

VI.6 Relative Importance of Rangeland Grasshoppers in Western North America: A Numerical Ranking From the Literature

Richard J. Dysart

Introduction

There are about 400 species of grasshoppers found in the 17 Western States (Pfadt 1988). However, only a small percentage of these species ever become abundant enough to cause economic concern. The problem for any rangeland entomologist is how to arrange these species into meaningful groups for purposes of making management decisions. The assessment of the economic status of a particular grasshopper species is difficult because of variations in food availability and host selectivity. Mulkern et al. (1964) reported that the degree of selectivity is inherent in the grasshopper species but the expression of selectivity is determined by the habitat. To add to the complexity, grasshopper preferences may change with plant maturity during the growing season (Fielding and Brusven 1992). Because of their known food habits and capacity for survival, about two dozen grasshopper species generally are considered as pests, and a few other species have been called beneficials (Watts et al. 1989).

Between these extremes are more than 350 grasshopper species that are of little or no economic concern. However, while most species alone never cause serious economic loss, together an assemblage of minor species can inflict serious damage to rangeland. Through the years, the pest grasshoppers have received the greatest attention. Grasshoppers of the family Acrididae surpass all other arthropods in their destructiveness to rangeland (Watts et al. 1982). Although few in number, the pest grasshoppers cause losses to western rangeland estimated at \$393 million per year, based on 1977 dollars (Hewitt and Onsager 1983).

Reviewing the Literature

Several authors have made estimates of the relative importance of the major pest grasshoppers on western rangeland, but the work by Hewitt (1977) is probably the most thorough and the most cited. To my knowledge, however, no estimates have been made on the relative importance of the minor, occasional, and nonpest grasshoppers. The purpose of this chapter is to score and rank the western grasshopper species, in terms of relative economic importance, on the basis of remarks made by many grasshopper experts in their reports and publications. It

is important to point out that these estimates represent merely the opinions of those involved, not conclusive proof. By including a large number of articles and authors that cover most of the literature on the subject, I hope that the resulting compilation will be a consensus from the literature, without introduction of bias on my part.

This review is restricted to grasshoppers found in 17 Western United States (Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming) plus the 4 western provinces of Canada (Alberta, British Columbia, Manitoba, and Saskatchewan). Furthermore, only grasshoppers belonging to the family Acrididae are included here, even though many research papers reviewed mentioned species from other families of Orthoptera.

In my evaluation, I have emphasized the impact of grasshoppers on rangeland rather than on cropland. In cases where authors made comparative remarks, such as “this species is of major importance to crops, but only of minor importance to range ...,” I used only the rangeland remarks to assign a pest-status category to that species.

For my review of the North American grasshopper literature, I selected only articles in which the authors had grouped or characterized a number of grasshopper species according to their importance. Because of this limitation, several important taxonomic analyses (Brooks 1958, Handford 1946, and Otte 1981 and 1984) could not be used for my purposes.

Pest-Status Categories

Grasshoppers are important herbivores, and any pest classification is based on whether they compete with or benefit human activities. Many articles I reviewed contained proof that a species actually caused measurable injury to rangeland, but many did not. Also, most articles which claimed that certain grasshopper species were beneficial presented no data to support the claim.

In my review, I have used the authors' remarks regardless of the evidence presented. In most instances, it was not

difficult to assign species to one of my pest-status categories because the authors had made clear statements concerning the relative importance of grasshopper species in a study. However, it was sometimes necessary to make an interpretation from somewhat vague statements, such as "... occasionally common on rangeland." After reviewing each article, I translated the authors' remarks on a particular grasshopper species into one of five categories:

Serious pest species (S) Authors usually made clear statements about grasshoppers in this category, such as "... frequently causes major damage to rangeland," or "... one of the 10 most destructive species in our study."

Minor pest species (M) Authors categorized such species with phrases like "... this species occasionally causes injury to forage grasses," or "... populations may require control treatment in specific areas."

Innocuous species (I) Authors' remarks often contained phrases like "... of no economic importance," or "... this species was rarely encountered in the study area." Also, if an author categorized 10 grasshopper species as "serious pests" and another 10 species as "minor pests" but then discussed 10 additional species without mention of economic importance, I classified the latter species as "innocuous."

Possibly beneficial species (b?) In this and the next category I included grasshoppers that feed to some extent on undesirable rangeland plants, such as the perennial snakeweeds (*Gutierrezia* spp.). I also assigned species to the "possibly beneficial" category when the authors' remarks were either uncertain or intentionally ambiguous, for example "... possibly beneficial since it feeds on noxious forbs."

Beneficial species (B) In these cases the author's remarks were clear and unequivocal: "... this grasshopper is a beneficial insect."

Scientific Names

In this chapter, grasshopper names follow the usage recognized by the following sources, by subfamily:

Acridinae—Otte (1981)

Cyrtacanthacridinae—Arnett (1985), Helfer (1987)

Gomphocerinae—Otte (1981)

Melanoplineae—Arnett (1985), Helfer (1987)

Oedipodinae—Otte (1984)

Also the scientific names of all grasshoppers discussed were checked for proper usage by Dan Otte (Academy of Natural Sciences, Philadelphia) while this chapter was still in manuscript form. However, I am responsible for the accuracy of all names as printed here. In general, I have tried not to use names of subspecies, but in several instances that was unavoidable.

My Findings

My review of the literature yielded 69 articles (table VI.6–1) in which the authors provided opinions of the relative pest status for the grasshopper species in their studies. In the articles selected, a total of 377 different grasshopper species were discussed by 77 different authors and coauthors over a period of 70 years (1924–93). When these authors' opinions were translated into my five pest-status categories, there were a total of 2,731 rankings on the 377 species. The 2,731 rankings broke down into the five categories as follows:

	<i>Percent</i>
Serious pest species	17.4
Minor pest species	15.7
Innocuous species	65.7
Possibly beneficial species	0.5
Beneficial species	0.7

The 377 grasshoppers (table VI.6–2) included species in the following five acridid subfamilies: Acridinae (1), Cyrtacanthacridinae (8), Gomphocerinae (63), Melanoplineae (185), and Oedipodinae (120). Also listed in table VI.6–2 are the status category tally counts for each species. In order to make calculations, I assigned points for each status category, as follows: Serious = +2, Minor = +1, Innocuous = 0, Possibly beneficial = -1, and Beneficial = -2.

The total score for each grasshopper species was calculated by multiplying the category tally count times the respective point values for each pest-status category. The rank number was determined by the magnitude of the total score for each species. In cases of tie scores, the species with the highest frequency of mentions as a "serious" and "minor" pest was given the higher rank.

Table VI.6–1—Summary of pest-status rankings of 377 western rangeland grasshoppers from 69 articles

Literature citation	Geographic region	Number of grasshopper species in each status ¹					Total species
		“S”	“M”	“T”	“b?”	“B”	
Arnett (1985)	17 Western States	10	1	59	0	0	70
Ball (1936)	Arizona	0	0	10	0	13	23
Ball et al. (1942)	Arizona	13	27	99	1	1	141
Banfill and Brusven (1973)	Idaho	3	4	19	0	0	26
Bird (1961)	Western Canada	3	2	0	0	0	5
Brusven (1967)	Kansas	1	6	15	0	0	22
Brusven (1972)	Idaho	4	9	2	1	0	16
Brusven and Lambley (1971)	Idaho	2	13	13	0	0	28
Buckell (1936a)	Western Canada	5	1	0	0	0	6
Buckell (1936b)	Western Canada	6	0	0	0	0	6
Capinera (1987)	17 Western States	25	0	0	0	0	25
Capinera and Sechrist (1982)	Colorado	16	11	99	3	0	129
Capinera and Thompson (1987)	Colorado	2	4	3	0	0	9
Coppock (1962)	Oklahoma	10	5	97	1	0	113
Ewen and Mukerji (1984)	Western Canada	4	0	0	0	0	4
Fielding and Brusven (1990)	Idaho	3	4	0	0	0	7
Gibson (1938)	Western Canada	7	6	0	0	0	13
Hagen (1970)	Nebraska	4	8	62	0	0	74
Harper (1952)	California	4	19	1	0	0	24
Hauke (1953)	Nebraska	8	8	97	0	0	113
Hebard (1936)	North Dakota	6	3	59	0	0	68
Hebard (1938)	Oklahoma	10	15	36	0	0	61
Helfer (1987)	17 Western States	19	16	234	0	0	269
Henderson (1924)	Utah	4	8	26	0	0	38
Henderson (1931)	Utah	6	5	1	0	0	12
Hewitt (1977)	17 Western States	26	0	0	0	0	26
Hewitt and Barr (1967)	Idaho	1	5	30	0	0	36
Hewitt et al. (1974)	17 Western States	26	0	0	0	0	26
Isely (1938)	Texas	2	0	36	0	0	38
Kemp and Dennis (1991)	Montana	6	0	0	0	0	6
Kemp and Onsager (1986)	Montana	6	0	0	0	0	6
Kevan (1979)	Western Canada	5	0	1	0	0	6
Knowlton and Janes (1932)	Utah	6	21	0	0	0	27
La Rivers (1948)	Nevada	4	9	63	0	0	76
Middlekauff (1958)	California	2	2	0	0	0	4
Mitchener (1953)	Manitoba	3	2	0	0	0	5
Mulkern (1980)	North Dakota	2	10	25	0	0	37
Mulkern et al. (1962)	North Dakota	7	0	19	0	0	26
Mulkern et al. (1969)	17 Western States	7	11	40	3	0	61
Nerney (1960)	Arizona	3	1	0	0	0	4

Table VI.6–1—Summary of pest-status rankings of 377 western rangeland grasshoppers from 69 articles (Continued)

Literature citation	Geographic region	Number of grasshopper species in each status ¹					Total species
		“S”	“M”	“I”	“b?”	“B”	
Nerney (1961)	Arizona	2	3	0	0	0	5
Nerney and Hamilton (1969)	Arizona	2	6	0	0	0	8
Newton et al. (1954)	Montana and Wyoming	12	0	52	0	0	64
Parker (1952)	17 Western States	19	3	0	0	0	22
Parker (1957)	17 Western States	3	9	2	0	0	14
Parker and Connin (1964)	17 Western States	3	9	1	0	0	13
Pfadt (1949)	17 Western States	8	2	0	4	0	14
Pfadt (1977)	17 Western States	4	8	15	0	0	27
Pfadt (1982)	Arizona	2	1	14	0	0	17
Pfadt (1984)	Colorado	1	12	11	0	0	24
Pfadt (1988)	17 Western States	13	17	5	0	1	36
Pfadt and Hardy (1987)	17 Western States	13	0	0	0	0	13
Putnam (1962)	British Columbia	2	1	0	0	0	3
Richman et al. (1993)	New Mexico	19	23	122	0	1	165
Scoggan and Brusven (1972)	Idaho	4	12	21	0	0	37
Scoggan and Brusven (1973)	Idaho	1	9	38	0	0	48
Shewchuk and Kerr (1993)	Alberta	3	0	0	0	0	3
Shotwell (1938a)	Northern Great Plains	5	0	4	0	0	9
Shotwell (1938b)	17 Western States	10	16	13	0	0	39
Shotwell (1941)	17 Western States	2	10	0	0	0	12
Strohecker et al. (1968)	California	11	9	146	1	0	167
Turnock (1977)	Western Canada	3	0	0	0	0	3
Van Horn (1972)	Colorado	5	10	19	0	0	34
Vickery and Scudder (1987)	Western Canada	7	3	91	0	0	101
Wakeland (1951)	17 Western States	5	11	0	0	0	16
Watts et al. (1989)	17 Western States	25	0	0	0	2	27
White and Rock (1945)	Alberta	5	5	66	0	0	76
Wilbur and Fritz (1940)	Kansas	4	8	18	0	0	30
Woodruff (1937)	Kansas	0	7	11	0	0	18
Totals		474	430	1,795	14	18	2,731
Percent of total rankings		17.4	15.7	65.7	0.5	0.7	100.0

¹S = serious, M = minor, I = innocuous, b? = possibly beneficial, B = beneficial.

Table VI.6–2—Alphabetical list of 377 western rangeland grasshoppers with pest-status scores and ranks

Grasshopper species	Sub-family ²	Number of rankings ¹					Total	Score	Rank
		“S”	“M”	“I”	“b?”	“B”			
<i>Acantherus piperatus</i> Scudder & Cockerell	G	0	0	4	0	0	4	0	163
<i>Achurum sumichrasti</i> (Saussure)	G	0	0	5	0	0	5	0	148
<i>Acrolophitus hirtipes</i> (Say)	G	0	0	16	0	0	16	0	113
<i>Acrolophitus maculipennis</i> (Scudder)	G	0	0	5	0	0	5	0	149
<i>Acrolophitus nevadensis</i> (Thomas)	G	0	0	7	0	0	7	0	133
<i>Aeoloplides chenopodii</i> (Bruner)	M	0	0	3	0	1	4	-2	374
<i>Aeoloplides elegans</i> (Scudder)	M	0	0	1	0	0	1	0	264
<i>Aeoloplides fratercula</i> (Hebard)	M	0	0	1	0	0	1	0	265
<i>Aeoloplides fuscipes</i> (Scudder)	M	0	0	1	0	0	1	0	266
<i>Aeoloplides minor</i> (Bruner)	M	0	0	2	0	0	2	0	214
<i>Aeoloplides rotundipennis</i> Wallace	M	0	0	1	0	0	1	0	267
<i>Aeoloplides turnbulli</i> (Caudell)	M	0	3	9	1	0	13	2	65
<i>Aeoloplus californicus</i> Scudder	M	0	0	1	0	0	1	0	268
<i>Aeoloplus tenuipennis</i> (Scudder)	M	0	0	7	0	1	8	-2	368
<i>Aeropedellus clavatus</i> (Thomas)	G	6	2	13	0	0	21	14	32
<i>Ageneotettix brevipennis</i> (Bruner)	G	0	0	1	0	0	1	0	269
<i>Ageneotettix deorum</i> (Scudder)	G	27	7	11	0	0	45	61	5
<i>Ageneotettix salutator</i> (Rehn)	G	0	0	2	0	0	2	0	215
<i>Agnostokasia sublima</i> Gurney & Rentz	M	0	0	2	0	0	2	0	216
<i>Agroecotettix modestus</i> Bruner	M	0	0	2	0	0	2	0	217
<i>Agymnastus ingens</i> (Scudder)	O	0	0	3	0	0	3	0	183
<i>Aidemona azteca</i> Saussure	M	0	0	3	0	0	3	0	184
<i>Amblytropidia mysteca</i> (Saussure)	G	0	0	5	0	0	5	0	150
<i>Amphitornus coloradus</i> (Thomas)	G	18	12	12	0	0	42	48	8
<i>Anconia hebardii</i> Rehn	O	0	0	2	0	0	2	0	218
<i>Anconia integra</i> Scudder	O	0	0	5	0	1	6	-2	370
<i>Argiacris militaris</i> (Scudder)	M	0	0	1	0	0	1	0	270
<i>Argiacris rehni</i> Hebard	M	0	0	2	0	0	2	0	219
<i>Arphia behrensi</i> Saussure	O	0	0	3	0	0	3	0	185
<i>Arphia conspersa</i> Scudder	O	0	2	22	0	0	24	2	66
<i>Arphia pseudonietana</i> (Thomas)	O	1	8	20	0	0	29	10	36
<i>Arphia ramona</i> Rehn	O	0	0	1	0	0	1	0	271
<i>Arphia saussureana</i> Bruner	O	0	0	1	0	0	1	0	272
<i>Arphia simplex</i> Scudder	O	0	0	8	0	0	8	0	128
<i>Arphia sulphurea</i> (Fabricius)	O	0	0	5	0	0	5	0	151
<i>Arphia xanthoptera</i> (Burmeister)	O	0	0	8	0	0	8	0	129
<i>Asemoplus hispidus</i> (Bruner)	M	0	0	1	0	0	1	0	273
<i>Asemoplus montanus</i> (Bruner)	M	0	1	3	0	0	4	1	105
<i>Asemoplus sierranus</i> Hebard	M	0	0	1	0	0	1	0	274
<i>Aulocara ellioti</i> (Thomas)	G	39	7	3	0	0	49	85	2

Table VI.6–2—Alphabetical list of 377 western rangeland grasshoppers with pest-status scores and ranks (Continued)

Grasshopper species	Sub-family ²	Number of rankings ¹					Total	Score	Rank
		“S”	“M”	“I”	“b?”	“B”			
<i>Aulocara femoratum</i> (Scudder)	G	12	8	6	0	0	26	32	12
<i>Aztecacris gloriosus</i> (Hebard)	M	0	0	4	0	0	4	0	164
<i>Barytettix cochisei</i> Gurney	M	0	0	1	0	0	1	0	275
<i>Barytettix humphreysii</i> (Thomas)	M	0	0	3	0	0	3	0	186
<i>Booneacris glacialis</i> (Scudder)	M	0	0	2	0	0	2	0	220
<i>Boopedon auriventris</i> McNeill	G	0	0	6	0	0	6	0	142
<i>Boopedon flaviventris</i> (Bruner)	G	2	1	0	0	0	3	5	54
<i>Boopedon gracile</i> Rehn	G	0	0	5	0	0	5	0	152
<i>Boopedon nubilum</i> (Say)	G	4	6	11	0	0	21	14	31
<i>Bootettix argentatus</i> Bruner	G	0	0	6	0	1	7	-2	369
<i>Bradynotes obesa</i> (Thomas)	M	0	1	8	0	0	9	1	91
<i>Buckellacris chilcotinae</i> (Hebard)	M	0	0	1	0	0	1	0	276
<i>Buckellacris hispida</i> (Bruner)	M	0	0	1	0	0	1	0	277
<i>Buckellacris nuda</i> (Walker)	M	0	0	3	0	0	3	0	187
<i>Camnula pellucida</i> (Scudder)	O	35	7	5	0	0	47	77	3
<i>Campylacantha olivacea</i> (Scudder)	M	1	0	9	0	0	10	2	80
<i>Chimarocephala elongata</i> Rentz	O	0	0	1	0	0	1	0	278
<i>Chimarocephala pacifica</i> (Thomas)	O	0	0	3	0	0	3	0	188
<i>Chloealtis abdominalis</i> (Thomas)	G	0	0	9	0	0	9	0	125
<i>Chloealtis aspasma</i> (Rehn & Hebard)	G	0	0	1	0	0	1	0	279
<i>Chloealtis conspersa</i> (Harris)	G	0	0	14	0	0	14	0	116
<i>Chloealtis diana</i> (Gur., Stro. & Helf.)	G	0	0	2	0	0	2	0	221
<i>Chloealtis gracilis</i> (McNeill)	G	0	0	2	0	0	2	0	222
<i>Chloroplus cactocaetes</i> Hebard	M	0	0	2	0	0	2	0	223
<i>Chorthippus curtipennis</i> (Harris)	G	6	7	15	0	0	28	19	19
<i>Chortophaga mendocino</i> Rentz	O	0	0	1	0	0	1	0	280
<i>Chortophaga viridifasciata</i> (DeGeer)	O	0	3	17	0	0	20	3	58
<i>Chrysochraon petraea</i> (Gur., Stro. & Helf.)	G	0	0	2	0	0	2	0	224
<i>Cibolacris parviceps</i> (Walker)	G	0	0	8	0	0	8	0	130
<i>Cibolacris samalayuca</i> Tinkham	G	0	0	1	0	0	1	0	281
<i>Circotettix carlinianus</i> (Thomas)	O	0	1	13	0	0	14	1	84
<i>Circotettix crotalum</i> Rehn	O	0	0	2	0	0	2	0	225
<i>Circotettix maculatus</i> Scudder	O	0	0	3	0	0	3	0	189
<i>Circotettix rabula</i> Rehn & Hebard	O	0	0	14	0	0	14	0	117
<i>Circotettix shastanus</i> Bruner	O	0	0	2	0	0	2	0	226
<i>Circotettix stenometopus</i> (Stro. & Buxt.)	O	0	0	2	0	0	2	0	227
<i>Circotettix undulatus</i> (Thomas)	O	0	2	9	0	0	11	2	72
<i>Clematodes larreae</i> Scudder	M	0	0	4	0	0	4	0	165
<i>Conalcea huachucana</i> Rehn	M	0	0	3	0	0	3	0	190
<i>Conozoa carinata</i> Rehn	O	0	1	2	0	0	3	1	109

Table VI.6–2—Alphabetical list of 377 western rangeland grasshoppers with pest-status scores and ranks (Continued)

Grasshopper species	Sub-family ²	Number of rankings ¹					Total	Score	Rank
		“S”	“M”	“I”	“b?”	“B”			
<i>Conozoa hyalina</i> (McNeill)	O	0	0	1	0	0	1	0	282
<i>Conozoa rebellis</i> (Saussure)	O	0	0	4	0	0	4	0	166
<i>Conozoa sulcifrons</i> (Scudder)	O	0	6	10	0	0	16	6	46
<i>Conozoa texana</i> (Bruner)	O	0	0	12	0	0	12	0	121
<i>Cordillacris crenulata</i> (Bruner)	G	4	7	11	0	0	22	15	29
<i>Cordillacris occipitalis</i> (Thomas)	G	13	4	14	0	0	31	30	15
<i>Cratypedes lateritius</i> (Saussure)	O	0	0	6	0	0	6	0	143
<i>Cratypedes neglectus</i> (Thomas)	O	0	5	12	0	0	17	5	51
<i>Dactylotum bicolor pictum</i> (Thomas)	M	0	1	12	0	0	13	1	86
<i>Dactylotum bicolor variegatum</i> (Scudder)	M	0	0	3	0	0	3	0	191
<i>Dendrotettix hesperus</i> (Hebard)	M	0	0	2	0	0	2	0	228
<i>Derotmema delicatulum</i> Scudder	O	0	0	4	0	0	4	0	167
<i>Derotmema haydeni</i> (Thomas)	O	0	1	20	0	0	21	1	83
<i>Derotmema laticinctum</i> Scudder	O	0	0	3	0	0	3	0	192
<i>Derotmema saussureanum</i> Scudder	O	0	0	2	0	0	2	0	229
<i>Dichromorpha elegans</i> (Morse)	G	0	0	1	0	0	1	0	283
<i>Dichromorpha viridis</i> (Scudder)	G	0	0	7	0	0	7	0	134
<i>Dissosteira carolina</i> (Linnaeus)	O	3	11	18	0	0	32	17	24
<i>Dissosteira longipennis</i> (Thomas)	O	8	2	3	0	0	13	18	23
<i>Dissosteira pictipennis</i> Bruner	O	0	2	2	0	0	4	2	75
<i>Dissosteira spurcata</i> Saussure	O	3	8	6	0	0	17	14	30
<i>Encoptolophus californicus</i> (Bruner)	O	0	0	1	0	0	1	0	284
<i>Encoptolophus costalis</i> (Scudder)	O	5	3	7	0	0	15	13	34
<i>Encoptolophus pallidus</i> Bruner	O	0	0	3	0	0	3	0	193
<i>Encoptolophus robustus</i> Rehn & Hebard	O	0	0	1	0	0	1	0	285
<i>Encoptolophus sordidus</i> (Burmeister)	O	2	3	6	0	0	11	7	43
<i>Encoptolophus subgracilis</i> Caudell	O	0	3	6	0	0	9	3	60
<i>Eritettix abortivus</i> (Bruner)	G	0	0	2	0	0	2	0	230
<i>Eritettix simplex</i> (Scudder)	G	7	3	15	0	0	25	17	26
<i>Esselenia vanduzeei</i> Hebard	G	0	1	3	0	0	4	1	106
<i>Eupnigodes megacephala</i> (McNeill)	G	0	1	2	0	0	3	1	110
<i>Eupnigodes sierranus</i> Rehn & Hebard	G	0	0	2	0	0	2	0	231
<i>Hadrotettix magnificus</i> (Rehn)	O	0	0	5	0	0	5	0	153
<i>Hadrotettix trifasciatus</i> (Say)	O	0	3	22	0	0	25	3	57
<i>Hebardacris albida</i> (Hebard)	M	0	0	3	0	0	3	0	194
<i>Hebardacris excelsa</i> (Rehn)	M	0	0	2	0	0	2	0	232
<i>Hebardacris mono</i> Rehn	M	0	0	2	0	0	2	0	233
<i>Heliastus benjamini</i> Caudell	O	0	0	4	0	0	4	0	168
<i>Heliaula rufa</i> (Scudder)	G	0	0	11	0	0	11	0	124
<i>Hesperotettix curtipennis</i> Scudder	M	0	0	1	0	1	2	-2	375

Table VI.6–2—Alphabetical list of 377 western rangeland grasshoppers with pest-status scores and ranks (Continued)

Grasshopper species	Sub-family ²	Number of rankings ¹					Total	Score	Rank
		“S”	“M”	“I”	“b?”	“B”			
<i>Hesperotettix nevadensis</i> Morse	M	0	0	1	0	0	1	0	286
<i>Hesperotettix pacificus</i> Scudder	M	0	0	1	0	0	1	0	287
<i>Hesperotettix speciosus</i> (Scudder)	M	1	0	7	2	0	10	0	112
<i>Hesperotettix viridis</i> (Thomas)	M	0	2	17	5	5	29	-13	377
<i>Hippiscus ocelote</i> (Saussure)	O	0	2	12	0	0	14	2	69
<i>Hippopedon capito</i> (Stal)	O	0	0	3	0	0	3	0	195
<i>Hippopedon gracilipes</i> (Caudell)	O	0	0	3	0	0	3	0	196
<i>Horesidotes cinereus</i> Scudder	G	0	0	5	0	0	5	0	154
<i>Hypochlora alba</i> (Dodge)	M	0	0	13	2	1	16	-4	376
<i>Hypsalia merga</i> Gurney & Buxton	M	0	0	1	0	0	1	0	288
<i>Hypsalia miwoki</i> Gurney & Eades	M	0	0	1	0	0	1	0	289
<i>Hypsalia petasata</i> Gurney & Eades	M	0	0	1	0	0	1	0	290
<i>Hypsalia rentzi</i> Gurney & Eades	M	0	0	1	0	0	1	0	291
<i>Hypsalia satur</i> (Scudder)	M	0	0	1	0	0	1	0	292
<i>Hypsalia tioga</i> Gurney & Eades	M	0	0	1	0	0	1	0	293
<i>Karokia blanci</i> (Rehn)	M	0	0	1	0	0	1	0	294
<i>Lactista aztecus</i> (Saussure)	O	0	2	2	0	0	4	2	76
<i>Lactista gibbosus</i> Saussure	O	0	0	3	0	0	3	0	197
<i>Leprus intermedius</i> Saussure	O	0	0	9	0	0	9	0	126
<i>Leprus wheeleri</i> (Thomas)	O	0	1	6	0	0	7	1	97
<i>Leptysmia marginicollis</i> (Serville)	M	0	0	6	0	0	6	0	144
<i>Leuronotina ritensis</i> (Rehn)	O	0	0	3	0	0	3	0	198
<i>Ligurotettix coquilletti</i> McNeill	G	0	0	4	0	1	5	-2	372
<i>Ligurotettix planum</i> (Bruner)	G	0	0	2	0	0	2	0	234
<i>Melanoplus ablutus</i> Scudder	M	0	0	1	0	0	1	0	295
<i>Melanoplus alpinus</i> Scudder	M	0	1	7	0	0	8	1	95
<i>Melanoplus angustipennis</i> (Dodge)	M	4	4	12	0	0	20	12	35
<i>Melanoplus aridus</i> (Scudder)	M	0	2	4	0	0	6	2	73
<i>Melanoplus arizonae</i> Scudder	M	0	3	4	0	0	7	3	61
<i>Melanoplus artemesiaae</i> (Bruner)	M	0	0	1	0	0	1	0	296
<i>Melanoplus ascensus</i> Scudder	M	0	0	1	0	0	1	0	297
<i>Melanoplus aspasmus</i> Hebard	M	0	0	1	0	0	1	0	298
<i>Melanoplus beameri</i> Hebard	M	0	0	1	0	0	1	0	299
<i>Melanoplus bernardinae</i> Hebard	M	0	0	1	0	0	1	0	300
<i>Melanoplus bispinosus</i> Scudder	M	0	2	3	0	0	5	2	74
<i>Melanoplus bivittatus</i> (Say)	M	2	14	6	0	0	47	68	4
<i>Melanoplus bohemani</i> (Stal)	M	0	0	1	0	0	1	0	301
<i>Melanoplus borealis</i> (Fieber)	M	2	1	8	0	0	11	5	53
<i>Melanoplus bowditchi</i> Scudder	M	1	0	13	1	0	15	1	82
<i>Melanoplus bruneri</i> Scudder	M	3	1	6	0	0	10	7	44

Table VI.6–2—Alphabetical list of 377 western rangeland grasshoppers with pest-status scores and ranks (Continued)

Grasshopper species	Sub-family ²	Number of rankings ¹					Total	Score	Rank
		“S”	“M”	“I”	“b?”	“B”			
<i>Melanoplus buxtoni</i> Strohecker	M	0	0	1	0	0	1	0	302
<i>Melanoplus caroli</i> Gurney & Helfer	M	0	0	2	0	0	2	0	235
<i>Melanoplus chimariki</i> Gurney & Buxton	M	0	0	1	0	0	1	0	303
<i>Melanoplus chiricahuae</i> Hebard	M	0	0	1	0	0	1	0	304
<i>Melanoplus cinereus</i> Scudder	M	0	1	5	0	0	6	1	99
<i>Melanoplus complanatipes</i> Scudder	M	0	1	5	0	0	6	1	100
<i>Melanoplus confusus</i> Scudder	M	1	4	17	0	0	22	6	48
<i>Melanoplus daemon</i> Strohecker	M	0	0	1	0	0	1	0	305
<i>Melanoplus dawsoni</i> (Scudder)	M	2	5	11	0	0	18	9	39
<i>Melanoplus desultorius</i> Rehn	M	1	0	1	1	1	4	–1	366
<i>Melanoplus devastator</i> Scudder	M	9	1	0	0	0	10	19	20
<i>Melanoplus differentialis</i> (Thomas)	M	13	11	4	0	0	28	37	10
<i>Melanoplus discolor</i> (Scudder)	M	0	0	7	0	0	7	0	135
<i>Melanoplus dodgei</i> (Thomas)	M	0	0	3	0	0	3	0	199
<i>Melanoplus elaphrus</i> Strohecker	M	0	0	1	0	0	1	0	306
<i>Melanoplus elater</i> Strohecker	M	0	0	1	0	0	1	0	307
<i>Melanoplus eremitus</i> Strohecker	M	0	0	1	0	0	1	0	308
<i>Melanoplus fasciatus</i> (Walker)	M	0	0	7	0	0	7	0	136
<i>Melanoplus femurnigrum</i> Scudder	M	0	0	2	0	0	2	0	236
<i>Melanoplus femurrubrum</i> (DeGeer)	M	18	19	3	0	0	40	55	7
<i>Melanoplus flabellatus</i> Scudder	M	0	0	1	0	0	1	0	309
<i>Melanoplus flavidus</i> Scudder	M	0	2	11	0	0	13	2	70
<i>Melanoplus foedus</i> Scudder	M	2	9	13	0	0	24	13	33
<i>Melanoplus franciscanus</i> Scudder	M	0	0	2	0	0	2	0	237
<i>Melanoplus fricki</i> Strohecker	M	0	0	1	0	0	1	0	310
<i>Melanoplus frigidus</i> (Boheman)	M	0	0	1	0	0	1	0	311
<i>Melanoplus fultoni</i> Hebard	M	0	0	1	0	0	1	0	312
<i>Melanoplus gladstoni</i> Scudder	M	8	3	11	1	0	23	18	21
<i>Melanoplus glaucipes</i> (Scudder)	M	0	1	4	0	0	5	1	102
<i>Melanoplus gracilipes</i> Scudder	M	0	0	1	0	0	1	0	313
<i>Melanoplus gracilis</i> (Bruner)	M	0	0	3	0	0	3	0	200
<i>Melanoplus harperi</i> Gurney & Buxton	M	0	0	1	0	0	1	0	314
<i>Melanoplus herbaceus</i> Bruner	M	0	0	5	0	1	6	–2	371
<i>Melanoplus hesperus</i> Hebard	M	0	0	1	0	0	1	0	315
<i>Melanoplus hupah</i> Strohecker & Helfer	M	0	0	1	0	0	1	0	316
<i>Melanoplus huporeus</i> Hebard	M	0	0	1	0	0	1	0	317
<i>Melanoplus huroni</i> Blatchley	M	0	0	5	0	0	5	0	155
<i>Melanoplus immunis</i> Scudder	M	0	0	1	0	0	1	0	318
<i>Melanoplus impudicus</i> Scudder	M	0	0	2	0	0	2	0	238
<i>Melanoplus inconspicuous</i> Caudell	M	0	0	2	0	0	2	0	239

Table VI.6–2—Alphabetical list of 377 western rangeland grasshoppers with pest-status scores and ranks (Continued)

Grasshopper species	Sub-family ²	Number of rankings ¹					Total	Score	Rank
		“S”	“M”	“I”	“b?”	“B”			
<i>Melanoplus indigenus</i> Scudder	M	0	1	3	0	0	4	1	107
<i>Melanoplus infantilis</i> Scudder	M	12	7	11	0	0	30	31	13
<i>Melanoplus islandicus</i> Blatchley	M	0	0	1	0	0	1	0	319
<i>Melanoplus keeleri</i> (Thomas)	M	0	2	14	0	0	16	2	67
<i>Melanoplus keiferi</i> Gurney & Buxton	M	0	0	1	0	0	1	0	320
<i>Melanoplus kennicotti</i> Scudder	M	0	0	5	0	0	5	0	156
<i>Melanoplus lakinus</i> (Scudder)	M	0	1	7	0	0	8	1	96
<i>Melanoplus lemhiensis</i> Hebard	M	0	0	1	0	0	1	0	321
<i>Melanoplus lepidus</i> Scudder	M	0	0	2	0	0	2	0	240
<i>Melanoplus ligneolus</i> Scudder	M	0	0	1	0	0	1	0	322
<i>Melanoplus lithophilus</i> Gurney & Buxton	M	0	0	1	0	0	1	0	323
<i>Melanoplus magdalenae</i> Hebard	M	0	0	2	0	0	2	0	241
<i>Melanoplus marginatus</i> (Scudder)	M	1	3	0	0	0	4	5	52
<i>Melanoplus microtatus</i> Hebard	M	0	0	1	0	0	1	0	324
<i>Melanoplus montanus</i> (Thomas)	M	0	0	3	0	0	3	0	201
<i>Melanoplus muricolor</i> Strohecker	M	0	0	1	0	0	1	0	325
<i>Melanoplus nanus</i> Scudder	M	0	0	1	0	0	1	0	326
<i>Melanoplus occidentalis</i> (Thomas)	M	7	7	10	0	1	25	19	18
<i>Melanoplus oklahomae</i> Hebard	M	0	0	2	0	0	2	0	242
<i>Melanoplus olamentke</i> Hebard	M	0	0	1	0	0	1	0	327
<i>Melanoplus oregonensis</i> (Thomas)	M	0	0	4	0	0	4	0	169
<i>Melanoplus pacificus</i> (Scudder)	M	0	0	1	0	0	1	0	328
<i>Melanoplus packardii</i> Scudder	M	23	12	5	0	0	40	58	6
<i>Melanoplus payettei</i> Hebard	M	0	0	1	0	0	1	0	329
<i>Melanoplus pictus</i> Scudder	M	0	2	1	0	0	3	2	78
<i>Melanoplus pinaleno</i> Hebard	M	0	0	1	0	0	1	0	330
<i>Melanoplus platycercus</i> Hebard	M	0	0	1	0	0	1	0	331
<i>Melanoplus plebejus</i> (Stal)	M	0	0	3	0	0	3	0	202
<i>Melanoplus ponderosus</i> Scudder	M	0	0	7	0	0	7	0	137
<i>Melanoplus punctulatus</i> (Scudder)	M	0	0	3	0	0	3	0	203
<i>Melanoplus regalis</i> (Dodge)	M	0	0	7	0	0	7	0	138
<i>Melanoplus rileyanus</i> Scudder	M	0	0	2	0	0	2	0	243
<i>Melanoplus rugglesi</i> Gurney	M	5	0	3	0	0	8	10	38
<i>Melanoplus rusticus</i> (Stal)	M	0	0	1	0	0	1	0	332
<i>Melanoplus saltator</i> Scudder	M	0	0	1	0	0	1	0	333
<i>Melanoplus sanguinipes</i> (Fabricius)	M	53	7	1	1	0	62	112	1
<i>Melanoplus scudderi</i> (Uhler)	M	0	0	7	0	0	7	0	139
<i>Melanoplus siskiyou</i> Strohecker	M	0	0	1	0	0	1	0	334
<i>Melanoplus snowii</i> (Scudder)	M	0	0	2	0	0	2	0	244
<i>Melanoplus sonomaensis</i> Caudell	M	0	0	2	0	0	2	0	245

Table VI.6–2—Alphabetical list of 377 western rangeland grasshoppers with pest-status scores and ranks (Continued)

Grasshopper species	Sub-family ²	Number of rankings ¹					Total	Score	Rank
		“S”	“M”	“I”	“b?”	“B”			
<i>Melanoplus splendidus</i> Hebard	M	0	0	4	0	0	4	0	170
<i>Melanoplus stonei</i> Rehn	M	0	0	1	0	0	1	0	335
<i>Melanoplus texanus</i> (Scudder)	M	0	0	4	0	0	4	0	171
<i>Melanoplus thomasi</i> Scudder	M	0	2	1	0	0	3	2	79
<i>Melanoplus tristis</i> Bruner	M	0	0	2	0	0	2	0	246
<i>Melanoplus truncatus</i> Scudder	M	0	0	1	0	0	1	0	336
<i>Melanoplus tuberculatus</i> Morse	M	0	0	1	0	0	1	0	337
<i>Melanoplus tunicae</i> Hebard	M	0	0	1	0	0	1	0	338
<i>Melanoplus viridipes</i> Scudder	M	0	0	1	0	0	1	0	339
<i>Melanoplus walshii</i> Scudder	M	0	0	1	0	0	1	0	340
<i>Melanoplus warneri</i> Little	M	0	0	1	0	0	1	0	341
<i>Melanoplus washingtonius</i> (Bruner)	M	0	0	1	0	0	1	0	342
<i>Melanoplus wilsoni</i> Gurney	M	0	0	1	0	0	1	0	343
<i>Melanoplus wintunus</i> Strohecker & Helfer	M	0	0	1	0	0	1	0	344
<i>Melanoplus yarrowii</i> (Thomas)	M	0	4	1	0	0	5	4	55
<i>Mermiria bivittata</i> (Serville)	G	6	12	10	0	0	28	24	17
<i>Mermiria picta</i> (Walker)	G	0	1	8	0	0	9	1	92
<i>Mermiria texana</i> Bruner	G	0	0	6	0	0	6	0	145
<i>Mestobregma impexum</i> Rehn	O	0	0	4	0	0	4	0	172
<i>Mestobregma plattei</i> (Thomas)	O	0	1	8	0	0	9	1	93
<i>Mestobregma terricolor</i> Rehn	O	0	0	3	0	0	3	0	204
<i>Metaleptea brevicornis</i> (Johannson)	A	0	0	2	0	0	2	0	247
<i>Metator nevadensis</i> (Bruner)	O	0	0	5	0	0	5	0	157
<i>Metator pardalinus</i> (Saussure)	O	4	9	15	0	0	28	17	25
<i>Microtes helferi</i> (Strohecker)	O	0	0	3	0	0	3	0	205
<i>Microtes occidentalis</i> (Bruner)	O	0	0	3	0	0	3	0	206
<i>Microtes pogonata</i> (Strohecker)	O	0	0	1	0	0	1	0	345
<i>Netrosoma nigropleura</i> Scudder	M	0	0	1	0	0	1	0	346
<i>Nisquallia olympica</i> Rehn	M	0	0	2	0	0	2	0	248
<i>Oedaleonotus borckii</i> (Stal)	M	0	1	4	0	0	5	1	103
<i>Oedaleonotus enigma</i> (Scudder)	M	7	4	4	0	0	15	18	22
<i>Oedaleonotus orientis</i> Hebard	M	0	0	1	0	0	1	0	347
<i>Oedaleonotus pacificus</i> (Scudder)	M	0	0	1	0	0	1	0	348
<i>Oedaleonotus phryneicus</i> Hebard	M	0	0	1	0	0	1	0	349
<i>Oedaleonotus pictus</i> (Scudder)	M	0	0	1	0	0	1	0	350
<i>Oedaleonotus tenuipennis</i> (Scudder)	M	0	0	1	0	0	1	0	351
<i>Oedomerus corallipes</i> Bruner	M	0	0	1	0	0	1	0	352
<i>Opeia atascosa</i> Hebard	G	0	0	2	0	0	2	0	249
<i>Opeia obscura</i> (Thomas)	G	13	5	11	0	0	29	31	14
<i>Orphulella pelidna</i> (Burmeister)	G	0	3	10	0	0	13	3	59

Table VI.6–2—Alphabetical list of 377 western rangeland grasshoppers with pest-status scores and ranks (Continued)

Grasshopper species	Sub-family ²	Number of rankings ¹					Total	Score	Rank
		“S”	“M”	“I”	“b?”	“B”			
<i>Orphulella speciosa</i> (Scudder)	G	3	3	14	0	0	20	9	40
<i>Paraidemona mimica</i> (Scudder)	M	0	0	1	0	0	1	0	353
<i>Paraidemona punctata</i> (Stal)	M	0	0	1	0	0	1	0	354
<i>Paratylotropidia brunneri</i> Scudder	M	0	0	4	0	0	4	0	173
<i>Paratylotropidia morsei</i> Rehn & Rehn	M	0	0	2	0	0	2	0	250
<i>Pardalophora apiculata</i> (Harris)	O	0	0	12	0	0	12	0	122
<i>Pardalophora haldemani</i> (Scudder)	O	0	1	13	0	0	14	1	85
<i>Pardalophora phoenicoptera</i> (Burmeister)	O	0	0	3	0	0	3	0	207
<i>Pardalophora saussurei</i> (Scudder)	O	0	0	5	0	0	5	0	158
<i>Paropomala pallida</i> Bruner	G	0	0	7	0	0	7	0	140
<i>Paropomala virgata</i> (Scudder)	G	0	0	4	0	0	4	0	174
<i>Paropomala wyomingensis</i> (Thomas)	G	1	1	13	0	0	15	3	62
<i>Paroxya atlantica</i> Scudder	M	0	0	2	0	0	2	0	251
<i>Paroxya clavuliger</i> (Serville)	M	0	0	1	0	0	1	0	355
<i>Phaedrotettix dumicola palmeri</i> (Scudder)	M	0	0	1	0	0	1	0	356
<i>Phaulotettix compressus</i> Scudder	M	0	0	1	0	0	1	0	357
<i>Phaulotettix eurycercus</i> Hebard	M	0	0	1	0	0	1	0	358
<i>Phlibostroma quadrimaculatum</i> (Thomas)	G	13	11	6	0	0	30	37	9
<i>Phoetaliotes nebrascensis</i> (Thomas)	M	8	11	10	0	0	29	27	16
<i>Poecilotettix longipennis</i> (Townsend)	M	0	0	1	0	0	1	0	359
<i>Poecilotettix pantherinus</i> (Walker)	M	0	0	4	0	1	5	-2	373
<i>Poecilotettix sanguineus</i> Scudder	M	0	0	4	0	0	4	0	175
<i>Prorocorypha snowi</i> Rehn	M	0	0	3	0	0	3	0	208
<i>Prumnacris rainierensis</i> (Caudell)	M	0	0	2	0	0	2	0	252
<i>Pseudopomala brachyptera</i> (Scudder)	G	0	0	15	0	0	15	0	114
<i>Psinidia amplicornis</i> Caudell	O	0	0	1	0	0	1	0	360
<i>Psinidia fenestralis</i> (Serville)	O	0	0	3	0	0	3	0	209
<i>Psoloessa delicatula</i> (Scudder)	G	1	4	20	0	0	25	6	47
<i>Psoloessa texana</i> Scudder	G	1	1	8	0	0	10	3	63
<i>Rhammatocerus viatorius</i> (Saussure)	G	0	0	3	0	0	3	0	210
<i>Schistocerca alutacea albolineata</i> (Thomas)	C	0	1	4	0	0	5	1	104
<i>Schistocerca alutacea rubiginosa</i> (Harris)	C	0	0	1	0	0	1	0	361
<i>Schistocerca alutacea shoshone</i> (Thomas)	C	2	6	3	0	0	11	10	37
<i>Schistocerca americana</i> (Drury)	C	2	2	5	0	0	9	6	50
<i>Schistocerca damnifica</i> (Saussure)	C	0	0	2	0	0	2	0	253
<i>Schistocerca emarginata</i> Scudder	C	1	4	11	0	0	16	6	49
<i>Schistocerca nitens</i> (Thunberg)	C	2	4	1	0	1	8	6	45
<i>Schistocerca obscura</i> (Fabricius)	C	0	0	5	0	0	5	0	159
<i>Shotwellia isleta</i> Gurney	O	0	0	3	0	0	3	0	211
<i>Spharagemon bolli</i> Scudder	O	0	0	7	0	0	7	0	141

Table VI.6–2—Alphabetical list of 377 western rangeland grasshoppers with pest-status scores and ranks (Continued)

Grasshopper species	Sub-family ²	Number of rankings ¹					Total	Score	Rank
		“S”	“M”	“I”	“b?”	“B”			
<i>Spharagemon campestris</i> (McNeill)	O	0	0	15	0	0	15	0	115
<i>Spharagemon collare</i> (Scudder)	O	1	5	20	0	0	26	7	42
<i>Spharagemon cristatum</i> (Scudder)	O	0	0	2	0	0	2	0	254
<i>Spharagemon equale</i> (Say)	O	0	7	17	0	0	24	7	41
<i>Spharagemon superbum</i> Hebard	O	0	0	2	0	0	2	0	255
<i>Stenobothrus brunneus</i> Thomas	G	1	1	7	0	0	9	3	64
<i>Stenobothrus shastanus</i> (Scudder)	G	0	2	2	0	0	4	2	77
<i>Stethophyma gracile</i> (Scudder)	G	0	0	6	0	0	6	0	146
<i>Stethophyma lineata</i> (Scudder)	G	0	0	4	0	0	4	0	176
<i>Stictippus californicus</i> (Scudder)	O	1	2	2	0	0	5	4	56
<i>Syrbula admirabilis</i> (Uhler)	G	0	1	10	0	0	11	1	88
<i>Syrbula montezuma</i> (Saussure)	G	0	1	3	0	0	4	1	108
<i>Tomonotus ferruginosus</i> Bruner	O	0	0	4	0	0	4	0	177
<i>Trachyrhachys aspera</i> Scudder	O	0	1	5	0	0	6	1	101
<i>Trachyrhachys coronata</i> Scudder	O	0	0	4	0	0	4	0	178
<i>Trachyrhachys kiowa</i> (Thomas)	O	13	10	13	0	0	36	36	11
<i>Trepidulus hyalinus</i> (Scudder)	O	0	0	2	0	0	2	0	256
<i>Trepidulus rosaceus</i> (Scudder)	O	0	0	5	0	0	5	0	160
<i>Trimerotropis agrestis</i> McNeill	O	0	0	13	0	0	13	0	118
<i>Trimerotropis albescens</i> McNeill	O	0	0	3	0	0	3	0	212
<i>Trimerotropis arenacea</i> Rehn	O	0	0	6	0	0	6	0	147
<i>Trimerotropis arizonensis</i> Tinkham	O	0	0	2	0	0	2	0	257
<i>Trimerotropis barnumi</i> Tinkham	O	0	0	2	0	0	2	0	258
<i>Trimerotropis bifaciata</i> Bruner	O	0	1	1	0	0	2	1	111
<i>Trimerotropis californica</i> Bruner	O	0	1	10	0	0	11	1	89
<i>Trimerotropis cincta</i> (Thomas)	O	0	0	9	0	0	9	0	127
<i>Trimerotropis cyaneipennis</i> Bruner	O	0	1	9	0	0	10	1	90
<i>Trimerotropis diversellus</i> Hebard	O	0	0	1	0	0	1	0	362
<i>Trimerotropis fontana</i> Thomas	O	0	2	10	0	0	12	2	71
<i>Trimerotropis fratercula</i> McNeill	O	0	0	4	0	0	4	0	179
<i>Trimerotropis gracilis</i> (Thomas)	O	0	1	11	0	0	12	1	87
<i>Trimerotropis inconspicua</i> Bruner	O	0	0	8	0	0	8	0	131
<i>Trimerotropis koebelei</i> (Bruner)	O	0	0	3	0	0	3	0	213
<i>Trimerotropis latifasciata</i> Scudder	O	0	2	13	0	0	15	2	68
<i>Trimerotropis maritima</i> (Harris)	O	0	1	8	0	0	9	1	94
<i>Trimerotropis melanoptera</i> McNeill	O	0	0	4	0	0	4	0	180
<i>Trimerotropis modesta</i> Bruner	O	0	0	4	0	0	4	0	181
<i>Trimerotropis occidentalis</i> (Bruner)	O	0	0	2	0	0	2	0	259
<i>Trimerotropis pacifica</i> Bruner	O	0	0	2	0	0	2	0	260
<i>Trimerotropis pallidipennis</i> (Burmeister)	O	1	13	9	0	0	23	15	27

Table VI.6–2—Alphabetical list of 377 western rangeland grasshoppers with pest-status scores and ranks (Continued)

Grasshopper species	Sub-family ²	Number of rankings ¹					Total	Score	Rank
		“S”	“M”	“I”	“b?”	“B”			
<i>Trimerotropis pistrinaria</i> Saussure	O	0	0	13	0	0	13	0	119
<i>Trimerotropis pseudofasciata</i> Scudder	O	0	1	6	0	0	7	1	98
<i>Trimerotropis salina</i> McNeill	O	0	0	4	0	0	4	0	182
<i>Trimerotropis saxatilis</i> McNeill	O	0	0	2	0	0	2	0	261
<i>Trimerotropis sparsa</i> (Thomas)	O	0	0	13	0	0	13	0	120
<i>Trimerotropis thalassica</i> Bruner	O	0	0	2	0	0	2	0	262
<i>Trimerotropis titusi</i> Caudell	O	0	0	1	0	0	1	0	363
<i>Trimerotropis tolteca</i> (Saussure)	O	0	0	1	0	0	1	0	364
<i>Trimerotropis verruculata</i> (Kirby)	O	1	0	5	0	0	6	2	81
<i>Trimerotropis verruculata suffusa</i> Scudder	O	0	0	12	0	0	12	0	123
<i>Tropidolophus formosus</i> (Say)	O	0	0	9	0	1	10	–2	367
<i>Xanthippus aquilonius</i> Otte	O	0	0	1	0	0	1	0	365
<i>Xanthippus corallipes</i> (Haldeman)	O	3	9	17	0	0	29	15	28
<i>Xanthippus montanus</i> (Thomas)	O	0	0	8	0	0	8	0	132
<i>Xanthippus olancha</i> (Caudell)	O	0	0	2	0	0	2	0	263
<i>Xeracris minimus</i> (Scudder)	G	0	0	5	0	0	5	0	161
<i>Xeracris snowi</i> (Caudell)	G	0	0	5	0	0	5	0	162

¹ S = serious, M = minor, I = innocuous, b? = possibly beneficial, B = beneficial.

² A = Acridinae, C = Cyrtacanthacridinae, G = Gomphocerinae, M = Melanoplinae, O = Oedipodinae.

Each of the 377 species is represented (in order of overall score and rank) in the bar graph shown in figure VI.6–1. From left to right, it displays 111 grasshopper species with scores above zero (“pests”), 254 species with a score of zero (“innocuous”), and 12 species with scores below zero (“possibly beneficial” or “beneficial”).

Pest Species.—A total of 114 different grasshoppers were categorized as either a serious or a minor pest in at least one paper, but only 111 species had total scores above zero. In table VI.6–3, I have listed 38 of the highest ranked “pest” species, those with scores of 10 and above. As expected, the migratory grasshopper (*Melanoplus sanguinipes*) was ranked as the number 1 pest, with the highest total score (112 points) of the 377 grasshopper species.

Innocuous Species.—There were 254 grasshopper species with a total score of zero. Within this group, higher rank numbers were assigned to species having the highest frequency of mention. Several species, including *Acrolophitus hirtipes*, *Pseudopomala brachyptera*, and *Spharagemon campestris*, were mentioned frequently but were never described as either a pest or a beneficial. For innocuous species with only a single ranking, the rank number has no significance; it was assigned due to the alphabetical arrangement of scientific names.

Beneficial Species.—Overall, 19 different grasshoppers were categorized by at least one author as either beneficial or possibly beneficial, but only 12 species had total scores below zero. The highest ranked “beneficial” grasshoppers are listed in table VI.6–4. Although 12 spe-

Grasshopper Pest Rankings

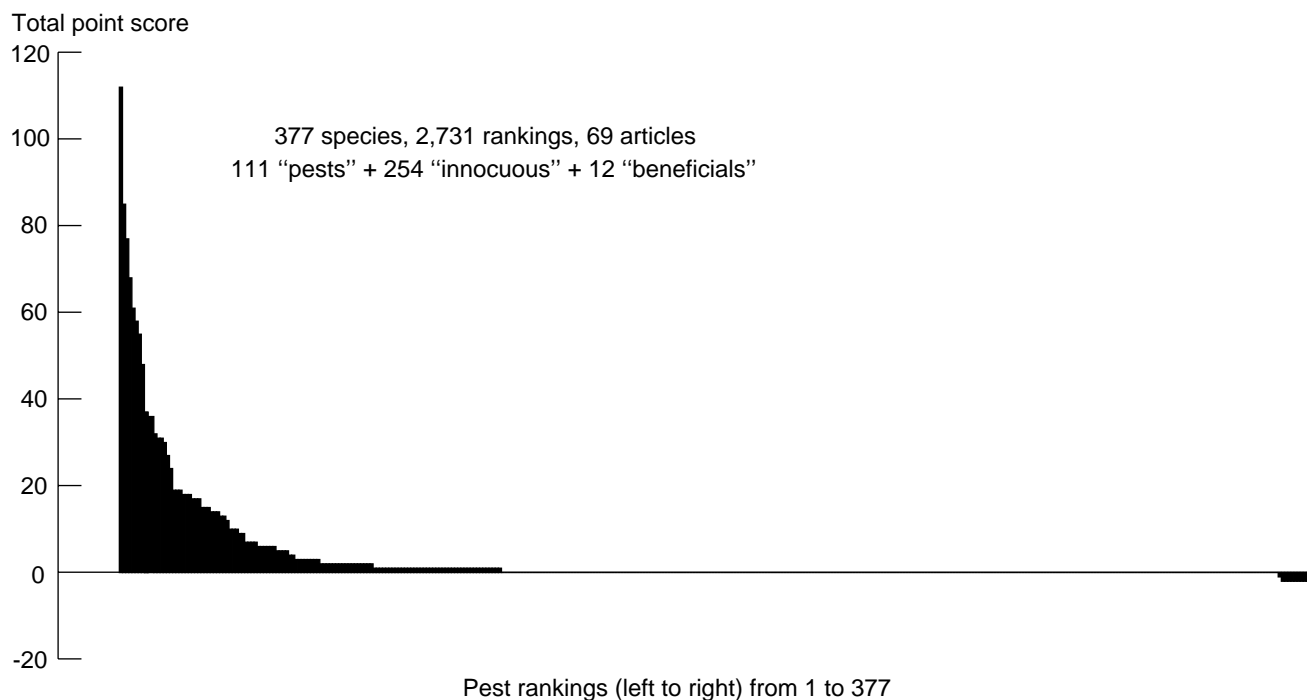


Figure VI.6-1—Graphic display of total scores of 377 western range grasshoppers arranged (left to right) by pest-status rank number. Graph is plotted from data shown in table VI.6-2.

cies were scored as “beneficial,” only 2 were mentioned as such with any frequency: *Hesperotettix viridis* Thomas, a grasshopper commonly associated with snakeweed (*Gutierrezia* spp.), and *Hypochlora alba* Dodge, which prefers to feed on sagebrush (*Artemisia* spp.).

Conclusions

In his 1977 review, Hewitt divided the western rangelands into three different regions: Great Plains, Intermountain, and Pacific Coastal. The literature I reviewed covered a cross section of these same regions, but the reader should be aware that not all of the 377 grasshoppers listed here are common to all regions. Indeed, one limitation of my scoring scheme is that widespread species are cited more frequently and thus accumulate higher total scores than species with a more

restricted distribution. A serious pest that occurs in a small geographic area would not be such a pest in the big picture. Three such species, listed in table VI.6-3, are *Dissosteira longipennis*, *Melanoplus devastator*, and *Oedaleonotus enigma*.

The graph in figure VI.6-1 offers a view of the whole spectrum of western grasshoppers and should provide some perspective when evaluating their relative importance as pests and as beneficials. From the graph it seems clear that nearly one-third (111) of the western grasshopper species are at least occasionally classified as pests. Again I must stress that damage to rangeland is rarely caused by only a single pest species but usually by an assemblage of several grasshopper species.

About two-thirds (254) of the western grasshoppers are thought to be of no economic importance, and only 12 species are considered to be of possible benefit to the

Table VI.6–3 —List of the 38 most serious “pest” grasshoppers on western rangeland (those listed have scores of 10 and above)

Grasshopper species	Sub-family ²	Number of rankings ¹					Total	Score	Rank
		“S”	“M”	“I”	“b?”	“B”			
<i>Melanoplus sanguinipes</i> (Fabricius)	M	53	7	1	1	0	62	112	1
<i>Aulocara elliotti</i> (Thomas)	G	39	7	3	0	0	49	85	2
<i>Camnula pellucida</i> (Scudder)	O	35	7	5	0	0	47	77	3
<i>Melanoplus bivittatus</i> (Say)	M	27	14	6	0	0	47	68	4
<i>Ageneotettix deorum</i> (Scudder)	G	27	7	11	0	0	45	61	5
<i>Melanoplus packardii</i> Scudder	M	23	12	5	0	0	40	58	6
<i>Melanoplus femurrubrum</i> (DeGeer)	M	18	19	3	0	0	40	55	7
<i>Amphitornus coloradus</i> (Thomas)	G	18	12	12	0	0	42	48	8
<i>Phlibostroma quadrimaculatum</i> (Thomas)	G	13	11	6	0	0	30	37	9
<i>Melanoplus differentialis</i> (Thomas)	M	13	11	4	0	0	28	37	10
<i>Trachyrhachys kiowa</i> (Thomas)	O	13	10	13	0	0	36	36	11
<i>Aulocara femoratum</i> (Scudder)	G	12	8	6	0	0	26	32	12
<i>Melanoplus infantilis</i> Scudder	M	12	7	11	0	0	30	31	13
<i>Opeia obscura</i> (Thomas)	G	13	5	11	0	0	29	31	14
<i>Cordillacris occipitalis</i> (Thomas)	G	13	4	14	0	0	31	30	15
<i>Phoetaliotes nebrascensis</i> (Thomas)	M	8	11	10	0	0	29	27	16
<i>Mermiria bivittata</i> (Serville)	G	6	12	10	0	0	28	24	17
<i>Melanoplus occidentalis</i> (Thomas)	M	7	7	10	0	1	25	19	18
<i>Chorthippus curtipennis</i> (Harris)	G	6	7	15	0	0	28	19	19
<i>Melanoplus devastator</i> Scudder	M	9	1	0	0	0	10	19	20
<i>Melanoplus gladstoni</i> Scudder	M	8	3	11	1	0	23	18	21
<i>Oedaleonotus enigma</i> (Scudder)	M	7	4	4	0	0	15	18	22
<i>Dissosteira longipennis</i> (Thomas)	O	8	2	3	0	0	13	18	23
<i>Dissosteira carolina</i> (Linnaeus)	O	3	11	18	0	0	32	17	24
<i>Metator pardalinus</i> (Saussure)	O	4	9	15	0	0	28	17	25
<i>Eritettix simplex</i> (Scudder)	G	7	3	15	0	0	25	17	26
<i>Trimerotropis pallidipennis</i> (Burmeister)	O	1	13	9	0	0	23	15	27
<i>Xanthippus corallipes</i> (Haldeman)	O	3	9	17	0	0	29	15	28
<i>Cordillacris crenulata</i> (Bruner)	G	4	7	11	0	0	22	15	29
<i>Dissosteira spurcata</i> Saussure	O	3	8	6	0	0	17	14	30
<i>Boopedon nubilum</i> (Say)	G	4	6	11	0	0	21	14	31
<i>Aeropedellus clavatus</i> (Thomas)	G	6	2	13	0	0	21	14	32
<i>Melanoplus foedus</i> Scudder	M	2	9	13	0	0	24	13	33
<i>Encoptolophus costalis</i> (Scudder)	O	5	3	7	0	0	15	13	34
<i>Melanoplus angustipennis</i> (Dodge)	M	4	4	12	0	0	20	12	35
<i>Arphia pseudonietana</i> (Thomas)	O	1	8	20	0	0	29	10	36
<i>Schistocerca alutacea shoshone</i> (Thomas)	C	2	6	3	0	0	11	10	37
<i>Melanoplus rugglesi</i> Gurney	M	5	0	3	0	0	8	10	38

¹ S = serious, M = minor, I = innocuous, b? = possibly beneficial, B = beneficial.

² G = Gomphocerinae, M = Melanoplinae, O = Oedipodinae.

Table VI.6–4 —List of the 12 highest ranked “beneficial” grasshoppers on western rangeland (those listed all have scores below zero)

Grasshopper species	Sub-family ²	Number of rankings ¹					Total	Score	Rank
		“S”	“M”	“I”	“b?”	“B”			
<i>Hesperotettix viridis</i> (Thomas)	M	0	2	17	5	5	29	–13	377
<i>Hypochlora alba</i> (Dodge)	M	0	0	13	2	1	16	–4	376
<i>Hesperotettix curtippennis</i> Scudder	M	0	0	1	0	1	2	–2	375
<i>Aeoloplides chenopodii</i> (Bruner)	M	0	0	3	0	1	4	–2	374
<i>Poecilotettix pantherinus</i> (Walker)	M	0	0	4	0	1	5	–2	373
<i>Ligurotettix coquilletti</i> McNeill	G	0	0	4	0	1	5	–2	372
<i>Melanoplus herbaceus</i> Bruner	M	0	0	5	0	1	6	–2	371
<i>Anconia integra</i> Scudder	O	0	0	5	0	1	6	–2	370
<i>Boottettix argentatus</i> Bruner	G	0	0	6	0	1	7	–2	369
<i>Aeoloplus tenuipennis</i> (Scudder)	M	0	0	7	0	1	8	–2	368
<i>Tropidolophus formosus</i> (Say)	O	0	0	9	0	1	10	–2	367
<i>Melanoplus desultorius</i> Rehn	M	1	0	1	1	1	4	–1	366

¹ S = serious, M = minor, I = innocuous, b? = possibly beneficial, B = beneficial.

² G = Gomphocerinae, M = Melanoplineae, O = Oedipodinae.

rangeland. This small number of “beneficial” grasshoppers, amounts to only 3 percent of the 377 species involved in this review, which is several orders of magnitude less than the recent estimate of 10 percent claimed by Lockwood (1993). The grasshopper most frequently called a beneficial is *Hesperotettix viridis*. Although often seen feeding on snakeweed, it also feeds on more than 30 other rangeland plants (Pfadt 1988). Another grasshopper, *Hypochlora alba*, is highly ranked as a beneficial because of its preference for sagebrush. But the value of sagebrush on rangeland is widely debated. As a strong competitor with desirable forage plants for domestic livestock, it is considered by some as an undesirable weed. Others consider sagebrush a beneficial plant because it comprises an important portion of the diet of mule deer, antelope, and the sage grouse (Watts et al. 1982).

Concerning the relative importance of the major pest grasshoppers, I believe that the rankings shown in table VI.6–3 represent a good consensus of opinions from the North American literature. Although experts differ over the ranking of individual species, most agree that there are about 2 dozen western grasshoppers that should be

categorized as pests. I believe that a statement by Watts et al. (1989) summarized the pest issue quite well: “About a dozen species frequently occur in high densities, and . . . an additional 12 species occasionally occur in high densities.” Readers are free to compare their own opinions with the species listed and the pest-status rankings shown.

References Cited

- Arnett, R. H. 1985. Orthoptera (grasshoppers, crickets, and katydids), Order 11. In: American insects, a handbook of the insects of America north of Mexico. New York: Van Nostrand Reinhold: 116–138.
- Ball, E. D. 1936. Food plants of some Arizona grasshoppers. *Journal of Economic Entomology* 29: 679–684.
- Ball, E. D.; Tinkham, E. R.; Flock, R.; Vorhies, C. T. 1942. The grasshoppers and other Orthoptera of Arizona. *Tech. Bull.* 93. Tucson, AZ: Arizona Agricultural Experiment Station. 373 p.
- Banfill, J. C.; Brusven, M. A. 1973. Food habits and ecology of grasshoppers in the Seven Devils Mountains and Salmon River breaks of Idaho. *Melandria* 12: 1–21.

- Bird, R. D. 1961. Ecology of the aspen parkland of western Canada in relation to land use. Res. Branch Publ. 1066. Ottawa, ON: Canada Department of Agriculture: 89–92.
- Brooks, A. R. 1958. Acridoidea of southern Alberta, Saskatchewan, and Manitoba (Orthoptera). Canadian Entomologist 90, Suppl. 9: 1–92.
- Brusven, M. A. 1967. Differentiation, ecology and distribution of immature slant-faced grasshoppers (Acridinae) in Kansas. Tech. Bull. 1490. Manhattan, KS: Kansas Agricultural Experiment Station: 1–59.
- Brusven, M. A. 1972. Differentiation and ecology of common Catantopinae and Cyrtacanthacridinae nymphs (Orthoptera: Acrididae) of Idaho and adjacent areas. Melanderia 9: 1–31.
- Brusven, M. A.; Lambley, J. D. 1971. Part I. The food habits and ecology of grasshoppers from southern Idaho rangeland. Coop. Proj. Rep. 12-14-100-9726 (33). Moscow, ID: University of Idaho and U.S. Department of Agriculture. 85 p., 46 tables.
- Buckell, E. R. 1936a. Part 1. The influence of man on the distribution of grasshoppers in Canada. In: Proceedings of the 4th international locust conference, anti-locust research; March, 1936; Cairo, Egypt. [Place of publication and publisher unknown.] Appendix 12: 1–7.
- Buckell, E. R. 1936b. Part 3. Summary of losses and expenditures due to grasshoppers in Canada 1925–1934. In: Proceedings of the 4th international locust conference, anti-locust research; March, 1936; Cairo, Egypt. [Place of publication and publisher unknown.] Appendix 1: 1–13.
- Capinera, J. L. 1987. Population ecology of rangeland grasshoppers. In: Capinera, J. L., ed. Integrated pest management on rangeland: a shortgrass prairie perspective. Boulder, CO: Westview Press: 162–182.
- Capinera, J. L.; Sechrist, T. S. 1982. Grasshoppers (Acrididae) of Colorado: identification, biology and management. Bull. 584S. Fort Collins, CO: Colorado State University and Colorado Agricultural Experiment Station. 161 p.
- Capinera, J. L.; Thompson, D. C. 1987. Dynamics and structure of grasshopper assemblages in shortgrass prairie. Canadian Entomologist 119: 567–575.
- Coppock, S. 1962. The grasshoppers of Oklahoma (Orthoptera: Acrididae). Processed Ser. P-399. Stillwater, OK: Oklahoma Agricultural Experiment Station. 143 p.
- Ewen, A. B., Mukerji, M. K. 1984. *Melanoplus* spp., *Camnula pellucida* (Scudder), and other grasshoppers (Orthoptera: Acrididae). In: Kelleher, J. S.; Hulme, M. A., eds. Biological control programs against insects and weeds in Canada 1969–1980. Slough, UK: Commonwealth Agricultural Bureaux: 61–62.
- Fielding, D. J.; Brusven, M. A. 1990. Historical analysis of grasshopper (Orthoptera: Acrididae) population responses to climate in southern Idaho. Environmental Entomology 19: 1786–1791.
- Fielding, D. J.; Brusven, M. A. 1992. Food and habitat preferences of *Melanoplus sanguinipes* and *Aulocara elliotti* (Orthoptera: Acrididae) disturbed rangeland in southern Idaho. Journal of Economic Entomology 85: 783–788.
- Gibson, A. 1938. Report on the grasshopper situation and organization for grasshopper control in Canada, Rep. 4. In: Proceedings of the 5th international locust conference, anti-locust research; [dates of meeting unknown]; Brussels, Belgium. [Place of publication and publisher unknown]: 10–107.
- Hagen, A. F. 1970. An annotated list of grasshoppers (Orthoptera, Acrididae) from the eleven panhandle counties of Nebraska. Res. Bull. 238. Lincoln, NE: Nebraska Agricultural Experiment Station. 60 p.
- Handford, R. H. 1946. The identification of nymphs of the genus *Melanoplus* of Manitoba and adjacent areas. Scientific Agriculture 26(4): 147–180.
- Harper, R. W. 1952. Grasshoppers of economic importance in California. Sacramento, CA: California Department of Agriculture Bulletin 41(3): 153–175.
- Hauke, H. A. 1953. An annotated list of the Orthoptera of Nebraska, part II, the Tettigidae and Acrididae. Lincoln, NE: Bulletin of the University of Nebraska State Museum 3(9): 1–79.
- Hebard, M. 1936. Orthoptera of North Dakota. Tech. Bull. 284. Fargo, ND: North Dakota Agricultural Experiment Station. 69 p.
- Hebard, M. 1938. An ecological survey of the Orthoptera of Oklahoma. Tech. Bull. 5. Stillwater, OK: Oklahoma Agricultural Experiment Station. 31 p.
- Helfer, J. R. 1987. How to know the grasshoppers, crickets, cockroaches and their allies, 2d edition. New York: Dover. 363 p.
- Henderson, W. W. 1924. A taxonomic and ecological study of the species of the subfamily Oedipodinae (Orthoptera—Acrididae) in Utah. Bull. 191. Logan, UT: Utah Agricultural Experiment Station. 150 p.
- Henderson, W. W. 1931. Crickets and grasshoppers in Utah. Circ. 96. Logan, UT: Utah Agricultural Experiment Station. 38 p.
- Hewitt, G. B. 1977. Review of forage losses caused by rangeland grasshoppers. Misc. Publ. 1348. Washington, DC: U.S. Department of Agriculture, Agricultural Research Service. 24 p.
- Hewitt, G. B.; Barr, W. F. 1967. The banded-wing grasshoppers of Idaho (Orthoptera: Oedipodinae). Res. Bull. 72. Moscow, ID: University of Idaho and Idaho Agricultural Experiment Station. 64 p.

- Hewitt, G. B.; Onsager, J. A. 1983. Control of grasshoppers on rangeland in the United States—a perspective. *Journal of Range Management* 36: 202–207.
- Hewitt, G. B.; Huddleston, E. W.; Lavigne, R. J.; Ueckert, D. N.; Watts, J. G. 1974. *Rangeland entomology*. Range Sci. Ser. 2. Denver, CO: Society for Range Management. 99 p.
- Isely, F. B. 1938. The relations of Texas Acrididae to plants and soils. *Ecological Monographs* 8(4): 551–604.
- Kemp, W. P.; Dennis, B. 1991. Toward a general model of rangeland grasshopper (Orthoptera: Acrididae) phenology in the steppe region of Montana. *Environmental Entomology* 20: 1504–1515.
- Kemp, W. P.; Onsager, J. A. 1986. Rangeland grasshoppers (Orthoptera: Acrididae): modeling phenology of natural populations of six species. *Environmental Entomology* 15: 924–930.
- Kevan, D.K.McE. 1979. Orthoptera (s. str.). In: Danks, H. V., ed. *Canada and its insect fauna*. *Memoirs Entomol. Soc. Can.* 108. Ottawa, ON: Entomological Society of Canada: 321–323.
- Knowlton, G. F.; Janes, M. F. 1932. The 1931 grasshopper outbreak in Utah. *Proceedings of the Utah Academy of Science* 9: 105–108.
- La Rivers, Ira. 1948. A synopsis of Nevada Orthoptera. *American Midland Naturalist* 39(3): 652–720.
- Lockwood, J. A. 1993. Environmental issues involved in biological control of rangeland grasshoppers (Orthoptera: Acrididae) with exotic agents. *Environmental Entomology* 22: 503–518.
- Middlekauff, W. W. 1958. Biology and ecology of several species of California rangeland grasshoppers (Orthoptera: Acrididae). *Pan-Pacific Entomologist* 34: 1–11.
- Mitchener, A. V. 1953. A history of grasshopper outbreaks and their control in Manitoba, 1799–1953. *Ann. Rep.* 84. Ottawa, ON: Entomological Society of Ontario: 27–35.
- Mulkern, G. B. 1980. Population fluctuations and competitive relationships grasshopper species (Orthoptera: Acrididae). *Transactions of the American Entomological Society* 106: 1–41.
- Mulkern, G. B.; Anderson, J. F.; Brusven, M. A. 1962. Biology and ecology of North Dakota grasshoppers. I. Food habits and preferences of grasshoppers associated with alfalfa fields. *Res. Rep.* 7. Fargo, ND: North Dakota Agricultural Experiment Station. 26 p.
- Mulkern, G. B.; Toczek, D. R.; Brusven, M. A. 1964. Biology and ecology of North Dakota grasshoppers. II. Food habits and preferences of grasshoppers associated with the sandhills prairie. *Res. Rep.* 11. Fargo, ND: North Dakota Agricultural Experiment Station. 59 p.
- Mulkern, G. B.; Pruess, K. P.; Knutson, H.; Hagen, A. F.; Campbell, J. B.; Lambley, J. D. 1969. Food habits and preferences of grassland grasshoppers of the North Central Great Plains. *Bull.* 481. Fargo, ND: North Dakota Agricultural Experiment Station. 32 p.
- Nerney, N. J. 1960. Grasshopper damage on short-grass rangeland of the San Carlos Apache Indian Reservation, Arizona. *Journal of Economic Entomology* 53: 640–646.
- Nerney, N. J. 1961. Effects of seasonal rainfall on range condition and grasshopper population, San Carlos Apache Indian Reservation, Arizona. *Journal of Economic Entomology* 54: 382–385.
- Nerney, N. J.; Hamilton, A. G. 1969. Effects of rainfall on range forage and populations of grasshoppers, San Carlos Apache Indian Reservation, Arizona. *Journal of Economic Entomology* 62: 329–333.
- Newton, R. C.; Esselbaugh, C. O.; York, G. T.; Prescott, H. W. 1954. Seasonal development of range grasshoppers as related to control. *Rep. E-873*. Billings, MT: U.S. Department of Agriculture, Agricultural Research Service, Bureau of Entomology and Plant Quarantine. 18 p.
- Otte, D. 1981. *The North American grasshoppers*. Vol. I. Acrididae: Gomphocerinae and Acridinae. Cambridge, MA: Harvard University Press. 275 p.
- Otte, D. 1984. *The North American grasshoppers*. Vol. II. Acrididae: Oedipodinae. Cambridge, MA: Harvard University Press. 366 p.
- Parker, J. R. 1952. Grasshoppers. In: *Insects, the yearbook of agriculture 1952*. Washington, DC: U.S. Department of Agriculture: 595–605.
- Parker, J. R. 1957. Grasshoppers, a new look at an ancient enemy. *Farm. Bull.* 2064. Washington, DC: U.S. Department of Agriculture. 40 p.
- Parker, J. R.; Connin, R. V. 1964. Grasshoppers, their habits and damage. *Agric. Inf. Bull.* 287. Washington, DC: U.S. Department of Agriculture. 28 p.
- Pfadt, R. E. 1949. Range grasshoppers as an economic factor in the production of livestock. *Wyoming Range Management* 7: 1–7.
- Pfadt, R. E. 1977. Some aspects of the ecology of grasshopper populations inhabiting the shortgrass plains. In: Kulman, H. M.; Chiang, H. C., eds. *Insect ecology*. *Tech. Bull.* 310. St. Paul, MN: University of Minnesota and Minnesota Agricultural Experiment Station: 77–79.
- Pfadt, R. E. 1982. Density and diversity of grasshoppers (Orthoptera: Acrididae) in an outbreak on Arizona rangeland. *Environmental Entomology* 11: 690–694.

-
- Pfadt, R. E. 1984. Species richness, density, and diversity of grasshoppers (Orthoptera: Acrididae) in a habitat of the mixed grass prairie. *Canadian Entomologist* 116: 703–709.
- Pfadt, R. E. 1988. Field guide to common western grasshoppers. Bull. 912. Laramie, WY: University of Wyoming and Wyoming Agricultural Experiment Station. [Species factsheets nos. 1–37, dated through Sept. 1993.]
- Pfadt, R. E.; Hardy, D. M. 1987. A historical look at rangeland grasshoppers and the value of grasshopper control programs. In: Capinera, J. L., ed. *Integrated pest management on rangeland: a shortgrass prairie perspective*. Boulder, CO: Westview Press: 162–182.
- Putnam, L. G. 1962. The damage potential of some grasshoppers (Orthoptera: Acrididae) of the native grasslands of British Columbia. *Canadian Journal of Plant Science* 42: 596–601.
- Richman, D. B.; Lightfoot, D. C.; Sutherland, C. A.; Ferguson, D. J. 1993. A manual of the grasshoppers of New Mexico, Orthoptera: Acrididae and Romaleidae. Handbk. 7. Las Cruces, NM: New Mexico State University and New Mexico Cooperative Extension Service. 112 p.
- Scoggan, A. C.; Brusven, M. A. 1972. Differentiation and ecology of common immature Gomphocerinae and Oedipodinae (Orthoptera: Acrididae) of Idaho and adjacent areas. *Melandria* 8: 1–76.
- Scoggan, A. C.; Brusven; M. A. 1973. Grasshopper—plant community associations in Idaho in relation to the natural and altered environment. *Melandria* 12: 22–33.
- Shewchuk, B. A.; Kerr, W. A. 1993. Returns to grasshopper control on rangelands in southern Alberta. *Journal of Range Management* 46(5): 458–462.
- Shotwell, R. L. 1938a. Some problems of the annual grasshopper survey. *Journal of Economic Entomology* 31: 523–533.
- Shotwell, R. L. 1938b. Species and distribution of grasshoppers responsible for recent outbreaks. *Journal of Economic Entomology* 31: 602–610.
- Shotwell, R. L. 1941. Life histories and habits of some grasshoppers of economic importance on the Great Plains. Tech. Bull. 774. Washington, DC: U.S. Department of Agriculture. 47 p.
- Stroecker, H. F.; Middlekauff, W. W.; Rentz, D. C. 1968. The grasshoppers of California (Orthoptera: Acridoidea). Bull. 10. Berkeley, CA: California Insect Survey. 177 p.
- Turnock, W. J. 1977. Adaptability and stability of insect pest populations in prairie agricultural ecosystems. In: Kulman, H. M.; Chiang, H. C., eds. *Insect ecology*. Tech. Bull. 310. St. Paul, MN: University of Minnesota and Minnesota Agricultural Experiment Station: 89–101.
- Van Horn, D. H. 1972. Grasshopper population numbers and biomass dynamics on the Pawnee site from fall of 1968 through 1970. Tech. Rep. 148. Colorado Springs, CO: U.S. International Biological Program, Grassland Biome. 70 p.
- Vickery, V. R.; Scudder, G.G.E. 1987. The Canadian orthopteroid insects summarized and updated, including a tabular check-list and ecological notes. *Proceedings of the Entomological Society of Ontario* 118: 25–45.
- Wakeland, C. 1951. Changing problems and procedures in grasshopper and Mormon cricket control. *Journal of Economic Entomology* 44: 76–82.
- Watts, J. G.; Hewitt, G. B.; Huddleston, E. W.; Kinzer, H. G.; Lavigne, R. J.; Ueckert, D. N. 1989. *Rangeland entomology*, 2d edition. Range Sci. Ser. 2. Denver, CO: Society for Range Management. 388 p.
- Watts, J. G.; Huddleston, E. W.; Owens, J. C. 1982. Rangeland entomology. *Annual Review of Entomology* 27: 283–311.
- White, R. M.; Rock, P.J.G. 1945. A contribution to the knowledge of the Acrididae of Alberta. *Scientific Agriculture* 25: 577–596.
- Wilbur, D. A.; Fritz, R. F. 1940. Grasshopper populations (Orthoptera, Acrididae) of typical pastures in the bluestem region of Kansas. *Journal of the Kansas Entomological Society* 13: 86–100.
- Woodruff, L. C. 1937. A grasshopper survey for eastern Kansas, 1936. *Journal of the Kansas Entomological Society* 10: 75–83.