the difficulties of the 1923 season, Cooley repeated his

praise of the Pest Law and credited its operation for the "salvation of many farmers during the past three years."[22]

Cooley and other state officials cooperated in efforts to overcome funding problems which had forced counties to take up the aforementioned measures. Canadians expressed concerns about grasshoppers migrating from hatching beds in Montana. H. L. Seamans[23] offered his support in pressuring the State government, through Montana's Commissioner of Agriculture, to appropriate more money for the State Entomologist's work.[24]

Adding to the threats of already diminishing resources, Lockwood notified Cooley that the Bureau of the Budget had reduced the appropriation for Cereal and Insect Investigations by $10,440 beginning on July 1, 1924. This could further reduce the Bureau of Entomology's ability to extend personnel and money for the grasshopper battles in Montana. Compounding problems, Commissioner Chester C. Davis reported to Cooley that the Farm Mortgage organizations had refused to help finance claims arising from grasshopper campaigns. Davis added that they might have to approach some Northern Montana bankers for funding of the claims. When the bankers balked at the proposal, Commissioner Davis further suggested that the State Land Board could buy up these claims. In another attempt to overcome the bankers' hesitancy to support further campaigns during 1924, Cooley wrote an article for The Montana Banker, which

appeared in the autumn of 1923. He repeated his arguments about the benefits, to farmers in particular and Montana's economy in general of prompt intervention against the grasshopper outbreaks [25]

To increase the levels of support for the State Entomologist's Office, Linfield and Cooley sought the endorsement of Governor Joseph M. Dixon, who responded in the affirmative. Dixon stated that he would bring the matter to the attention of the State Board of Examiners[26] with his recommendation that they do all in their power to decide favorably on the increased funds and methods for obtaining them. Cooley hoped that Commissioner Davis could attend the Board of Examiners' meeting to lend his support. Davis assured Cooley he would attend and expressed confidence in the Board's positive action. The Board considered the arguments for the overdraft authorization and approved the total request of $9,300. This would cover the State Entomology Emergency Fund to February 1925. But Commissioner Davis and Cooley had to find a purchaser to advance the money and accept reimbursement by the legislature.[27]

During this period of numerous Montana bank failures, local banks hesitated to abide the additional risks of backing claims for grasshopper work. However, the State Board of Examiners had outlined a plan for operation of a revolving emergency fund, which kept banks in the equation. The State Entomologist's Office would submit claims relat-

ing to the grasshopper work on a regular basis to the Board of Examiners which would approve the claims monthly and certify them before the next legislature for a deficiency appropriation. Banks assigned a specific claim earned interest on it until they received full payment. To ensure the security of these loans by the banks, "responsible firms, corporations and individuals . . . consented to act as limited guarantors pending payment of [the] claims by the state." Montana normally offered an interest rate of six percent to the banks, but under the emergency circumstances Governor Dixon and Commissioner Davis recommended that the state pay the banks eight percent, unless they expressed satisfaction with the lower rate.[28] Financially, Cooley and the State Entomologist's Office scraped through the 1923 season. The new scheme for deficit spending in 1924 offered the opportunity to carry out entomology's mission more as Cooley envisioned.

J. L. Humphrey, the manager of the Capital Trust and Savings Bank in Great Falls, had written an anxious letter to Commissioner Chester C. Davis in July 1922, agonizing over the grasshopper ravages of the 1922 season and asking how Montana agriculture would fare in 1923 if the grasshoppers returned. He planted the seeds which may have germi-

nated into the Great Falls Grasshopper Conference of August 1923 when he asked,

> . . . would it be visionary or foolish for you as Commissioner of Agriculture of this state, to call a general meeting at Helena of influential farmers, college men, business men and state officials immediately, for the purpose not only of discussing this thing, but to take some definite action towards eliminating the pest, as far as 1923 is concerned. [sic][29]

Cooley informed President Alfred Atkinson of Montana State College about the emergency situation brought about by grasshopper devastations and migrations in 1923. At the urging of Cooley and others, Atkinson called a conference at Great Falls for August 31, 1923. In his announcement President Atkinson invited agricultural, railroad, banking and business representatives. He also included Senators and Representatives of the surrounding states, each state's Commissioner of Agriculture, officers of M.S.C., the State Entomologist, county agents and farm bureau officials. Atkinson hoped that entomologists from Alberta and Saskatchewan also could participate. Seamans wrote to Cooley ten days before the conference offering to bring up anything which would help Cooley's Department, "financially or otherwise." Cooley only had to "tip [him] off before the meeting." After entomologists of the states and provinces had reported on conditions in their areas, discussions would cover grasshopper control, the immediate future of grasshopper infestations, and plans to meet the needs of future outbreaks.[30]

Cooley agreed with Director Linfield's suggestion of inviting special interests rather than the general public. Cooley thought the conference would set the preliminary groundwork for raising money or gaining state or national legislative support, rather than attempt to resolve completely field problems encountered in the course of fighting grasshoppers. The Canadians canceled a similar conference when word arrived of Montana's efforts. They viewed their own plans as unnecessary duplication.[31]

Organizers of the Grasshopper Conference deemed it a success. Representatives of banks, railroads, credit and loan institutions, newspapers and the agricultural press attended from the private sector. Members of Congress, the State Department of Agriculture, the U. S. Department of Agriculture, county agents[32] and officers, and staff members from Montana State College, the Experiment Station, and the Extension Service represented interested governmental entities--as did officials from the Canadian Government and Province of Alberta. When top officers of railroad companies could not attend personally, they sent others in their stead. Though unsure of how they might contribute in the control of grasshoppers, the railroads expressed a desire to assist wherever they might. Of the Montana congressional delegation, only Representative Scott Leavitt of the Eastern District put in an appearance, though Representative John M. Evans expressed his support for the

conference and its aims. Leavitt had given his pledge of cooperation in his acceptance of the invitation.[33]

After President Atkinson's welcome to the conference delegates, Great Falls' Mayor Harry B. Mitchell described how grasshoppers had stripped the vegetation clean on his boyhood farm in Minnesota. In that case, the grasshoppers had disappeared and never returned. But in Montana, the grasshoppers seemed to get worse with each passing season.[34]

The intense and widespread infestations of 1923 promised more of the same for 1924--a major reason behind the conference call. Unlike earlier outbreaks, the Sarcophagid (flesh) flies provided little natural control over the progression of grasshopper outbreaks and did not prevent extensive egg laying, thus preparing the stage for problems in 1924. Without aggressive control measures the Montana agricultural community expected losses of from four to six million dollars in 1924, from grasshoppers alone.[35]

Cooley, the first entomologist to address the conference, presented a short history of the problem since 1917. He again referred to Melanoplus atlanis, the Lesser Migratory grasshopper, in terms of its similarities to Melanoplus spretus, the Rocky Mountain Locust of fifty years before.[36] But the importance of the Two-Striped and the Roadside locusts paled when compared to the widespread nature of M. atlanis's destruction. Organized efforts had

kept the Lesser Migratory grasshopper under control and isolated to particular farms and county sections in 1923, because of their unusual migratory nature that year. Instead of merely moving to an adjacent farm after exhausting the vegetation where they had fed, the grasshoppers "[flew] clear across the range."[37]

Agent Carl H. Peterson of Fergus County seconded Cooley's assessment of Melanoplus atlanis's predominance, faulting it for 95% of the damage in his county since 1920. However, fewer grasshoppers appeared in Fergus County than in previous years. He credited the ongoing organized campaigns and "concerted action by the community" for decreasing the grasshopper threat more with each passing season. Peterson expected even less grasshopper trouble in the county for 1924.[38]

Peterson also admitted that the Lesser Migratory grasshopper behaved differently from the other two major species--Melanoplus bivittatus and Camnula pellucida. During the 1922 season, Peterson had persuaded farmers to burn and mow roadside weeds. This decreased the attractiveness of the area for feeding and egg-laying by M. bivittatus and C. pellucida but had little effect on M. atlanis that fed and laid eggs in widespread patterns--a behavior unamenable to effective treatment by simple roadside cultural practices.[39] Only the poison bait method succeeded against the Lesser Migratory grasshoppers.

Cooley painted a picture of a state under siege. Only four counties in the southeast corner and other scattered counties in the rest of Montana had reported little or no grasshopper trouble. Montana, "the storm center of the situation," drew polite criticism from Canadian neighbors to the north. The Canadians encouraged Montana to control the grasshoppers within state borders so Alberta and Saskatchewan could better focus their efforts on native breeding populations without constantly guarding against migrations from the south.[40]

Congressman Scott Leavitt repeated the tales of devastation told by others as he sketched the severe damage he had viewed during his tours of Montana and Alberta. He argued that the Canadians had good reason to blame Montana for much of their problems. Many areas along the borders failed adequately to fight the grasshoppers, allowing the insects to feed and to continue their migrations into Canada. Since an American state's failure involved another sovereign nation, national responsibility and international concerns came into play. Leavitt proclaimed that the universal nature of grasshopper outbreaks--respecting neither county, state, nor international boundaries--required state intervention regardless of county lines and federal support due to the transnational aspects of the problem.[41]

With regards to funding for grasshopper campaigns, Cooley praised State Senator Hazelbaker's County Insect Pest Law. In the absence of this law, many counties could not and would not have carried on campaigns. On another note, Cooley discussed the slashing of the State Entomologist's Fund from $3,900 to $450. He listed the loss of Strand as the greatest which had befallen the State Entomologist's Office. Strand had kept in contact with county agricultural agents, commissioners, and other officials to organize and inform them about the grasshopper situation. Cooley contended that "with the State Entomologist law providing for the organization of each county" the state had an effective means of battling the grasshopper and other insect menaces, only as long as he had the personnel.[42]

Cooley then elucidated the ways he had handled the 1923 season with the shortage of personnel and funds. He had kept in contact with field personnel, namely county agents and other county appointed leaders, from his desk. Using the mails to send pertinent circulars and receive reports on conditions from the field and prices of materials for the poison formula, Cooley stretched the limits of his budget and directed the campaigns as well as he could. The telephone and telegraph enabled him to respond faster to emergency conditions. He used the minimal fund to travel only when absolutely necessary. The delegates

listened as Cooley described an organization "gone to pieces" and the major reason for such a serious grasshopper predicament. Responsibilities of "teaching, experiment station work and executive duties" prevented Cooley from dedicating all the time needed for the grasshopper campaign. He concluded by suggesting that the federal government had to assist all the northwestern states suffering from the latest round of grasshopper outbreaks.[43]

F. S. Cooley[44] opined that the counties having their own agricultural extension agents had conducted the most effective work against the grasshoppers. In these counties, 6,000 farmers, about one-tenth of Montana's total, spread bait. Discontinuance of extension work in some counties led to a lack of organized treatment and in turn a heavy amount of damage and crop loss. Lockwood added that several other counties had battled grasshoppers without advice and organization from Bozeman or county agents. Therefore, statistics did not reflect materials used and savings of crops in these counties--though these counties functioned less efficiently without a proper organization and advice.[45]

F. E. McSpadden, the Cascade County agent, reported dead grasshoppers clinging to grass blades and grain heads in the eastern and southeastern regions of the county. Cooley thought that the insects suffered from a fungus or bacterial disease, having earlier examined some of the

specimens McSpadden had sent in. Lockwood interjected that the grasshoppers clearly demonstrated symptoms of "a plant disease of a fungus oil . . . due to the vegetation."[46] This offered good news to conference participants since it could prevent adult grasshoppers from laying eggs.

As other agents exchanged ideas and experiences, they dramatized grasshopper movements and damage throughout the 1923 season. George W. Morgan, Hill County agent, recounted that grasshoppers had hatched at the beginning of May--earlier than usual. The crop came in late so the grasshoppers ate the area clean before the plants reached a stage where they might have endured limited damage. Early grasshoppers coupled with late crop growth had caused greater losses. After eating the fields clean the grasshoppers had migrated, presenting no further problems in the county. Pondera County agent, Blaine Ferguson, recounted seeing a three mile phalanx of grasshoppers "almost as straight as a fence row" traveling four to ten rods per day. They had consumed everything in their path, including the poison set out to intercept them. By the end of June and the first of July, the county had exhausted the poison stocks and panic ensued as the grasshoppers took flight over the tops of buildings. Additional poison came too late to stop the grasshoppers which flew west, making the sky white with countless beating wings. Ranchers had even reported numerous grasshoppers on the mountain tops of

Glacier Park, reinforcing the widespread nature of the migration upon conference participants.[47]

Other county agents related that favorable weather and natural enemies of the grasshoppers had alleviated some of the damages but long term financial burdens had dried up sources of money to carry on the battles. Agent Charles Ruzicka of Chouteau County narrated the abnormally early appearance of grasshoppers in greater numbers than any year since 1917. However, by August the county had fewer grasshoppers than at the same time in 1921 or 1922. Ruzicka credited migrations out of the territory and some work by disease and the fleshfly maggot. The fleshfly had made its appearance during the early part of June. Rains had begun in mid-June and created ideal conditions for the spread of disease among the remaining grasshoppers. Nevertheless, Ruzicka testified that the lack of a general campaign had prevented the saving of many crops. Sufficient numbers of grasshoppers had withstood the twin onslaughts of disease and parasites to force the abandonment of "two-thirds to three-fourths of the land that was plowed up." Blaine Ferguson of Pondera County emphasized the financial nature of the grasshopper fight. Since richer counties drew upon a greater tax base than the poorer counties where he had worked, they could better afford the costs for effective grasshopper control. With dismay he confessed he did not know "how . . . to fight the grasshoppers another year

without any funds" and with the low tax base and increasingly precarious positions of Montana bankers.[48]

Commissioner Chester C. Davis added evidence for the serious financial plight of Montana counties. In Pondera and other counties which suffered the largest outbreaks of grasshoppers, assessed valuations had plunged from one-third to one-half during the passing three years. Uncontrolled insects only added to the downward pressures on land values. Davis declared that the crisis had forced Montana to issue warrants "in excess of the constitutional limit of indebtedness." State revenues had paid off registered warrants of eleven months previous. He argued that the legislature had to increase the one mill limitation to enable counties to pay much of the costs of campaigns and take pressures off of state funds. Yet, Davis also pressed for state financing and federal cooperation in survey work on grasshoppers so vital information could empower the State Entomologist and other state authorities to make knowledgeable decisions for upcoming campaigns. In addition, the federal government had an important responsibility for the survey and treatment of federal lands, which often served as nurseries and way-stations for grasshoppers on their way to Montana croplands.[49]

Lockwood responded to the idea of greater federal responsibilities and funding. As far as he knew only Indian agencies provided money for the actual poisoning of grass-

hoppers. The agencies intervened when grasshoppers threatened the food crops of the Indians. Linfield argued that the issue revolved around control rather than methodology. Entomologists and the agricultural community had a workable method of attacking grasshopper outbreaks; now authorities had to resolve the problems of applying these methods to actual control. He compared the grasshopper threat to the perceived menaces of rodents and predators to which the federal government freely applied money and labor. Linfield concluded that fighting grasshoppers afforded a "service to the community" in eliminating pests injurious to the "agricultural or livestock industry of a district." The damage too often came from public lands. Rodent and predator control by the federal government set a precedent for federal intervention in insect control. At the state level Linfield advocated increased financial support for a centralized organization which included counties without county agricultural agents.[50]

Sam Stephenson, the President of the First National Bank in Great Falls, bemoaned the strained relationship between banks and farmers. He identified difficulties with selling bonds to the banks to finance grasshopper campaigns since much talk in the northern Montana counties focused on the evils of "big" banks. Stephenson warned that farmers could not expect bank cooperation by constantly "knocking the financial institutions." In order to survive and

prosper the banks needed farmers and stockmen. On the other hand, the agriculturalists required the cooperation of the banks. Banks, farmers, stockmen, and others had to interact in a cooperative spirit or share inevitable failure.[51]

Lockwood, facing federal budget constraints on the Bureau of Entomology, announced that the Bureau office in Billings would have to limit itself to finding grasshopper egg-beds and areas of grasshopper parasite activity. When surveyors from the office found grasshopper egg-laying activity, they would notify farmers and others of the activity through posters in the area and advise that cultural treatment by plowing or harrowing could minimize danger of an outbreak. Through this means the Bureau of Entomology hoped to encourage better tilling of headlands, roadsides, and sections between ditches and fence rows. Lockwood hoped that the posting would at least notify farmers to prepare to use other methods of control in the event of a grasshopper outbreak.[52]

Cooley then treated the ongoing complaints of stock poisoning when cattle and horses consumed grasshopper bait. After examining the files of the State Veterinary, Cooley reported that the vast majority of cases related to carelessness in the handling, storage, mixing, or distribution of the poisoned bran mash. A couple of incidents led to evidence of malicious, purposeful poisoning. He assured

the conference that no cases had indicated poisoning of stock when applicators used the grasshopper bait properly.[53]

Responding to a question as to why entomologists failed to use more parasites in the control of grasshoppers and other insect pests, Cooley explained the special circumstances required to make such an approach viable. According to Cooley the entomologist traveled to a "foreign country" to capture a required parasite. After bringing it back to the laboratory the entomologist attempted to increase the parasite's numbers to a level which might survive and reproduce in the wild. Unfortunately, native parasites on grasshoppers had already reached an equilibrium population with grasshopper numbers. Entomologists could not increase parasite numbers beyond the capacity of their prey group to support them, which would ecologically jeopardize the parasites own long term survival.[54]

During the final business period of the Grasshopper Conference, the Resolution Committee of the Conference[55] passed four resolutions. Delegates elected a committee which included Davis, Cooley, and Lockwood to carry them to fruition. The resolutions noted the recent high costs of grasshopper destruction in the northwestern states, the need for energetic control measures, the likelihood of increased damage without more intervention, and the insufficient financial resources for efficient control in Monta-

na and the Canadian provinces. Therefore, the resolutions urged Montana to take up warrants to pay for county grasshopper work; requested "Senators and Representatives of the Northern Great Plains Area" to influence the federal government to finance grasshopper extermination and control in 1924; urged the Federal Department of Agriculture "to give further scientific assistance in the campaign"; encouraged Montana state authorities "to provide adequate State aid, pending the next session of the Montana legislature." Davis, Cooley, and Lockwood spent much of the remainder of 1923 gathering data for presentation to the federal government and the Montana executive and legislative branches. Most of the survey work following the Conference went toward compiling data for arguments in meeting the resolutions set forth during the Great Falls' Grasshopper Conference. Within Montana the State Entomologist's Office used suggestions arising from the Conference as an organizing tool. Thus, the questionnaire presented to county agents and other county officials included questions about the species of grasshoppers present in 1923; the prevalence of grasshoppers and the damage done; parasites and the degree of control they exercised; migrations; egg laying activity; and prospects for 1924.[56]

Seeking additional information from North Dakota, South Dakota, Wyoming, Oregon, Idaho, and Washington, Cooley asked each state's appropriate authorities to coop-

erate for the common good of all. Cooley explained that the committee needed the data to prepare a report for Congress, detailing the grasshopper conditions in each of the northwestern states and how they changed from year to year. Conditions broken down on a county by county basis would have better served the requirements of the committee report, but Cooley accepted what the individual states could easily provide. He also asked what each state had done at state and county levels and the results of campaigns as well as what damage the grasshoppers inflicted due to the "lack of sufficient funds to put on an effective campaign." In mid-September, in an effort to keep the Congressional delegation informed of the progress of the post-conference activity, Cooley told Senator Wheeler that the committee continued its work but "had not yet completed its plans" about what to ask of Congress.[57] Nevertheless, the committee pressed on with its business.

The committee faced procrastination and apathy from Montana's neighboring states. In mid-November, Cooley expressed his disappointment to Lockwood about the tardy reactions to his correspondence. North Dakota offered no information on the costs involved in fighting the grasshoppers and gave no basis for an estimate. South Dakota sent a complete report but did not contribute financially to grasshopper campaigns in the state. Like North Dakota, Wyoming and Idaho offered no information on costs but

provided data from the results of a questionnaire distributed to their county agents. Cooley assumed Washington had experienced little difficulties with grasshoppers since they provided no information. In November, Lockwood suggested rural mail carriers of Wyoming, North Dakota, and Montana as intelligence sources on the grasshopper situation in 1923. The "Fourth Assistant Postmaster" had given the committee permission to gather data from the carriers on grasshopper egg-laying, when carriers noticed grasshopper appearance and numerical reductions, and a legal description of the territories involved. Lockwood pursued particulars on grasshopper damage levels when Cooley experienced difficulties obtaining such figures. As an employee of a federal agency, Lockwood easily collected information which other state authorities hesitated to release to what they may have considered an authority of a competing agricultural state. Lockwood filled in much of the remaining data with results of his own work at the Bureau of Entomology.[58]

Lockwood also conducted his grasshopper survey during the autumn of 1923 in efforts to bridge the information gaps. Furthermore, he collected information on egg-laying activities of Melanoplus atlanis, Melanoplus bivittatus, and Camnula pellucida. The Montana Department of Agriculture and the Federal Bureau of Entomology each paid half of the $1,400 cost of the autumn surveys for parasites and

egg-laying sites. In part, Lockwood contradicted Parker's earlier statements about the impossibility of detecting the widespread eggs of the Lesser Migratory grasshopper and making predictions about the extent and location of trouble during an upcoming season. During his explorations, Lockwood discovered that M. atlanis invariably oviposited at the base of plants which shaded the ground. With this search strategy in mind, he found extensive areas of egg-laying by the Lesser Migratory. Though Lockwood found infestations of grasshoppers by flesh-flies and bee-flies in limited areas, he predicted continued problems in 1924 for other areas not so blessed.[59]

Lockwood carried out part of his survey for the committee report through the mails. In his questionnaire to county agents and other county representatives in counties without agents he included questions concerning the cost of the 1923 campaign including the total cost to the county; the amounts of materials used; the county's taxable valuation, not including corporations assessed by the state board; the county's bonded indebtedness; the acreages under cultivation, cultivated but abandoned, and acres of wild land; savings and loss estimates; whether the county expected grasshoppers in 1924; and how grasshoppers in 1923 compared with numbers in 1922.[60] Large areas of abandoned farms reflected the years of drought and grasshoppers. W. P. Stapleton of Yellowstone County expressed the farm-

ers' distrust of savings estimates released by federal and state authorities but somewhat contradicted his position by admitting that farmers had agreed that savings had resulted from the use of the poison bran grasshopper bait. He then offered to develop a combined estimate of savings with Lockwood. Some respondents to Lockwood's survey questionnaire praised the efforts of the Grasshopper Conference but feared federal paternalism, while others proclaimed the need for federal intervention since counties could no longer carry the burden of financing grasshopper campaigns themselves.[61]

As the 1923 grasshopper season drew to a close Cooley prepared for an expected recurrence of similar problems in 1924. The general worsening of weather patterns and grasshopper depredations since 1916 added to this perennial pessimism. Drastic funding cuts for the State Entomologist forced the office to limp along with temporary crisis-related help and the aid of other federal and state agencies. After meeting with George A. Dean, Stewart Lockwood, and Chester Davis in Helena during late October, the participants agreed not to ask for federal aid for individual farmers. Instead, they planned "to ask the Forestry Service and the Indian Reservations to control grasshoppers on their lands contiguous" to areas under active treatment by farmers. In an effort to line up additional assistance for 1924, Cooley petitioned the U. S. Department of Agriculture

to increase funding for the Bureau of Entomology's Billings' office. In addition, he noted the Bureau office required more personnel which Montana and other northwestern states needed to help organize local grasshopper campaigns.[62]

Henry C. Wallace of the U.S.D.A. informed Cooley that Professor George A. Dean, an experienced grasshopper investigator, would look over the situation in the field. Upon Dean's return, Wallace planned to meet with him and develop appropriate strategies to meet the crisis. Wallace concluded by offering the services of Dean as the U.S.D.A. liaison with the Grasshopper Committee to keep Washington, D.C. informed and cooperate as much as possible. Lockwood wrote Cooley that Senators Phipps of Colorado and Kendrick of Wyoming also had expressed interest in grasshopper control. The North Dakota delegation, Lockwood further surmised, "would get behind any movement to better the control of insect pests." Nothing definite emerged from the Grasshopper Committee's late 1923 approaches to federal officials but encouraging responses compelled them to continue their efforts. Part of this problem stemmed from the slowness of getting out a printed report of the Great Falls' Conference to transportation companies and governmental officials due to financial constraints.[63]

The grasshopper-fighting troops and generals spread the good news of a relatively successful campaign. Farmers

from 21 Montana counties reported more than one million dollars in crop savings. They credited cooperation with the extension service and the poisoning campaign for checking the tide of losses. Newspapers reported that 1923's total expenditure of $64,640 worked out to a saving of around sixteen dollars per dollar spent. According to Cooley's figures, counties had spent $94,844 on the campaign, using 4,233 tons of bait to treat 466,184 acres. He figured the total savings to farmers at $1,616,750. In his annual report, Linfield called 1923 a successful year in terms of crop production. Even crops on most non-irrigated lands came in above initial expectations with the production of high quality wheat leading Montana's market. Linfield thought that Montana had seen the worst combination of drought and deflation ever and did not expect to see its like again soon. He anticipated one or the other within a short unspecified period--he could not see beyond the decade.[64] But good news for Cooley had a tinge of disappointment for Parker as he continued his studies in Minnesota. Cooley had to write him that,

> We cannot get you any grasshoppers of any kind now. We had had a heavy freeze long before your letter came. We have had several since and I have seen no living grasshoppers since about the time you left.[65]

Montana still faced a final year of struggle with the forces of biology, politics, and finance in its eight-year grasshopper war.

## NOTES

1. F. B. Linfield, "Agricultural Service from The Montana Experiment Station: Thirtieth Annual Report, July 1, 1922, to June 30, 1923," February 1924, pp. 5-7, 61, in Agricultural Experiment Station, Montana: Bulletins and Circulars, vol. 20, Montana State University Archives, Bozeman, Montana.

2. R. A. Cooley to J. A. Hyslop, 16 November 1923, File "Insect Pest Survey Reports, 1923-1948," Acc. 00016, Box 5 of 15, Montana State University Archives, Bozeman, Montana; J. R. Parker to R. A. Cooley, 16 May 1923, File "Parker, J. R., Asst Ent. (Corresp.) 1923," Acc. 00016, Box 4 of 15, Montana State University Archives, Bozeman, Montana.

3. Parker to Cooley, 16 May 1923.

4. Stewart Lockwood to the County Agents of Montana, Memorandum, 2 November 1923, File "Grasshopper Control, 1923, and Plans for 1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

5. [R. A. Cooley to J. R. Parker], 13 June 1923, File "Parker, J. R., Asst. Ent. (Corresp.) 1923," Acc. 00016, Box 4 of 15, Montana State University Archives, Bozeman, Montana; J. R. Parker to R. A. Cooley, 26 June 1923, File "Parker, J. R., Asst Ent. (Corresp.) 1923," Acc. 00016, Box 4 of 15, Montana State University Archives, Bozeman, Montana.

6. See, for example, J. O. Hembre, "Grasshopper Outlook in 1923," Questionnaire, 30 June 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

7. H. M. Kauffman, "Grasshopper Outlook in 1923," Questionnaire, 8 June 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; Ralph D. Mercer, "Grasshopper Outlook in 1923," Questionnaire, 11 June 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; Hembre, "Grasshopper Outlook in 1923."

8. R. A. Cooley to Senator B. K. Wheeler, 21 August 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

9. R. A. Cooley to Blaine Ferguson, 18 August 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; R. A. Cooley to E. H. Strickland, 21 August 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; E. H. Strickland to R. A. Cooley, 27 August 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; R. A. Cooley to J. T. Jardine, 8 September 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

10. R. A. Cooley, "Montana Insect Pests for 1923 and 1924: Being the Twentieth Report of the State Entomologist of Montana," Bulletin 170, January 1925, p. 17, in Agricultural Experiment Station, Montana: Bulletins and Circulars, vol. 21, Montana State University Archives, Bozeman, Montana.

11. The "high-line" referred to the Great Northern Railroad Line, Montana's northernmost mainline route.

12. J. A. Hyslop to R. A. Cooley, 24 September 1923, File "Insect Pest Survey Reports, 1923-1948," Acc. 00016, Box 5 of 15, Montana State University Archives, Bozeman, Montana; Cooley to Hyslop, 16 November 1923.

13. H. T. Fernald to J. R. Parker, 20 July 1922, File "Staff, 1921-1947," Acc. 00016, Box 1 of 15, Montana State University Archives, Bozeman, Montana; J. R. Parker to H. T. Fernald, 27 July 1922, File "Staff, 1921-1947," Acc. 00016, Box 1 of 15, Montana State University Archives, Bozeman, Montana.

14. R. A. Cooley to F. B. Linfield, 30 March 1922, File "Staff, 1921-1947," Acc. 00016, Box 1 of 15, Montana State University Archives, Bozeman, Montana.

15. 'Recent Difficulties in the State Organization,' in "Report of Grasshopper Conference Held at Great Falls, Montana, August 31, 1923," File "Grasshopper Conference, Great Falls, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; Cooley, "Montana Insect Pests for 1923 and 1924," Bulletin 170, p. 3.

16. "Experiment Station Report of the Department of Entomology," 27 December 1923, File "Summary of Work Reports, 1920-1925," Acc. 00016, Box 1 of 15, Montana State University Archives, Bozeman, Montana; "Annual Report of Zoology-Entomology for the Year Ending June, 1923," File "Annual Reports, 1921-1939," Acc. 00016, Box 1 of 15, Montana State University Archives, Bozeman, Montana; R. A. Cooley to I. M. Hawley, 21 September 1923, File "Grasshopper Control, 1923, and Plans for 1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; R. A. Cooley to President Atkinson and Director Linfield, 12 September 1923, File "Grasshopper Control, 1923, and Plans for 1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

17. F. B. Linfield, "The Work of the Montana Experiment Station: Thirty-First Annual Report, July 1, 1923, to June 30, 1924," February 1925, p. 2, in Agricultural Experiment Station, Montana: Bulletins and Circulars, vol. 21, Montana State University Archives, Bozeman, Montana; R. A. Cooley to J. R. Parker, 22 June 1923, File "Parker, J. R., Asst Ent. (Corresp.) 1923," Acc. 00016, Box 4 of 15, Montana State University Archives, Bozeman, Montana.

18. "Summary Report of the North-West International Committee on Farm Pests Held at Manitoba Agricultural College, Winnipeg, Manitoba, Canada, April 18 and 19, 1923," p. 5, File "Grasshopper Conference, Great Falls, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

19. J. R. Parker to R. A. Cooley, 18 June 1923, File "Parker, J. R., Asst Ent. (Corresp.) 1923," Acc. 00016, Box 4 of 15, Montana State University Archives, Bozeman, Montana; R. A. Cooley to J. R. Parker, 21 June 1923, File "Parker, J. R., Asst Ent. (Corresp.) 1923," Acc. 00016, Box 4 of 15, Montana State University Archives, Bozeman, Montana; Carl H. Peterson, "Grasshopper Outlook in 1923," Questionnaire, 8 June 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; [Cooley to Parker], 13 June 1923; Harold F. DePue, "Grasshopper Outlook in 1923," Questionnaire, 8 June 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; W. H. Sutton, "Grasshopper Outlook in 1923," Questionnaire, 15 June 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

20. M. M. Oliphant, "Grasshopper Outlook in 1923," Questionnaire, 25 June 1923, Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; A. L.

Strand, "Poison Grasshoppers--Not Live Stock," May 1923, pp. 1, 4, in Agricultural Experiment Station, Montana: Bulletins and Circulars, vol. 20, Montana State University Archives, Bozeman, Montana; "Year's War on Grasshoppers Saves Million," Newspaper Clipping, [n.d.], File "Grasshopper Control, 1923, and Plans for 1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

21. R. A. Cooley to Henry C. Wallace, 16 November 1923, File "Grasshopper Control, 1923, and Plans for 1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; R. A. Cooley to A. L. Lovett, 8 September 1923, File "Grasshopper Control, 1923, and Plans for 1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; Chas. H. Ruzicka, "Grasshopper Outlook in 1923," Questionnaire, 8 June 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; M. P. Ostby, "Grasshopper Outlook in 1923," Questionnaire, 21 June 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; G. E. Lewis, "Grasshopper Outlook in 1923," Questionnaire, 7 June 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; Ralph D. Mercer, "Grasshopper Outlook in 1923," Questionnaire, 8 June 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; H. L. Lantz, "Grasshopper Outlook in 1923," Questionnaire, 8 June 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

22. Murray E. Stebbins, "Grasshopper Outlook in 1923," Questionnaire, 9 June 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; R. E. Bodley, "Grasshopper Outlook in 1923," Questionnaire, 7 June 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; W. H. Jones, "Grasshopper Outlook in 1923," Questionnaire, 16 June 1923," File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; Stewart Lockwood to R. A. Cooley, [n.d.] November 1923, File "Grasshopper Control, 1923, and Plans for 1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; R. A. Cooley to Frank A. Hazelbaker, 19 January 1923, File "Grasshopper Control, 1923, and Plans for 1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; R. A. Cooley to Frank A. Hazelbaker, 26 October 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

23. Seamans served as the Entomologist in Charge of the Canada Department of Agriculture Entomological Branch in the Entomological Laboratory at Lethbridge, Alberta. He had served as Montana's Assistant State Entomologist prior to A. L. Strand.

24. H. L. Seamans to R. A. Cooley, 2 July 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; R. A. Cooley to H. L. Seamans, 24 July 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

25. Stewart Lockwood to R. A. Cooley, 12 November 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; Chester C. Davis to R. A. Cooley, 1 October 1923, File "Grasshopper Control, 1923, and Plans for 1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; Chester C. Davis to R. A. Cooley, 3 October 1923, File "Grasshopper Control, 1923, and Plans for 1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; Chester C. Davis to R. A. Cooley, 5 November 1923, File "Grasshopper Control, 1923, and Plans for 1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

26. The State Board of Examiners included the Governor, the Attorney General, and the Secretary of State.

27. Joseph M. Dixon to Alfred Atkinson, 24 September 1923, File "Grasshopper Control, 1923, and Plans for 1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; R. A. Cooley to C. C. Davis, 1 October 1923, File "Grasshopper Control, 1923, and Plans for 1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; Davis to Cooley, 3 October 1923; Cooley to Atkinson and Linfield, 12 September 1923.

28. Chester C. Davis to R. A. Cooley, 7 November 1923, File "Grasshopper Control, 1923, and Plans for 1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; R. A. Cooley to Alfred Atkinson, 5 December 1923, File "Grasshopper Control, 1923, and Plans for 1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

29. J. L. Humphrey to Chester C. Davis, 3 July 1922, File "Montana Department of Agriculture, 1921-1922," Acc. 00016, Box 1 of 15, Montana State University Archives, Bozeman, Montana.

30. H. L. Seamans to R. A. Cooley, 21 August 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; Alfred Atkinson, [Call for Grasshopper Conference], 9 August 1923, in "Report of Grasshopper Conference Held at Great Falls, Montana, August 31, 1923," File "Grasshopper Conference, Great Falls, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; "Preliminary Outline of Proposed Grasshopper Conference," Memorandum, 26 July 1923, File "Grasshopper Conference, Great Falls, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

31. R. A. Cooley to Stewart Lockwood, 13 August 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; [E. H.] Strickland to R. A. Cooley, Telegram, 4 August 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

32. R. A. Cooley made a particular point of involving county agents by writing to the County Agent Leader at M. S. C. to enlist his cooperation in notifying the agents about the conference. See R. A. Cooley to J. C. Taylor, 13 August 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

33. "The Great Falls Conference: Report of Grasshopper Conference Held at Great Falls, Montana, August 31, 1923," File "Grasshopper Conference, Great Falls, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; Chester C. Davis to R. A. Cooley, 21 August 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; H. W. Byerly to R. A. Cooley, 22 August 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; W. P. Kenney to R. A. Cooley, 22 August 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; R. A. Cooley to John M. Evans, 8 September 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; Scott Leavitt to R. A. Cooley, 21 August 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

34. "Report of Grasshopper Conference," pp. 3-4.

35. Ibid.

36. "Report of Grasshopper Conference," pp. 5-6. Cooley claimed the backing of the National Museum and the Museum of Natural History in Philadelphia in his interpretation of the two species as the same. See "Report of Grasshopper Conference," p. 36. Despite Cooley's repeated arguments of similarities --leading to conclusions that Melanoplus spretus and M. atlanis were one and the same species--entomologists today recognize that Melanoplus spretus abides in the sleep of extinction, though they continue arguing about the causes of its demise. See Howard Ensign Evans, Life on a Little-known Planet (Chicago: University of Chicago Press, 1984), pp. 195-226.

37. "Report of Grasshopper Conference," pp. 35-36, 51.

38. Ibid., pp. 50-51.

39. Ibid., p. 51.

40. Ibid., p. 38.

41. Ibid., pp. 93-95.

42. Ibid., pp. 38-39.

43. Ibid., pp. 40-41.

44. Frederick S. Cooley was the Extension Service Director from 1913 through 1924.

45. Ibid., pp. 42-44.

46. Ibid., pp. 44-45.

47. Ibid., pp. 45-46, 53, 59.

48. Ibid., pp. 57, 58-59.

49. [Transcription Deleted From Original "Report of Grasshopper Conference" with Cover Letter "Dudley Crowther to R. A. Cooley, 28 September 1923"], pp. b, c-d, File "Grasshopper Conference, Great Falls, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

50. Ibid., pp. d, e.

51. "Report of Grasshopper Conference," p. 79.

52. Ibid., pp. 10-11.

53. Ibid., p. 27.

54. Ibid., pp. 92-93.

55. The Resolution Committee included Chairman Chester C. Davis, R. A. Cooley, Blaine Ferguson, and C. D. Greenfield; See "Resolutions" [of the Great Falls Grasshopper Conference], File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

56. "Resolutions,"; R. A. Cooley, Form Letter, 10 September 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; "Grasshopper Conference Program, Great Falls, Montana, August 31, 1923," File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

57. R. A. Cooley to A. L. Lovett, 20 September 1923, File "Grasshopper Control, 1923, and Plans for 1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; R. A. Cooley to B. K. Wheeler, 20 September 1923, File "Grasshopper Control, 1923," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

58. R. A. Cooley to Stewart Lockwood, 16 November 1923, File "Grasshopper Control, 1923, and Plans for 1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; Stewart Lockwood to R. A. Cooley, 3 November 1923, File "Grasshopper Control, 1923, and Plans for 1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; R. A. Cooley to Stewart Lockwood, 4 December 1923, File "Grasshopper Control, 1923, and Plans for 1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; F. P. Lane to Stewart Lockwood, 25 September 1923, File "Grasshopper Survey Report, Stewart Lockwood, 1923-1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; C. L. Corkins to Stewart Lockwood, 29 September 1923, File "Grasshopper Survey Report, Stewart Lockwood, 1923-1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

59. R. A. Cooley to A. T. Hibbard, 1 October 1924, File "Grasshopper Control--Campaign 1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; "Grasshopper Survey--Autumn of 1923: Rosebud County --Stewart Lockwood," File "Grasshopper Survey Report, Stewart Lockwood, 1923-1924," Acc. 00016, Box 6 of 15,

Montana State University Archives, Bozeman, Montana. Also see reports for Pondera, Treasure, Carbon, Phillips, Valley, Wibaux, Stillwater, and Glacier Counties in File "Grasshopper Survey Report, Stewart Lockwood, 1923-1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; "Grasshopper Survey--Autumn of 1923: Phillips County--Stewart Lockwood," File "Grasshopper Survey Report, Stewart Lockwood, 1923-1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; "Grasshopper Survey--Autumn of 1923: Valley County--Stewart Lockwood," File "Grasshopper Survey Report, Stewart Lockwood, 1923-1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

60. For example, see W. L. Hanson to Stewart Lockwood, 27 September 1923, File "Grasshopper Survey Report, Stewart Lockwood, 1923-1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

61. W. L. Hanson to Stewart Lockwood, Survey Sheet, 27 September 1923, File "Grasshopper Survey Report, Stewart Lockwood, 1923-1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; D. B. Noble to Stewart Lockwood, 26 September 1923, File "Grasshopper Survey Report, Stewart Lockwood, 1923-1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; W. P. Stapleton to Stewart Lockwood, 5 October 1923, File "Grasshopper Survey Report, Stewart Lockwood, 1923-1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; G. E. Lewis to Stewart Lockwood, 2 October 1923, File "Grasshopper Survey Report, Stewart Lockwood, 1923-1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; H. N. Kauffman to Stuart Lockwood, 8 October 1923, File "Grasshopper Survey Report, Stewart Lockwood, 1923-1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

62. R. A. Cooley, Memorandum, 26 October 1923, File "Grasshopper Control, 1923, and Plans for 1924, Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; Cooley to Wallace, 16 November 1923.

63. Henry C. Wallace to R. A. Cooley, 21 November 1923, File "Grasshopper Control, 1923, and Plans for 1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; Stewart Lockwood to R. A. Cooley, 1 December 1923, File "Grasshopper Control, 1923, and Plans for 1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana; Stewart Lockwood to R. A.

Cooley, 30 October 1923, File "Grasshopper Control, 1923, and Plans for 1924," Acc. 00016, Box 6 of 15, Montana State University Archives, Bozeman, Montana.

64. "Year's War on Grasshoppers Saves Million," Newspaper Clipping, [n.d.]; Cooley, "Montana Insect Pests for 1923 and 1924," Bulletin 170, p. 13; Linfield, "Agricultural Service from The Montana Experiment Station," pp. 5, 6.

65. R. A. Cooley to J. R. Parker, 6 November 1923, File "Parker, J. R., Asst Ent. (Corresp.) 1923," Acc. 00016, Box 4 of 15, Montana State University Archives, Bozeman, Montana.

# CHAPTER 6

## 1924: FINALE

Grasshoppers dominated Montana entomology's attention for the eighth and final season since 1917. Only remnants remained to inflict localized damage on crops and grasslands. From May through November observers recorded near normal temperatures and slightly below normal precipitation levels. Grasshopper outbreak reports ebbed and flowed in severity. But R. A. Cooley, expecting the worst based on his experiences of the past few years, renewed his struggle for more personnel--both permanent and temporary--and funding. Rising costs and shortages of materials drove up campaign expenses, giving rise to more resistance among counties and farmers.[1]

To meet part of the crisis after the special legislative session had failed to appropriate funds for the State Entomology Office, Cooley combined cost-cutting measures with creative financing--based on the 1923 plan through Montana banks--to cover his 1924 budget. At Cooley's request, railroads granted a reduced freight rate for poison bait materials, thereby increasing the affordability of campaigns to counties. Though survey work proceeded in a less organized fashion than in 1923, it provided valuable

information for the railroads and banks, who had a monetary stake in the outcome of the campaigns, and for entomological science, which gathered an arsenal of knowledge and experiences for future grasshopper control. The 1924 season developed as the least destructive of the previous four, with the state entomological organization playing a large part in suppressing outbreaks wherever they occurred. These interventions brought sizable crop savings and staved off bankruptcy for many Montana farmers.

Grasshoppers appeared in fewer numbers and covered far less territory in 1924 than in the previous year. Nevertheless, this last major season generated protest, panic, and finally relief. The president of the University of Alberta, Dr. H. M. Tory, faulted Montana's feeble efforts to fight grasshoppers "scientifically." Without considering the difficulties faced by the Montana economy, Tory simplistically blamed "the state of mind of the farmers themselves" for passively watching as hundreds of square miles lost every blade of grass. H. L. Seamans added fuel to Canadian concerns by criticizing the dubious grasshopper situation south of the border. Alberta consequently prepared for a grasshopper "invasion from northern Montana during early August."[2]

Initially, Montana authorities considered Canada's criticisms seriously and accepted the likelihood of ever-worsening conditions. In mid-May Cooley painted a picture

of gloom and doom, describing grasshoppers "boiling out of the ground" in the north-central section of the state. The absence of spring rains and the return of grasshoppers promised more crop failures in counties already reeling from repeated annual losses. But by June Cooley expressed greater confidence that his organization could handle the outbreak since fewer grasshoppers appeared than initially reported. The State Entomologist's Office quickly organized seriously infested counties.[3] As Cooley assessed the rapid response to this threat, he took pride in the maturity of his organization.

However, in late June, bad news arrived. Ed Udine described large numbers of grasshoppers in southern Glacier County along the Marias River, west of Cut Bank, including the eastern section of the Blackfeet Indian Reservation. Grasshopper densities ranged from 450 to 600 per square yard on the edge of one field and from 250 to 300 per square yard in the middle. With such unbelievable conditions, farmers openly despaired and some totally abandoned their homesteads.[4] Even in this "best of all possible years"--compared to the most recent two--lives and dreams changed forever.

By mid-July news again shifted from bad to good. J. R. Parker expressed his satisfaction that fewer grasshopper problems had materialized than the State Entomologist's Office had anticipated. He informed Stewart Lock-

wood that field workers had conducted successful campaigns in Pondera and Teton Counties over the last month and managed to hold crop losses to very low levels. Some days later, Parker had to reassure Lockwood that enough grasshoppers still survived for him (Lockwood) to carry out his field studies near Willow Creek, but not enough overly to trouble the farmers.[5]

As expected, grasshoppers caused greater damage and losses in communities where the farmers had decided not to cooperate with the State Entomologist's Office or county agents to conduct any organized campaigns. The Lesser Migratory locust (Melanoplus atlanis), none other than the supposedly extinct Rocky Mountain locust according to Cooley and other professional entomologists, predominated in the 1924 outbreaks. M. atlanis's migratory nature had evoked panic from the Canadians and despair among financially strapped farmers. Over the season these grasshoppers infested a smaller area than in 1923, covering the western section of Chouteau County extending westward to the centers of Pondera and Teton Counties. Scattered outbreaks occurred in southwestern Montana in Granite, Lewis and Clark, Jefferson, Broadwater, Beaverhead, Madison, and Gallatin Counties and south-central Montana in Carbon, Stillwater, Wheatland, Sweetgrass, and Yellowstone Counties.[6] Other grasshopper species caused only minor problems in localized infestations.

Never certain what to expect in 1924 because of conflicting reports, the State Entomologist's Office also wavered in its personnel decisions. With the seesawing nature of grasshopper outbreaks, Cooley considered removing Parker, Associate Professor, from his research work and placing him in charge of the grasshopper campaigns for the season. Evidently he considered Parker's work less critical by 1924. Cooley further expressed the enduring need for an Assistant State Entomologist, whom he wanted to maintain the most current intelligence on insect conditions in the state and act on emergencies as they arose. During years when no emergencies appeared, the assistant would devote his time to preparation and maintenance of information-gathering and campaign organizational networks, and focus his attention on lesser pests--a misnomer since they also caused substantial aggregate losses.[7]

During crisis periods the assistant would "plan his organization, communicate with the county agents, [and] issue mimeograph information and circulars." Regarding research as the major method for keeping the "right scientific spirit," Cooley expected this assistant to conduct experiments and observations as part of his duties. He also wanted an unspecified number of temporary assistants under the direction of the assistant State Entomologist. Cooley expected to appoint an assistant "at once" with money collected through an agreement with the State Bank-

ers' Association fund--capital strictly for the expenses of the State Entomologist's Office, not for poisoning-supplies or labor. Working through county agents and commissioners and making use of the County Insect Pest Law, the State Entomologist and his assistant would direct the organization and meet the ongoing problems of the campaigns as in the past. Cooley also expected his Assistant State Entomologist and the temporary assistants to spend most of the summer in the field meeting with farmers, publicizing campaigns locally, leading mixing bees, and making early surveys for grasshopper troubles. Accordingly, they would communicate with Bozeman by mail, telephone, and telegraph.[8]

By mid-May the Banker's Association fund had underwritten some $7,000 for the State Entomologist's budget. Still, Cooley could find no qualified man for an assistant. A. L. Strand, who had at first expressed his uncertainty, was a graduate student at the University of Minnesota and refused the position. H. L. Seamans responded from Canada that recent instability in funding of the Montana work by a fickle legislature had forced him to reject the offer. By the end of May, Cooley could enlist no qualified assistant. Instead, he decided that he and Parker along with experienced "district men" could handle whatever came. By the middle of June, when grasshopper troubles again diminished, Cooley arranged to take his first summer off in 24 years of

service, leaving Parker and "two or three temporary people" to carry on. Of his upcoming three month vacation he proclaimed simply, "I am a bit played out and I am going to go."[9] Cooley left, confident that the organization he had developed over the years would prevail.

Due to the often repeated difficulties and even impossibilities of applying cultural control methods in many Montana environments, poison bran mash application remained the method of choice for 1924. This grasshopper control technique had also gained cost advantages over cultural, catching machine, and other methods on a per acre basis. Poison application required less labor per unit area and less costly apparatus. In Montana, farmers provided "free labor," decreasing expenditures even further. Baits also worked effectively under varied vegetative and ground conditions.[10] In most cases Montana farmers had no choice other than poison bait--if they did anything at all.

Confined to a single treatment option, the grasshopper campaigners faced instabilities in prices and availability of the bait formula ingredients. In June, the Great Western Sugar Company of Billings offered molasses at $50 per ton, which even company officials considered excessive for feeding to grasshoppers. In response, Cooley planned to buy "cheap cane sugar molasses" from Seattle if the Great Northern Railroad agreed to give a break on freight rates. W. P. Hogarty of the Billings company volunteered that some

county agents claimed good results without molasses, a result discovered during earlier trials at the Experiment Station. Nevertheless, Cooley recommended using molasses in reduced amounts if the prices prohibited the full complement. Rather than do nothing, he told agents and other county leaders to proceed without molasses when necessary.[11] Unlike the previous season, the State Entomologist's Office did not offer any substitutes for molasses.

However, replacements for bran which had also increased in price promised possible changes in the basic formula--at least on a temporary basis. Hoping to find a use for a waste product of grain processing, P. R. Trigg, Sales Manager of the Montana Flour Mills Company in Lewistown, wrote Cooley in mid-April asking whether the college had experimented with oat offal or ground oat hulls in the poison formula. Cooley communicated his interest and inquired about sources. He observed that oat offal possessed a strong odor which probably would attract grasshoppers well, and perhaps better than the bran-sawdust mixture already in use. Earlier in April, Cooley had approved the bran-sawdust mixture, whenever bran cost too much and farmers could get free sawdust for the price of hauling. Still he reminded county leaders that the mixture should contain only one-half sawdust by bulk, otherwise they risked poor performance, wasted time, money and labor.[12]

Department of Entomology records reveal no results on oat offal substitutes.

The State Entomologist did not suggest substitutes for every ingredient in the basic formula. Cooley considered the amyl acetate almost sacrosanct, since it had proven its effectiveness as an attractant over the years. Thus, he advised county agents to accept only amyl acetate 'technical' and nothing else. But if agents and farmers used the wet rather than the dry mix method of bait preparation, Cooley recommended replacing the crude sodium arsenite for crude arsenic. The sodium arsenite dissolved rapidly in water and did not settle to the bottom of the mix like the crude arsenic. This permitted more uniform spreading of the actual killing agent and no unnecessary concentration which might kill stock.[13] The wet mix also prevented human poisoning from arsenic dust settling on a laborer's skin.

Parker's experiments with temperature effects on feeding behavior of grasshoppers also contributed to the more efficient use of the poison bait. In his work at Minnesota, Parker observed that Camnula pellucida adults fed on plants only at temperatures above 20°C. and below 32°C. They fed on the baits beginning at air temperatures of 18 to 20°C. and reached a feeding peak at 21.6 to 25°C. Feeding gradually diminished at temperatures above 25°C. So for greater effectiveness and lower costs for labor and materials, Parker counseled the distribution of baits

according to temperature rather than time of day, as authorities had instructed in the past.[14] Parker had yet to work out feeding temperatures for Melanoplus bivittatus and Melanoplus atlanis. Even with its primary control method in place and his staff constantly perfecting it, the office of the State Entomologist still struggled to properly finance its state insect work.

Financing the supervision of the organization and direction of the grasshopper campaigns had proven difficult for the State Entomologist's Office, especially after the savaging of the State Entomologist's Fund by the 1923 legislature. In addition to the discharge of Strand the previous season, Cooley proclaimed the intention of his office to publish the report of the State Entomologist every two years instead of annually "in the interest of economy." The State Entomologist also had earlier coordinated insect control with related research conducted through the Experiment Station's Department of Entomology--another long standing cost-conscious strategy. In this way Montana realized savings in salaries and avoided duplicating insect collections, libraries, equipment, and buildings. Other states had separated these related functions which drove up costs.[15]

Governor Joseph Dixon demonstrated his concern by calling a special session of the Montana legislature to deal with funding problems. Cooley expressed his pleasure

and hopes to Agricultural Commissioner C. C. Davis but suggested a figure of $8,500 for the State Entomologist's Fund instead of the $9,300 figure he had originally calculated as necessary in 1923. He reasoned that he had lower expenses for the previous season than he initially had determined, so he could get along on the lower amount. Promptly writing a letter to H. S. Buell, Chairman of the Appropriations Committee, Cooley described the serious financial condition of the State Entomologist's Office and urged correction of "the error of the last legislature." He repeated the figure of $8,500 given to Davis and advised Buell that the Board of Examiners had already approved submission of a deficiency claim of $9,300 to the next legislature. Since Cooley could find no bank to purchase the claims and submit them to the next legislature, he decided instead to seek renewed funding from the legislature. If the legislature failed to give the State Entomologist an appropriation, Cooley planned to turn to bank support to buy up the claims under the original scheme. Cooley also reminded Buell that the state could have either economic improvement with proper funding for his office--or a harvest of grasshoppers for legislative constituents.[16] The legislature voted for grasshoppers.

Other problems beyond an uncooperative citizen-legislature faced Montana grasshopper control efforts. In early April the State Entomologist's Office still had not paid

the printing bill for the report of the Great Falls Conference of August, 1923. Cooley apologized to the printer and promised him that the bill headed the list of payments from the expected fund. On another front, the resolution committee of the Great Falls Conference still had no concrete plans for approaching Congress. Members favored asking for federal assistance only through the Forest Service and Indian Service.[17]

The State Entomologist also fought to prevent excessive financial burdens from falling directly on the farmers, who often could not meet the added expenses. Cooley opposed a resolution passed by county agents at their Bozeman meeting in March, 1924, which proposed that farmers pay one-half the cost of materials. He argued that in some areas of Montana farmers could only give their labor; they had little or no money. This resolution would only guarantee an increase in untreated "waste lands" and croplands. Cooley proffered amendments to the County Insect Pest Law, added in 1923, as a possible solution to county funding problems for grasshopper campaigns. The legislature had increased the maximum allowable levy from one-half to one mill and given county commissioners the option of paying with registered warrants or from their county's general fund.[18] These provisions met the county officials' and agents' major objections to the County Insect Pest Law of 1921.

Interactions between the State Entomologist's Office and various Montana businesses increased while Cooley lobbied for funding and price breaks to carry out the 1924 grasshopper campaign. W. P. Hogarty from the Great Western Sugar Company complained of payments for molasses past due from Montana counties for two and three years. He said the company could supply molasses in 1924 only if buyers paid during the current year. Complicating relations, farmers reeled from financial hardships brought on by drought and grasshoppers and often took out their frustrations against banks and railroads whom they regarded as exploiters rather than partners. Yet, Cooley approached the state's railroads in late March to seek a concession in freight rates--free if possible--on bran, arsenic, sawdust, salt and molasses. He hoped to apply more county finances directly to the grasshopper campaigns and reassured the railroads that he would allow "no unfair use of the privilege for private purposes."[19]

Montana railroads partially cooperated with Cooley's efforts at reducing the cost of putting on the grasshopper campaigns by granting a half-rate on items used for the grasshopper poison bait formula. The Great Northern, Northern Pacific, and even the Butte, Anaconda and Pacific railroads allowed the half-rate on their lines. Since grasshoppers caused few problems in the area served by their line, the State Entomologist made no similar requests

of the Chicago, Milwaukee and St. Paul. Local officials of the Oregon Short Line in Butte promised to consider special rates only if a grasshopper emergency arose. Under the agreement with the railroads, campaign leaders notified the State Entomologist's Office in advance of each shipment, specifying the "shipper, point of origin, name and amount of material and consignee." Cooley would then endorse these statements for representatives of each railroad, providing a further check against fraud.[20]

Further clarifications in the agreements between the State Entomologist and the railroads soon followed. The Great Northern agreed to apply half-rates on any materials originating anywhere along their line and "consigned to County Agents or other State or Government Officials." Except for the Northern Pacific, which guaranteed a half-rate for shipments also originating out of state, railroads maintained a half-rate only for materials emanating from within Montana. Cooley saw Northern Pacific's offer as improving the prospects for less expensive molasses from Seattle. With reference to shipments made before the half-rate agreements, railroads consented to apply like charges if Parker, who had taken over direction of the campaign, notarized that the materials related to the grasshopper campaign and supplied the freight bills to the railroads.[21] The State Entomologist's Office thus success-

fully reduced some of the more oppressive costs of the 1924 campaign.

The State Entomologist's operating fund persisted as a major problem while Cooley and Parker worked out understandings with the railroads on freight rates. Cooley had earlier confided his belief that the legislature would come through with an appropriation because of farmer sentiment throughout the state--a sentiment generally demanding aggressive grasshopper control. When the legislature failed him once again, Cooley returned to the banking community, despite earlier discouragements because of an unstable Montana economy. Cooley saw no choice but to drop the issue and hope grasshoppers disappeared of their own accord.[22] But Montana bankers finally entered the fray after the State Entomologist had argued and cajoled behind the scenes.

Help arrived when the State Bankers' Association Fund which provided for a deficiency appropriation claim to present for reimbursement of the contributing banks during the 1925 legislature. Cooperating member banks advanced $500 each toward an ultimate goal of $8,500. By mid-April the fund contained only $4,350 from twelve banks. Another thirty banks sent discouraging replies. Though initially President Atkinson and Cooley had discussed giving up without the full $8,500, Cooley proposed using the money pledged thus far and hoped for an eventual total of at

least $5,000. He drew up a revised budget reflecting the lower total of $4,350. This included a campaign manager and a temporary assistant, traveling expenses for both persons, and office expenses. By the beginning of the following month the fund totaled $6,100, while the officers of the State Bankers' Association still tried to bring the amount up to $8,500. Some of the remaining thirty banks had made contributions. The fund already totaled $2,200 more than any former appropriation of the legislature. Ever anxious about the disposition of their money, subscribing banks requested details about cooperating counties and the control methods they used.[23] Not only did farmers distrust the banks, the bankers seemed to question the word of the State Entomologist, perhaps associating him more with the agricultural than the business community--an agricultural sector which had distrusted the banks in the past.

Cooley reported an expenditure of only $3,400 for grasshopper work in 1924--an amount quickly approved by the State Board of Examiners. Grasshoppers had appeared in significantly fewer numbers than initially feared, so counties required less assistance from Cooley's office. The final chapter of the 1924 campaign played out in the 1925 session of the state legislature when the Assembly's Committee on Appropriations passed an appropriation to pay the claims arising from the State Bankers' Association

Fund. The State Entomologist's Office submitted a total budget of $9,300 per year to the 1925 legislature. With this money Cooley hoped to hire a permanent assistant and temporary assistants as insect emergencies arose. The budget included traveling and other expenses for these employees.[24] Survey work fell within the scope of duties and the budget as in all previous years.

Survey work for 1924 entailed ongoing efforts to discover each season's insect outbreaks which required immediate actions, and preparation for the following year. Federal research funds enabled the State Entomologist's Office to pay for part of the necessary survey work and traveling expenses for survey and control work. Parker and Cooley concentrated more on control work than in conducting as extensive a survey as in the autumn of 1923. During his three-month tenure replacing Cooley in the grasshopper campaign, Parker engaged two of his employees to observe and report on grasshopper-related indicators. Robert B. Tootell, one of the two, organized mixing and distribution of poison bait near Chouteau in early July. Parker sent him some entomological collecting equipment and instructed him to gather "flies which attack the grasshoppers" and "grasshoppers which appear to be 'loggy' or sick" and "probably . . . contain maggots." Parker expected Tootell to collect and observe activity levels of adult and imma-

ture grasshoppers with respect to ambient temperature during the slack times in the mixing.[25]

Unlike Tootell's preoccupations in north central Montana, F. T. Cowan's early July trip to eastern Montana primarily involved observation and survey work. Other than watching for the usual activities, parasites, and diseases of grasshoppers, Parker told Cowan to catalog the effects of air temperature on grasshopper activity levels, keeping copious notes on stages of development and specific activities. In contrast to his directions for Tootell, Parker enjoined Cowan to help individual farmers in mixing and scattering the poison bait whenever he could. Thus, Cowan's primary job remained surveying.[26]

After the worst of the July outbreak, Parker shifted Tootell to more extensive and intensive observational duties. In addition to watching for parasitic flies and disease, he wanted Tootell to detail any egg-laying by grasshoppers. One month later, obviously dissatisfied with Tootell's superficial treatment of vital information, Parker requested additional data on how much time he spent in each county, what towns he visited, and any persons he interviewed for his report. Further correspondence does not indicate how much of this request Tootell complied with strictly by memory. In late September Parker tried gathering additional observations from the people in charge of various county campaigns--an attempt to fill in the gaps

left by having only two people available to cover the survey of so much land area.[27]

Although control measures were in place, and succeeding, grasshoppers formed a critical but small part of the agricultural catastrophe developing in Montana. Looking beyond the immediate saving of crops from grasshoppers and other pests, Linfield considered the broader economy of Montana and the nation. He wrote that railroads, faced with increasing costs of labor and materials, could not decrease freight rates and maintain their profit margins. So, rail companies probably would increase the cost of transport for Montana farmers and thus the cost of manufactured and processed goods--even food. If the railroads maintained or decreased freight rates, farmers still faced increased costs as their lands lost fertility. In the near future, they had to supplement the soil's fertility with artificial supplements even as land values continued their downward spiral.[28]

Linfield maintained his pessimism in the face of increased prices for wheat and other grains. Since national and worldwide economic conditions portended a downward price trend, he considered it unwise to base expansion of Montana agricultural production on a fleeting price advantage. However, 1924 realized increased production over 1923, "the year of maximum production up to that time." Montana produced 47,700,000 bushels of wheat in 1923 and

51,668,000 bushels in 1924. Aggressive grasshopper control added greatly to this successful crop production. Counties spent $42,030 for the 1924 campaigns using 1,779 tons of poison bait. With these materials they treated 241,371 acres of land and saved about $794,300 in crops.[29]

Cooley wrapped up the business of 1924 and contemplated thoughts on what entomologists had to accomplish in future grasshopper studies. In December, 1924, the State Entomologist's Office still awaited the tardy responses to earlier inquiries sent to Montana counties. This prevented the office from completing its report on grasshopper conditions during 1924 for the upcoming legislature. The State Bankers' Association also required additional information in support of the funding which they had provided the State Entomologist for the year. Beyond the details of business and paperwork, Cooley noted that an efficient method of control existed, but entomologists lacked sufficient knowledge on why grasshopper outbreaks came and went. Satisfied with the data gathered about temperature effects on the life cycles and activities of grasshoppers, Cooley believed that the accumulating new scientific knowledge promised to "point the way to more complete control of this pest."[30]

The grasshopper had given the State Entomologist's Office and the Department of Entomology of Montana State College and the Experiment Station a major focus during much of these eight years. Naturally Cooley interpreted

the limited survey data of 1924 to mean that grasshopper troubles would return in 1925, though he conceded a considerable decrease in the extent of the problem. The humble grasshopper had bolstered Cooley's arguments for increased funding for entomological activities at federal, state, and local levels.[31] Though grasshopper outbreaks remained at minor levels until the 1930s, Cooley may still have breathed a sigh of relief. He informed A. T. Hibbard, Secretary of the State Bankers' Association that "during the season two other serious wheat pests have turned up in the state . . . the Hessian fly and the western wheat stem saw fly."[32] Montana entomology still had its economic and political justification for existence and a mission to the state.

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# CHAPTER 7

# CONCLUSION

R. A. Cooley and his state entomological forces successfully battled grasshoppers during the period from 1917 through 1924. Their intervention allowed many Montana farmers to survive economically at least until the Depression of the 1930s. Though grasshopper depredations did not pose the entire nor even the major threat to Montana agriculture, they inflicted critical losses on many farmers already brought to the economic edge by drought, high production costs, and marginal profits. Natural controls on grasshoppers, including the weather, diseases, parasites, and predators, could not cope alone with the exploding grasshopper populations.

The Montana farm economy suffered from several pressures brought about by the return of grasshoppers. Demands for agricultural products during World War I had encouraged many farmers to gamble with crop production on marginal lands. But high demand and high prices for farm commodities ended after the troops returned home. Instead, farmers found themselves increasingly in debt as costs of farming overwhelmed profits. For many in Montana so close to economic failure grasshopper destruction threatened the

slim margin of survivability and forced them to leave farming or the state.

The State Entomologist of Montana met his responsibilities first by monitoring the need for artificial controls during insect outbreaks. Sometimes done at the official and highly organized level, with funding from the state and federal governments, egg bed surveys allowed more exact outbreak predictions and timely treatment when grasshoppers began to hatch. Farmers and agents on the scene also reported egg-laying areas and hatches in a haphazard fashion. Under proper conditions, the State Entomologist recommended early cultural controls or poisoning upon grasshopper emergence. The office compiled outbreak maps from official and unofficial surveys of infestations and egg-beds. With these maps, interested parties could trace the progress of the battles against grasshoppers and the State Entomologist provided a valuable weapon in his funding requests. Surveys also took the form of questionnaires which requested particulars on treatments used, results, cooperation among farmers, strategies, costs, and the like.

The outbreaks provided an ideal laboratory for further studies of the biology, behavior, and natural histories of the most destructive grasshopper species in Montana. Thus, entomologists discovered the differences between the Lesser Migratory (Melanoplus atlanis) and the Clear-Winged (Camnula pellucida) grasshoppers. Since M. atlanis oviposited in

widespread areas and tended to migrate while C. pellucida concentrated egg-laying in delimited territories and migrated only short distances, farmers could fight the Clear-Winged grasshoppers before or as they hatched while they had to battle the Lesser Migratory when these attacked croplands.

The Department of Entomology's division within the Experiment Station also developed control methods, especially through improvements in the poison bran mash technique. During the outbreak period the State Entomology Office changed its emphasis from a combination of chemical, mechanical, and cultural methods to one nearly completely chemical. The use of poison bait caused less damage to standing crops. Entomologists substituted amyl acetate for citrus fruits and crude arsenic for Paris green, both more effective and less expensive than the ingredients they replaced. They also discovered that farmers could leave out molasses under emergency conditions and mix rotted sawdust with the bran whenever costs dictated. After settling on the most effective poison bait formula, the State Entomologist's Office continued defending it from less desirable substitutes.

Parker's grasshopper feeding studies which determined the ideal time of day for the most effective poison bait treatment provided valuable intelligence to make the best use of materials, time, and labor. Later experiments with

temperature-related feeding enabled workers to treat according to ambient temperature rather than merely time of day--a more exact treatment strategy.

The State Entomologist also worked through county agents. The Bozeman office kept the agents informed about insect problems, and poison material sources and prices through pamphlets, bulletins, circulars, special publications, correspondence, personal visits, demonstrations, conferences, and other techniques. Counties without agents received assistance from agents in adjacent counties and the State Entomologist's representatives. Field and mixing demonstrations, often conducted by assistants from Bozeman, provided practical experience to both agents and farmers before they embarked into the rural battlefields.

Financing of grasshopper campaigns at the county and local community levels depended on subscription lists of those willing to contribute voluntarily to the effort. As the period progressed, this approach provided unsatisfactory funding levels. The County Insect Pest Law of 1921 enabled counties to tax landowners for campaign costs and make use of the free labor furnished by farmers. Modification of this law in 1923 increased the mill levy and permitted counties to pay their costs from general funds rather than outstanding warrants. The State Entomologist viewed this law as part of the triad which had saved Montana agriculture from the grasshoppers.

The State Entomologist depended on the State Entomologist's Fund to finance his office's functions, including the employ of an Assistant State Entomologist, survey work, supplies, travel, and scientific journal subscriptions. Adequate in normal insect years, the fund rapidly became exhausted during the grasshopper outbreaks, at times halting travel and surveying. When the legislature drastically reduced the fund in 1923, the State Entomologist discharged his assistant, reduced the frequency of his reports and travel, and took other cost-cutting measures. Futilely demonstrating the need for proper funding to the legislature, he finally turned to the private sector to create a fund for his office's work. But the insecurity of funding prevented hiring a new permanent assistant.

Cooperation between federal agencies and the State Entomologist's Office compensated somewhat for deficiencies at local and state levels. The U.S.D.A. Bureau of Entomology office in Billings supplied personnel and information which eased the burdens of the Bozeman office in eastern parts of Montana. In addition, the Forest Service and the Indian Service agreed to pay for treatment on their lands which adjoined private farmlands.

The Great Falls' Grasshopper Conference of 1923 disseminated information about the grasshopper troubles to state and federal officials. Though Cooley hoped that the conference would establish the groundwork for additional

state and federal assistance to farmers, he had to settle for indirect help through treatment of public lands and additional personnel in federal agencies within the affected states. Direct financial assistance was not in the offing. Realities had not fully met hopes.

A study of the results of the interventions by the state entomological organization revealed that it played a critical part in staving off ruin for many farmers. Heavily infested, untreated areas fared much more poorly than treated areas. Many crops which farmers otherwise would have lost were saved. Whenever counties conducted a less extensive campaign, greater losses occurred. Calculations of savings versus expenditures consistently established a positive balance, an analysis supported by farmer testimony and newspaper reports. Official entomologists contributed to the survival of agriculture in Montana.

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