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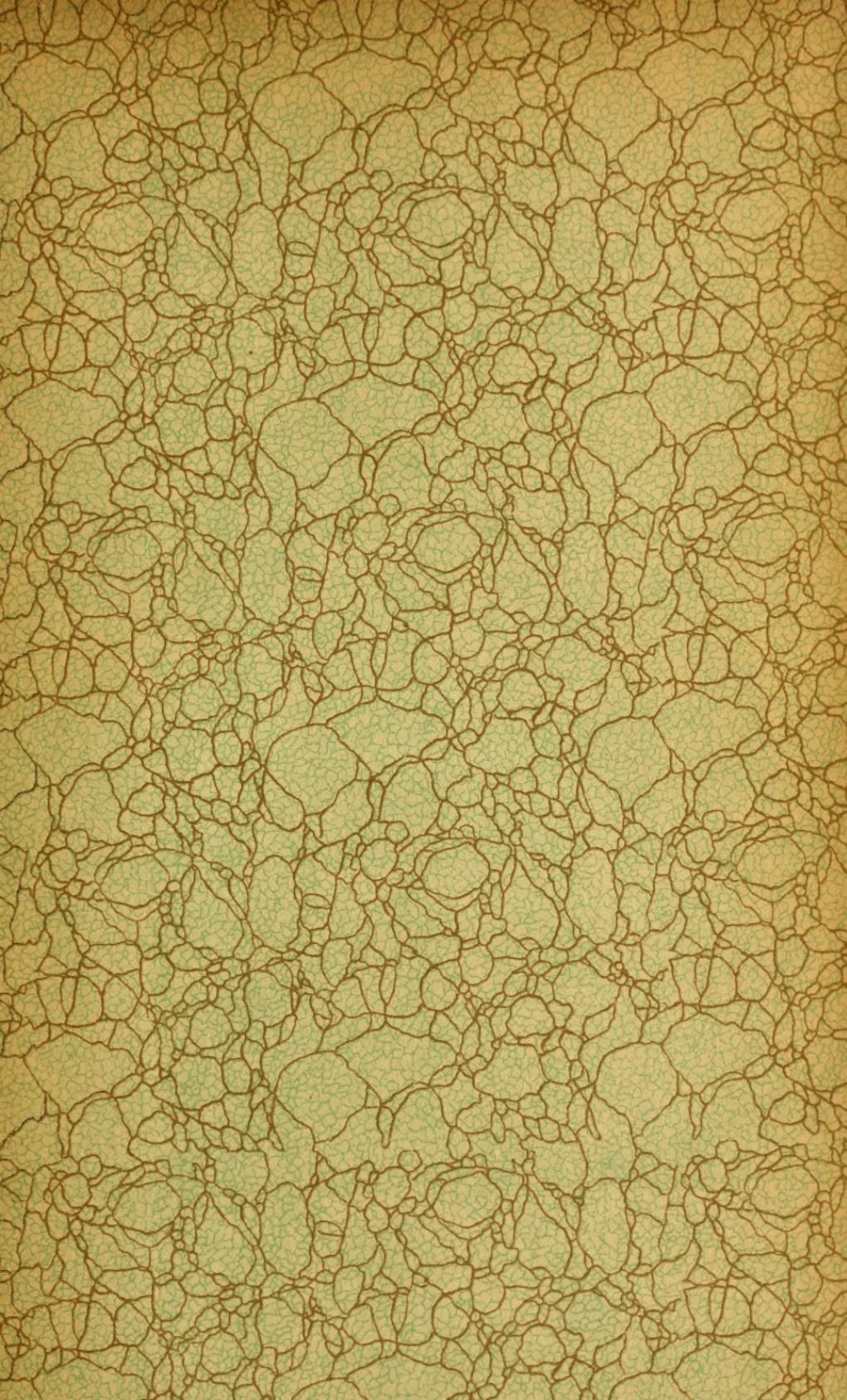


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THIRD ANNUAL REPORT

OF THE

ENTOMOLOGIST

OF THE

State Experiment Station

OF THE

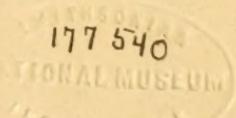
University of Minnesota,

TO THE GOVERNOR,

FOR THE YEAR 1897.

BY OTTO LUGGER,
PROFESSOR OF ENTOMOLOGY,
UNIVERSITY OF MINNESOTA.

ST. PAUL:
MCGILL-WARNER COMPANY.
1898.



LETTER OF TRANSMITTAL.

STATE EXPERIMENT STATION,
UNIVERSITY OF MINNESOTA.
January 1, 1898.

To His Excellency, D. M. Clough, Governor of Minnesota:

SIR—In accordance with the law, I have the honor to present herewith my third annual report as Entomologist of the Experiment Station of the University of Minnesota for the year ending December 31, 1897.

Very respectfully,

Your obedient servant,

OTTO LUGGER.



FINANCIAL REPORT.

		No. of voucher.	Amount.
1896.			
Aug. 30.	To salary and labor during August.....	1-4	190.00
30	" trips to Grand Rapids, Duluth and return....	5-7	13.60
30	" sleepers.....	8	3.00
30	" trip to Cloquet	9	4.26
30	" hotel bills.....	10	4.90
30	" Art Engraving Co. for illustrations.....	11	33.90
30	" J. Carbutt.....	12	2.25
30	" Zimmerman Bros.....	13-14	2.14
30	" express (4.50); postage (4.00); other ex- penses, (7.50).....	15-16	15.55
Sept. 30	" salary and labor during September	1-3	161.00
25	" trips to Windom, Worthington, Perham.....	4-7	15.50
18	" Art Engraving Co. for illustrations.....	8	8.00
17	" Otto Heidemann for drawings.....	9	30.00
25	" Zimmerman Bros.....	10	3.91
14	" Canadian Entomologist.....	11	3.00
1	" Chas. J. Ross for drawing paper.....	12	3.00
14	" Houghton, Mifflin & Co.....	13	40.00
12	" Henry Holt & Co.....	14	1.85
16	" American Entomological Soc.....	15	6.25
18	" express.....	16	2.25
9-28	" Bausch & Lomb Optical Co.....	17-19	36.42
15	" postage stamps.....	20	3.00
8	" Stevens & Robertson.....	21	1.20
11	" Zimmerman Bros.....	22	2.40
Oct. 30	" salary and labor during October.....	1-3	130.00
30	" trip to Duluth.....	4	8.50
30	" Art Engraving Co. for illustrations.....	5	19.00
30	" Zimmerman Bros.....	6	1.70
30	" Houghton, Mifflin & Co.....	7	45.00
30	" Wykoff, Seamans & Benedict.....	8	1.00
30	" express, etc.....	9-10	4.05
Nov. 30	" salary and labor during November.....	1-2	100.00
30	" type-writing	3	14.10
30	" ice during summer.....	4	4.00
7	" Zimmerman Bros.....	5	19.17
30	" Art Engraving Co. for illustrations.....	6	17.50
Oct. 19	" D. E. Stechert.....	7	30.06

		No. of Voucher.	Amount.
1897.			
Dec. 1	To W. H. Gruenhagen.....	8	4.55
Nov. 27	" import duty on one book.....	9	1.25
5	" express.....	10	.85
Dec. 31	" salary and labor during December.....	1-3	115.00
31	" express.....	4	1.10
1897.			
Jan. 1	" trips to Delano acct. of printing report.....	5.20
Dec. 30	" J. B. Lippingcott Co.....	5	3.66
5	" Art Engraving Co. for illustrations.....	6	20.35
30	" Gustav E. Stechert.....	7	21.93
1887.			
Jan. 1	" Cambridge Entomological Club.....	8	5.00
1	" W. H. Gruenhagen.....	9	6.40
Feb. 1	" salary and labor during January, 1897.....	10-12	145.00
10	" four trips to Delano acct. of printing report.....	10.40
Jan. 28	" trip to entomol. convention in Chicago.....	13	46.35
Dec. 31	" Bausch & Lomb Optical Co.....	14	1.13
Oct. 6	" Entomological Soc. of Washington.....	17	5.00
Dec. 22	" Gas Saving Co.....	16	1.00
Jan. 25	" Zimmerman Bros.....	17	5.90
27	" G. E. Stechert.....	18	5.85
28	" Whitall, Tatum & Co.....	19	23.66
15	" R. Kellogg.....	20	2.00
28	" C. A. Hoffman.....	21	.75
18	" Schuneman & Evans.....	22	.86
Feb. 8	" express, special deliveries, etc.....	23	4:15
Mch. 1	" printing of second annual report.....	1,727.70
1	" salary and labor during February.....	1-2	60.00
Feb. 20	" Bausch & Lomb Optical Co.....	3	1.35
22	" Lindig Bros.....	4	3.64
20	" L. Bruner.....	5	10.00
Jan. 25	" J. W. Folsom.....	6	7.00
Feb. 19	" printing letterheads, etc.....	8	15.00
19	" 4 trips to Delano.....	10.40
Mrch. 1	" W. H. Gruenhagen.....	9	7.03
Feb. 26	" Entomological Society of Philadelphia.....	11	6.00
Mch. 30	" salary and labor during March.....	12-13	60.00
30	" street car fare, telegr., etc		2.40
May 1	" salary and labor during April.....	1-2	120.00
4	" John Guth.....	3	13.80
Mch. 27	" Minneapolis Paper Co.....	4	9.15
Apr. 30	" Harrison & Smith	5	1.50
2	" stamps for 2nd annual report	6	20.00
May 1	" Charles Scribners Sons.....	7	2.90
Apr. 1	" New York Entomological Society.....	8	4.00
2	" Zimmerman Bros.....	9	16.50
8	" G. E. Stechert	10	22.94

		No. of Voucher.	Amount
1887.			
Feb. 23	To trip to Rochester.....	11	6.16
May 8	" express, etc.....	12	3.75
'Feb. 1	" W. H. Gruenhagen.....	13	.15
June 1	" salary and labor during May.....	1-4	165.50
May 25	" Dr. F. Bauman	5	29.50
20	" Zimmerman Bros.....	6	18.24
12	" G. E. Stechert.....	7	25.23
7	" Minneapolis Paper Co.....	8	3.75
12	" Longmans, Green & Co.....	9	5.50
10	" Charles Scribner's Sons.....	10	5.80
15	" Noyes Bros. & Cutler.....	11	6.18
23	" trips to Battle Lake, Wadena, Perham.....	12	19.60
28	" trips to Mankato, Mendota, etc.....	13	3.17
28	" C. F. Hoppe.....	14	6.11
29	" H. L. Crippen.....	15	5.55
29	" express, telegrams, etc.....	16	1.05
30	" trip to Frazee City and return.....	17	7.50
June 30	" salary and labor during June.....	1-3	325.00
July 30	" salary and labor during July.....	1-2	130.00
10	" H. L. Crippen.....	3	3.75
16	" expenses paid by E. B. Forbes.....		51.24
Aug. 13	" expenses paid by E. B. Forbes.....		42.50
			\$4,405.24

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INTRODUCTION.

The third annual report of the Entomologist of the State Experiment Station of the University of Minnesota, respectfully submitted to His Excellency, Governor D. M. Clough, contains an account of all such Orthopterous insects as Locusts, Grasshoppers, Crickets, Cockroaches and others which occur in our state, and which have proved so destructive in the past, and are ever ready to cause severe losses in the future. Other work only commenced or partly finished will be submitted later.

There remains for the entomologist the pleasant duty of expressing his sincere thanks to all persons that have aided him in many ways in his work. Especial thanks are due to the different newspapers, who with unfailing courtesy published all articles written for the instruction of the farmers in regions infested by injurious insects. The Chicago, St. Paul, Minneapolis & Omaha, the Great Western, the St. Paul & Duluth, the Northern Pacific, the Minneapolis & St. Louis, and the Great Northern R. R. Companies also deserve thanks for their liberality in furnishing free transportation over their roads whenever such was asked.

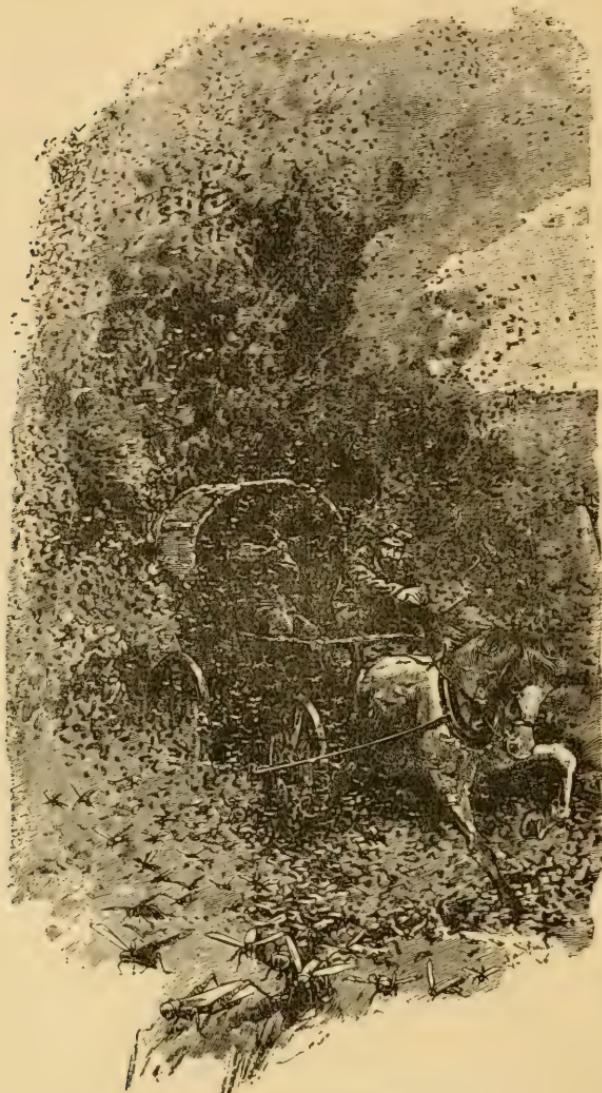
Locusts, grasshoppers, cockroaches, crickets and similar insects are all injurious to agriculture and allied pursuits, and frequently destroy not alone the crops of a farm, but those of entire counties and even states. As a knowledge of the structure, habits, etc., greatly assists us in combatting this enemy, it is very important that everyone interested in the various branches of agriculture should be thoroughly familiar with these small foes, and for this reason the following pages were prepared. They contain the description of the habits of the most destructive species of locusts, and also give the proper methods to combat them. A short description of the structure of one species is given, as well as illustrated descriptions of nearly all orthopterous insects known to exist in Minnesota.

The descriptions of many of the insects given are taken from a number of sources, but mainly from the excellent works of Scudder, Comstock, Fernald, Beutenmueller, Morse, Blatchley, and McNeill; needed material, books, etc., were kindly loaned by Professors Forbes, Garman, Osborn and others. The illustrations were made by the assistant of the writer, Mr. E. B. Forbes, who deserves especial thanks for his faithful work, by Miss Lydia M. Hart, and by W. T. Shaw, a student of the Agricultural College, who made the drawings of the anatomical details. A few others were kindly loaned by Dr. L. O. Howard, chief of the Entomological Division of the Department of Agriculture. The illustrations in the first part of the bulletin were bought from the late Prof. C. V. Riley.

The Art Engraving Co., of St. Paul, prepared the illustrations for the printer, and deserves credit for its good work.

It is the pleasant duty of the entomologist to express his sincere thanks to all persons who have aided him in the preparation of this bulletin.

OTTO LUGGER.



A Swarm of Locusts.

Onward they come, a dark, continuous cloud
Of congregated myriads numberless,
The rushing of whose wings was as the sound
Of a broad river, headlong in its course
Plunged from a mountain summit, or the roar
Of a wild ocean in the autumn storm,
Shattering its billows on a shore of rocks.

—SOUTHEY.

THE ORTHOPTERA OF MINNESOTA.

It is well known to all farmers, gardeners, fruit-growers and others that locusts, or grasshoppers, and all their allies, are the worst enemies they have to fear and to combat, especially if they belong to the migratory species and occur, as is usually the case, in vast numbers. Our state is so situated that armies of these devouring insects can be expected from time to time, and it is well to be always prepared. Since we possess a large number of native species of locusts, grasshoppers, cockroaches, etc., besides the migratory locusts, it is well that not alone the agriculturist, but all engaged in producing food and dealing in such should be able to distinguish between them, and for this purpose all the species known to occur in Minnesota have been described, and, if necessary, illustrated. All locusts, in fact all orthopterous insects found in our state, are more or less injurious, because all live mainly from plants, some of which we grow for our own use; but some species are more destructive than others, as they prefer cultivated crops, and the farmers should be able to recognize such insects at a glance.

In the First Annual Report of the U. S. Entomological Commission we can find an excellent description of the destructive power of locusts, and many of our farmers know to their cost how correct this description is. No one who has not witnessed the ravaging power of locusts can fully conceive of or appreciate it. The organization and habit of the typical locust admirably fit it for ravenous work. Muscular, gregarious, with powerful jaws, and ample digestive and reproductive systems; strong of wing and assisted in flight by numerous air sacs that buoy—all these traits conspire to make it the terrible engine of destruction which history shows it to have been under conditions favorable to its excessive multiplication. Insignificant individually but mighty collectively, locusts fall upon a country like a plague or a blight. The farmer plows and plants. He cultivates

in hope, watching his growing grain, in graceful, wave-like motion wafted to and fro by the warm summer winds. The green begins to golden; the harvest is at hand. Joy lightens his labor as the fruit of past toil is about to be realized. The day breaks with a smiling sun that sends his ripening rays through laden orchards and promising fields. Kine and stock of every sort are sleek with plenty, and all the earth seems glad. The day grows. Suddenly the sun's face is darkened, and clouds obscure the sky. The joy of the morn gives way to ominous fear. The day closes, and ravenous locust-swarms have fallen upon the land. The morrow comes, and oh! what a change it brings! The fertile land of promise and plenty has become a desolate waste, and old Sol, even at his brightest, shines sadly through an atmosphere alive with myriads of glittering insects. Falling upon a cornfield, the insects convert in a few hours the green and promising acres into a desolate stretch of bare, spindling stalks and stubs. Covering each hill by hundreds; scrambling from row to row like a lot of young famished pigs let out to their trough; insignificant individually, but mighty collectively, they sweep clean a field quicker than would a whole herd of hungry steers. Imagine hundreds of square miles covered with such a ravenous horde, and one can get some realization of the picture presented in many parts of the country west of the Mississippi during years of locust invasion. Their flight may be likened to an immense snow-storm, extending from the ground to a height at which our visual organs perceive them only as minute, darting scintillations, leaving the imagination to picture them indefinite distances beyond. It is a vast cloud of animated specks, glittering against the sun. On the horizon they often appear as a dust tornado, riding upon the wind like an ominous hail storm, eddying and whirling about like the wild, dead leaves in an autumn storm, and finally sweeping up to and past you with a power that is irresistible. They move mainly with the wind, and when there is no wind they whirl about

in the air like swarming bees. If a passing swarm suddenly meets with a change in the atmosphere, such as the approach of a thunder storm or a gale of wind, they come down precipitately, seeming to fold their wings, and fall by the force of gravity. At other times, in alighting, they circle in myriads about you, beating against everything animate or inanimate; driving into open doors and windows; heaping about your feet and around your buildings; their jaws constantly at work biting and testing all things in seeking what they can devour. In the midst of the incessant buzz and noise which such a flight produces, in the face of the unavoidable destruction everywhere going on, one is bewildered and awed at the collective power of the ravaging host, which calls to mind so forcibly the plagues of Egypt. The noise their myriad jaws make when engaged in their work of destruction can be realized by any one who has fought a prairie fire, or heard the flames passing along before a brisk wind, the low crackling and rasping — the general effect of the two sounds is very much the same. Nothing, however, can surpass the prophet Joel's account of the appearance and ravages of these insects.

While the destruction of crops by the winged insects is often sudden and complete, the unsledged insects still more effectually, though more slowly, denude a country of vegetation, sometimes rendering the ground as bare and desolate in midsummer as it is in the Mississippi Valley in midwinter. The little creatures are often so thick, soon after hatching, that they blacken everything, and their hopping, as one passes through a field or piece of prairie, gives the impression, at a short distance, of heat flickering in the air.

Minnesota has been frequently visited by locusts in years previous to those in which such occurrences were historically recorded, and the traditions of the Indians mention that these insects had formerly taken possession of the country, holding it for seventeen years, and that in times past they had consumed all vegetation as far east as Stillwater. The

statement made by Capt. Jonathan Carver (in his "Narrative" of the year 1766), that large swarms of locusts "infest these parts and the interior colonies and oftentimes do much mischief," shows that such occurrences took place and were repeated. Of course it is rather difficult to say what the Captain meant by "these parts," but the usual application of the word "interior" is to the regions west of the Great Lakes.

The visitation of Lord Selkirk's Red River colony in 1818 by locusts extended to portions of Minnesota. In 1830 and 1842 parts of the state were overrun by locusts; in 1849 they were found in vast numbers along the prairie regions west of the big woods; in 1857 locusts destroyed all the crops in the Red River Valley, so that the infant colony did not have any grain, but was obliged to live by hunting and fishing. The papers published in Minnesota during the summer and autumn of 1856 are full of accounts of invading swarms of locusts, and they reached the region lying along the Upper Mississippi. They occurred in vast numbers at the Chippewa Agency at Gull Lake (Cass county), and arrived at Otter Tail Lake on July 24. During the last days of August they reached St. Anthony. Judging from the accounts published they swept over the whole region west of the big woods. The records of the hatching swarms of 1857 are still more numerous; the insects caused immense damage, "appearing in such masses as to crackle beneath the feet of persons walking over the prairies." When they left they went south and southeast, "for several days they were high in the air, like a snow storm." From 1863 to 1877 there was hardly a year in which the locusts did not make themselves noticeable within our borders, but principally in the Red River Valley when not heard of elsewhere. The "oldest inhabitant" of Moorhead, Mr. Robert Probstfield; gave the following years in which locusts appeared in that vicinity: "In 1863, 1864, 1865 (in 1865 very little damage done; not numerous), 1866, 1867, 1869 (in a few localities

bad, in others less, in a few none), in 1870, 1871, bad, 1872, bad, 1873, 1874, 1875, 1876." In 1877 the young locusts hatched in forty-two or more counties, lying mainly in the southwestern quarter of the state, the area, however, not reaching the southwestern corner. In the central part of the egg-area they hatched in excessive numbers. A portion of the eggs were destroyed by parasites, or at least failed to hatch. During the months of May and June an unusual amount of rainfall delayed or even prevented hatching, while owing to the large number of cool, cloudy, or rainy days, on which the locusts were averse to eating, the wheat attained a very luxuriant growth, becoming every day less capable of being injured. Still the injury was considerable, but the farmers and citizens were battling manfully with their little foes. For a time the prospect in Minnesota was gloomy, but the favorable weather together with the substantial aid and encouragement of the governor, Hon. John S. Pillsbury, and the business men of the cities and towns and railroad companies, induced the farmers to fight the battle through. In spite of all this the locusts were so numerous in some counties as to destroy the larger part of the wheat crop, and some nineteen counties* in all lost more or less; still the state raised a fine crop of wheat.

The locusts that hatched in Minnesota commenced to rise late in June, but most of them flew from July 1 to July 7 towards the northwest. Later, and until early in August,

* Counties.	Acres.	Counties.	Acres.
Kandiyoki.....	35,337	Todd.....	6,868
Chippewa.....	15,638	Renville.....	19,924
Wright.....	18,747	Sibley.....	8,799
Stearns.....	43,294	McLeod.....	20,315
Nicollet.....	6,151	Meeker.....	32,786
Pope.....	18,218	Yellow Medicine	12,700
Douglas.....	18,788	Brown	14,215
Swift.....	13,318	Redwood	6,803
Otter Tail.....	30,711		
Stevens.....	8,106	Total, 19 Counties....	337,188
Grant.....	6,470		

the wind was quite changeable, and the insects seemed to beat about, sometimes going northwest, and at other times retracing their course, flying southeast and south. Towards the middle of August the winds became more constant from the northwest, and the direction of flight more constant south and southeast, until all the healthy locusts had left.

Since that time portions of the state were twice invaded by this species of locust, viz., the Migratory Locust (*Melanoplus spretus*). The history of both invasions has been given in former bulletins, and only the essential points will be repeated. It seems that during the summer of 1885 a few struggling specimens of this migratory locust reached Otter Tail County (Perham). Their offspring were seen again in 1886, when they caused but very slight damage; in 1887 they had already increased to such an extent that the crops of 3,000 acres were swept away. In 1888 people became alarmed and appealed to the governor, A. R. McGill, for assistance. Many machines, hopper-dozers, were used to kill the enemy, and with good results. Nearly 200 of such machines were at work, each having a superficial surface of over 4,800 square inches. The men operating them were requested to keep a measurement in inches of locusts swept off the pans; they reported from two to twenty-one inches daily, which would make about 5,000 bushels of dead locusts, and as these were quite small at the time, not much larger than a grain of oats, it takes an immense number to fill a bushel measure. At Perham another method was adopted by the citizens, who offered a bounty of one dollar per bushel. The quantity of locusts caught by the "balloon hopper-catcher," the invention of Mr. A. Maguire, was astonishing, and 14,643 bushels were caught and paid for between the first and the twenty-seventh of July. As it required about 7,000 locusts to fill a bushel measure, 102,438,000 were destroyed by this means alone. All told about 35,000 bushels of locusts were killed in Otter Tail county before they had caused very great loss.

In 1889 about the same area was infested, but as money had been appropriated by the legislature to combat the insects before they were hatched, no loss was caused by them. Instead of depending alone upon "hopper-dozers" and "balloon-catchers," the fields that were found to be filled with eggs were deeply plowed. Other remedies were also applied, as will be mentioned in the proper place. In all 6,361.59 acres were plowed, and with most excellent results.

In 1891 another invasion, on a smaller scale, took place. This time parts of the Red River Valley were invaded, not alone by the Rocky Mountain Locust, but also by two other species of migratory kinds, the Lesser Migratory Locust (*Melanoplus atlantis*), and the Pellucid Locust (*Cannula pellucida*). By the immediate use of hopper-dozers and other means farmers succeeded in preventing serious loss, and being forewarned they plowed every field that was even suspected of containing eggs, and on this account no locusts appeared in 1892.

Since that time (1891) the state has been free of this dreaded insect, but, as may be judged from the history of invasions just given, our farmers can not expect that these migratory locusts will not again appear in the future. In fact, our state, or rather portions of our state, are uncomfortably near the permanent breeding grounds of this locust, which extend chiefly along the eastern Rocky Mountain range, from longitude 102° to 140° west of Greenwich, and from latitude 53° to 40° north, comprising most of the levels below an altitude of 6,000 feet and above 3,000 feet. In many portions of this area they breed every year, and lead an essentially migratory existence. This permanent breeding area gradually shades into a sub-permanent region, in which locusts breed more or less frequently, and which is liable to be invaded at any time, or rather whenever the insects become very numerous in their true breeding grounds. This region includes a large portion of British America, nearly all of the Dakotas, Western Nebraska,

Northwest Kansas, and the northern half of Colorado. Although Minnesota may be said to be located in the temporary region, i. e., a region only periodically visited, yet parts of our state are unpleasantly near the boundary or danger line, and therefore apt to be overrun by hordes of hungry locusts, and such has been frequently the case as shown above. From 1863 to 1878 there was hardly a year in which locusts did not occur in sufficient numbers to injure the crops somewhere. When not occurring elsewhere they were surely found in the Red River Valley. They did not breed there during all these years, but sufficient new swarms came from the Northwest to recruit the invading army and make it formidable.

As has been mentioned before, the state has been free of the Rocky Mountain Locust since 1891. At present the nearest point known to be infested with this insect is South Dakota, and farmers living near the boundary line should be on the lookout.

Besides this species, frequently also called the "Hateful Locust," two other kinds, both more or less migratory, have caused much injury. One kind, the Lesser Migratory Locust (*Melanoplus atlantis*) is still with us; at present it is chiefly confined to the country along the St. Paul & Duluth Railroad. It is a little smaller than *spretus*, though very closely resembling it. Its wings are also much longer than the body, which enables it to fly long distances. This species is essentially an Eastern one, being found in larger or smaller numbers from the northern part of Florida to the extreme north of Eastern United States. Like the hateful Western locust it is single-brooded in Minnesota; it matures more rapidly, becoming winged quite early in July. Eggs are deposited soon afterwards, and oviposition continues until cold weather. This insect is sometimes called the "White Mountain Locust," from the fact that the great losses to all sorts of crops sustained in different regions of New England from locusts are almost all caused by this

insect. As a full account of it has been given in the First Entomological Report of Minnesota (Bulletin No. 43) it is not necessary to repeat it here. The illustration (Fig. 1, *d, e, f*), shows this species.



FIG. 1.—*a*, single egg of *Pellucid Locust*; *b*, egg-mass opened to show eggs inside; *c*, egg-mass; *d*, female; *e*, male. Lesser Migratory Locust; *f*, pupa. Natural size. Original.

The other kind of migratory locust (*Camnula pellucida*) (Fig. 1, *i, h*) is no longer found in Minnesota. It was, however, with us since the autumn of 1891, and caused con-

siderable damage together with *atlantis*. Especially the vicinity of Duluth was invaded as early as the summer of 1891. The insects became very numerous and caused considerable damage to lawns and gardens in 1892, but as a parasite, the Tachina-fly described later, became still more numerous the great majority of the intruders were killed. Still a large army of these migratory locusts appeared in 1893 and caused considerable injury. Quoting from the report mentioned above the two species of locusts found so numerous near Duluth acted very peculiarly. As is well known locusts do not like to rest upon moist ground, but always crawl away from it by climbing upon higher plants, or fences and outhouses if such are near. While the writer was in Duluth it rained, and consequently the locusts tried to escape to more elevated positions than the wet soil. They did so by crawling upon the walls of houses, which were soon covered with them. Strange to say nearly all the locusts found in the lower part of the city were members of the pellucid species, while the lesser migratory species could only be found near or upon the tops of the hills. To express this fact in numbers, 1,000 locusts were caught with a net on the front of a house on Second street, and were carefully inspected; all were pellucid locusts (*Camnula pellucida*). Another 1,000 were captured in the same way on Fourth street: 880 were pellucid locusts, 92 were the lesser migratory locusts (*atlantis*), and 24 were the common red-legged kind (*femur-rubrum*). Still another 1,000 were captured at the base of a large building, the Pavilion, which is located on the top of the hill overlooking the wonderful scenery of Duluth and its harbor. Here it was found that 972 specimens belonged to the lesser migratory species, 3 to the pellucid, and 25 to the red-legged kind. This peculiar distribution of the two migratory species was also seen elsewhere; wherever the soil was moist, or near water or swampy places, the pellucid species was more numerous.

In 1894 both species of locusts became very numerous

near Duluth, and caused considerable damage by almost denuding the lawns and gardens. They were at first most numerous in the more elevated places and upon the slopes of the hills, but as soon as the food became scarce in these localities the locusts invaded the lower portions of the city and vicinity, and destroyed almost every green thing in fields and gardens. As they reached their adult stage numerous swarms left the infested region in search of feeding grounds, and became thus established in many localities south and southeast of Duluth. In this manner the region about Pine City, Rush City and Taylor's Falls became infested. During the year 1895 some 230 hopper-dozers were operated near the places mentioned above, which required 95 barrels of kerosene oil. The work was commenced rather late, but was successfully performed, and nearly all the crops were saved. Of course the use of hopper-dozers is only a makeshift; the proper remedy is the plowing of all land containing eggs, as will be explained elsewhere. In 1897 locusts were again rather numerous near North Branch, but only the lesser migratory species (*atlanis*), the pellueid one having entirely disappeared.

Mr. E. B. Forbes, who took charge of the work in the absence of the entomologist, reported as follows: Mr. Hovton, of North Branch, Isanti Co., reported on June 17 locusts in destructive numbers in an old rye field belonging to a farm not in operation. The field had not been plowed since the spring of 1895. The locusts had spread from here in all directions but principally across a road to the south, and into fields containing rye and wheat. At that place they had spread over 200 acres, and commenced to cause injury. The farmers were very much excited, and had hauled several loads of straw onto the grass and brush separating the old field from the growing grain. The locusts had collected in considerable numbers on this straw and many were burned with it. In a number of other places locusts had also hatched in large numbers in old and unplowed fields.

and spread thence to cultivated ground. Hon. Aug. Anderson, of Taylor's Falls, had two dozen hopper-dozers made at that place and shipped to North Branch. Here these machines and about 100 gallons of kerosene oil were used with good results for a short time. The farmers were advised in the Isanti county papers to plow all fields in the infested neighborhood.

HOW LOCUSTS DEPOSIT THEIR EGGS.

It is very important to know the manner and localities in which eggs are laid by the different kinds of locusts, because the only true and always successfull remedy depends almost entirely upon this knowledge. In former papers the method of laying eggs by the Rocky Mountain Locust was discussed, but it is best to repeat and enlarge upon what was written at that time. The following figures will illustrate the method of egg-laying better than words. The holes for the reception of the eggs are made by means of two pairs of horny valves at the tip of the abdomen of the female (Fig. 2, b and c). These open and shut rapidly, and are well adapted to execute this function. The female, pressing the tip of her abdomen forcibly against the soil, rapidly opens and shuts these hard and pointed valves, and soon pushes them into the ground, thus drilling a hole. Fig. 3 illustrates this action, and the various positions assumed by the female are plainly indicated. In a short time nearly the entire and greatly extended abdomen is inserted in a little curved and more or less oblique cavity. The legs are hoisted above the back during the operation of drilling this hole, which requires more or less time, depending entirely upon the condition and character of the soil. As soon as the hole is finished, it is filled with a frothy and mucous material. Professor Riley, in describing the method

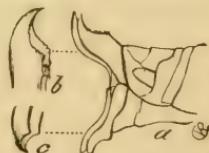


FIG. 2.—Rocky Mountain Locust—*a*, anal characters of female showing horny valves, *b*, and *c*. (After Riley).

of laying eggs, writes: "By repeatedly extracting and studying specimens in every stage of oviposition, we have been able to ascertain the exact method by which the egg-mass is formed. If we could manage to watch a female

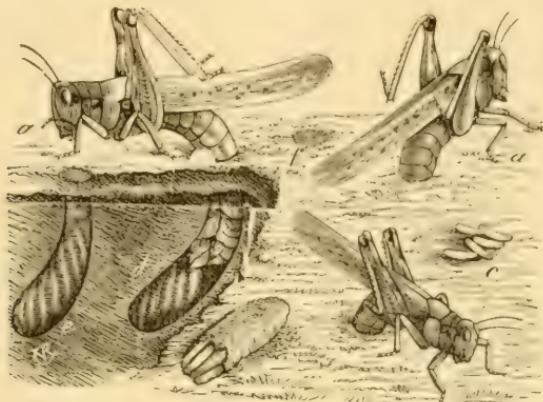


FIG. 3.—Rocky Mountain Locust, in the act of laying eggs. (After Riley).

from the time the bottom of her hole is moistened by the sebific fluid, we should see the valves all brought together, when an egg would pass down the oviduct along the ventral side, and, guided by a little finger-like style, pass in between the horny valves, and issue at their tips amid the mucous fluid already spoken of. Then follows a period of convulsions during which more mucous material is elaborated, until the whole end of the body is bathed in it, when another egg passes down and is placed in position. These alternate processes continue until the full complement of eggs are in place, the number ranging from twenty to thirty-five, but averaging about twenty-eight. The mucous matter binds all the eggs in a mass, and when the last is laid, the mother devotes some time to filling up the somewhat narrower neck of the burrow with a compact and cellular mass of the same material, which, though light and easily penetrated, is more or less impervious to water, and forms a very excellent protection. When fresh the mass is soft and moist, but it soon acquires a firm consistency.

To the casual observer, the eggs of our locust appear to be thrust indiscriminately into the hole made for their reception. A more careful study of the egg-mass, or egg-pod, will show, however, that the female took great pains to arrange them, not only so as to economize as much space as possible, consistent with the form of each egg, but so as to best facilitate the escape of the young locust; for if, from whatever cause, the upper eggs should fail to hatch, or should hatch later than the lower ones, the former would offer an impediment to the exit of the young in their endeavor to escape from these last, were there no provision against such a possibility. The eggs are, indeed, most carefully placed side by side in four rows, each row containing seven. They oblique a little cross-wise of the cylinder (Fig. 4, a). The posterior or narrow end, which issues first from

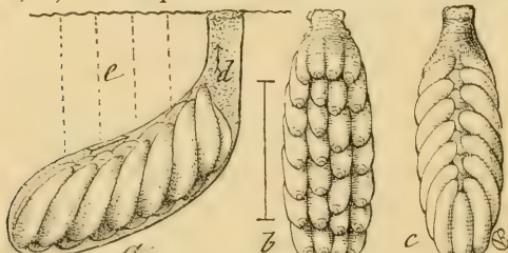


Fig. 4.—Egg-mass of Rocky Mountain Locust—
a, from the side, within burrow; b, from beneath;
c, from above; enlarged. (After Riley).

the oviduct, is thickened, and generally shows two pale rings around the darker tip (Fig. 4, b). This is pushed close against the bottom of the burrow, which, being cylindrical,

does not permit the outer or two side rows to be pushed quite as far down as the two inner rows, and for the very same reason the upper or head ends of the outer rows are necessarily bent to the same extent over the inner rows, the eggs when laid being somewhat soft and plastic. There is consequently an irregular channel along the top of the mass (Fig. 4, c.) which is filled only with the same frothy matter that surrounds each egg, which matter occupies all the other space in the burrow not occupied by the eggs. The whole plan is seen at once by a reference to the accompanying figure, which represents, enlarged, a side view of the mass within the burrow (a) and a bottom

(b) and top (c) view of the same, with the earth which adheres to it removed.

Each female of the Rocky Mountain locust lays on an average about three egg-masses; this is done at intervals of two weeks, so that the egg-laying season extends from six to eight weeks.

The egg is surrounded by a shell consisting of two layers, of which the outer one is thin, semi-opaque, thus producing the creamy-yellow color; highly magnified it appears (Fig. 5. a) densely and minutely pitted or rather marked by hexagonal concavities (Fig. 5, b). The inner and thicker layer is deep yellow, smooth and translucent, so that the form of the embryo can be plainly seen when maturing inside. The outer layer is quite brittle, but the inner one very tough, requiring a strong pressure to rupture it. As the embryo within matures (Fig. 5, c), the egg-shell becomes weakened, and the egg plump and somewhat more transparent.

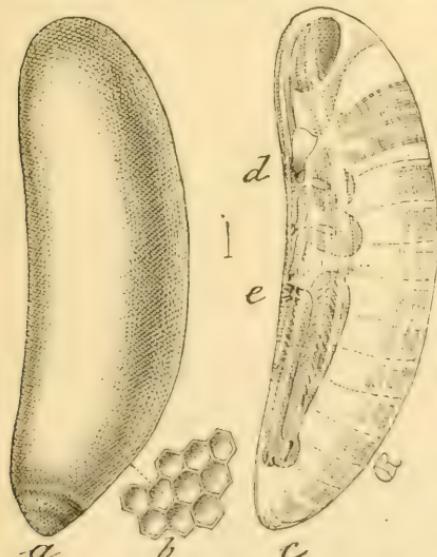


FIG. 5.—Egg of Rocky Mountain Locust—
, showing sculpture of outer shell; b, the
same very highly magnified; c, the embryo,
just before hatching. (After Riley).

By the muscular efforts of the enclosed insect, but chiefly by thorns arming the hind tibiae, Fig. 5, e, the shell is eventually broken, and the young locust pushes its way through the neck of the burrow towards the light.

Nearly all the eggs in a pod hatch at the same time, and the young escape through the small hole left for this purpose. When the young insect reaches the surface it is quite weak, and still

surrounded by a very delicate film, which has to be first

removed before the young locust can jump about. By contracting and expanding muscular movements this enveloping film splits along the middle of the back, near the head, and is gradually pushed backwards, remaining as a white crumpled pellet behind. At first pale and colorless, the young locust assumes its dark color in the course of an hour.

From this account of the hatching process, we can readily understand why the female in ovipositing prefers compact or hard soil to that which is loose. The harder and less yielding the walls of the burrow, the easier will the young locust crowd its way out.

Though the covering which envelopes the little animal when first it issues from the egg is quite delicate, it nevertheless, in the struggles of hatching, undoubtedly affords much protection, and it is an interesting fact that while, as we have seen, it is shed within a few minutes of the time when the animal reaches the free air, it is seldom shed, if, from one cause or another, there is a failure to escape from the soil, even though the young locust may be struggling for days to effect an escape.

While yet enveloped in this pellicle, the animal possesses great forcing and pushing power, and if the soil is not too compact, will frequently force a direct passage through the same to the surface, as indicated by the dotted lines (Fig. 4, *e*). But if the soil is at all compressed it can make little or no headway, except through the appropriate channel (Fig. 4, *d*). While crowding its way out, the antennæ and four front legs are held in much the same position as within the egg, the hind legs being generally stretched. But the members bend in every conceivable way and where several insects are endeavoring to work through any particular passage the amount of squeezing and crowding they will endure is something remarkable. Yet if by chance the protecting pellicle is worked off before issuing from the ground, the animal loses all power of further forcing its way out. The in-

stinctive tendency to push upwards is also remarkable. In glass tubes, in which eggs were hatched in order to watch the young, these last would always turn their heads and push towards the bottom whenever the tubes were turned mouth downwards; while in tin boxes, where the eggs were placed at different depths in the ground, the young never descend, even when they were unable to ascend on account of the compactness of the soil above.

The above minute account of the manner in which eggs are laid, and how the young are enabled to reach the surface, plainly indicates one good method by which the hatching of the eggs may either be prevented entirely, or by which the young may be prevented from reaching the surface. By plowing the fields containing eggs of the Rocky Mountain locust, we perform two operations: first of all we remove the eggs from near the surface and cover them with five or six inches of soil; secondly, we invert the position of the hole containing the egg-mass, so that instead of its mouth pointing upwards, it now points downwards. At all events, the young insects are prevented from reaching the surface, if this becomes compacted by rain and snow. Consequently if we plow during autumn or soon after the eggs are laid we are safe; although if we plow in the spring with a normal amount of rain, we also effectually prevent their hatching. Plowing has this additional advantage: the egg-masses in many cases are thoroughly broken up, the individual eggs become surrounded by earth and moisture, and being no longer protected by the water-proof coat of dried mucous matter, they soon rot and perish.

To repeat again: If we desire to get rid of the migratory species of locusts now infesting several places in the state it is absolutely necessary to plow every inch of the cultivated ground throughout the invaded region or all land in which eggs have been laid.

The Lesser Migratory Locust lays its eggs in essentially the same manner. It always prefers, however, old stubble

fields, bare spots in timothy fields and neglected and dry pastures. In other words well drained spots free of vegetation, and consequently a soil free of roots, are preferred.

The Pellucid Locust has different habits as far as egg-laying is concerned. The females of the pellucid locusts commence to deposit their eggs about the end of July, usually at least fourteen days later than the other migratory kinds. Their method of doing so is entirely different. As a general rule they select for this purpose pasture land, road sides, or, by preference, clearings from which the stumps have not yet been removed, although the land has already been used for crops. In such places large numbers of eggs are deposited in the sod. Usually they are placed right upon the surface of the soil, where they are protected by the grass and by the rubbish found in such situations (Fig. 1, *b* and *c*). Occasionally the eggs are deposited just beneath the surface, but only where the ground is sufficiently loose to enable the insects to do so. The eggs are about 4 mm. in length, and 1 mm. in diameter; they are slightly curved and rounded at the ends (Fig. 1, *a*). They are deposited in layers, each with three or four eggs, which overlap and appear somewhat irregular (Fig. 1, *b*). These diagonally overlapping layers are built up until an elongated cylindrical mass from 10 to 15 mm. in length is formed. This whole mass of eggs is protected by a water-proof covering composed of bits of earth cemented together with the frothy material produced by the mother insect at the time the eggs are deposited and arranged by her. One end of this protective layer of waterproof material is very thin, almost or entirely open, thus affording the young and weak locust an easy means of egress. Each cylindrical capsule contains about twenty eggs. In many places, in which the locusts had been very numerous, in a square inch of sod were found as many as six egg-masses, which means 17,000 eggs to the square foot, enough to make crops in their vicinity a very problematical affair.

REMEDIES AGAINST LOCUSTS.

As has been stated before, the only method to reduce and destroy these injurious insects, that promises success, is the plowing of all the land in which eggs have been deposited. And in this case, as in so many others, where measures are directed against destructive insects, concerted action is all-important. If one farmer does this work in a careful manner, and his neighbor refuses to plow up a piece of meadow land filled with eggs, all the work of the one farmer will be more or less performed in vain, as the other careless one can breed upon his land enough locusts to destroy the crops of many of the surrounding farms. We still lack laws that in a case like this can force the negligent farmer to do his part of the work to get rid of such dangerous intruders, and unless such laws are made and enforced, no uniformly good results can be expected from any methods that might be applied to rout the enemy.

Since the method employed to kill the locusts depends almost entirely upon the question: Can young insects reach the surface of plowed fields, or not? It was very important to make some experiments to be able to give a positive reply to that question. To do so eggs of locusts (*spretus* and *atlanis*) were planted at different depths in flower pots which contained soil similar to that from which the eggs had been removed. The result of these experiments may be learned from the table below.

SOIL KEPT DRY.

Eggs planted 1 inch below surface produced 93 per cent of locusts.							
" " 2 inches "	"	"	"	86	"	"	"
" " 3 "	"	"	"	51	"	"	"
" " 4 "	"	"	"	13	"	"	"
" " 5 "	"	"	"	02	"	"	"
" " 6 "	"	"	"	none	"	"	"

SOIL MOISTENED FROM TIME TO TIME.

Eggs planted 1 inch below surface produced 87 per cent of locusts.							
" " 2 inches "	"	"	"	43	"	"	"
" " 3 "	"	"	"	11	"	"	"
" " 4 "	"	"	"	01	"	"	"
" " 5 "	"	"	"	none	"	"	"
" " 6 "	"	"	"	"	"	"	"

All the eggs experimented with were in pods, which were in no way injured or broken.

To guard against any lateral movements of the young locusts, and to prevent them from reaching the surface of the soil near the sides of the pots, where cracks in the soil would naturally form by contraction of the earth, the surface of this part of the soil was covered with a tight fitting ring of oiled cardboard. All the egg-pods were carefully planted in or near the center. Lifting up later the ring of cardboard, many locusts were found under it, showing that they had tried hard to reach the surface by digging in a horizontal direction towards the least compressed soil.

One thousand eggs, either single ones or in twos and threes, but all free from any mucous covering, were planted to a depth of one inch and a half. The soil above them was gently compressed and kept moist. Only 103 young locusts managed to reach the surface. As this happened while the writer was away from the office, he can not be certain whether or not some of them came up from below the ring of cardboard near the inner rim of the flower pot, this board having warped considerably on account of the moisture of the soil.

Early in July, after all the experiments had been finished, the soil from the various flower pots was thrown into a large box and was thoroughly loosened with the fingers. In consequence of this seven young locusts made their appearance, showing that some of the eggs, or of the young insects, had retained their vitality up to that time.

PLOWING. The chief and safest method to combat locusts consists in plowing the land known to contain their eggs. By carefully investigating the suspected fields in a number of places an approximate knowledge can be gained as to the number of eggs they contain. If a field has thus been ascertained to contain eggs it should be plowed at least five to six inches deep. If done properly, and in time, the very great majority of eggs are prevented from hatching, or

rather the young locusts hatched are prevented from reaching the surface. The best time to plow the fields is the autumn, as by doing so the surface of the plowed fields becomes hardened by the rains and snows of winter, and the egg-pods and single eggs are thoroughly surrounded by earth washed around them. Early in spring is also a good time, providing the plowing is followed by the usual spring showers. But even if no rain should follow the plowing the more or less violent winds of spring will smooth and make the soil compact, sufficiently so to prevent the great majority of young locusts from reaching the surface. Of course the plowing must be done thoroughly; simply scratching the surface of the infested field is of but slight use, though even then many egg-pods are torn to pieces and numerous of the now unprotected eggs are destroyed.

If large fields are thus plowed we secure another advantage: in case locusts should reach the surface they find no food, and before they can walk to other fields covered with plants, they starve.

Plowing is an excellent remedy even after the locusts have hatched and reached the surface. In such a case plowing should commence at the outer edge of a field, and a number of plows should be used at the same time, the plows following each other as closely as possible. The locusts are in this manner forced towards the center of the field, where a black mass of struggling insects is crowded together. But few of them escape; as one plow makes a furrow, this is rapidly filled with locusts, the following plow covers them up, and most are buried alive; those that escape this fate have to starve, and only a few near the edges of the field can save their lives.

BURNING.—In many places, where the eggs are not numerous enough to warrant plowing, all the old stubble and dead grass, etc., should be preserved until the locusts hatch. After plowing around such fields to prevent the escape of the fire, the enclosed space can be burned over

if there is enough fuel to do so thoroughly, and if a fair wind is blowing at the time, untold numbers of locusts are killed. Whenever straw can be had it is wise to make long rows of such material across the fields and thus add to the autodafe.

COLLECTING THE EGGS.—The Rocky Mountain locust prefers certain places for the purpose of depositing the eggs, and such places are easily discovered. If this is the case the eggs should be collected and destroyed, and the state should offer some inducement in the way of bounty for such collection and destruction. Every bushel of eggs destroyed is equivalent to a hundred acres of grain saved, and when we consider the amount of destruction caused by the young, and that the ground is often known to be filled with eggs, or that, in other words, the earth is sown with the seeds of future destruction, it is surprising that more laws have not been made looking to their extermination.

One of the most rapid ways of collecting the eggs, especially where they are numerous and in light soil, is to slice off about an inch of the soil by trowel or spade, and then cart the egg-laden earth to some sheltered place, where, after being allowed to dry, it is sieved, so as to separate the egg-masses from the dirt. The eggs thus collected can be easily destroyed by throwing them into deep pits, providing the ground is packed hard on the surface. In Algeria, a country badly infested with locusts, the soldiers are often employed to gather eggs, and owing to a bounty paid for all eggs thus collected, immense numbers of them are gathered and destroyed.* The same is the case in southern Russia. In thickly settled regions, where labor is abundant and cheap, this method should be adopted.

Poisoning.—There are cases where plowing can not be performed, notwithstanding the fact that numerous eggs have been deposited in the ground. Frequently old timothy-fields are badly infested, but as the farmers need the grass for

*In 1897, 322 miles of ditches were constructed, in which were killed 270,000 bushels of young locusts.

their stock such fields can not be plowed. The same is true with pastures. In this case it is best to poison the plants growing on the edges of adjoining grain-fields; a strip ten feet wide is usually sufficient. The locusts, driven away by the animals in the enclosed pastures, gradually reach the poisoned plants outside and are soon killed. The best material for this purpose, and the one that has been used in a number of cases with marked success, is London purple. It is best simply because it is light, and sticks better to such smooth plants as wheat, etc., than the heavier Paris green.

Poisoning locusts in gardens and fields from which chickens and cattle can be kept away, may also be resorted to with good results, using bran-mash as poisoned bait. This is made by thoroughly mixing Paris green or London purple with dry rye or wheat bran, about one and one-half to two pounds of the poison to twenty-five pounds of bran is a good proportion; to this is added enough water to form a mash thick enough to be formed into balls without falling apart when laid upon the ground. Frequently cheap molasses is added to keep the mash from becoming too dry. Such balls are laid among the plants that we wish to protect. If an army of young locusts is moving towards a field it can be stopped and almost annihilated by offering them this food, which seems to have a wonderful attraction, as the balls are soon covered by struggling insects all eager to devour it. The consequence to them can be imagined.

CATCHING BY MEANS OF "HOPPER-DOZERS" AND OTHER MACHINERY.—The "hopper-dozers" mostly used are made as follows: A sheet of ordinary sheet iron, such as is used for making stove-pipes, is turned up one and one-half inches around the edges and riveted at the corners. This makes a shallow pan about eight feet long, two feet broad and one and one-half inches deep. To the bottom of this are riveted six small strips which can be fastened to the three runners on which the pan rests. To the rear side of the pan is screwed a light wooden frame, as long as the pan and one and one-

half feet high. Over this frame a piece of canvas is stretched. This frame serves the important office of throwing back all those locusts that otherwise jump clear over the pan, and to throw them into the oil. The runners on which the pan rests are usually made from saplings or small pieces of board having an upward curve in front to prevent them from catching in the ground. The front ends of the runners are all fastened by screws to a cross-piece which is, in turn, drawn by two ropes, one at each end. These ropes are joined in front and fastened to a single-tree. Sometimes two "hopper-dozers" are fastened to a long pole by means of short ropes; this is very easily drawn by one horse. Just in front of the pan is fastened a piece of rope which sweeps the ground a few inches in advance and serves to stir up the hoppers and make them jump into the pans. In the pan is laid a piece of cloth, which is first thoroughly saturated with water. About a pint of kerosene oil is then thrown in and the upright sheet or sail of canvas is also moistened with it. The machine is drawn over the fields or wherever the locusts are thickest. In a short time it is usually partially filled with dead or dying insects.

The slightest touch of kerosene oil, either from the pan or from the canvas sheet behind it, means death to the locust, for the oil spreads over its body in the same way that a single drop of it will spread over a large surface of water. It seems to produce a paralysis, which is first shown by the stiffening of the legs. A very large proportion of the locusts that come in contact with the oil in the pan immediately jump out again, but they invariably die in the course of a few seconds or minutes. Fig. 6 shows a hopper-dozer in operation in a hayfield. A narrow strip is cut around the margin of the field and the hopper-dozer is drawn around in this strip, with great success. Fig. 7 shows two fastened together and drawn side by side. Figs. 8 and 9 show two other hopper-dozers more in detail so as to enable anybody, even with but little ingenuity, to make them. The nature of the ground

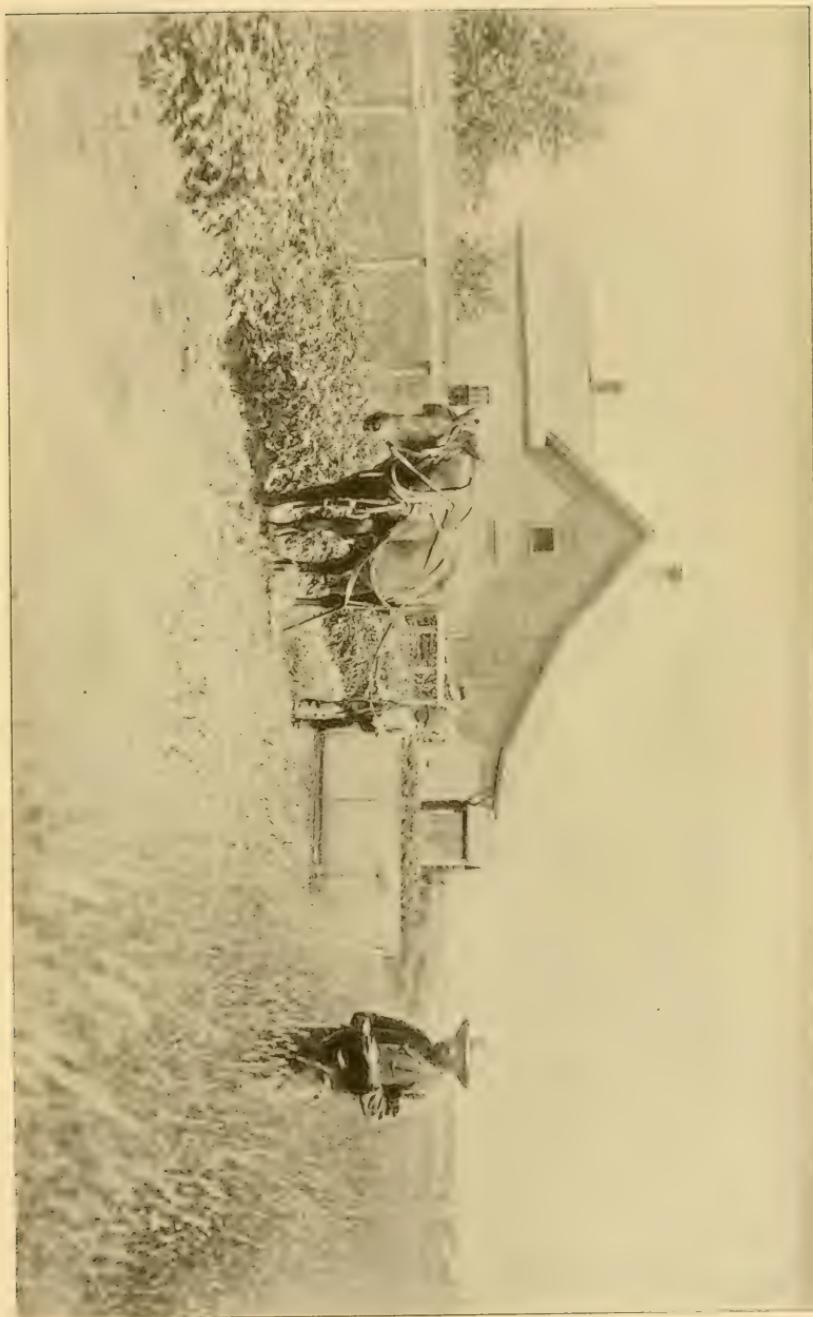


Fig. 6.—Single hopper-dozer in operation. Original.

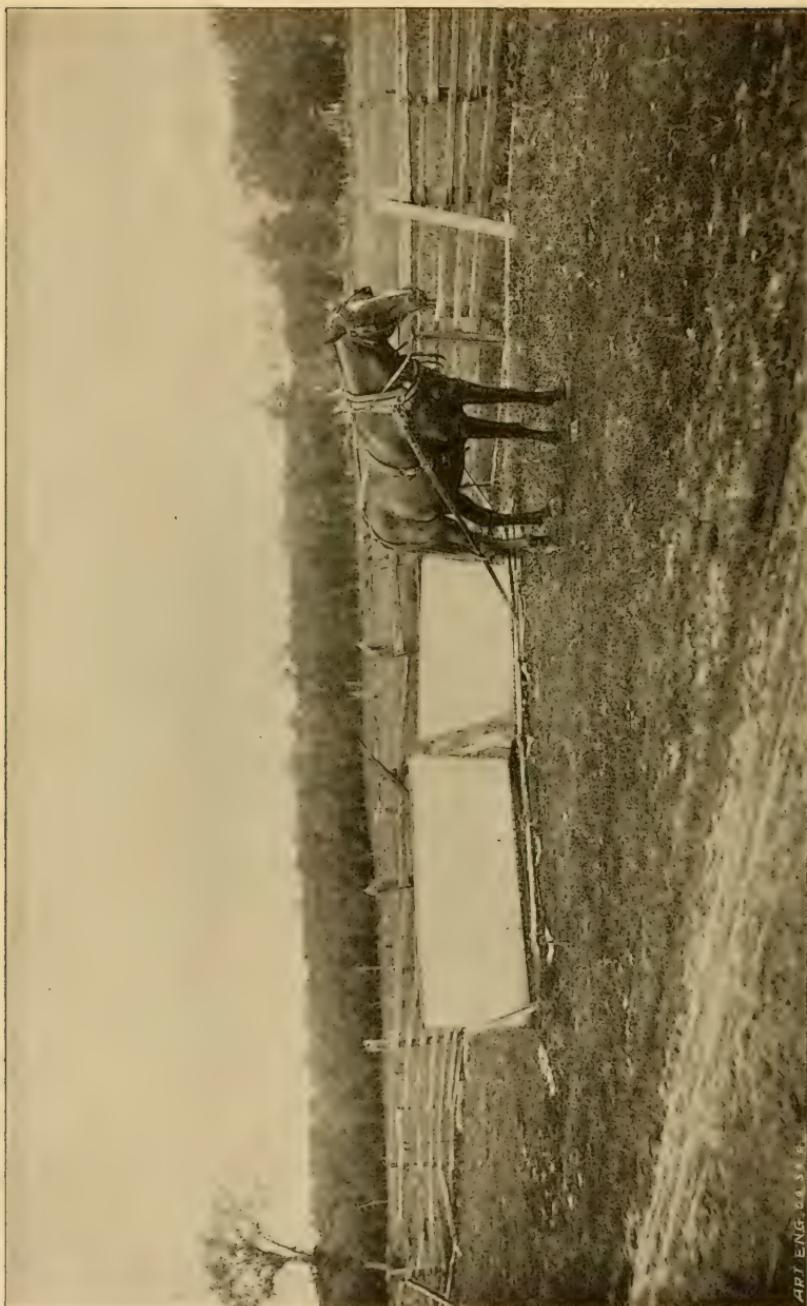


Fig. 7.—Double hopper-dozing in operation. Original.

in the infested region does not always admit of using more than one hopper-dozer at a time. But wherever it is level and free of stones as many as four hopper-dozers can be joined together by means of short ropes, thus forming a continuous pan some forty feet long. Immense numbers of insects

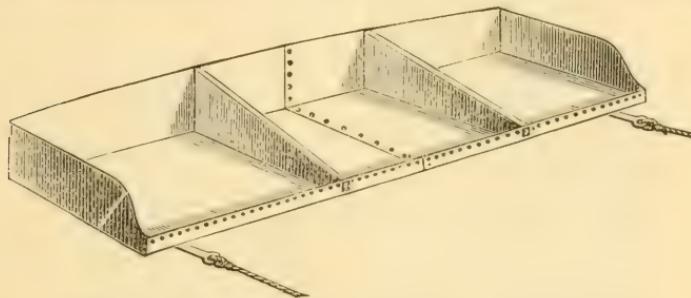


Fig. 8.—Large hopper-dozer, with partitions. After Riley.

can thus be captured and killed. Formerly a mixture of coal tar with oil, or coal tar alone, was used; this has one advantage, but only an imaginary one, i. e., the farmers operating the dozer actually see the enemy perish before their eyes, while, when using nothing but kerosene oil, only

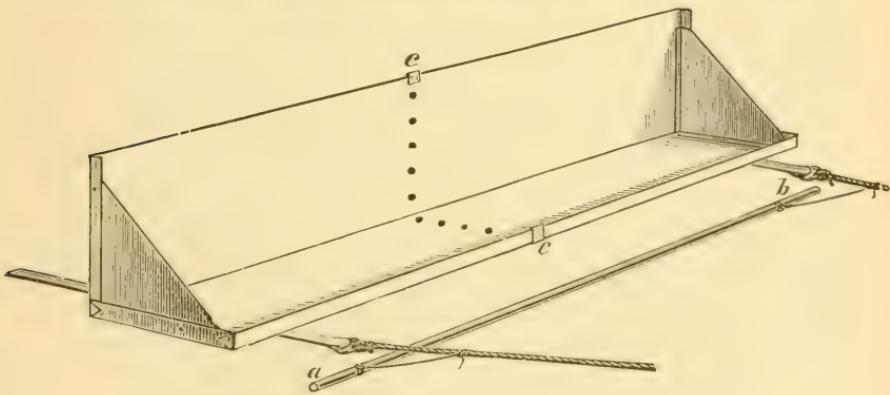


Fig. 9.—Smaller hopper-dozer. After Riley.

one out of about every ten locusts is seen dying in the pan, nine jumping out again. But as these almost invariably perish later it matters but little. As the young and tender locusts are killed whenever they come in contact with such a pen-

trating oil as kerosene still another machine has been used to some extent, and in some cases with good results. It is the "Anderson's Coal Oil Contrivance," shown in Fig. 10. It is made in the following manner: "Three pieces of



Fig. 10.—Anderson's Coal Oil Contrivance. After Riley.

fence board, four feet long and three or four feet apart, serve as sled runners. To the front ends is nailed a fence board fifteen or more feet long. To this, and over the runners, three pieces of slat, each four feet long, are attached by a leather hinge; and inch and a half holes through the back end of these slats receive light standards, the lower ends of which are fastened to the back ends of the runners by leather hinges. Peg holes in the upper half of the standards enable you to place the slats at any desirable angle. On the back ends of these slats is nailed a strip fifteen long, parallel with the fence board and three feet from it; and to these is tacked coarse muslin fifteen feet in length, which forms an apron or movable screen that can be set at any angle. To the front ends of the outside runners a long piece of fence wire can be attached, and a mule can be hitched to the wire, much to the disgust of the mule. A boy can pull the light machine, but mules pull longer than boys do." The muslin is kept soaked with kerosene oil, and as the locusts jump against it they come in contact with this death-dealing substance. An oiled locust seems to lose all power in its long

hind legs; it will stretch them out, but they soon become useless both for walking and kicking. In some localities, and on days with little wind or dust, these simple contrivances are very useful.

The use of kerosene oil has an additional advantage: it leaves behind in the field a very strong odor which is disliked by the insects, and they almost stop feeding, moving about to escape it. Of course one thing should be remembered, namely that this oil is just as deadly to plants as to locusts, hence great care should be used to prevent its spilling. In less level regions the rim of the pan should be made wider, and partitions should also be added, as shown in one of the above illustrations (Fig. 8). Sometimes instead of pulling the pan it can be left stationary, and the insects can be driven into it. This has frequently been done in fields containing numerous stumps, and with good results.

In places where the machines can not be used on account of the rough, uneven, and too sloping condition of the ground, and when cattle and chickens can be kept away, there is no better way of destroying large numbers of the locusts than by use of the poisoned baits already mentioned. There are many other machines known that can catch large numbers of locusts, but for our state, level in most parts likely to be invaded by such insects, the hopper-dozers described above are the best, and by all means the cheapest machines known.

How many locusts are really killed by a hopper-dozer is difficult to say, as nine out of the ten that jump into it jump out again, only to die afterwards in the field. But if only five or six bushels of the still small locusts are scraped off the "dozer" during a day's labor, this would mean fifty or sixty bushels killed by a single machine. This is by no means an exaggerated estimate, but if only ten per cent of these numbers were killed it would well pay for the work.

But after all, no matter how useful hopper-dozers may be against locusts and other insects feeding upon grass,

they are in the former case only a makeshift to be employed when better remedies can no longer be used. In places where they can not be employed other machines may be used, which capture the locusts in bags, or in which they are crushed by rollers, etc.

To repeat again, the true remedy consists in plowing, and wherever locusts are numerous this method has to be employed. Plow the soil containing the eggs during the autumn, if possible, as by doing so the surface of the plowed ground becomes thoroughly compact by wind, rain and snow. Plowing in spring, if well done, and as early as possible, will also be successful, though in some cases, and especially in a dry season, a few locusts may succeed in reaching the surface.

REMEDIES AGAINST COCKROACHES AND OTHER ORTHOPTEROUS INSECTS.

Remedies, or supposed remedies, against the former are very numerous, and many patented and unpatented nostrums are in the markets to help the irate housekeeper to destroy the enemy. As a general rule, however, these nostrums are only good for the dealer who sells them and the buyers. Vigilance and cleanliness are necessary to prevent the cockroaches becoming the nuisance they are now in many homes. A large number of our dwelling places are, it almost seems, built to assist the increase of this pest, by giving them lots of snug quarters in which they are safe and out of reach. Besides, these intruders, like the English Sparrow, have imported themselves to remain, and as both seem to possess great intelligence they are perfectly able to take care of themselves and to keep out of the way of servants and food doctored with poison for their benefit. Mr. F. H. Chittenden, in one of the excellent publications of the Division of Entomology, Department of Agriculture, under its efficient chief Dr. L. O. Howard, gives the following remedies:

Poisons.—“As just noted, roaches often seem to display a knowledge of the presence of poisons in food, and, notwithstanding their practically omnivorous habits, a very little arsenic in baits seems to be readily detected by them. In attempting to eradicate roaches from the department store-rooms where cloth-bound books are kept, various paste mixtures containing arsenic were tried, but the roaches invariably refused to feed on them in the least. This applies particularly to the German roach, or Croton bug, and may not hold so strongly with the less wary and perhaps less intelligent larger roaches.

A common remedy suggested for roaches consists in the liberal use of pyrethrum powder or buhach, and when this is persisted in considerable relief will be gained. It is not a perfect remedy, however, and is at best but a temporary expedient, while it has the additional disadvantage of soiling the shelves or other objects over which it is dusted. When used it should be fresh and liberally applied. Roaches are often paralyzed by it when not killed outright, and the morning after an application the infested premises should be gone over and all the dead or partially paralyzed roaches swept up and burned.

There are many proprietary substances which claim to be fairly effective roach poisons. The usefulness of most of these is, however, very problematical, and disappointment will ordinarily follow their application. The only one of these that has given very satisfactory results is a phosphorous paste, also sold in the form of pills. It probably consists of sweetened flour paste containing phosphorous, and is spread on bits of white paper or cardboard and placed in the runways of the roaches. It has been used very successfully in the department to free desks from Croton bugs, numbers of the dead insects being found in the drawers every day during the time the poison was kept about.

FUMIGATION.—Whenever roaches infest small rooms or apartments which may be sealed up nearly air-

tight, and also on shipboard, the roach nuisance can be greatly abated by the proper use of poisonous gases, notably bisulphide of carbon. This substance, distributed about a pantry or room in open vessels, will evaporate, and, if used in sufficient quantity, will destroy roaches. Unless the room can be very tightly sealed up, however, the vapor dissipates so rapidly that its effect will be lost before the roaches are killed. The hatches of ships, especially of smaller coasting vessels, may be battened down, a very liberal application of bisulphide of carbon having been previously made throughout the interior. If left for twenty-four hours the roaches and all other vermin will unquestionably have been destroyed. In the use of this substance it must be always borne in mind that it is violently explosive in the presence of fire, and every possible precaution should be taken to see that no fire is in or about the premises during the treatment. It is also deadly to higher animals, and compartments should be thoroughly aired after fumigation. A safer remedy of the same nature consists in burning pyrethrum in the infested apartment. The smoke and vapors generated by the burning of this insecticide are often more effective in destroying roaches than the application of the substance in the ordinary way as a powder. There is no attendant danger of explosion, and the only precaution necessary is to see that the room is kept tightly closed for from six to twelve hours. The smoke of burning gunpowder is also very obnoxious and deadly to roaches, particularly the black English roach. On the authority of Mr. Theo. Pergande, gunpowder is commonly used in Germany to drive these roaches out of their haunts about fireplaces. The method consists in molding cones of the moistened powder and placing them in the empty fireplace and lighting them. The smoke coming from the burning powder causes the roaches to come out of the crevices about the chimney and fire bricks in great numbers, and rapidly paralyzes or kills them, so that they may be after-

wards swept up and destroyed. This remedy will only apply to old houses with large fireplaces, and has no special significance for the modern house. It is presented, however, as a means applicable wherever conditions similar to those described occur.

TRAPPING.—Various forms of traps have been very successfully employed in England and on the continent of Europe as a means of collecting and destroying roaches. These devices are all so constructed that the roaches may easily get into them and can not afterwards escape. The destruction of the roaches is effected either by the liquid into which they fall or by dousing them with hot water. A few of the common forms of traps and the methods of using them are here described.

A French trap consists of a box containing an attractive bait, the cover of which is replaced by four glass plates inclined toward the center. The roaches fall from the covering glasses into the box and are unable to escape. A similar trap used in England is described by Westwood. It consists of a small wooden box in the top of which a circular hole is cut and fitted with a glass ring, so that it is impossible for the roaches to escape. This trap is baited nightly, and the catch thrown each morning into boiling water. A simpler form of trap, which I am informed by E. C. Pratt is very successfully used in London, England, consists of any deep vessel or jar, against which a number of sticks are placed, and bent over so that they project into the interior of the vessel for a few inches. The vessel is partially filled with stale beer or ale, a liquid for which roaches seem to have a special fondness. In the morning these vessels are found charged with great quantities of dead and dying roaches, which have climbed up the inclined sticks and slipped off into the vessel. We have had fair success with this last method against the oriental roach in Washington, but against the more wary and active Croton bug it seems less effective.

Traps of the sort described, placed in pantries or baker-

ies, will unquestionably destroy great quantities of roaches, and keep them, perhaps, more effectively in check than the use of the troublesome insect powders or the distribution of poisoned baits, especially as the latter are so often ineffective."

Prof. J. B. Smith writes that "the most satisfactory way of dealing with these insects is by means of a phosphorus paste, spread upon bits of soft bread and placed near their haunts, all other food particles being put out of reach. A short period of such treatment will usually prove effective. Almost as good is a mixture of equal parts of finely powdered chocolate and borax, dusted into the crevices where the insects hide. The mixture should be intimate, and is best made in a mortar, so that with each part of chocolate, of which the roaches are very fond, they will get also a particle of borax, which is poisonous to them. This mixture has proved successful in many instances within my own experience, and has the advantage of being cheap as well as non-poisonous to man."

In an article on "Mexican Superstition and Folk-lore" the following recipe to get rid of cockroaches is given: "Catch three and put them in a bottle, and so carry them to where two roads cross. Here hold the bottle upside down, and as they fall out repeat aloud three *credos*. Then all the cockroaches in the house from which those three came will go away." This remedy is at all events not a costly one!

Few people are aware that cockroaches are of some use; they are a popular remedy for dropsy in Russia, and both cockroach tea and cockroach pills are known in the medical practice. Salted cockroaches are said to have an agreeable flavor—for those that like highly flavored sauces. These insects have also the one redeeming character—they will eat the festive bed bugs.

The remedies against other orthopterous insects that are injurious to agriculture, etc., will be given under the descriptions of the insects, hence it is not necessary to repeat them here.

PARASITES AND OTHER ENEMIES OF LOCUSTS.

Locusts have a large number of parasitic enemies, and whenever locusts, as hosts, become at all numerous, their parasites become equally and more numerous, and soon gain mastery. This struggle for existence is constantly going on; it is a very cruel one, as no pardon is asked nor given. This is of course a good thing for the farmer, as without it all the labor he performs to rid his fields of such intruders would be performed in vain. When locusts become very numerous it seems as if they became weaker and predisposed to catch any disease that is liable to attack them, and they soon succumb. Especially a bacterial disease is very effective, and carries off many, even nearly all locusts in a given region. But this takes place only when the climatic conditions have been such as to have weakened the vitality of these insects. Continuous rain is very injurious to such sun- and warmth-loving beings. During rain locusts hide and take no food, hence a long continued spell of rain does not alone injure their constitution, but also forces them to a long abstinence from food, a condition very bad for such hungry and greedy beings.

Besides such bacterial diseases others caused by higher organized plants, such as fungi, frequently occur and more than decimate the hosts of hungry locusts.

We can always be certain that in dry seasons locusts will become destructive, even very much so, simply because they are healthier, hence devour more, and as plants do not thrive as well in a droughty season we can soon see how destructive such insects can become if favored by such conditions as much sunshine and little rain. They show by their very actions their abhorrence to moisture and dampness, and towards evening all, large and small, try to escape the same by crawling upon something that is elevated or higher than the ground. During the night, when all our locusts are more or less quiet and sleeping, and do not produce such loud sounds as the grasshoppers and crickets,

they can be found upon the stalks of plants, several feet above the ground, or upon fences and outhouses, if such are accessible.

Social insects are more liable to epidemics than solitary species, for in social species a constant contact with the diseased objects as well as with the other members of the same colony greatly facilitates the spread of a disease. This explains, in part, why a disease will spread much more rapidly, and work more effectually, when insects occur together in large numbers, than when few and scattered. The same thing occurs when an epidemic of yellow fever or cholera sweeps through our land. How much more quickly and fatally it works in our cities than in thinly populated regions! Some of these diseases seem to force their victim to wander about, and thus spread them in all directions. Thus locusts attacked by the **Locust-fungus** (*Empusa grilli* Fres.), invariably climb some tall weed or grass, and cling to it long after death.

Figure 11 shows a locust (*Melanoplus bivittatus* Say), which has been attacked by the fungus and killed after it had climbed to the top of a plant. The figure shows well the frantic efforts of the locust to cling to its support. This peculiar effect of the disease to force the sick and dying insect to cling to tall plants enables its spores to infect a much wider area, as they can from this elevated position fall on the food of the locusts as well as on the locusts themselves. This fungus has also the power of throwing its spores to a considerable distance.

Besides the minute parasites mentioned thus far, and



FIG. 11.—*Melanoplus bivittatus* killed by a fungus. Original.

which belong to the vegetable kingdom, a large number of parasites, members of the animal kingdom, seem to make it their business to destroy locusts. The more important ones are given and illustrated.

THE RED-MITE. (*Trombidium locustarum* Ril.). Quite early in the spring, or as soon as the surface of the earth is dry and fairly warm, full-grown red-mites or locust-mites can be seen running over the ground in fields and gardens. They are especially common if locusts were numerous in the previous year. These friendly mites, illustrated in Figs. 12 and 13, of a vivid scarlet color, and with the peculiar gloss of silk, are well known to children, who are in the habit of calling them the "lucky spiders," very likely from the German "Glueckspinnen," because finding them in the early spring is claimed to be the certain promise of a lucky day. And no wonder, because they are only found running about on warm and dry spring days, when all nature is reviving from a long winter's rest, when the bare

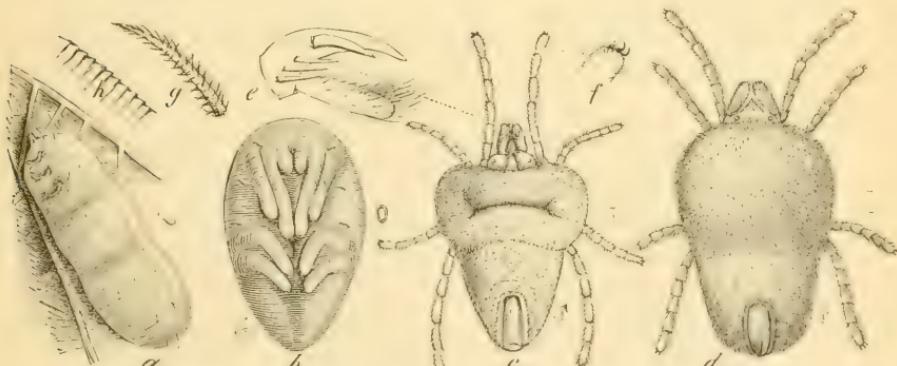


Fig. 12.—*Trombidium locustarum*.—a, mature larva when about to leave the wing of a locust; b, pupa; c, male adult when just from the pupa; d, female—the natural sizes indicated to the right; e, pupal claw and thumb; f, pedal claws; g, one of the barbed hairs; h, the striations on the larval skin. (After Riley).

and cold ground becomes clothed in delicate green colors, and when the first flowers gladden the eyes. The illustration (Fig. 12), shows the great difference that exists between the sexes. During the spring the females deposit

from three hundred to four hundred very small, globular, orange-colored eggs, which are usually hidden in the soil at a depth of one to two inches; this is shown in Fig. 13, *a*, as well as an individual egg, *c*. These eggs soon give forth

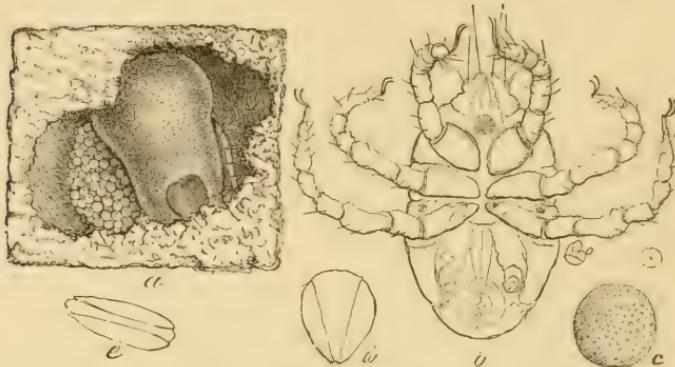


Fig. 13.—*Trombidium locustarum*.—*a*, female with her batch of eggs (after Emerton); *b*, newly hatched larva, natural size indicated by the dot within the circle; *c*, egg; *d*, *e*, vacated egg shells. (After Riley).

small orange-colored, six-legged and very active mites, fig. 13, *b*, whose aim in life seems to be to find living food, to which they fasten themselves. If they succeed in finding a locust, they fasten themselves very securely to its wings, or in case of a pupa to its wing-pads, and almost invariably to its under side. Here they use their mouth-parts so diligently, that their bodies soon swell with the life-blood of the attacked host; their former long legs become shorter and shorter in proportion, and are soon almost invisible (Fig. 12, *a*). In this condition they can, of course, no longer move about, and they look very much like minute drops of blood, or like eggs, and are frequently mistaken for such. We can well imagine that a locust thus infested by one or more of such rapid growing mites, must soon become disabled, or at least greatly weakened. To such locusts life is no longer a continuous round of pleasure, and they soon take a gloomy view of it, and refuse to join their festive brethren; they either congregate with similarly affected ones, and are thus

found in large numbers upon fences, etc., or they drag about their enfeebled bodies, separated from their relatives. When these mites, fastened to locusts, become fully grown they drop to the ground, and hide for several weeks without taking any food. Gradually the pupal state is assumed, without going through a molt, as would be the case if mites were true insects. Inside this pupa, shown in Fig. 12, *b*, the mature mite is formed. Breaking through the retaining pupal skin it appears as an eight-legged being, which passes the winter in the ground. But the mite is not idle, except when the temperature sinks below the freezing point. It feeds upon all sorts of soft food, and whenever it has access to the eggs of locusts it greedily eats them. In soil containing eggs of locusts large numbers of these mites congregate. They creep into every hole in search of these eggs and thrive upon such rich food. The great advantage of plowing over all other remedies is also seen in regard to these red-mites, as the plowing of fields in which eggs of locusts have been deposited will destroy the young locusts hatching from them, but not the mites, which can easily work their way towards the surface. Plowing destroys our enemies, but not our friends!

TACHINA-FLIES.—These beneficial flies are generally of a gray color, and resemble very much large house-flies; they are of very great assistance in killing locusts. In fields crowded with locusts they can be seen buzzing around a wide-awake hopper, who seems to know the threatening danger, as he will dodge the flies in the most excited and ridiculous manner. But all dodging and kicking proves in most cases of no avail, as the persevering fly will certainly succeed in fastening its white and elongated egg upon the neck of the victim or under its wings. The maggots hatching from such eggs eat their way into the body of the locust. Here they devour everything, frequently leaving, however, the vital organs untouched, they being, very likely, less tender than the fatty parts stored up for the formation

of future organs. If fully grown the maggots force their way through the skin of their host and drop to the ground. Here they burrow in the earth, and, contracting into brown barrel-shaped puparia, they rest awhile.

Inside this puparium, composed of the old larval skin, the true pupa is formed, and later the winged fly, which breaks through the surrounding skins and crawls towards the light of day. In a very short time it is able to use its wings, and is ready to enjoy life after its own fashion. A locust harboring such a maggot, or several of them, is less active than others, and seems to look upon life as a rather serious affair, in fact to think it a real bore. Fishermen in search of bait catch such languid locusts much more readily than healthy ones, but find, in pulling away their wings or heads, a humane way that disciples of Isaac Walton have, nothing but an almost empty shell, by no means a tempting morsel for a fish. Several species of Tachina-flies infest locusts.

FLESH-FLY.—(*Sarcophaga carnaria* Linn.), a well known scavenger in Europe, Australia and America, is also found as a true parasite in many species of locusts.

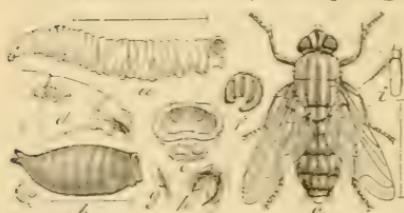


Fig. 14.—*Sarcophaga carnaria* var.—a, larva; b, pupa; c, fly, the hair lines showing average natural length. (After Riley).

It, as well as its earlier stages, are illustrated in Fig. 14. This illustration will also show the shape, size and general appearance of a true tachina-fly, which is quite similar to it.

BEE-FLY.—(*Systæchus oreas*). When fields, meadows and pastures are inspected for the eggs of locusts the larvae of these flies are always found, showing that these friends of the farmer are doing good work. The adult fly is illustrated in Fig. 15, the larva in Fig. 16. The beautiful flies are frequently seen towards the middle of July: they are then employed in sipping honey with their very



Fig. 15.—*Systaechus oreas*.—Female fly. (After Riley).

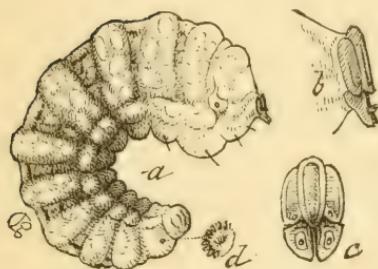


Fig. 16.—*Systaechus oreas*.—a. larva; b. head from side; c. head from front; d. preanal spiracle. (After Riley).

long proboscis from the various species of composite flowers. This proboscis can be used for other purposes than sipping nectar, as the writer found out to his sorrow, when he attempted to catch some of them with his hand, and succeeded. Violent pain, a swollen finger, and added knowl-

edge were other results of the catch not bargained for. Early in August these flies are exceedingly numerous, hovering in the air and keeping their wings in such rapid motion that they can not be distinguished, but appear like a haze surrounding the body of the insects; when disturbed these flies will dart away with wonderful speed, to remain again stationary in the air in another spot. These bee-flies, although possessing a blackish-gray ground color, are so densely covered with pale yellow hairs, that this color is entirely hidden; this hair is so long that the outlines of the insects are obscured, and they resemble on this account very small bumble-bees.

The eggs and method of oviposition are not known. The larvae are found among the egg-masses of the locusts; they have curved bodies, swollen in front and tapering behind; their color is opaque white with translucent yellowish

markings. The small and flattened head, (Fig. 16, *b* and *c*), is dark brown, with broad, almost triangular jaws. All the larvæ found during August and September, though varying greatly in size, possess similar forms, and all are almost unable to move. They are most frequently close to the egg-pods, which in some cases are found empty. The young maggots must possess a very different form and decidedly different habits from the adult larvæ, otherwise they would be altogether too slow and awkward to find the eggs of locusts. No pupæ have been found and all the larvæ kept in breeding cages have dried up before changing.

BLISTER-BEETLES.

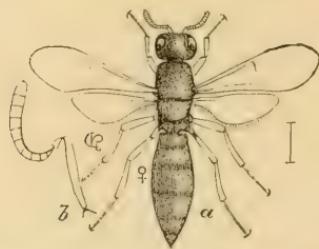
Several species of Blister-beetles or Spanish-flies occur in large numbers throughout the infested region. In fact some of them cause considerable damage to potatoes and other plants. Many of these blister-beetles are known to feed in their early stages upon the eggs of locusts. A very interesting report upon the peculiar life-histories of these beetles was published in the "First Annual Report of the United States Entomological Commission." The following species of these beetles are abundant in Minnesota: the Ash-gray Blister-beetle (*Macrobasis unicolor* Kirby), the Margined Blister-beetle (*Epicauta cinerea* Forst.), the Black Blister-beetle (*Epicauta pennsylvanica* De G.), and the Red-headed Blister-beetle (*Epicauta trichrus* Pall.). All these beetles, frequently best known as being very injurious to potatoes, beans and other cultivated plants, surely have one great redeeming character, in being our best friends by checking an undue increase of noxious species of locusts. Their life-history may be summed up in a few words: they deposit, from July to October, their orange or yellow-colored eggs in irregular masses in loose ground, each female producing from four hundred to five hundred eggs. In about ten days these eggs hatch, producing very active, long-legged larvæ with large heads and strong jaws, which run about search-

ing everywhere for the eggs of locusts. If an egg-pod has been found, the larva forces its way into it and commences to devour an egg; if two larvæ have found the same prize a mortal combat takes place, lasting until a single larva remains as sole owner of this store of food. As soon as one or two eggs have been consumed the larva throws off its skin, and reappears in a very different shape, being now white, soft, and possessing only small legs. In the course of another week a second molt takes place, disclosing a larva with rudimentary mouth-parts and legs, and of a very clumsy aspect. Soon another molt takes place, but only slight changes are seen in this form of the larva. After eating the remaining eggs in the pod, and leaving it, it burrows in the soil, where it forms a smooth cavity, within which it rests. Soon it splits its skin again, disclosing now quite rudimentary, tuberculous mouth-parts and legs; the semi-pupa thus formed is rigid and of a deeper yellow color. It hibernates in this condition. In spring the skin is again torn open, and a larva appears looking like that of the second shape, but smaller and whiter; it is quite active, but does not seem to require any food. It changes into a true pupa, and eventually into a winged beetle.

Besides these species still another one with bright metallic colors, the *Cantharis Nuttalli*, is exceedingly abundant in years following locust troubles. Very likely the larvæ of this beetle possess similar habits, and are consequently very beneficial.

OTHER PARASITES AND CANNIBALS.

Quite a number of eggs of the locusts are destroyed by other true parasitic insects, one of which is illustrated in Fig. 17. It is called *Scelio Luggeri*, Ril. In some egg-pods every egg is eaten by the larvæ of this useful insect, so that instead of harboring the embryo of a locust the egg contains a small wasp. These minute insects are difficult to find, as they are not distinguished by metallic colors, which is usually the case

Fig. 17.—*Scelio Luggeri*. After Riley.

in allied insects, but are of a dingy black color, with honey-yellow legs. Moreover, they do not fly about actively, but rather crawl over the soil. If disturbed they jump like fleas and vanish from sight.

A large number of carnivorous insects have also been observed to assist us in reducing the numbers of locusts, either by eating the eggs or by devouring the young insects. Numerous larvæ of egg-feeding beetles occur, of which the most important ones belong to the genus *Amara*. In some fields every second egg-pod contains the larva of *Amara lator*, Kirby; if not actually inside the egg-pod it is found upon the outside of it or very close to it. Numerous larvæ of a larger species (*Amara obesa*, Say), are also found; the

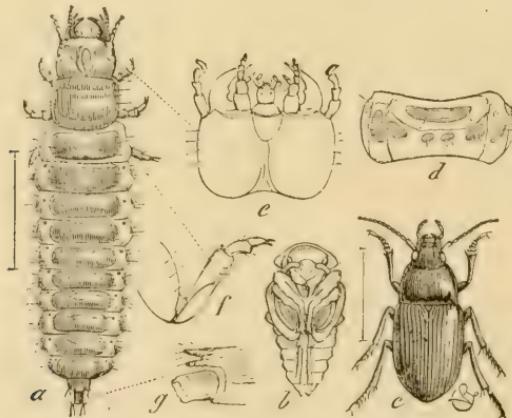
Fig. 18.—*Amara obesa*. After Riley.

illustration (Fig. 18) shows the different stages of this useful insect.

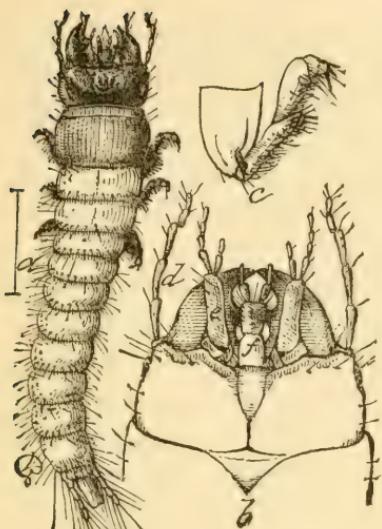


Fig. 19.—*Harpalus herbivagus*.
After Riley.

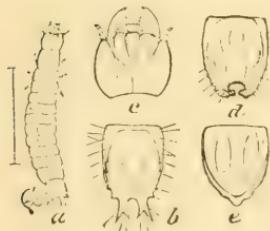


Fig. 20.—Larva of
Cryptocephalus bicolor.
After Riley.



Fig. 20½.
Calosoma frigidum
Natural size.
Original.

Still another coleopterous larva is usually found in large numbers; it is the larva of *Harpalus herbivagus* Say, an insect very abundant in fields infested with locusts. It is shown in Fig. 19.

A very interesting little coleopterous larva is also found in considerable numbers inside of the egg-pods of locusts. It is shown in Fig. 20, and produces a small Click-beetle (*Cryptocephalus bicolor*, Esch., var. *lacustris*).

Numerous larvæ of flies occur near the egg-masses, some of which are known to be our friends.

Very active and doing good work are also the larvæ of *Calosoma frigidum* Kirby, and of *Calosoma calidum*, Fab., the former of which is only found near edges of forests, while the latter occurs everywhere in the prairies. The mature beetles of these species feed al-

so upon the half-grown locusts. The adult of *Calosoma frigidum* is shown in Fig. 20½. This species possesses very different habits from the other species of *Calosoma*, with the exception of *scrutator*. It climbs trees in search of the caterpillars of Canker-worms, and is as active in this work as the green species, which, owing to its protective color, is better equipped for such an arboreal life. It would not be a bad idea to utilize *frigidum* in the war against the noxious

Gypsy-moth, so destructive in Massachusetts. Hiding during the day, but very active at night, are also other large ground-beetles, belonging to the genera of *Pasimachus* and *Scarites*; especially the former are very fond of young locusts and have been seen devouring them in great numbers.

Many other beetles, flies and wasps are known to feed upon locusts, or to use them as food for their young. But enough has been shown to indicate that the life of a locust is not one constant round of pleasure. This becomes very plain if we consider that besides the enemies already mentioned the locusts are badly invaded by internal parasites, for instance by that curious being, the Hair-snake (*Gordius* species). If we remove the head of a parasitized locust we sometimes see its whole interior filled with this parasite, which is many times as long as its host, and it will be seen that all the important organs of the locust are compressed and unable to perform their necessary functions, hence the insect looks "pale and sickly."

OTHER ENEMIES OF THE LOCUSTS.

A large number of birds and animals eat locusts whenever they have a chance to do so. Domestic fowls eat them greedily, but soon tire of this diet if the insects become very numerous. Most active of all in destroying locusts is a small tern, the Black Tern, (*Hydrochelidon nigra surinamensis*), which is very common in the prairies, even many miles from any water. It and the Rosy Gull (*Larus Franklini*), are constantly engaged in catching the young locusts, for themselves as well as for their young. Both species of aquatic birds follow the plow, very much in the same way as the crow is in the habit of doing elsewhere. The various species of blackbirds, such as the Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*); the Red-shouldered Blackbird (*Agelaius phoeniceus*); the Rusty Blackbird (*Scolecophagus carolinus*); the Bronzed Grackle (*Quiscalus quiscula aeneus*);

the Brewer's Blackbird (*Scoleopagus cyanocephalus*); and the Cowbird (*Molothrus ater*), all catch and eat locusts. The first four are the most active ones, especially as long as they have to provide for their young. At this period they are making constant trips from nest to field and return. A Yellow-headed Blackbird, distinguished by lacking a feather in the left wing, made thirty-seven trips per hour to a field adjoining the river, where it had its nest in a clump of cat-tails. Strange to say, later in the season, the locusts took revenge by eating off all the leaves and softer parts of the cat-tails, thus exposing the nest. As soon as the young blackbirds are able to follow their parents they all go locust-hunting. Owls and hawks also feed largely upon these insects, as the balls voided by them always contain numerous parts of locusts. Other birds no doubt also eat locusts, at least the unfledged ones. Prairie chickens have frequently been seen in the roads picking up locusts, and the same can be stated of some rails.

Animals also eat locusts, and the skunk grows fat upon this food. Even gophers do not despise a dish of tender locusts, which is also to the taste of toads, frogs and snakes.

VALUE OF LOCUSTS AS FERTILIZERS.

Locusts contain a large amount of nitrogen, and whenever they are caught on a large scale this valuable fertilizer ought to be utilized. Prof. D. N. Harper made an analysis of locusts given him for that purpose. He writes: "I report herewith the result of my analysis of the locusts handed to me for examination as to their contents for fertilizing ingredients. The locusts and the alcoholic liquor in which they were preserved were evaporated to dryness at a temperature of boiling water. They were then pulverized and thoroughly intermixed, and portions taken for analysis. This resulted as follows:

	(per cent)
Nitrogen.....	10.71
Phosphoric acid soluble in water.....	1.52
Phosphoric acid insoluble in water.....	.24 1.76

The phosphoric acid in such phosphates as are insoluble in water or solution of ammonium citrate of 1.09 specific gravity is termed *insoluble phosphoric acid*; in such as are insoluble in water but soluble in ammonium citrate solution is termed *reverted phosphoric acid*. "Soluble" and "reverted" phosphoric acid are equally available by the plant as food. Insoluble phosphoric acid is not as readily available. Nitrogen is the most valuable fertilizing ingredient."

CONCLUSION.

It is possible to successfully fight and exterminate locusts, providing active measures are adopted at once, and are, moreover, carried out faithfully. This is only true, however, if we have to deal with local swarms, and not with armies covering whole states. In the former case if every one owning a farm in the infested region will only properly cultivate the same, will plow it during the fall, permit no fields to be idle, and seed it in the spring, no fears of loss need be entertained.

In describing the habits of insects, their growth and metamorphoses, as well as their relation to agriculture, horticulture and allied pursuits, it is very important and necessary to study not alone the general form of an insect, but also its external and internal anatomy. For our purpose it will be sufficient to select one member of the order of orthoptera, the common Two-striped Locust (*Melanoplus bivittatus*), and to describe in as general terms as possible the different parts of the same.

EXTERNAL ANATOMY.*

The body of a locust consists of an external thick skin, hardened and stiffened by a substance called chitine, which protects the softer organs within. Chitine is a peculiar substance found only in the teguments of articulated animals. The harder external skin is the analogue of the skeleton of the mammalia, and to it are fastened all the muscles that are necessary for the functions of an insect. As this outer skeleton must be more or less rigid, insects would not be able to move at all if it were not jointed or segmented in such a manner that each segment, or ring, is connected with the neighboring ones by a softer membrane. Each segment may be again subdivided into smaller pieces. We can observe

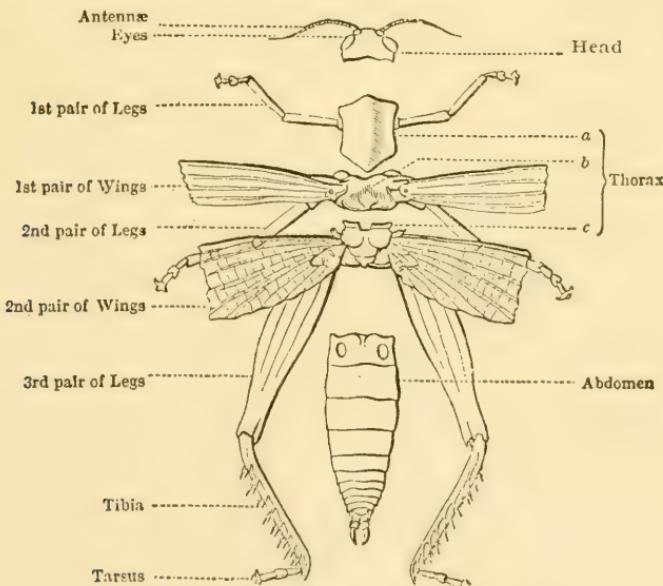


Fig. 21.—A locust dissected to show divisions of body.

such segments quite readily in caterpillars; the abdomen of the locust also shows them very distinctly, as here the seg-

* See explanation of anatomical illustrations at end of chapter.

ments are not as complicated as they are at the extremities of the body, the head and end of the abdomen. The long and narrow body of a locust, laterally compressed, is like that of all other true insects in their perfect state, divided into three well marked regions, the *head*, *thorax* and *abdomen*. The head is flattened from before backwards, and elongated vertically. It bears the eyes, the antennæ and the mouth-parts, and is movably joined, by a short neck, to the second region of the body. The thorax forms, with the head, the anterior half of the body. It carries on its lower surface the three pairs of legs, which gradually increase in size from before backward, the third pair being *much* the largest. The two pairs of wings are fastened to the posterior portion of the dorsal surface of the thorax. The abdomen, a little longer than head and thorax combined, is composed of a number of movable segments without appendages.

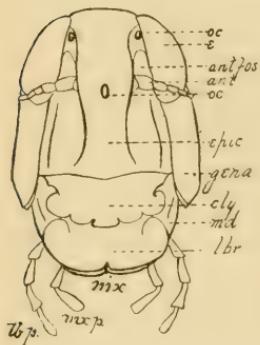


Fig. 22.—Front view of the head of *Melanoplus bivittatus*. Original.

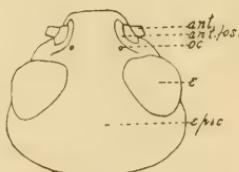


Fig. 23.—Vertical view of the head of *Melanoplus bivittatus*. Original.

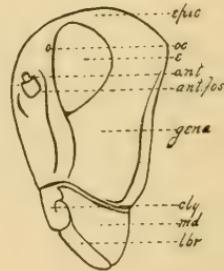


Fig. 24.—Lateral view of the head of *Melanoplus bivittatus*. Original.

THE HEAD (Fig. 22, 23, 24).—The outer or dorsal surface of the head consists of a very broad and long frontal and a much smaller and shorter occipital area. The *epicranium* (*epic*), which forms the covering of the dorsal occipital area, becomes narrow and runs downwards between

the eyes and antennæ to about the middle of the frontal area, where it enlarges again, and ends below in a prominent, straight, transverse suture. Faint lines indicate that the epicranium is formed by the fusion of two originally separate pieces. An obscure ridge between the upper ends of the eyes perhaps also indicates the union of two segments. The large projecting *compound eyes* (*e*), are oval and highly polished and are situated on the upper portion of the sides of the head. These eyes are composed of many thousands of hexagonal facets or lenses and are marked with parallel vertical bands of brown pigment. A little in front of the upper margin of each of the compound eyes is a convex oval area, in which the integument is so thin and transparent that the tissue below can be seen. These minute spots are the *ocelli* (*oc*) or simple eyes. A third ocellus can be seen between the antennæ on the median line of the epicranium. The *antennæ* (*ant*) are composed of a larger basal joint and twenty-six movable rings which increase gradually in length from base to tip. The basal joints of the antennæ are fastened to the centers of two oval areas, the *antennary fossæ* (*ant. fos*), which are located between the eyes on the narrow frontal portion of the epicranium. The antennæ can be moved in all directions. The lower and straight edge of the epicranium articulates with a wide, short plate, the *clypeus* (*cly*), the sides of which are deeply notched, showing the traces of a division into two plates. In front of this is a movable, flap-like *labrum* (*lbr*), the free edge of which is deeply notched on the median line, the remnant of the suture formed by the union of the halves or paired appendages which the labrum represents. On the side of the head is a suture, which runs from the lower anterior angle of the eye to the lower margin of the epicranium, and separates the latter from the large plate, the *gena* (*gena*), which forms the side of the head, and terminates below in a free, pointed edge. Between the lower anterior edge of the gena and the clypeus is a dark colored area, the outer surface of the basal portion of the *mandible* (*md*).

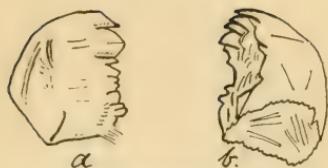


FIG. 25.—Mandibles of *Melanoplus bivittatus*; *a*, external view; *b*, internal view. Original.

which allows them to move towards or away from the median line, but in no other direction. The large *occipital foramen*, by which the cavity of the head communicates with that of the neck, is bounded above by the epicranium, at the sides by the gena, and below by a crescent-shaped sternal plate, the *gula*. Movable articulated with the lower straight edge of the *gula* is the *labium* or lower lip (Fig. 26),

formed by the union of a pair of appendages, which are immovably united, but still show upon the median lines traces of this union. The labium consists of a basal portion, the *mentum* (*m*); a pair of terminal apron-shaped pieces, convex behind

and concave in front, the two halves of the *ligula* (*li*); on each outer edge of the *mentum* is a small piece, the *palpiger* (*palpr*), and upon this the three-jointed *labial palpus* (*lb. p*). By removing the *gula* and the *labium* the posterior faces of the anterior mouth-parts are exposed. Forming the posterior boundary of the mouth, in the median line, is a dark-colored chitinous spiny pad, the *metastoma* or tongue, which has its anterior face covered with rows of spines. Arching over the tongue and forming the anterior boundary of the mouth are the black tips of the *maxillæ* (*mx*), meeting

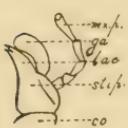


FIG. 26.—Labium or lower lip of *Melanoplus bivittatus*. Original.

upon the median line. Each *maxilla* is made up of a basal joint or *cardo* (*co*), which is directed transversely to the long axis of the head, and articulates with the lower posterior edge of the *gena*. The second joint, or *stipes* (*stip*), runs forward at right

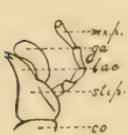


FIG. 27.—Maxilla of *Melanoplus bivittatus*. Original.

angles to the cardo and parallel to the long axis of the head. It is movable towards and away from the median line. The *maxillary palpus* (*mx. p*) is carried upon the outer angle of the stipes, and is made up of two short and three long joints. The *lacinia* (*lac*), the toothed black-tipped cutting portion of the maxilla, is carried upon the inner margin of the distal end of the stipes. The *galea* (*ga*), or soft, brown, spoon-shaped portion of the maxilla, is carried upon the outer angle of the stipes and bends around in front of the lacinia. The illustration, (Fig. 27), shows the different parts described above.

THE THORAX.—To study the thorax, the legs and wings should be removed. It will be seen that the thorax is made up of three segments, each of which bears a pair of legs. These three segments are known as the *prothorax* (*pro*), *mesothorax* (*meso*), and *metathorax* (*meta*). The prothorax, (Fig. 28), has the sides and dorsal surface covered

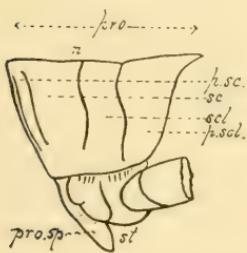


FIG. 28.—Lateral view of the prothorax of *Melanoplus bivittatus*. Original.

by a large, sun-bonnet shaped piece, the *pronotum* (*n*). The dorsal portion of the pronotum is prolonged backwards along the median line and partially overlaps the second division or mesothorax. The anterior portion of the pronotum is crossed by three grooves or sutures, which divide it into four immovably united pieces; the first of these forms the anterior margin of the pronotum, and is called the *prothoracic prescutum* (*p. sc.*); the second is the *prothoracic scutum* (*sc.*); the third the *prothoracic scutellum* (*scl.*), and the last the *prothoracic postscutellum* (*p. sel.*). The ventral portion of the prothorax, (Fig. 29), is formed by a slender, movable *sterum* (*st*), which connects the sides of the pronotum with each other. On the median line it carries, in this species, a large club-shaped spine (*pro. sp.*). Near the outer ends of the sternum are the fossæ for the attachment of

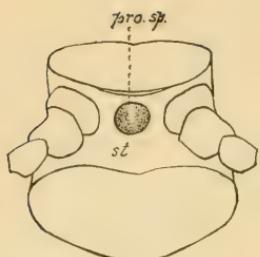


FIG. 29.—Ventral view of the prothoracic sternum of *Melanoplus bivittatus*. Original.

two nearly rectangular posterior prolongations; the *metasternum* (*meta. st*) is a somewhat larger plate, which consists of an anterior square tongue filling the space between the posterior horns of the mesosternum, and a large pentagonal portion. The first abdominal sternum (*1st abd. st*) is morticed into the posterior margin of the metasternum in nearly the same way that the latter is joined to the preceding sternum.

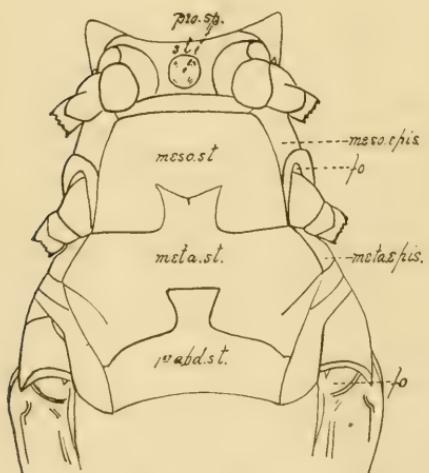


FIG. 30.—Ventral view of the thorax of *Melanoplus bivittatus*. Original.

the limbs. The mesothorax and metathorax are much more complicated, and together with the first abdominal segment, are soldered into a firm-walled box. The flattened ventral surface of this box is made up of three pieces; the *mesosternum* (*meso. st*), which consists of an anterior median portion and

In this ventral view of the thorax, (Fig. 30), the lower ends of the episterna and the fossæ (*fo*) for the articulation of the legs, are visible at the sides of the sterna. Parallel with the anterior half of the mesosternum are the lower ends of the *mesothoracic episterna* (*meso. epis*). Parallel with the posterior half of the mesosternum are the fossæ of the second pair of legs. The inner borders of these fossæ are not formed by the mesosternum itself, but by slender horn-like backwards prolongations of the lower end of the episternum. Parallel with the anterior

borders of these fossæ are not formed by the mesosternum itself, but by slender horn-like backwards prolongations of the lower end of the episternum. Parallel with the anterior

half of the metasternum are the lower ends of the *metathoracic episterna* (*meta. epis*), separating the fossæ of the second legs from those of the third and sending prolongations backwards to form the inner margins of the latter.

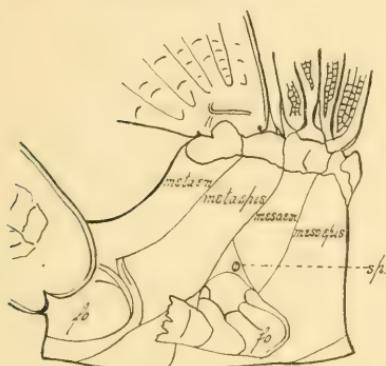


Fig. 31.—Lateral view of the thorax (pleurites) of *Melanoplus bivittatus*. Original.

In a side view of a thorax, (Fig. 31), from which the pronotum, wings and legs have been removed, the space above the leg fossæ is occupied by four rectangular pieces, which slope obliquely upwards and forwards. The anterior margin of each of these is marked by a dark stripe or band of pigment, and the posterior margin

by a light stripe. The first or most anterior piece is the *mesothoracic episternum* (*meso. epis*). Its lower margin is prolonged downwards and backwards and forms the anterior and lower boundary of the fossæ of the second leg. The second piece is the *mesothoracic epimeron*, (*meso. em*). Its lower end forms the upper and posterior margin of the leg fossæ. The third piece is the *metathoracic episternum* (*meta. epis*). The fourth is the *metathoracic epimeron* (*meta. em*). Between the metathoracic epimeron and metathoracic episternum, just above the mesothoracic leg fossæ, is a small oval aperture provided with a pair of lip-like chitinous valves. This is the respiratory aperture or *spiracle*, (*sp*) of the metathoracic segment. Along the upper margins of the episterna and epimera are a few small, irregular pieces, to which the wings are articulated. The dorsal surface of the meso-and metathorax, (Fig. 32), is formed by two nearly square areas, which occupy the space between the wings. They are soft and membranous, and the pieces which compose them are not sharply defined. The anterior

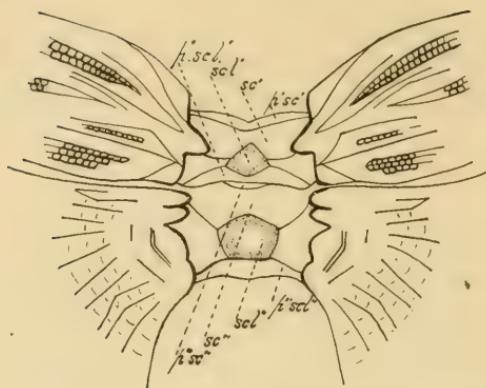


Fig. 32.—Dorsal view of the meso- and metathorax of *Melanoplus bivittatus*. Original.

border of each is formed by a narrow plate, the *prescutum*. Back of this is a large, convex, dark-colored, glistening surface, the *scutum*. Behind the scutum is a membranous piece upon the median line, the *scutellum*. The posterior margin is occupied by a long, narrow, light-colored piece, the *post-scutellum*.

THE WINGS.—The anterior or upper pair of wings (Fig. 33), named *tegmina* or *wing-covers*, are about as long as

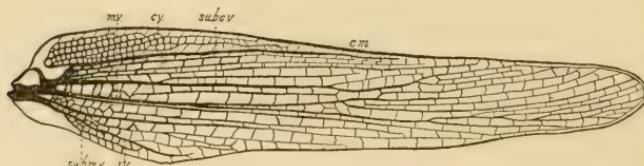


Fig. 33.—Tegmina, elytra or wing-cover of *Melanoplus bivittatus*. Original.

the body, beyond the posterior end of which they project. They are narrow and the anterior and posterior margins are seen, when the wing is extended, to be nearly parallel. When folded upon the body their outer faces are vertical, with the anterior margin below, and the posterior or *internal* edges in contact along the back, the left slightly overlapping the right. Each wing-cover is a thin, transparent, rather stiff plate of chitine, marked with a yellowish-brown stripe. It is strengthened by a network of chitinous tubes,

the *veins*, of which there are five on each wing, diverging from the proximal end of the wing, and giving rise to smaller veins. These in turn divide into much smaller *veinlets*, which inosculate with each other and divide the surface of the wing into small, irregular polygonal areas or *cells*. The vein nearest the anterior or *costal* margin (*c. m.*) of the wing is the *costal vein*, (*c. v.*). It is undivided and may be traced for a little more than half the length of the wing. The second very much larger vein is the *sub-costal* (*sub. c. v.*). It gives rise to several large branches, the subdivisions of which form the framework of the greater part of the wing. The third or *median* (*m. v.*) is much smaller and soon divides into two branches of nearly equal size. The remaining pair, which are known as the *sub-median*, (*sub. m. v.*) and *internal* (*i. v.*), run close to and parallel with each other near the internal or posterior margin of the wing. The tegmina is divided by these veins into three areas. The

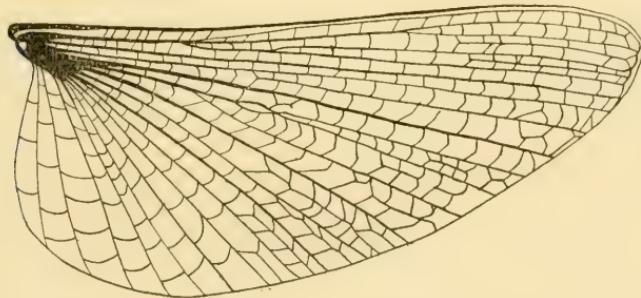


Fig. 34.—Wing of *Melanoplus bivittatus*. Original.

costal area forms the anterior edge of the wing and is bounded posteriorly by the costal vein; the *median area* is much the largest, and lies between the sub-costal and sub-median veins; the *internal area* is the free margin posterior to the internal vein. The second or lower pair of wings, (Fig. 34), are about equal to the first in length, and when the animal is at rest, are folded up under the latter. If the dark-colored marginal vein of this lower wing is gently

pulled outwards or forwards with a pair of forceps, it will be seen that it is a thin parchment-like membrane, with a stiff anterior edge, which is nearly straight, while the rounded outer and posterior margins are thin and flexible. When the wing is fully extended its upper surface is convex, and its anterior margin is rendered still more rigid by being overlapped by the internal margin of the upper wing or wing-cover. The numerous radiating veins are so arranged that their elasticity causes the wing to fold upon itself like a fan as soon as its margin is released.

THE LEGS (Fig. 35). The large leaping leg consists of five regions: The *coxa* (*c*), or basal division, which is joined to the thorax; a small articulation, the *trochanter*, (*tr*), immovably joined to the distal dorsal portion of the coxa; the *femur*, (*f*), a long, swollen, club-shaped segment, which makes up nearly half the length of the limb. When the animal is at rest it extends upwards and backwards,

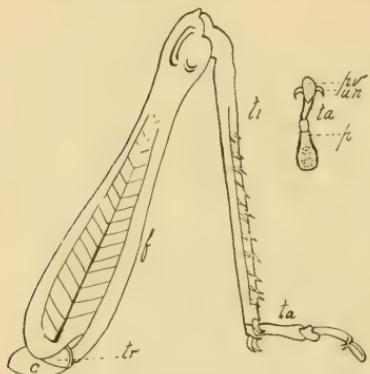


Fig. 35.—Hind leg of *Melanoplus bivittatus*. Original.

with its distal end above the dorsal surface of the body. This joint contains the powerful leaping muscles, the areas indicating the points of attachment being visible externally. The *tibia*, (*ti*) is about as long as the femur, but is very slender and of uniform diameter. When at rest it extends downwards and backwards, at an acute angle, from the distal end of the femur, but in the act of jumping it is thrown backwards and the limb becomes straight. The *tarsus* (*ta*), or foot, is made up of four movable pieces. The first and longest carries upon its lower surface three soft pads (*p*), which by their adhesion to foreign bodies serve as points of resistance in leaping. The second joint is much

shorter and carries but one pad. The third is long and slender, with two curved, pointed claws or *ungues* (*un*), between which is a concave sucking disk, the fourth joint or *pulvillus* (*pv*). The first and second pairs of legs are much like the third, but much smaller, and they meet the body at a different angle, to fit them for crawling instead of leaping.

THE ABDOMEN.—This is made up of a number of segments without appendages, movable upon each other, and presenting only slight differences. The typical number of abdominal segments appears to be eleven, and in both sexes eleven terga are present, although only eight sterna are visible in the female and nine in the male. Fig. 36 shows a cross-section through the abdomen of a locust. The first abdominal segment is somewhat different from the others and its sternal and tergal portions are widely separate. The sternal portion is immovably united to that of the metathorax, and has been already described (*abd. st*) (Fig. 30). The tergum is soft, membranous, and dark-colored like those of the thorax, and is strongly crested in the median line. Near its lower edges are a pair of large apertures closed by membrane, the *auditory organs*, (Fig. 37, *au*), or ears. On the anterior margin of this orifice is a much smaller opening, the first abdominal *spiracle*, (Fig. 37, *sp*). The remaining abdominal segments are composed of a narrow sternal portion and a much larger tergal one. The two sides of the tergum meet along the back to form a ridge. Near the lower margin of each half of the



Fig. 36.—Cross-section through abdomen.

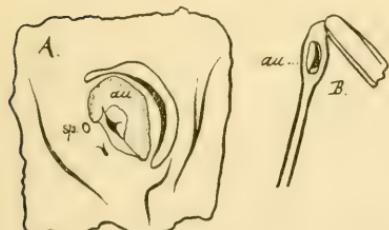


FIG. 37.—Auditory organs (*au*) of *Melanoplus bivittatus* (A), and of a Katydid (B). Original.

tergum is a couple of longitudinal furrows, the traces of the sutures between the epimera and the episterna. Near the

anterior angles of the episternal regions of the second, third, fourth, fifth, sixth, seventh and eighth segments are the openings of the spiracles, *sp*. As the structure of the terminal segments differs considerably, according to the sex of the individual, both males and females should be studied and compared. The females are usually more abundant than the males, and may be recognized by the presence of the strong, blunt, forceps-like ovipositor, which forms the posterior extremity of the body.

In the ventral view, (*C*), of the abdomen of the *male*, (Fig. 38), nine distinct movable sterna are visible; they are

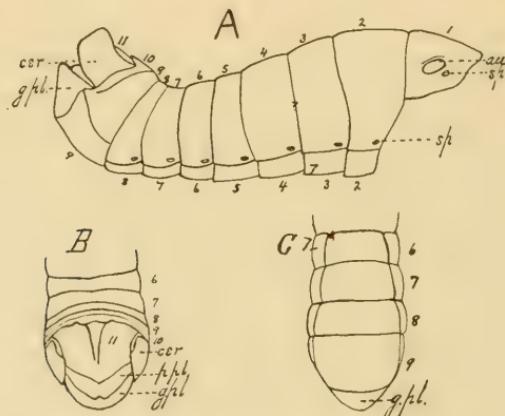


Fig. 38—Abdomen of male *Melanoplus bivittatus*. *A*, lateral view; *B*, dorsal view; *C*, ventral view. Original.

nearly equal in length and similar in shape. Posterior to the ninth sternum, the ventral surface of the body is occupied by a large spoon-shaped *sub-genital plate*, (*g pl*), convex below and concave above. Above this plate is a large chamber open behind, and at the sides the *genital chamber*. On the lower floor of this chamber, and therefore on the upper surface of the sub-genital plate, is the male reproductive orifice.

In a dorsal view, (*B*), the terga are substantially alike as far as the eighth. The eighth is a little shorter than the seventh. The ninth is only about one-fifth as long as the eighth, and

is immovably united to the tenth, a faintly marked suture separating the two. On the median line the tenth tergum is very narrow, but at the sides it is about as long as the ninth. The posterior margin of the tenth is sharply defined. The eleventh tergum is a movable shield-shaped plate upon the median dorsal surface. It is about as long as the eighth tergum, and it is divided into two nearly equal portions by a faint transverse suture. In shape it is quite different from the other terga, and its sides as well as its posterior margin, are free. On each side of this plate the outline of the dorsal surface of the body is completed by a setose movable plate, about as large as the eleventh tergum, the *cercus*, (*cer*). This plate projects back from the lateral margin of the tenth tergum, to which it is movably articulated. Projecting beyond the end of the eleventh tergum the end of the ventral sub-genital plate is visible. If the end of the eleventh tergum is raised, a pair of vertical plates can be seen on each side of the median line, the *podical plates*. Between these plates is the *anus*, and below them the genital chamber, already noticed.

In a side view, (A), the sterna of the second to eighth segments are equal in length to the corresponding terga, and the constrictions between the segments entirely surround the body. The suture, which on the dorsal surface marks the line between the ninth and tenth terga, does not extend downwards, and the lower margins of these two terga form a single plate. Below this plate is the ninth sternum, as long as the area formed by the union of the ninth and tenth terga. Running backwards from the posterior margin of the tenth tergum is the flat cercus. Above this a portion of the eleventh tergum is visible. Below and internal to the cercus is the *podical plate*, triangular in a side view, and below this the large sub-genital plate, which is joined to the ninth sternum.

The abdomen of the female, (Fig. 39), in a ventral view, (C), has the first to the seventh sterna like those of the male.

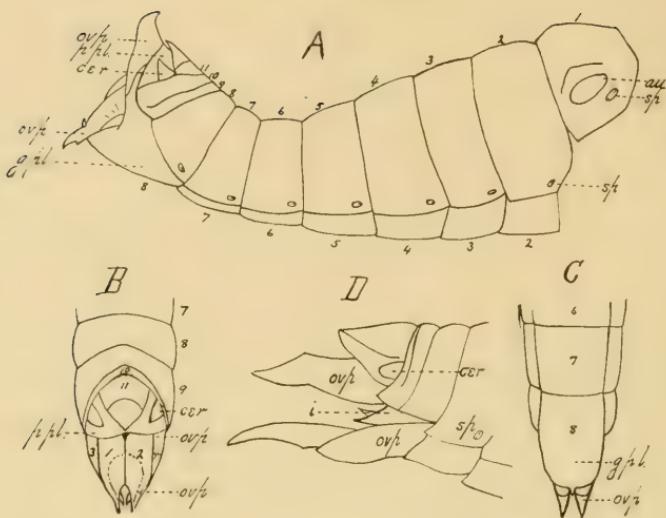


Fig. 39.—Abdomen of female of *Melanoplus bivittatus*.—A, lateral view; B, dorsal view; C, ventral view; D, egg-guide. Original.

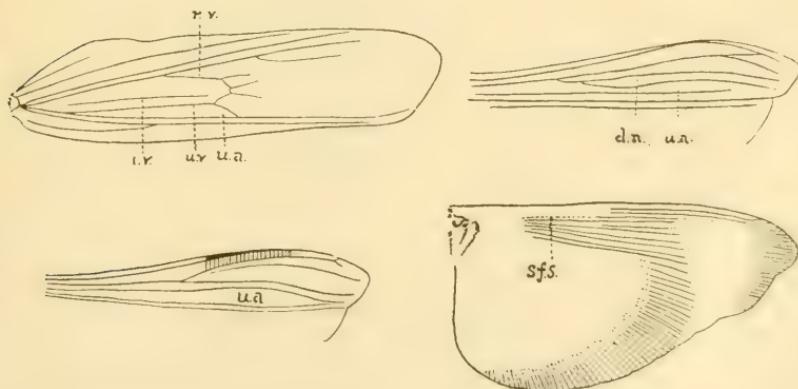
The eighth sternum is nearly twice as long as the seventh, and forms the *sub-genital plate* (*g. pl.*). Its posterior end is pointed, curved upwards, and its extremity lies between the plates of the ovipositor.

In a dorsal view, (B), the first ten segments are substantially like those of the male. The shield-shaped eleventh tergum is shorter and wider than in the male. On each side of it, at a little lower level, is the triangular *podical plate* (*p. pl.*), which is not vertical, as in the male, but is so placed that its broad surface is seen in a dorsal view. Above or dorsal to the podical plates, are the *cerci*, much smaller than in the male, but attached to the posterior margin of the tenth tergum. As in the male the *anus* is between the podical plates, just below the eleventh tergum. The space between the podical plates above and the sub-genital plate below is filled by the *ovipositor*, the top of which projects to some distance beyond the eleventh tergum.

In a side view, (A), the terga are substantially like those of the male, but the small cerci do not hide any portion of the

eleventh tergum, and more of the surface of the podical plate is visible than in the male, and the large genital chamber between the podical plates above and the sub-genital plate below is entirely occupied by the ovipositor.

The *ovipositor (ovp)*, is composed of six movable pieces, three on each side of the median line; a large *superior* or dorsal piece, an equally large *inferior* or ventral piece, and a short *internal* portion between the bases of the superior and inferior pieces. In a surface view the internal portions are hidden by the two superior and two inferior pieces, which are so arranged as to form a long sheath around the internal portions which form the true ovipositor. Each of the four pieces of the sheath is pointed posteriorly, and when the pieces are folded together the four tips are in contact. Running forward from the tip is a flattened, slightly concave surface, which in the superior pieces faces backwards and upwards, and in the inferior pieces, backwards and downwards. During oviposition the four pieces are brought together and their tips forced into the ground. They are then separated, and their flattened surfaces force the earth away on all sides, making a pit into which the internal pieces then guide the egg. Fig. 39, *D*, shows the egg-guide at *i*.



Showing wings or part of wings of various species of *Œdipodinæ*.

EXPLANATIONS TO ILLUSTRATIONS OF ANATOMY OF LOCUST.

HEAD.

e—Eye.
oc—Ocellus.
epic—Epicranium.
ant—Antenna.
ant fos—Antennal fossa.
cly—Clypeus.
lbr—Labrum.
gena—Gena.
md—Mandible.
m—Mentum.
li—Ligula.
palpr—Palpiger.
lb—Labium.
lb. p—Labial palpus.
mx—Maxilla.
mx. p—Maxillary palpus.
co—Cardo.
stip—Stipes.
lac—Lacinia.
ga—Galea.
f—Foveola.
d. v—Depression of vertex.
s. v—Scutellum of vertex.

THORAX.

pro—Prothorax.
meso—Mesothorax.
meta—Metathorax.
n—Notum of prothorax (pronotum).
n'—Notum of mesothorax (mesonotum).
n''—Notum of metathorax (metanotum).
p. sc—Prescutum of pronotum.
sc—Scutum of pronotum.
scl—Scutellum of pronotum.
p. scl—Postscutellum of pronotum.
p.' sc' — } The same sclerites of mesonotum.
sc' — }
scl' — }
p.' scl' — } The same sclerites of metanotum.
sc'' — }
scl'' — }
p.' scl'' — }

pro. sp—Prosternal spine.
st—Sternum of prothorax.
meso. st—Sternum of mesothorax.
meta. st—Sternum of metathorax.
meso. epis—Episternum of mesothorax.
meta. epis—Episternum of metathorax.
meso. em—Epimeron of mesothorax.
meta. em—Epimeron of metathorax.
fo—Fossa.
pz—Prozona.
mz—Metazona.
h. p—Hind process of pronotum.

ABDOMEN.

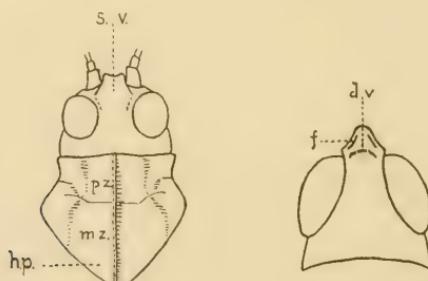
sp—Spiracle.
g. pl—Sub-genital plate.
cer—Cercus.
p. pl—Podical plates.
ovp—Ovipositor.
i—Egg-guide.

WINGS.

c. m—Costal margin.
c. v—Costal vein.
sub cv—Sub-costal vein.
m. v—Median vein.
sub m. v—Sub-median vein.
i. v—Internal vein.
D—Disk of wing.
sf. s—Subfrontal shoot.
r. v—Radial vein.
i. v—Intercalary vein.
u. v—Ulnar vein.
u. a—Ulnar area.
d. a—Discoidal area.

LEGS.

c—Coxa.
tr—Trochanter.
f—Femur.
ti—Tibia.
ta—Tarsus.
p—Pads of tarsus.
un—Ungues of tarsus.
pv—Pulvilli of tarsus.
au—Auditory organ.



INTERNAL STRUCTURE.

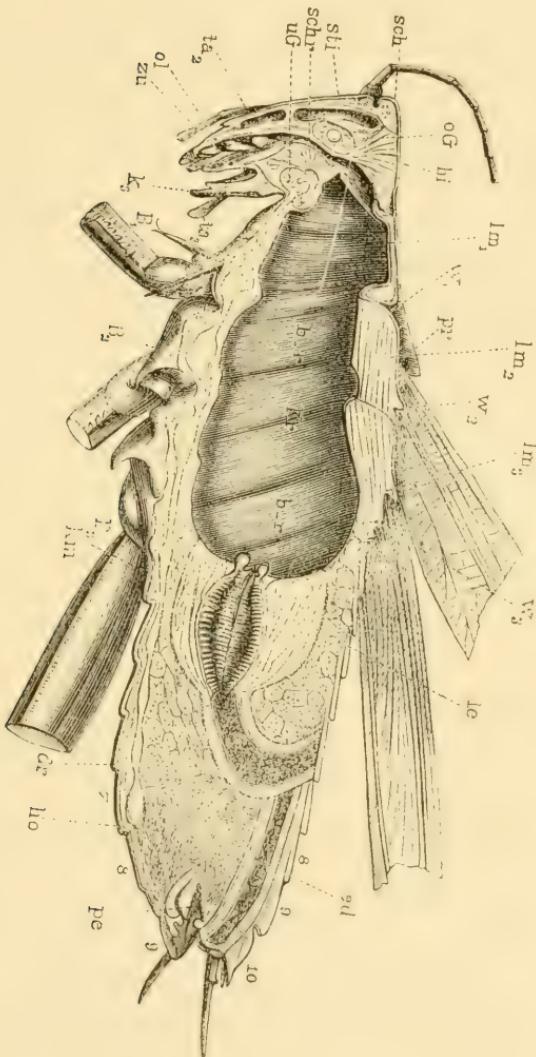


Fig. 40.—Longitudinal section through a male grasshopper (*Locusta viridisima L.*).—*hi*, occiput; *sch*, vertex; *sti*, frons; *ol*, labrum; *zu*, ligula; *schr*, oesophagus; *kr*, crop; *km*, gizzard; *le*, caecal pouch; *ed*, colon; *og*, supra, and *ng*, sub or intra-oesophageal ganglion; *b1*, *b2*, *b3*, thoracic ganglion; *ho*, testes; *dr*, glands of the same; *pe*, penis; *lm1*, *lm2*, *lm3*, muscles of the three parts of the thorax, the latter two moving the wing-covers and wings. After Gruber.

The illustration, Fig. 40, is a longitudinal section through a male grasshopper (*Locusta viridissima L.*), and shows most of the organs mentioned hereafter.

By fastening a locust, with the back uppermost under water and by cutting with a pair of fine-pointed scissors through the integument along the dorsal surface of the abdomen, the internal organs can be studied. Just below the integument on the dorsal surface of the abdomen, is seen a delicate tube, the *heart*. Just below the integument is a layer of small flat muscles, the *abdominal muscles*. By removing the dorsal integument of the thorax the *large alary muscles*, which move the wings, can be seen filling the dorsal portion of the meso- and metathorax. The muscles of the opposite sides of the body are sharply separated, and a thin chitinous partition runs down from the constriction between the meso- and metathorax, and separates the muscles of the wing-covers from those of the wings; a similar partition covers the posterior face of the wing-muscles. The space between the muscles of the abdomen and the viscera is filled with a loose network of light-colored substance, the *corpus adiposum*.

Running inward from the spiracles on the sides of the thoracic and abdominal segments are seen the tracheæ, rather tough transparent tubes, which divide into smaller branches passing to the various organs of the body. A spiral elastic fiber is coiled around the wall of each tracheal tube, which by its elasticity keeps the tube permanently open.

THE RESPIRATORY SYSTEM.—In holding a locust between our fingers we can readily observe its mode of breathing. The portion of the side of the body between the stigmata and the pleura (Fig. 36), contracts and expands, the contraction causing the spiracles to open. About 65 contractions per minute can be counted. This movement is caused by the fact that the sternal portion of the abdomen moves much more decidedly than the tergal one.

AIR SACKS.—Insects possessing great powers of flight are

especially equipped for this purpose with a large number of air sacks. Such organs are found in largest numbers in those that sail for many hours in the air, hence they are more numerous in the migratory locusts than in other members of the orthoptera or in bees and flies. By possessing such air sacks the locust can buoy itself up in the air, and as it constantly fills and refills these balloons without any great muscular exertion, it is easily borne along by favorable winds. The air sacks are intimately connected with the complicated system of air-tubes, or *tracheæ*, which ramify throughout the body; the air enters these tubes through a row of spiracles or breathing-holes (*stigmata*) located in the sides of the body. In locusts are found two pairs of thoracic and eight pairs of abdominal spiracles. The system of thoracic air-tubes, which is entirely independent of that of the abdomen, is not easily made out. The tubes arising from the two thoracic stigmata send out two well-defined tracheæ into the head, which subdivide and form the ocular air-sacks and some smaller ones in the front of the head. The five pairs of large abdominal air-sacks are derived directly from the spiracles; they can be readily seen by removing the integument from the back of the locust. There is also a large pair of air-sacks in the mesothorax, and two enormous ones in the prothorax. A number of smaller air-sacks are buried among the muscles, while others, spindle-shaped ones, occur in the end of the abdomen. As the process of respiration is much more easily performed in clear and sunny weather, we find locusts flying only at such times; in cloudy or damp weather, or after the sun sets, they are less active.

THE DIGESTIVE ORGANS.—These are quite dark in color, and vary slightly in structure according to the genus. The following description is true only of the genus *Schistocerca*. By removing the corpus adiposum, the wing-muscles and the heart, the *œsophagus* (Fig. 41, *oes*) is seen to be a tough, dark-brown, cylindrical tube, which runs up from the mouth,

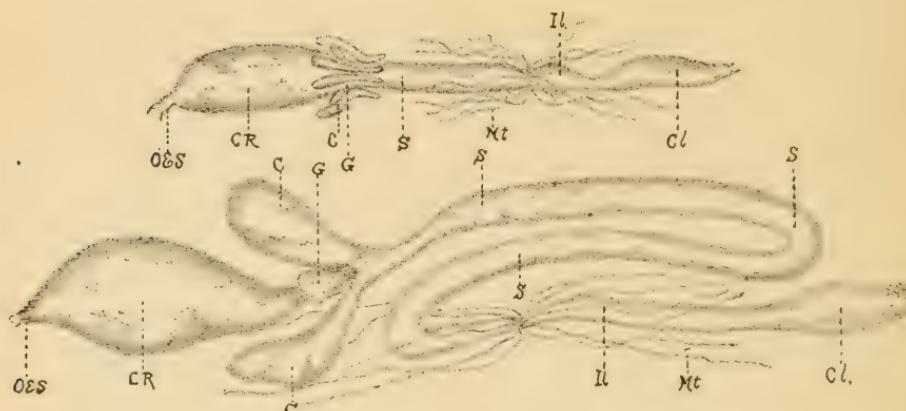


Fig. 41.—Digestive organs of a locust (above) and of a katydid or grasshopper (below). *Oes*, oesophagus; *cr*, crop; *G*, gizzard; *c*, caecal pouch and tubes; *S*, stomach; *mt*, malpighian tubes; *Ii*, ileum; *cl*, colon. Original.

and then bends at right angles, and passes into the thorax. In the mesothorax the oesophagus gradually enlarges to form a thick-walled pouch, the crop or *ingluvies* (*cr*), which occupies the meso- and metathoracic segments. On the sides of the anterior end of the *ingluvies* are the delicate, white, dendritic, *salivary glands*, which communicate with two *salivary ducts*, one of which runs forward on each side of the oesophagus into the head. Running back from the posterior end of the *ingluvies* to the seventh abdominal segment is a large cylindrical pouch, the *proventriculus* or gizzard (*G*). Its anterior end is about as large as the posterior end of the *ingluvies*, and its posterior end is much smaller. Surrounding the spot, where these two chambers join each other, are sixteen transparent cone-shaped pouches, the *pyloric* or *caecal pouches*, (*c*), placed base to base in such a way as to form a belt of eight fusiform pouches around the digestive tract. If the tracheæ, which bind them to the digestive tract, are removed it will be found that the pointed ends are free, eight of them running forewards on the sides of the *ingluvies*, and eight backwards on the *proventriculus*. Occupying the seventh, eighth and ninth abdominal segments is the *ventriculus*, or true stomach, (*S*) much smaller than the pro-

ventriculus, regularly cylindrical and abruptly constricted posteriorly, where it joins the *intestine*. Twined around the ventriculus are great numbers of small white tubes, the *malpighian tubes* (*mt*), which open into the ventriculus where it joins the proventriculus. The *ileum* (*il*), or small intestine, is a delicate, light-colored tube, which originates at the posterior end of the ventriculus, and bends abruptly upwards toward the dorsal surface, where it abruptly enlarges to form the *colon* (*cl*), a small, white, sacculated pouch, which lies directly below the terga of the ninth and tenth segments. From this a very short, narrow, *rectum* runs backward to the *anus*, which is situated between the podical plates on the lower surface of the eleventh tergum.

THE REPRODUCTIVE ORGANS.—The ovary is a long, white gland, situated above the ventriculus and proventriculus; it is made up of two sets of tubes or *ovarioles*, which are bound together into a compact mass. When this mass is carefully examined with a lens the two sets of tubes will be seen to run upwards, forwards and towards the median line. Near the posterior end of the ovary these tubes communicate with two delicate, transparent, *oviducts*, which run down around the posterior end of the ventriculus, to the ventral surface of the body. Here they unite to form a single median tube, the *vagina*, which opens externally upon the upper surface of the subgenital plate. On the median line between the internal plates of the ovi-positioner, there is a second much smaller external orifice, which opens into a small white pouch, the *spermatheca*, which lies above the posterior end of the vagina.

THE NERVOUS SYSTEM.—On each arch of the ingluvies is found a small, white, stellate spot, the *gastric ganglion*, radiating from which are a number of small nerves and a larger commissure, which may be traced forewards into the head, where it joins the *supra-oesophageal ganglia*, (Fig. 40, *oG*), which are situated between the eyes, in the upper surface of the oesophagus. From them a pair of short commis-

sures run down, forming a collar around the oesophagus to the ventral *nerve-chain*. This consists of commissural fibres, with the following ganglionic enlargements: A *sub-oesophageal ganglion*, (Fig. 40, *uG*), situated in the head, and sending nerves to the mouth-parts; one ganglion for each thoracic segment; four abdominal ganglia, one in the second, one in the fourth, one in the sixth, and one in the seventh segment. On each side of the nerve-chain, in the second and third thoracic and the first to seventh abdominal segments, are found *apodemata*, or projections from the sterna which support the nerve-chain.

METAMORPHOSES.

Like all other insects, the orthoptera, in growing, have to throw off their old skins and replace them with new and more commodious ones. In some orders the forms assumed after the various molts differ greatly; in butterflies, for instance, the caterpillars do not in the least resemble their parents, and the chrysalids or pupæ neither look like butterflies nor like caterpillars. All members of the order of orthoptera pass through an incomplete metamorphosis, i. e. the young insects differ but slightly from the adult ones. In the locusts the most striking differences are the absence of wings and the narrower and flattened prothorax, which is much more roof-like than in the adult. The abdomen is also quite different and more roof-shaped. The winged form is gradually assumed through a series of molts, varying from three or four to six. Species in which the wings are either entirely wanting, or that possess only rudimentary ones, generally pass through fewer molts than those having large wings when adult. The wings first appear as small wing-pads, which gradually become larger and larger, as may be seen in the illustration, (Fig. 42). As soon as the wings appear, the insect ceases to grow. There is no state of quiescence or rest in orthopterous insects as with insects that undergo a complete metamorphosis, and the



Fig. 42.—Early stages of Rocky Mountain Locust. After Riley.

species is always wingless the differences, except in size, between a newly hatched and a mature insect are sometimes very slight. Other species have in the adult stage only rudimentary wings and thus they resemble the pupal stage. It is, however, always easy to determine whether such an insect is an adult or not, as the wing-pads in the nymph are twisted in such a manner that, when closed, they are reversed and the inner surface in the imago is the outer surface in the pupa; the rudimentary lower wings are outside of the upper ones, instead of beneath. A trained eye can detect many other differences. The sexual characters are not well marked in the younger or first three stages; later the differences become apparent. Orthoptera being like all other insects enclosed in a rigid armor of a substance that will neither stretch nor grow, have to shed this skin from time to time. A locust, when ready to do so, quits feeding for a time and remains inactive during the process. In the First Annual Report of the U. S. Entomological Commission the following description is given of the last molt—from the pupa to the winged insect.

"When about to acquire wings the pupa crawls up some post, weed, grass-stalk, or other object, and clutches such object securely with the hind feet, which are drawn up under the body. In doing so the favorite position is with the head downward, though this is by no means essential. Remaining motionless in this position for several hours, with antennae drawn down over the face, and the whole aspect betokening helplessness, the thorax, especially the wing-

nymph or pupa is as active and hungry as the imago, and differs from it only by possessing but rudimentary wings and genitalia. The latter are, however, in some cases sufficiently developed to permit coition. In cases where the

pads, is noticed to swell. Presently the skin along this swollen portion splits right along the middle of the head and thorax, starting by a transverse, curved suture between the eyes, and ending at the base of the abdomen.

"Let us now imagine that we are watching one from the moment of this splitting, and when it presents the appearance of Fig. 43 *a*. As soon as the skin is split, the soft and white fore-body and head swell and gradually extrude more and more by a series of muscular contortions; the new head slowly emerges from the old skin, which, with its empty eyes, is worked back beneath, and the new feelers and legs are being drawn from their casings and the future wings from their sheaths. At the end of six or seven minutes our locust—no longer pupa and not yet imago—looks as in Fig. 43 *b*, the front four pupa-legs being generally detached and the insect hanging by the hooks of the hind feet, which were anchored while yet it had that command over them which it has now lost. The receding skin is transparent and loosened, especially from the extremities. In six or seven minutes more of arduous labor—of swelling and contracting—with an occasional brief respite, the antennæ and the front four legs are freed, and the fulled and crimped wings extricated. The soft front legs rapidly stiffen, and, holding to its support as well as may be with these, the nascent locust employs

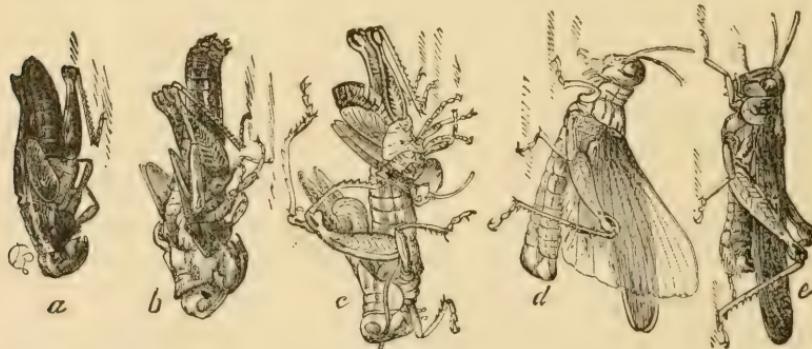


Fig. 43.—Molting of a locust (*Melanoplus spretus*).—*a*, nymph ready to change; *b*, the skin split along the back and the adult emerging; *c*, continues the process; and at *d*, the adult insect drying out; *e*, perfect adult. After Riley.

whatever muscular force it is capable of to draw out the end of the abdomen and its long hind legs (Fig. 43c). This in a few more minutes it finally does and with gait as unsteady as that of a new-dropped colt, it turns round and clammers up the side of the shrunken, cast-off skin, and there rests while the wings expand and every part of the body hardens and gains strength—the crooked wings straightening and the wings unfolding and expanding like the petals of some pale flower. The front wings are first rolled longitudinally to a point, and as they expand and unroll, the hind wings, which are tucked and gathered along the veins, at first curl over them. In ten or fifteen minutes from the time of extrication these wings are fully expanded and hang down like dampened rags. From this point on, the broad hind wings begin to fold up like fans beneath the narrower front ones, and in another ten minutes they have assumed the normal attitude of rest. Meanwhile the pale colors which always belong to the insect while molting have been gradually giving way to the natural tints, and at this stage our new-fledged locust presents an aspect fresh and bright. If now we examine the cast-off skin, we shall find every part entire with the exception of the rupture which originally took place on the back; and it would puzzle one who had not witnessed the operation to divine how the stiff hind shanks of the mature insect had been extricated from the bent skeleton left behind. They were in fact drawn over the bent knee-joint, so that during the process they were doubled throughout their length. They were as supple at the time as an oil-soaked string, and for some time after extrication they show the effects of this severe bending by their curved appearance.

"The molting, from the bursting of the pupa skin to the full adjustment of the wings and straightening of the legs of the perfect insect, occupies less than three quarters of an hour, and sometimes but half an hour. It takes place most frequently during the warmer part of the morning, and within an hour after the wings are once in position the parts have

become sufficiently dry and stiffened to enable the insect to move about with ease; and in another hour, with appetite sharpened by long fast, it joins its voracious comrades and tries its new jaws. The molting period, especially the last, is a very critical one, and during the helplessness that belongs to it the unfortunate locust falls a prey to many enemies which otherwise would not molest it, and not infrequently to the voracity of the more active individuals of its own species."

The first three skins are most frequently shed on or near the ground, under grass in little depressions, or under any other shelter that may offer. The last molts take place above the ground, as the insects like to fasten to some elevated object. The body is very soft and colorless after each molt, but soon hardens and shows the characteristic colors and markings of the species.

STRIDULATING ORGANS AND THE EAR.

Many of the orthopterous insects are musicians. Only earwigs, cockroaches, walking-sticks and praying-mantes possess no organs to produce sounds. The females of all orthopterous insects are voiceless. Such sounds do not correspond to our voice, as they are simply produced by friction. The organs by which such stridulating sounds are made are different in different families; they are very simple in some, but complex in others. The true locusts (*Acrididae*) produce sounds by rubbing the inner surface of the hind legs against the outer surface of the wing-covers. "With these insects there is a thickening of one of the main longitudinal veins in the center of the wing-cover (*vena radialis*), and a remarkable extension of the two areas between this vein and the costal margin of the wing-cover (*area scapularis* and *area externomedia*), which serves as a sounding board and which is wanting in the female. The most common representatives of the insects which stridulate in this

way belong to the genus *Stenobothrus*." Fig. 44 shows the teeth on the inside of the femur of the hind leg, which are scraped against the veins of the tegmina. An enlarged view

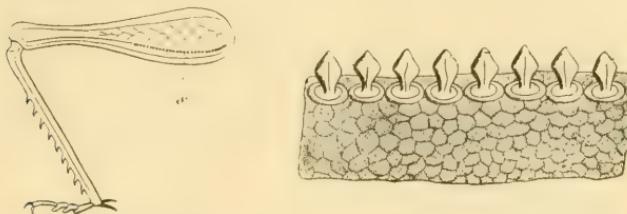


Fig. 44.—Hind leg of *Stenobothrus*; *s*, ridge with teeth. Ridge and teeth greatly enlarged. After Landois.

of these teeth is also given. According to Scudder, the *Stenobothri*, when about to stridulate, place themselves in a nearly horizontal position, with the head a little elevated; then they raise both hind legs at once, and grating the femora against the outer surface of the tegima, produce notes which in the different species vary in rapidity, number and duration. The first one or two movements are frequently noiseless or faint; and when the sky is overcast, the movements are less rapid. Prof. Scudder has recorded the songs of several species by means of a musical notation. The species of locusts that belong to the family of *Œdipodinae* produce sounds by rubbing together the upper surface of the front edge of the wings and the under surface of the wing-covers. Such insects produce sounds only while on the wing. When we watch the common large bright-colored locust that is so abundant during the summer upon roads and sandy spots and that often remains stationary while on the wing, we can see that the wing-covers are held almost motionless in a perpendicular position, while the large and fan-like lower wings are fully expanded, and are rapidly moved up and down. The longitudinal veins of the lower wings are well developed, and as the anterior vein strikes the upper wing while flying, a rattling sound is produced. In some cases both sexes can make such sounds. Landois

has studied in detail the organs that produce sounds in insects, and some of the illustrations are copied from his paper.

The Meadow Grasshoppers, Katydids and Tree-Crickets produce sounds in a different way from the locusts. Here also the males alone can produce love songs and they alone possess peculiar organs for this purpose. The upper wings of the male are entirely different from those of the female, which have the usual form. In the male large veins divide

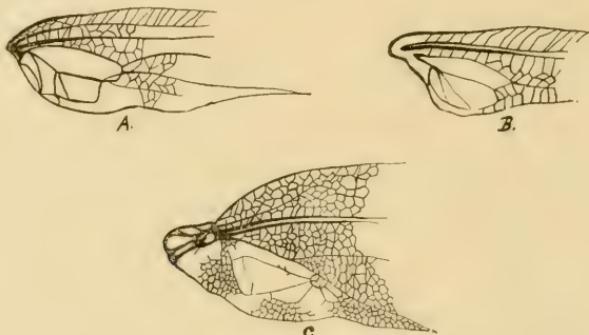


Fig. 45.—Wings of male grasshoppers.—A, *Orchelimum agile*; B, *Xiphidium fasciatum*; C, *Amblycorypha oblongilolia*. Original.

the wing into disk-like or drum-like spaces. Fig. 45 shows the upper wings of three species of grasshoppers, and Fig. 46

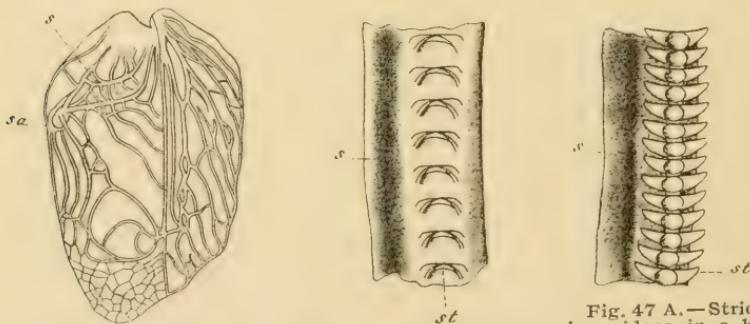


Fig. 46.—Wings of male cricket; s, vein with teeth; sa, scraper. After Landois.

Fig. 47.—Stridulating ridges in a field cricket. After Landois.

Fig. 47 A.—Stridulating ridges in a house-cricket; s, stridulating ridge; st, stridulating teeth. After Landois.

the upper wing of a cricket. The principal vein extending diagonally across the base of the wing, is furnished with

transverse ridges like a file. These ridges are also shown; their armature varies in the different species. On the inner margin of the wing is a hardened and elevated space or scraper, hence each upper wing is provided with a file and a scraper, the latter covered with short and stiff bristles. Fig. 48 shows the scraper at s, and the

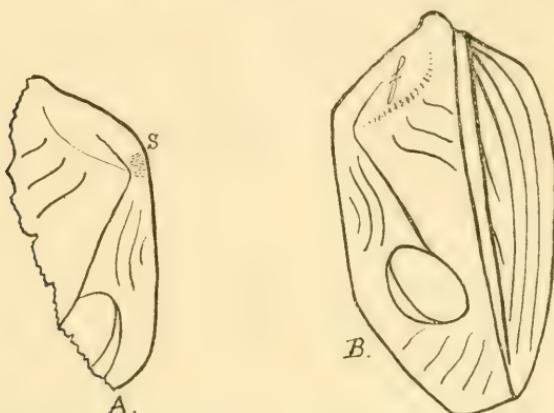


Fig. 48.—Stridulating organs (file and scraper) of *Gryllus abbreviatus*. A, dorsal surface; s, scraper formed of bristles; B, ventral surface; f, file. Original.

files at f. By elevating the upper wing at an angle of about forty-five degrees with the body, the scraper of one wing rests on the file of the other, and by moving the wings they rasp on each other. The sound is strengthened by the vibrating wings, which act as sounding-boards. The illustrations (Fig. 48) show the organs greatly enlarged. If insects produce sounds they must be able to hear them, otherwise the male locusts, grasshoppers and crickets would sing in vain, and we find in many cases in both sexes of those insects, organs that have most probably a function very similar to that of our ears; but we must not look for such organs where we are apt to expect them to be. The locusts have their ears on the first joint of the abdomen (Fig. 37), while the grasshoppers and crickets have them near the upper part of the front tibiae (Fig. 37 and 174, c-f). All three families of stridulating orthoptera raise the

wings at the time of producing sound by vibrating them, in fact almost the whole body vibrates—is a sort of sounding-board. Both actions strengthen the sounds. We can do the same thing if we vibrate the strings of a guitar and swing the instrument in the air; in this manner we imitate the sounds of bells, in other words, increase the sounds. It is also a well known fact that the pitch of a sound depends upon the number of vibrations. Knowing the number of vibrations we can judge from the sounds how many were made to produce them. If, for instance, a fly produces during flight the sound f' , it had to make 352 beats of the wings per second to do so. If our honey-bee is active the sound a' is produced during flight, or 440 beats per second; if tired e' is produced, or 336 beats per second.

Some insects also produce sounds to communicate with others of their kind. If we put some honey near the entrance of a bee-hive some of the bees will soon discover it, and they immediately call others to this valuable Klondyke of honey by producing the sounds a'' , h'' , or c'' , according to their size. These sounds will invariably call many bees from the hive, and the honey is soon stored away in safer quarters.

ORTHOPTERA OF MINNESOTA.

The members of this order are, almost without exception, injurious to agriculture, horticulture and forestry, and some of them have become a very annoying pest in our houses. When we listen during the warm nights of summer to the songs of our arboreal Katydids, to the chirping sounds of crickets, or to the shriller tones produced by locusts and grasshoppers, we are apt to forget that insects forming this order of insects belong to the most terrible scourges known to man. The older inhabitants of our state are not apt to forget, however, the devastations caused by the great swarms of migratory locusts in the past, while more recently farmers in various parts of the state had to

complain more than once about the losses inflicted by such insects.

With the exception of a single family of Orthoptera, the Praying Mantises, Rear-horses or Soothsayers (*Mantidae*), all the insects forming this order are more or less injurious to vegetation, and as insects of the above family are not found in our state it may be stated that all are injurious, and that all demand the careful attention of the practical farmer and of the student of agriculture and allied pursuits.

CHARACTERS OF THE ORDER ORTHOPTERA.

The Orthoptera form a very compact and natural order if we omit the small family of Earwigs (*Forficulidae*), as has been done by many writers, and the characters of the members of this order may be briefly stated as follows: They possess four wings, of which the first or upper pair are thick, leathery or parchment-like, overlapping while at rest, and forming protecting covers for the much more delicate second or lower pair of wings, which are thinner and folded longitudinally like a fan. The fore-wings or tegmina are not used in flight, the hind wings are the true organs for this purpose. Not all Orthoptera possess well developed wings, and there are some wingless genera and species in this order; in some cases the anterior wings are only rudimentary or wanting. The mouth-parts are formed for biting and chewing food. The metamorphosis is incomplete, i. e. insects belonging to this order have no period of inactivity from the moment they are hatched to their adult state, and the young insect always resembles the adult one or imago except in size and the absence of wings and perfect sexual organs.

The name Orthoptera is derived from two Greek words, i. e. *orthos*—straight, and *pteron*—a wing.

CLASSIFICATION OF ORTHOPTERA.

Prof. Comstock* divides this order into seven families, which are grouped in five sections. Each of the first four sections contain but a single family, the fifth one includes the three remaining ones. The names of the sections, with the exception of the first one, were suggested by the form of the legs. The following are the names of the sections and of the families they include:

- I. *Dermoptera*; includes the *Forficulidae* or EARWIGS.
- II. *Cursoria* or Runners; includes the *Blattidae* or COCKROACHES.
- III. *Raptatoria* or Graspers; includes the *Mantidae* or REAR-HORSES.
- IV. *Ambulatoria* or Walkers; includes the *Phasmidae* or WALKING-STICKS.
- V. *Saltatoria* or Jumpers; includes the *Acrididae* or LOUCSTS or SHORT-HORNED GRASSHOPPERS, the *Locustidae* or LONG-HORNED GRASSHOPPERS and KATYDIDS, and the *Gryllidae* or CRICKETS.

Prof. Scudder,** our highest authority on this order of insects, whether recent or fossil, also arranges them in the above seven families.

With the exception of the Rear-horses (*Mantidae*) all the families are represented by one or many species.

To enable the student to recognize the different families, the following table is quoted from Prof. Comstock's Introduction:

TABLE OF FAMILIES OF ORTHOPTERA.

- A. Posterior femora fitted for walking, i. e. resembling those of the other legs; ovipositor with the subgenital plate concealed; organs of flight of immature forms in normal position; insects mute.

*An Introduction to Entomology, by John Henry Comstock, 1888.

**Guide to the Genera and Classification of the N. A. Orthoptera, by Samuel Hubbard Scudder, 1897.

- B. Anterior wings leathery, very short, without veins, meeting in a straight line; posterior wings, when present, folded to the middle of the anterior margin; tarsi three-jointed, the pulvilli wanting; cerci horny, resembling forceps. 1. *Forficulidae*.
- BB. Anterior wings parchment-like, thickly veined; posterior wings folded to the base; tarsi five-jointed; cerci soft, jointed or without joints.
- C. Body oval, depressed; head wholly or almost wholly withdrawn beneath the pronotum; pronotum shield-like, transverse; legs compressed; cerci jointed; rapidly running insects.
 - 2. *Blattidae*.
- CC. Body elongated; head free; pronotum elongated; legs slender, rounded; cerci jointed or without joints; walking insects.
- D. Front legs fitted for grasping; cerci jointed.
 - 3. *Mantidae*.
- DD. Front legs simple; cerci without joints.
 - 4. *Phasmidae*.
- AA. Posterior femora fitted for jumping, i. e. very much stouter or very much longer, or both stouter and longer than the middle femora; ovipositor horny, free (except with the Mole crickets); organs of flight of immature forms inverted; stridulating insects.
- B. Antennæ short; tarsi three-jointed; supposed organs of hearing situated in the first abdominal segment; ovipositor short, composed of four separate plates; stridulating organs situated in hind femora and the costal area of the tegmina.
 - 5. *Acrididae*.
- BB. Antennæ long, setaceous; tarsi four or three-jointed; supposed organs of hearing situated in the anterior tibiæ and also in the prosternum; ovipositor elongated (except in the Mole crickets); composed of four connate plates.

C. Tarsi four-jointed; ovipositor (when exerted) forming a strongly compressed, generally sword-shaped blade; the stridulating organs of male limited to the anal area of the tegmina.

6. *Locustidae*.

CC. Tarsi three-jointed; ovipositor (when exerted) forming a nearly cylindrical, straight, or occasionally up-curved needle; the stridulating organs of the male extend across the anal and median areas of the tegmina.

7. *Gryllidae*.

Prof. Fernald* gives a very handy short table to separate the New England Orthoptera into families, in which each figure on the right leads to the same one on the left:

1	Hind legs longest; hind femora thickened; (jumpers)..	4
	Legs of nearly equal length; hind femora not thickened (runners).....	2
2	Abdomen with forceps-like appendage at the end.....	<i>Forficulidae</i> .
	Abdomen without forceps at the end.....	3
3	Body oval and flattened.....	<i>Blattidae</i> .
	Body long and slender.....	<i>Phasmidæ</i> .
4	Antennæ shorter than the body.....	<i>Acrididæ</i> .
	Antennæ longer than the body.....	5
5	Wing-covers flat above, but bent sharply down at the sides.....	<i>Gryllidae</i> .
	Wing-covers sloping down on the sides..	<i>Locustidae</i> .

FAMILY I.

EARWIGS.

(*Forficulidae*).

These insects resemble beetles, and are so different from true orthoptera that many entomologists consider them as members of a different order, the *Dermaptera* or *Euplexoptera*.

They possess very small and leathery wing-covers or

*The Orthoptera of New England, by C. H. Fernald, A. M., Ph. D., 1888.

tegmina, without veins, which meet, as in beetles, in a straight line down the back; they cover partially the lower wings, which are furnished with a peculiar network of veins, as may be seen in the illustration (Fig. 49). These lower

wings are large when extended, and present a beautiful appearance with their numerous radiating veins, which in closing the wing act as the bars of a fan. When snugly hidden away under the small upper wing it is difficult

Fig. 49.—Wing of *Labia minor*.

to understand how such a large object can be folded up into such a small space. This is done by first folding the wing longitudinally, and a second time transversely. It is very amusing to watch an earwig folding or unfolding these wings, as it needs for this purpose the assistance of the horny cerci resembling forceps. The tarsi are composed of three joints, and no pulvilli are found between the claws.

But two species are found in Minnesota, where these insects are rare. Earwigs are nocturnal in their habits, hiding during the day among all sorts of litter and in cracks and crevices. Sometimes they are attracted into houses by bright light. In Europe such insects are very abundant and prove sometimes injurious, especially to ripe fruit and to flowers in greenhouses. They are strictly vegetable feeders and are very fond of such sweet material as ripe fruit and the corollas of flowers, etc. When abundant they are caught below flower-pots and in other hollow objects, as the stems of sun-flowers, into which they crawl to hide during the day. Some people are very much afraid of such little insects; they believe that they will enter the ears and cause them all sorts of serious trouble. Of course such notions are nonsensical, and the insect, notwithstanding its formidable appearance, lacks the power of doing such harm; it may simply enter an ear as the first dark shelter that offers, if it is dislodged from its hiding place.



The female earwig lays a cluster of small, oval, yellowish and opaque eggs under a fallen leaf or under any other shaded object, and then nestles upon it as a hen on her eggs; she also protects the young for sometime after being hatched.

In the tropics large numbers of such insects are found; some of them are brightly colored, and decidedly ferocious in appearance, especially the males, which possess formidable looking forceps, those of the female being usually smaller and more simple.

Two genera, each represented by one species, occur in our state.*

GENUS *Labia* Leach.

Body small and convex; head moderately large; antennæ composed of from 10 to 15 joints, the sixth joint being plainly oboconic. Pronotum somewhat smaller than the head; wing-covers always present, though the wings are sometimes wanting. Abdomen somewhat widened in the middle; the last segment much longer than the others, and armed with a pair of forceps, separated at the base in the males, but not separated in the females. Legs comparatively short; the first joint of the tarsi as long as the other two, the simple and compressed second one is the shortest.

THE LITTLE EARWIG.

(*Labia minor* Linn.).

Head and sides of abdomen nearly black; mouth-parts, antennæ, thorax, wing-covers, exposed parts of the lower wings, and the middle of the upper side

Fig. 50.—*Labia minor*. Original.



*In studying the structure of the single and mutilated specimen of a second genus, the former was destroyed, hence only one genus could be described and illustrated. More material is needed for this purpose.

of the abdomen, yellowish-brown; the last segment of the abdomen and the forceps, reddish-brown. Legs and last two joints of the antennæ honey-yellow. The entire surface of the body is covered with fine and short hairs. The illustration, (Fig. 30), shows this insect greatly enlarged; the natural size is also given.

The only specimens collected in Minnesota were attracted to light, but as most of our windows are fitted with wire screens to exclude insects, earwigs may be more common than they appear to be. While tenting in July large numbers of this species were seen, attracted to the camp-fires, but none were secured at the time.

FAMILY II.

COCKROACHES.

(*Blattidae**).

These well-known insects possess an oval and usually very much depressed body, with the nearly horizontal head almost entirely withdrawn below the shield-like pronotum; the head is bent down in such a manner that the powerful mouth-parts, with their strong and biting jaws, project backwards between the bases of the first pair of legs. Besides the large eyes there are usually two rudimentary ocelli. The antennæ are very long and slender, often having upwards of hundred joints; the legs are long, armed with numerous bristles.

Cockroaches are by no means uncommon in our state, and some species, which are frequently called "Croton bugs" and "Black beetles," are well known household pests. Other species are found under rubbish, loose bark, about ant-hills, and, though common, are not often seen, as all cockroaches are more or less nocturnal insects. Some of the native species are attracted to light, others to sweetish fluids left out of doors. Cockroaches are general feeders, and the domestic species injure all kinds of provisions; they also

**Blatta*, a cockroach.

quite often spoil the covers of books by eating the size or paste used in bindings. Glue under postage stamps and similar things is frequently eaten by them. In more southern regions they become much more destructive. Blackened boots are ruined by them over night, as they devour the upper surface of the leather to obtain the molasses used in making blacking; they also gnaw off the upper surface of toe-nails of sleeping persons and even remove the eye-lashes of sleeping infants.

They are very fond of damp and warm situations, hence those invading our houses are most numerous in kitchens and especially in the vicinity of steam and water pipes. Their peculiar flat shape enables them to enter even very narrow cracks, and on that account we find them sometimes very numerous below the baseboards in kitchens, or in the drawers of tables, etc. Whenever they occur in numbers their disgusting, fetid odor reveals their presence, and rooms inhabited by them can be recognized by this odor, which is very difficult to remove. In pantries crowded with these insects the dishes will possess this odor even after having been washed. But notwithstanding all these bad qualities they possess one redeeming character; they are said to devour bed-bugs.

Most cockroaches deposit their eggs in a purse-like pod called an *Ootheca* (Fig. 51).

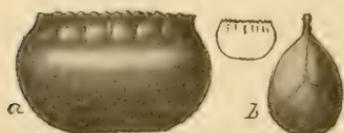


Fig. 51.—Ootheca of *Periplaneta orientalis*; *a*, side; *b*, end view. Natural size indicated by outline figure. From "Household Insects," published by U. S. Div. of Entomology.

This pod varies in the different genera in shape and size, but is usually more or less bean-shaped. It is divided into two rows of cells, each cell enclosing one egg, and pos-

sesses at the upper ridge a longitudinal slit, through which the young insects escape, frequently assisted by their mother. Such a brownish bean-like pod is frequently seen protruding from the end of the abdomen of a female, the latter carrying it until the eggs are ready to hatch. In some

cases living young are produced, but none of our native species have this habit. All young cockroaches resemble their parents in form, but are wholly wingless, the wings not appearing until after the fifth or last molt.

To the paleontologist, interested in tracing back the ancestry of insects, the *Blattidae* are a group of surpassing interest, as the oldest known insect is a cockroach described from the Middle Silurian of France. About eighty fossil species of this family are known. Prof. S. H. Scudder, our eminent authority on fossil and recent orthoptera, says of the cockroach: "Of no other type of insects can it be said that it occurs at every horizon where insects have been found in any numbers; in no group whatever can the changes wrought by time be so carefully and completely studied as here; none other has furnished more important evidence concerning the phylogeny of insects."

SYNOPSIS OF THE GENERA.

Prof. Fernald gives the following synopsis:

- | | |
|---|---|
| 1 | Sub-anal styles wanting in the males; last joint of the abdomen of the female not divided..... <i>Blatta</i> .
Sub-anal styles present in the males; last joint of the abdomen of the female divided.....2 |
| 2 | Supra-anal plate fissured..... <i>Periplaneta</i> .
Supra-anal plate not fissured..... <i>Platamodes</i> . |

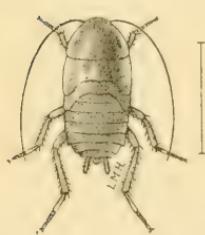


Fig. 52. — Unwinged Cockroach. Original.

Prof. Scudder, in his "Guide to Orthoptera," has divided this order into seven sub-families, two of which are found in our state, the *Blattinæ* containing the genera *Ischnoptera* (*Platamodes*) and *Blatta*, and the *Periplanetinæ*, the genus *Periplaneta*. A number of un-winged species of cockroaches occur in Minnesota under loose bark, but have not been studied. They are more or less active during warm days in winter, and not easily captured even then. One is shown in Fig. 52.

GENUS *Blatta*, Linn.

Insects belonging here possess a pad (*pulvillus*) between the claws of the feet; the seventh sternum of the abdomen is entire in both sexes; the sub-anal styles are rudimentary in the males.

THE CROTON BUG.

(*Blatta germanica* Fab.).

Few insects are better known than this household pest, which now occurs almost everywhere, not alone in the larger cities but in the smaller ones as well. Originally from the Orient it found a home long ago in Europe, and has since spread to all civilized regions of the globe. As nearly all vessels, and especially steamers, offer numerous shelters near steam and water pipes, these insects can readily spread from port to port. The name "Croton bug" originated in the City of New York, and was suggested by the fact that the insects became very numerous in houses containing water pipes connected with the Croton aqueduct.

The insects are light brown or dull yellowish, with a yellowish brown head and long yellowish antennæ; the pronotum is marked with two longitudinal black stripes. The wing-covers and wings extend beyond the tip of the abdomen.

About 36 eggs are enclosed in a capsule, which is carried about for a long time by the mother. It is stated that when the young cockroaches hatch, the mother assists them to escape from the oötheca. The young insects are perfectly white at first, but soon acquire their normal color. They have to shed their skins six times before they reach their full size, which takes from four to five months. After each molt the still soft insects are white, and are frequently called "Albino roaches." Although nocturnal in their habits they do not avoid the daylight as much as other species of cockroaches, and may frequently be seen moving about during

the day. These insects feed on almost everything, but seem to prefer wheat bread; they also delight to "sleep and board" among crackers, and these suffer severely during a long trip on board of a vessel. Libraries are often crowded with these insects, which find good shelters among the books, and here they cause sometimes much damage by gnawing the bindings of books bound in cloth. As most people living in houses frequented by these insects know them thoroughly well it is not necessary to give their life history in detail. This insect is much more active and wary than the larger kinds, and on that account more difficult to eradicate.

The insect illustrated in all stages in Fig. 53, measures from 11 to 13 mm. in length.



Fig. 53.—*Blatta germanica*; a, first stage; b, second stage; c, third stage; d, fourth stage; e, adult; f, adult female with egg-case; g, egg-case enlarged; h, adult with wings spread. All natural size except g. From "Household Insects," published by U. S. States Div. of Entomology.

GENUS *Periplaneta* Burmeister.

Last abdominal sternum of the female divided; sub-anal styles of the males well developed. Antennæ slim and tapering, longer than the body. Legs long and very spiny.

Wing-covers and wings extending beyond the end of the abdomen in both sexes.....*americana*.

Wing-covers and wings not reaching to the end of the abdomen in the males, rudimentary in the females..*orientalis*.

THE ORIENTAL COCKROACH OR BLACK BEETLE.

(*Periplaneta orientalis* Fab.)

This large insect is also a cosmopolite, inhabiting dwellings throughout the civilized world. It is a very dark brown, almost black and shining insect, with no bands or markings on the pronotum. Legs lighter in color than the body. In the male both wing-covers and wings are well developed, but do not quite reach the end of the abdomen; in the female the tegmina are very small, not more than one-fifth of an inch long, and no true wings are found beneath them. The illustration, (Fig. 54), shows this insect.

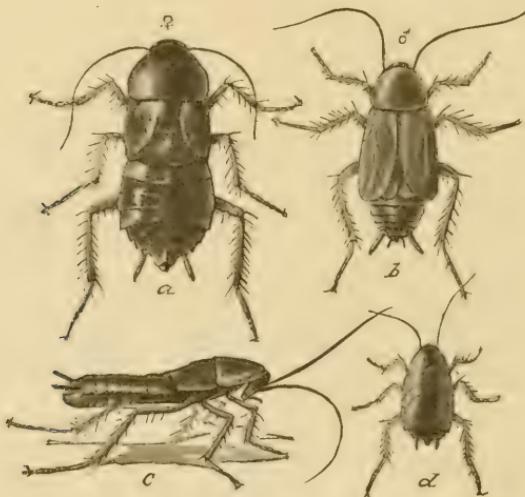


Fig. 54.—*Periplaneta orientalis*; a, female; b, male; c, side view of female; d, half-grown specimen. All natural sizes. From "Household Insects," published by U. S. Division of Entomology.

This species is very gregarious in habit, and many individuals, large and small, live together in colonies on the most friendly terms. The female deposits 16 eggs in two rows in a large and horny brown capsule, (Fig. 51), which is carried about for some time and is then dropped into a safe and warm place. The young roaches escape without assistance, and to enable them to do so they discharge a fluid that

softens the cement along the suture of the egg-capsule. The young, at first white, are very active, and feed, like their parents, upon any starchy food they can obtain. Flour, bread, meat, cheese, fruit, woolen clothes, even old leather, are not despised. The species is very shy, and is never seen during the day. It can become very destructive in stores and bakeries, where it defiles as much as it devours, and where its fetid odor becomes far from appetizing.

In Minnesota it is not found in large numbers. It seems as if the cold of our winters, which is sometimes rather severe, killed a large number of them every year, and thus kept it in check. Length, 20 to 23 mm.

THE AMERICAN COCKROACH.

(*Periplaneta americana* Fab.).

This is a native species, originating in tropical or subtropical America. It is illustrated in Fig. 55. It is reddish-

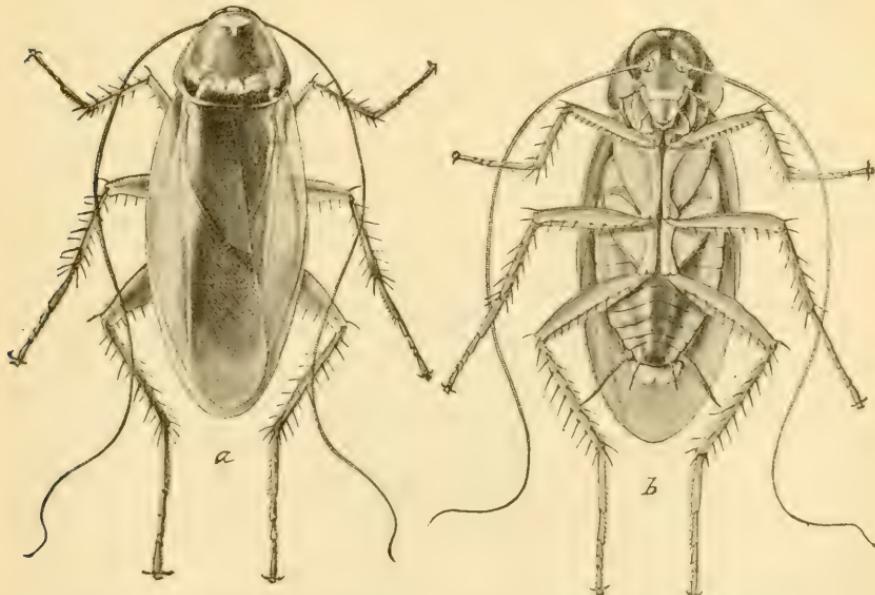


Fig. 55.—*Periplaneta americana*; a, view from above; b, from beneath; both enlarged one-third. From "Household Insects," published by U. S. Div. of Entomology.

brown, with paler and indistinct bands on the pronotum. The wings are unusually long, and both wing-covers and wings are well developed in both sexes, extending beyond the tip of the abdomen. The legs are much lighter in color than the body.

It is not often found in our houses, and only in larger cities. It seems that very severe cold will kill it; hence it is from time to time exterminated. It occurs most frequently in stores where bananas are kept and sold, and it is very likely that it is re-introduced every year with this fruit which also harbors many other things. [It will surprise the reader to hear that the following natural-history objects have been found hidden in banana bunches in the city of Minneapolis: a young snake (*Boa constrictor*), 14 inches long; a large crab, four inches across the back; two species of scorpions; several large thousand-legs (*Scolopendra*); some large and black cockroaches; several large and hairy bird-spiders, usually called tarantula, and many other smaller insects and other beings.]

The American cockroach is sometimes very injurious in greenhouses, where it destroys tender plants. Being found in large numbers on vessels it has found a home in many seaport towns in foreign countries.

THE AUSTRALIAN COCKROACH,

(*Periplaneta australasiae*),

resembles the American species very closely, but possesses a brighter and more clearly defined yellow band on the prothorax, and a yellow dash on the upper wings. Though more troublesome in the south it has also found a home in more northern regions, and is fast becoming a cosmopolitan. It may occur here from time to time, being introduced with goods from southern cities. This species is shown in Fig. 56.

As already mentioned, not infrequently foreign species of cockroaches are found hiding in bunches of bananas. As

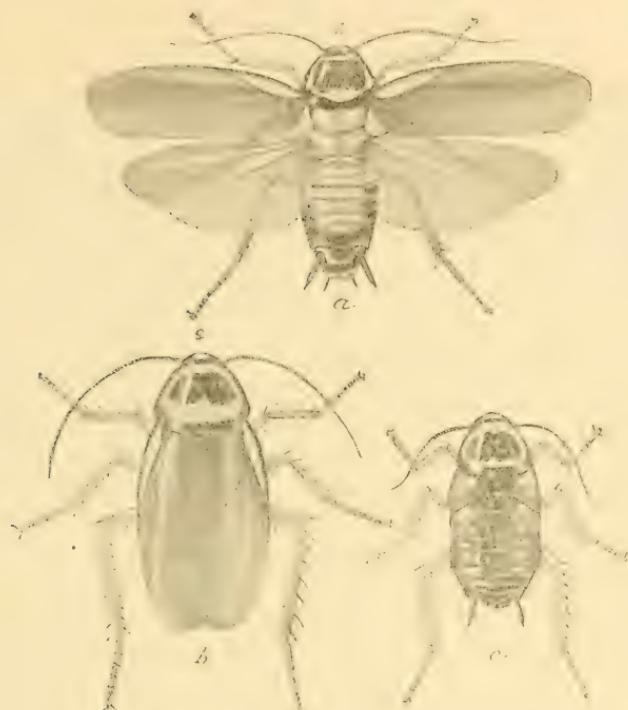


Fig. 56.—*Periplaneta australasiae*; a, male with spread wings b, female; c, pupa—all life size. From "Household Insects," published by U. S. Div. of Entomology.

a general rule they can not exist here and soon perish. The pupa of one species, *Nyctobora holosericea*, Burm., is shown in the illustration (Fig. 57).

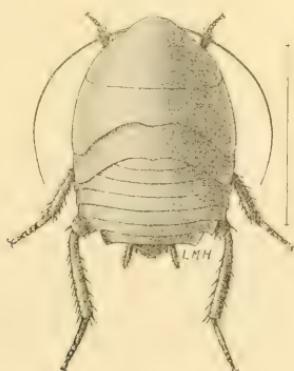


Fig. 57.—Pupa of *Nyctobora holosericea*. Original.

GENUS *Ischnoptera*.
(Platamodes Scudder).

A genus more closely allied to *Periplaneta* than to any other, but readily distinguishable from it by its much narrower and more elongated body, the sides being sub-parallel throughout their whole extent, while in *Periplaneta* the abdomen is much swollen. The wings and wing-covers extend beyond the abdomen, the latter being well rounded at the tip. The supra-anal plate is regularly rounded, but lacks altogether the fissuration seen in *Periplaneta*. The anal cerci are somewhat shorter and not so flattened as in *Periplaneta*, while the anal styles are very short, and turned abruptly downwards. In *Periplaneta* the sub-genital plate does not extend as far backward as the supra-anal. In *Ischnoptera* it extends backward farther. A further distinction between the two genera may be seen at the inner border of the eyes, which in *Ischnoptera* are nearly parallel, while in *Periplaneta* they approach one another anteriorly.

THE COMMON WOOD-COCKROACH.

(*Ischnoptera pennsylvanica* De G.).

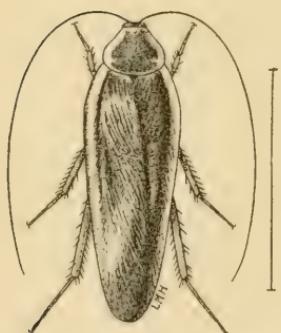


Fig. 58.—*Ischnoptera pennsylvanica*. Original.

This species, (Fig. 58), has long and delicate, light-colored wing-covers and wings which extend considerably beyond the tip of the abdomen. The margin of the pronotum is light, while the disk is dark; the lateral margins of the tegmina, especially at the base, are lighter than the discal portions.

It is a native of our woods, and is frequently found in July in our houses, being readily attracted to light.

Entomologists in the habit of "sugaring" for moths not infrequently find these roaches enjoying this sweet food. Length 25 mm. or more.

THE UNIFORM WOOD-COCKROACH.

(*Ischnoptera unicolor* Scud.).

Wings and wing-covers of a uniform, pale, shining, reddish-brown; color head and pronotum slightly darker, especially in the middle; abdomen darker above, especially on the borders; cerci dark brown; legs, especially the tibiae, darker than the body; eyes black; antennæ and palpi brown; antennæ reaching backwards to the tip of wing-covers. (Fig. 59).

These insects are not common, but are found occasionally late in June below loose bark in our forests.

THE NORTHERN WOOD-COCKROACH.

(*Ischnoptera borealis* Linn.).

It may also occur in our state, though no undoubted specimens have been found.

The family of cockroaches has not yet received the attention of entomologists and collectors, hence the species composing it are not as numerous as they will be in the future, when every part of our state has been thoroughly explored.

FAMILY III.

REAR-HORSES. PRAYING MANTIS.*

(*Mantidae*).

The peculiar insects forming this family are chiefly inhabitants of tropical countries, and but few species occur in the United States, and none in Minnesota. They are found, however, south of us not much beyond the northern part of Missouri. Wherever it occurs it attracts the attention of all observers, and even those not interested in such matters are apt to notice this grotesque insect, which assumes,

**Mantis*, a prophet; also Greek name for such insects

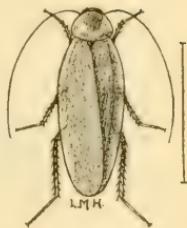


Fig. 59.—*Ischnoptera unicolor*.
Original.

when waiting for a victim, the position of prayer, as seen in the illustration, (Fig. 60). This peculiar position, as well

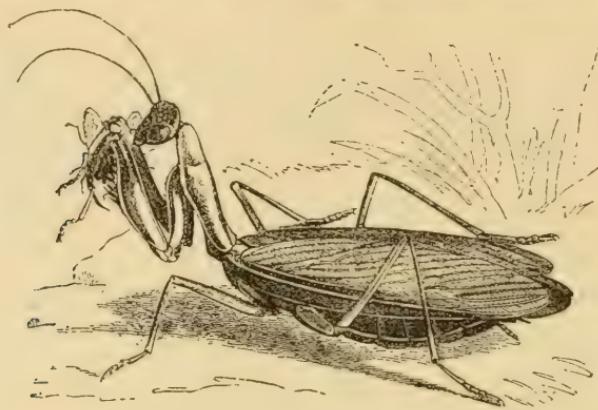


Fig. 60.—Praying Mantis.

as its strange motion of swaying to and fro the elongated front part of the body, and of assuming other strange attitudes, has procured it many popular names, some of which as peculiar as the insect itself. Rear-horse, Race-horse, Camel-cricket, Praying-mantis, Soothsayer, etc., are a few of them.

The elongated prothorax, which is the longest segment of the body, the enlarged front legs fitted for grasping, and in which the coxae are very greatly enlarged, the large and movable head loosely joined to a neck, are the most striking characters of this large insect. The wing-covers are brown or green, according to the sex, and are frequently highly colored and marked. The sexes differ considerably, the male being slender with long wings, while the female has only shorter ones, which can hardly be used for flight. As the insect is not a native of our state it is not necessary to give an extended description of it; the illustration is sufficient to show its essential features.

All the species of *Mantidæ* are carnivorous, but they do not pursue their prey as is usually the habit of such insects; they depend on their resemblance to twigs, leaves, etc., and

wait patiently for insects to come near, when they suddenly change their praying position to a preying one, and seize their unsuspecting victim with their terrible arms.

The eggs, which are laid in peculiar clusters on twigs and fences, are also encased in flattened oötheca, differing from those of the cockroaches by being composed of hardened silky matter. The ridiculous looking young insects are cannibals, and the old ones are the worst fighters on record, beating even the celebrated Kilkenny cats.

FAMILY IV.

WALKING-STICKS.

(*Phasmidæ**).

This family is also best represented in the tropics, where numerous species occur. Most of them possess very strange forms; some resemble fresh and green leaves, others look like old and withered ones, and still others resemble twigs very closely. The famous "Walking-leaf" is an insect that belongs to this family. On account of these peculiar shapes, insects of this kind are not readily seen, and thus escape their enemies among the feathered tribe. All are strictly vegetable feeders, hence can become injurious when found in large numbers upon useful plants. Several species occur in the United States, and one, which is illustrated in Fig. 61, is found in Minnesota.

Our American insects are spectre-like beings, possessing a linear body furnished with long legs and antennæ. Yet notwithstanding their long legs they are exceedingly slow in all their motions, and remain for a long time stationary.

Unlike other orthoptera mentioned thus far, their large and oval eggs are laid singly, not united with others in a capsule.

GENUS *Diapheromera* Gray.

Body long, slender and cylindrical. Head oval and slightly inclined. Antennæ long, slender, and composed of

**Phasma, a spectre.*

numerous joints, inserted in front of the eyes. Palpi short, cylindrical. Legs simple, the anterior pair similar to the others. Tarsi five-jointed. Elytra very short, or wanting.

THE COMMON WALKING-STICK.

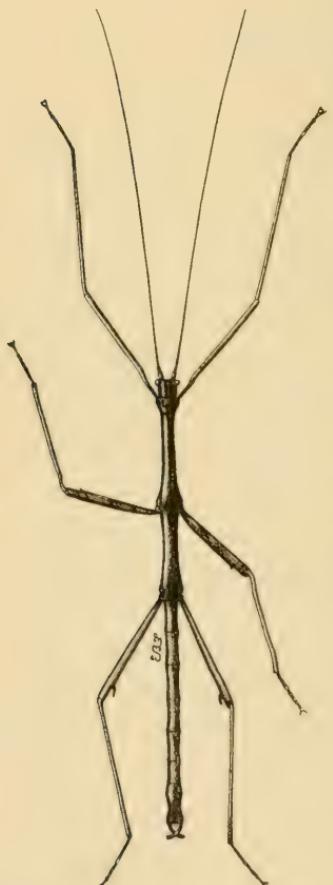
(*Diapheromera femorata* Say).

This is a very common insect in Minnesota, yet very few persons have ever seen it, and if it is shown to them they are greatly astonished to hear that it may be found in large

numbers during the autumn by beating bushes, especially of hazel and oak, over an inverted umbrella. The insect, (Fig. 61), is either greenish or greenish-brown. These colors vary, however, very greatly, the green color being dominant early in the season, while the brown color is more common later. The head of the male usually shows three brown stripes; that of the female two, one on each side, extending backwards from the base of the antennæ. With the exception of the anterior pair of legs the femora of all others are armed on the under side with stout and acute spines. The tibiae of the anterior legs of the male are green in most specimens found in Minnesota; the femora of the middle pair of legs are marked with darker bands. Elytra entirely wanting.

The black and oval egg is covered with an exceedingly hard

Fig. 61.—*Diapheromera femorata*.
Original.



and glossy shell, with a white edge enclosing a black line on one side and a brown top beautifully sculptured, which acts as a sort of stopper to each box-like egg. The eggs are not glued or fastened to any object, but are simply dropped to the ground, where they remain until the succeeding year; sometimes they do not hatch until the second year. The young walking-sticks resemble the old ones except in size; they are also brighter in color, and molt but twice.

This species is a very general feeder, and the foliage of all our trees and bushes, excepting the evergreens, is eaten. Sometimes these insects become very numerous, and in such a case can seriously injure our shade and forest trees. Being insects with chewing mouths, and very slow in all their motions, they can easily be killed by poisoning their food with some of the arsenical poisons.

The *Acrididæ* and the two following families of orthoptera form the section SALTATORIA or JUMPERS. All insects belonging to this section have their hind legs fitted for jumping, the femora being either very much stouter or longer, or both stouter and longer than those of the other legs. The peculiar parallel "fish-bone" markings seen upon them is produced by the attachment of the powerful muscles inside. The females in this section are usually furnished with more or less prominent ovipositors, and the wings of the immature forms (pupæ) are in an inverted position. Many species, especially among the *Acrididæ*, possess in the adult state only rudimentary wings and resemble immature insects. By carefully looking at the wings it will be seen that the adult insects, even the short-winged ones, have the tegmina in the proper position, while in the immature insects they are folded beneath the wings; the principal veins of the wing-covers and wings of the immature insects curve downward instead of upward.

FAMILY V.

LOCUSTS OR SHORT-HORNED GRASSHOPPERS.

(Acrididæ).

The members of this family differ from other *Saltatoria* in having the six to twenty-four jointed antennæ shorter than the body. They are either filiform, flattened, or ensiform, rarely clavate. The ovipositor of the female is short, composed of four plates. The first segment of the abdomen possesses on each side a supposed organ of hearing. Anterior and middle legs about equal, or nearly so, in length, much shorter than the posterior pair, which is fitted for jumping. The tarsi are three-jointed, the first joint, usually the longest and much longer than the second, has the under-side marked by two cross impressions, which, when seen on this side, give it the appearance of being composed of three pieces. Wing-covers, when not in use, rest partly horizontal on the back of the abdomen, and partly deflexed against the sides. Most of the species possess wings, but in a few these organs are wanting. The head is usually short and extended horizontally in two of the sub-families. Immediately under the vertex, but in some cases above it, there is on each side a little space bounded by elevated ridges. These spaces are called *lateral foveolæ*, and their variations in form afford characters much used in classification. The front is generally traversed by three vertical keels or *carinæ*. The pronotum is divided into four lobes by three more or less well marked transverse sutures, and is also frequently furnished with a median crest. The hind tibiae carry upon the upper side two rows of spines; the numbers of these is of use in distinguishing species; the presence or absence of the last spine in the outer row is of much greater importance. Besides these spines there are four articulated spurs, which are situated in two pairs, one on the outer and one on the inner side of the tibiae. In the male the ventral surface of the abdomen consists of nine segments, in the female there are but

eight. The caudal end of the body in the female has four horny appendages, the ovipositor; in the male the ventral pair of appendages is represented by a single plate.

As mentioned before, the males of many species of *Acri-didæ* possess stridulating organs.

Locusts deposit their eggs in oval or bean-shaped masses covered with a glutinous substance. As this method of laying eggs has been described more in detail when giving the description of our migratory species it is not necessary to give it here, especially as the life-histories of our locusts are nearly alike. The number of eggs deposited by the different species varies greatly, some egg-masses containing from twenty-five or thirty to sixty or more, and as in many cases several such masses are produced by each female, the number of offspring can be quite large. Other species, as the Coral-winged Locust (*Hippiscus tuberculatus*) deposit all eggs (125 to 130) in one single mass. The different species also select different times and places for this purpose, some digging holes in the fall, others in spring, some selecting hard gravel, elevated sandy spots, or well traveled roads, while some select soft wood for oviposition.

This family contains a large number of species, all more or less injurious. Even the non-migrating species seen everywhere during the warmer part of the year are very destructive, and deserve the full attention of the farmer. Yet as a very general rule nothing is done to reduce their number, nor are they even considered very injurious, excepting in seasons of drought, when every blade of grass is devoured. Damp and moist weather is injurious to most species of locusts, and is undoubtedly the most effectual natural agent to keep them in check. Extreme changes during winter seem to destroy the vitality of the eggs.

All young locusts are greedy feeders, and, considering their size, devour immense quantities of food. They molt their skin from three to five times. The wings, in form of small wing-pads, appear early and gradually, and become

larger with each molt. The pupa is not very different from the larva, only a little larger, but just as active and hungry as it or the adult.

Prof. Comstock gives the following classification:

- A. Pulvilli present between the claws of the tarsi; pronotum never extending over the abdomen.
- B. Prosternum unarmed.
 - C. Vertex and front of head meeting at an acute angle; vertex extending horizontally; front strongly receding..... 1. *Tryxalinæ*.
 - CC. Head rounded at the union of the vertex and front; front perpendicular, or nearly so.
 - D. The terminal spine of the outer row of the posterior tibiæ wanting; second abdominal segment smooth. 2. *Œdipodinæ*.
 - DD. The terminal spine of the outer row of the posterior tibiæ present; second abdominal segment granulated on the sides
 - 3. *Eremobinæ*.
 - BB. Prosternum tuberculate, or mucronate, or produced into a cone.
 - C. Head rounded at the union of the vertex and front; front slightly receding; antennæ filiform
 - 4. *Acridinæ*.
 - CC. Vertex extending horizontally in front of the eyes; front strongly receding; antennæ more or less flattened..... 5. *Opomalinæ*.
- AA. No pulvilli between the claws of the tarsi; pronotum extending over the abdomen..... 6. *Tettiginæ*.

Prof. Scudder, in his "Guide to Orthoptera," has only four sub-families; he unites 3 with 2, and 5 with 1.

Prof. Fernald gives the following simple table of the sub-families found in New England:

1	Pronotum extending back to the tip of the abdomen.....	<i>Tettiginæ</i> .
	Pronotum not extending back to the tip of the abdomen.....	2.

- 2 { Prosternum with a prominent spine.....*Acridinæ*.
 2 { Prosternum not spined, or with only an oblique tubercle.....3
 3 { Face very oblique.....*Tryxalinæ*.
 3 { Face not oblique, or but slightly so.....*Edipodinæ*.

SUB-FAMILY TETTIGINÆ.

GROUSE LOCUSTS.

These very small locusts possess a very unusual form, having the pronotum prolonged to such an extent that it projects to or beyond the abdomen. The head is deeply set in the pronotum, and the prosternum is expanded into a broad border partially enveloping the mouth. The short antennæ are very slender. The wing-covers are rudimentary, and resemble small rough scales; the wings are very large in proportion. Members of this sub-family possess no pulvilli between the claws of their tarsi.

Tettiginæ are very common in some localities, and especially near the shores of our lakes. Here they feed upon such lowly organized plants as lichens, molds, etc., in fact they eat mud containing decayed vegetable matter, and in this way they act very differently from other members of the order of orthoptera. Being usually of a dark color, which blends with the soil upon which the insects rest, they can not readily be seen; nor are they easily captured, as they are very active and possess enormous leaping powers.

There are two groups of *Tettiginæ*:

- A. Anterior femora more or less compressed, carinate above; antennæ with 12-14 joints.....*Tettigæ*.
 AA. Anterior femora distinctly and broadly sulcate above; antennæ with 15-22 joints.....*Batrachidææ*.

We possess three genera of *Tettigæ* in Minnesota:

- A. Median carina of pronotum cristiform; superior lateral sinus (at insertion of tegmina) shallow, not nearly so deep as the inferior sinus.....*Nomotettix*.
 AA. Median carina of pronotum low; superior lateral sinus nearly as deep as the inferior sinus.

- b. Vertex of fastigium generally broader than the eyes, projecting beyond them, generally angulate anteriorly.....*Tettix*.
- bb. Vertex of fastigium narrower than the eyes, and not projecting beyond them, usually truncate anteriorly.....*Paratettix*.

The genus *Tettigidea* is the only one found in Minnesota that belongs to the *Batrachideæ*.

GENUS *Nomotettix* Morse (1894).

Lateral lobes of the pronotum with the postero-dorsal sinus shallow, about one-half the depth of the antero-ventral sinus. Pronotum advanced upon the head, rather sharply tectiform. Occiput of head with a pair of nipple-like or mammillate protuberances between the posterior portion of the eyes and the median line.

Nomotettix parvus Morse.

Small. Vertex of head projecting in advance of eyes about two-thirds the length of an eye, the anterior margin obtuse-angulate, its sides straight, rounding shortly into sides of crown, the mid-carina showing from above as a very small, slightly projecting tooth. Mid-carina low on the crown, disappearing opposite the middle, or middle of the posterior half, of the eyes. Profile rounded or round-angulate at top, deeply excavate opposite eye, sub-protuberant opposite lower border of eyes, the face more retreating than in *cristatus*. Sides of crown sub-parallel, slightly excavate opposite anterior portion of eyes. Mammillæ of occiput

scarcely distinct, pronotum sharply tectiform, the mid-carina lower and less arched longitudinally than in *cristatus*; anterior margin of dorsum projecting but little over the head, obtuse-angled, the sides straight or very slightly excavate. Surface scabrous.



Fig. 62. — *Nomotettix parvus*. Original.

The specimens from which Prof. Morse described this interesting insect were

found near St. Anthony Park. The insect, illustrated in Fig. 62, must be uncommon, or very local, as no others have been discovered; the line gives its natural length.

GENUS *Tettix* Charpentier (1841).

Size small; form slender; head small, eyes globular, protruding; pronotum compressed anteriorly, median carina distinct, hind portion extending back over the abdomen to or beyond its extremity, and terminating in a long narrow point; wing-covers very short; wings fan-like, well developed, almost as broad as long, and as long or longer than the abdomen; lower anterior angle of sides of pronotum angulated and bent inward.

Tettix granulatus Kirby.

Anterior border of vertex considerably advanced in front of eyes, angulate, the apex very slightly rounded, or rarely with the mid-carina projecting a trifle. In profile the face is quite retreating, the vertex considerably advanced, sinuate opposite the eyes, and moderately protuberant opposite antennæ. The eyes are the least prominent in this of any species, and the body more slender. It is liable to be mistaken for *T. ornatus* only, but the outlines of the profile and vertex, considered together, need leave no doubt of the species.

Measurements.—Length of body, female, 15 mm., male, 12 mm.; pronotum, 13 mm.; hind femora, 6 mm.

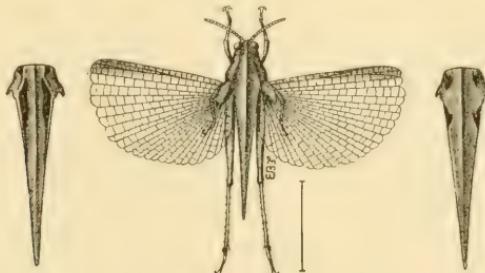


Fig. 63.—*Tettix granulatus* and two varieties. Original.

This is one of our most common species, found from April to late in September; it hibernates among rubbish and loose bark, but is more or less active during warm days. It is very common on the sandy shores of Lake Superior. It varies greatly in color and markings, some having a very distinct bright yellowish dorsal stripe extending from tip to tip. The insect, and two varieties, are shown in Fig. 63.

Tettix ornatus Say.

The name *ornatus* expresses well the appearance of this fine insect, which has numerous styles of ornamentation. Perhaps the name is a collective and not a specific one. Morse unites with *ornatus* the *triangularis* of Scudder, which differs from it by having the pronotum slightly extending beyond the tip of the abdomen and not prolonged into a slender point as in *ornatus*. The pronotum is very variable in length, in some reaching the end of the hind femur, in others passing it by 3.5 mm.; the wings are equally variable, and usually least developed proportionally in those specimens with the shortest pronotum. It is impossible to draw any line between these two forms, although the typical forms are quite distinct.

The species is readily recognizable from the characters of the vertex. This projects in front of the eyes, is somewhat rounded anteriorly and the mid-carina forms a distinct projecting tooth. The profile is rounded-angulate above, excavate opposite the eyes and protuberant opposite the antennæ. Very rarely a specimen is met which in a dorsal or a profile view approaches *granulatus* closely, but any doubt of its identity is usually dispelled by an examination of it from both directions.

Measurements.—Length of body, 9 to 10 mm.; pronotum, 9 to 11 mm.; posterior femora, 5 mm.



FIG. 64.—*Tettix ornatust*. Original.

This cinereous insect, marked with yellowish and black, is by no means uncommon, being found from April till October, yet it is very difficult to secure. Sometimes early in October, when the nights are already very cool, this insect may be found in large numbers upon wooden sidewalks, which warm

up earlier in the morning than the ground. Here they squat, evidently enjoying the warmth. A common form of it is shown in Fig. 64.

Tettix triangularis Scudder.

Variety *brachyptera* occurs in Minnesota, but has not been seen by the writer.

Tettix obscurus Hancock.

Form slender; pronotum flattened on the dorsum, and the lower margins of the lobes strongly distended laterally; surface of dorsum finely rugose. Wings overreach apical process.

A number of this species were captured early in spring in an open field near St. Anthony Park.

Tettix Luggeri Hancock.

Vertex slightly advanced in front of the eyes, anterior border convexed, mid-carina distinct; in profile face moderately ampliate opposite the antennæ, apex less prominent, frontal costa nearly straight, not excavate, with the vertex together rounded angulate. Pronotum tectiform, truncate anteriorly, median carina percurrent and prominent, apical process long, subulate, passing beyond the knee of hind femora. Wings reaching beyond the end of process.

A slender form allied to *T. granulatus*, but differing principally in the character of the vertex and the frontal costa which is not at all excavate. Entire length, female, 15 mm.; hind femora, 6 mm.; pronotum, 14.5 mm.

GENUS *Paratettix* Bolivar (1887).

A description of the genus has been given before.

Paratettix cucullatus Burm.

Fig. 65.—*Paratettix cucullatus*. Original.

This species (Fig. 65) is easily recognized by the form of the vertex. From above this appears about equal in width to one of the large and prominent eyes, and does not project in advance of them; its front margin is slightly hollowed, the concavity being divided by the mid-carina which projects a little. In profile the frontal costa is slightly sinuate opposite the eyes and strongly protuberant opposite the antennæ. The crown of the head is channeled longitudinally on either side of the mid-carina, the sulci being stopped abruptly opposite the hinder portion of the eyes by a pair of transverse, sometimes slightly oblique, ridges. This character is found in several species of this genus and in this species appears at a very early stage, showing distinctly in specimens only 3 mm. in length. The body is less compressed than in *granulatus*, being, in truth, depressed rather than compressed. The pronotum is advanced upon the head to the eyes, and the median carina is obsolete on the anterior portion; the posterior process extends 2 to 3 mm. beyond the hind femora, exceeded by the wings, and is very constant in proportions.

Measurements—Length of body, 10 mm.; pronotum, 12 mm.; posterior femora, 6 mm.

This species is very abundant in low fields fairly free from vegetation. It deposits eggs, like most of the locusts, in pod-like masses in the earth; 25 to 32 eggs have been found in each pod. The eggs hatch in about sixteen days into pale yellowish-white insects, with large and swollen heads, red eyes and short antennæ.

GENUS *Tettigidea* Scudder (1862).

Size small; form robust and clumsy; head large and broad, with the front less sloping and with median ridge of

the face more prominent than in the genus *Tettix* and *Paratettix*; antennæ 21 to 22 jointed; lower anterior angle of sides of pronotum rounded and not bent inward as in *Tettix*; front border of the pronotum thrust forward and partly concealing the head; median carina straight, somewhat curved anteriorly; lateral carina less prominent than in *Tettix*, and not so strongly bent inward in advance of the broader portion of the pronotum.

Tettigidea lateralis Say (*pennata*) Morse.



Fig. 66.—*Tettigidea lateralis*.—Original.

Head and sides of body blackish-brown; hind femora with a rather large ochraceous spot outside about the middle; underside of body dirty yellow; top of pronotum light or dark testaceous, sometimes the same color as the sides of the body, with a testaceous border. In the male the face and lower anterior portion of the pronotum are yellow. Wings and pronotum extending beyond the abdomen, wings somewhat longer than the pronotum. The insect is illustrated in Fig. 66.

Measurements.—Male, length of body, 10 mm.; pronotum, 11 mm.; posterior femora, 6 mm. Female, length of body, 14 mm.; pronotum, 15 mm.; posterior femora, 7.5 mm.

Tettigidea polymorpha Burm.

This seems to be simply a form of *lateralis*, distinguished from it by having shorter pronotum and wings. Otherwise they are either the same or very closely allied.

Both species are common in Minnesota, but especially *polymorpha* (*parvipennis* Harr.).

SUB-FAMILY TRYXALINÆ.

Prof. Jerome McNeill has quite recently published an excellent account of the insects forming this sub-family. Those

interested should consult his "Revision of the Tryxalinæ of North America." It is fully illustrated.

This sub-family is easily separated from all others with the exception of the *Œdipodinæ*, in which exist genera that form a perfect connecting link.

The Tryxalinæ differ from the other members of the *Acri-*
didæ by possessing a conical and elongated vertex, the front strongly receding, flattened antennæ, which are inserted between the middle of the eyes, or farther from the mouth than their middle. The eyes are usually longer than that part of the genæ below them; the posterior lobe of the pronotum is usually shorter than the anterior part; the median carina is not at all crested, and the last spine of the outer row of the posterior tibiae is wanting. The difference between this family and the *Œdipodinæ* is in the joining of the vertex and front, as indicated in the table of sub-families given before.

Most members of this sub-family of orthoptera are grass-loving insects, which delight to rest upon sandy spots surrounded by these plants. They strongly contrast in this respect with the *Œdipodinæ*, which generally prefer barren hillsides, dusty roads and other localities characterized by scanty vegetation. The short wings of the former are never brilliantly colored, nor are their tegmina large and showy, as this would not blend well with their surroundings. Yet the colors, even in the same species, are quite variable, brown or green tints predominating.

GENERA OF TRYXALINÆ FOUND IN MINNESOTA.

- A. Head equaling, never exceeding, the pronotum in length.
Antennæ triquetrous or strongly depressed at base; pronotum with the lateral lobes vertical and straight and the lateral carina not at all sinuate; median carina of the pronotum generally cut much behind the middle; the disk plain and unstriped.

- B. Spines of the exterior margin of the posterior tibiæ 15 or more; posterior margin of the disk of the pronotum mostly straight, scarcely angled or rounded.....*Pseudopomala*.
- BB. Spines of the exterior margin of the posterior tibiæ less than 15; posterior margin of the disk of the pronotum obtusely angled or rounded.
- C. Tegmina exceeding the abdomen considerably in both sexes (in some large females but little); lateral carinæ of the pronotum quite as distinct as the median; spurs at the apex of the posterior tibiæ on the inner side about equal.

Tryxalis.

- CC. Tegmina not exceeding the abdomen, even in the male.....*Opeia*.

- AA. Antennæ never triquetrous, sometimes plainly depressed basally or acuminate, most commonly filiform, rarely clavate; pronotum with the lateral lobes less distinctly vertical, with the lateral carina very rarely quite straight, but gently or strongly sinuate near the middle; median carina of the pronotum generally cut in or not far behind the middle.
- B. Scutellum of the vertex with a distinct median carina which is usually a coarse raised line stronger anteriorly.
- C. Spurs on the inner side of the posterior tibiæ very unequal, the apical spur being twice as long as the other; antennæ very greatly exceeding the head and pronotum, somewhat clavate.....*Eritettix*.
- CC. Spurs on the inner side of the posterior tibiæ about equal in length.
- D. Spines on the exterior margin of the posterior tibiæ 19-21.....*Syrbula*.

- DD.* Spines on the exterior margin of the posterior tibiæ not exceeding 15. Median carina of pronotum cut much behind the middle by the principal sulcus..*Chloëaltis*.
- BB.* Scutellum of the vertex with no distinct median carina.
- C.* Posterior margin of the metazone angulate. Tegmina usually much shorter than the abdomen, with the ulnar area not very much wider than the discoidal area....*Dichromorpha*.
- CC.* Posterior margin of the metazone rounded or not distinctly angulate. Tegmina not much shorter than the abdomen, with the ulnar area very wide and several times as broad as the discoidal area.
- D.* Hind tibiæ never red.....*Orphula*.
- DD.* Hind tibiæ red.
- E.* Median carina of the pronotum high and sharp, cut by the principal sulcus in, or plainly in front of, the middle. Intercalary vein very strong. Apical spurs on the inner side of the posterior tibiæ unequal.....*Mecostethus*.
- EE.* Median carina of the pronotum rarely cut plainly in front of the middle, in this case it is not high and sharp, or the intercalary vein is not strong.
- F.* Tempora elongate, narrow, from two to four times as long as broad. The apical spur on the inner side of the posterior tibiæ is much less than twice as long as the one beside it.
- G.* Antennæ filiform....*Stenobothrus*.
- GG.* Antennæ clavate..*Gomphocerus*.

FF. Tempora short, little longer than broad or, when twice as long, the apical spur on the inner side of the posterior tibiæ is twice as long as the one beside it.....*Eremnus*.

GENUS *Pseudopomala* Morse (1896).

This insect is included by McNeill in the Tryxalinæ, but has since been removed by Scudder to the Aeridiinæ.

"Vertex horizontal, longer than broad, semi-elliptical, medianly convex with a very distinct carina, laterally sulcate (female) extended into lamina (male), with the margins limited by lateral carinæ. The lateral foveolæ are wanting. The frontal costa is sulcate throughout with slightly divergent heavy lateral carinæ except at the immediate apex where it is much constricted. The face is very declivous and straight or a very little sinuate on account of the prominence of the frontal costa between the antennæ. These are very slightly triquetrous and very much flattened and expanding basally, equaling the short diameter of the eye nearly (male) or quite (female) and strongly acuminate. They equal the head and pronotum in length (female) or greatly exceed them (male). The pronotum is but little longer than the head. Its disk is nearly plain, slightly elevated toward the median carina which is distinct and cut only once much behind the middle by the principal sulcus, which alone is apparent upon the disk. The lateral carinæ are distinct, parallel, cut by the principal sulcus only. The posterior margin of the metazone is straight. The lateral lobes of the pronotum are vertical, slightly convex above, with the anterior and posterior margins strongly oblique, the one straight, the other sinuate just above the posterior lower angle, which is sharp and sub-rectangular. The lower margin is nearly straight and horizontal. The mesosternal lobes are separated by a space longer than broad (female) or by a linear ridge with a deep

pit on either side (male). The wings in both sexes and the tegmina (female) are abortive or they are well developed. In the male the scapular area is enlarged with prominent veins. The posterior femora are slender, not banded. The posterior tibiæ have the apical spurs on the inner side not very unequal. The last ventral segment of the male is horizontal, elongate conical and four times as long as the penultimate segment. The valves of the ovipositor are exerted, the lower ones furnished with a strong lateral tooth, the upper ones with two distinct basal teeth."

Pseudopomala brachyptera Scudder.

Brown, dotted faintly above with black. A very faint and obscure dark stripe extends from the lower border of each eye along the side of the pronotum. Hind femora dotted with black along the upper edge; terminal lobe dark. Spines tipped with black. The female, which is more uniformly brown than the male, is dotted with numerous

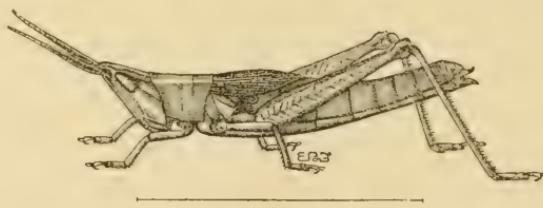


Fig. 67.—*Pseudopomala brachyptera*, Original.

minute dusky specks, and has shorter wing-covers and wings. Fig. 67 shows this insect.

MEASUREMENTS.—Length of body, male, 23.5-27 mm., female, 27.5-29.5 mm.; of long winged tegmina, male, 15.5-17 mm., female, 18-22 mm.; of tegmina, male, 9-12.3 mm., female, 7-12 mm.; of hind femora, male, 13.5-15.5 mm., female, 14-19 mm.; of head and pronotum, male, 7.3-8.6 mm., female, 7-12 mm.; of antennæ, male, 9.5-11.3 mm., female, 8.5-10 mm.

This is a very uncommon insect in Minnesota, and only one pair was found late in summer upon Gray Cloud Island. Closer collecting will doubtless show that it occurs also in other parts of the state, as the species has an extended range, occurring from Illinois to New York, in New England, and from Iowa to Utah.

GENUS *Opeia* McNeill.

Vertex nearly horizontal, shorter than the distance between the eyes, convex, a little sulcate behind the prominent lateral carinæ which meet at an angle of about 90 degrees. Median line distinct. Lateral soveolæ not visible from above, they are small sulci which extend from the ocelli toward the vertex and are not clearly separated from the front. The frontal costa is sulcate except at the apex, and its margins are slightly and regularly expanded downward. Seen from the side, the face is straight and strongly decliv- ent. The antennæ are considerably flattened basally and regularly acuminate, distinctly shorter than the head and pronotum. The pronotum has the disk nearly plain, being slightly elevated to the median carina. This and the lateral carinæ are unusually heavy and distinct and all three are cut by the principal sulcus only much behind the middle. The lateral carinæ are very slightly divergent from the middle of the pronotum to the posterior margin which is roundly angulate. The lateral lobes of the pronotum are not quite so high as long; they are nearly perpendicular, being very slightly convex above, and they have a nearly horizontal carina extending from the middle to the postrior margin. They have the anterior and posterior borders strongly oblique with the lower margin nearly straight. There is no posterior tubercle. The mesosternal lobes are separated (female) by a space about as long as wide, the metasternal lobes by a space longer than wide (female) or nearly contiguous (male). The tegmina are little shorter than the abdomen (female). The discoidal area is occupied by a weak

intercalary vein. The scapular area is decidedly expanded in the male, and filled with a single series of moderately strong curved cross veins. The posterior femora are not slender, they extend somewhat beyond the end of the abdomen. The valves of the ovipositor are but little exerted.

Opeia obscura Thos.

This is a western species, but a male, female and pupa were found late in October in the extreme western part of the state, in Brown's Valley. They occurred in some numbers in a swampy place, but were mistaken for common insects, hence but few were captured. It is a very variable species, with a brown or green dorsum, either plain or with a streak of fulvous along the median vein. The sides are marked by a stripe extending backward from the eye, widening and generally becoming more obscure. When most distinct, this stripe consists of five parts, as follows: an upper streak of brown or fuscous below the lateral carinæ, below this a lighter streak followed by a white line, and still below this the light and dark streak, repeated. These five elements of the lateral stripe vary greatly in intensity of coloration, but can nearly always be seen, and in all cases the lower fifth of the pronotum at least is brown. The tegmina have the discoidal area occupied by a row of large usually distinct quadrate fuscous spots and the scapular area contains a whitish mark.

This interesting species is illustrated in Fig. 67½.



Fig. 67½.—*Opeia obscura*. Original.

GENUS *Eritettix* Bruner (1889).

Head conical, occiput not elevated, furnished with three carinæ, one median and two supplementary; the former ex-

tends from the pronotum to the tip of the vertex where it is enlarged, the latter from the pronotum to a point opposite the anterior margin of the eyes where each suddenly bends to join the lateral carinæ of the vertex. The vertex is convex and equilaterally triangular. Its lateral carinæ are generally distinct, sometimes heavy, raised lines. The lateral foveolæ are present below the vertex, sub-triangular, not deeply impressed, sometimes not very apparent because of the slightness of the lower carinæ and because of their small size. The frontal costa has its sides somewhat regularly divergent from the vertex to the clypeus, generally a little constricted about the ocellus and slightly sulcate for a greater or less distance above this point but never sulcate to the vertex. The antennæ are thick, generally somewhat flattened at the base and clavate at the apex, which is bluntly acuminate and scarcely longer than the head and pronotum. The pronotum has the lateral and median carinæ distinct and cut once only by the principal sulcus decidedly behind the middle. In addition to these usual carinæ are two supplementary carinæ on either side about midway between the median and lateral carinæ. The posterior margin and the lateral lobes of the pronotum are very obtusely angulate. The lateral lobes of the pronotum are about as high as they are long, with the anterior border decidedly or little more oblique than the posterior. They have a more or less distinct carina which runs obliquely from the first sulcus to or toward the posterior margin. The lower anterior angle is obtuse, the posterior is rectangular. The lower margin is straight and horizontal on the posterior half, straight and slightly ascending on the anterior half. The mesosternal lobes are separated by a space much wider than long, and the metasternal lobes by a space longer than wide, in both sexes. The tegmina and wings are usually well developed, extending much beyond the middle of the wing and the scapular area in the male is widened and filled with a series of rather weak and not very regular oblique veins. There is no intercalary vein and

the dividing soon unites with the plicate vein. The ovipositor is nearly included. The posterior femora are more than usually heavy, with the apex extending beyond the abdomen, and they are never banded. The posterior tibiæ are obscure or reddish, never blue, and the inner apical spur is about twice as long as the one behind it.

Eritettix tricarinatus Thos.

This is also a very uncommon insect, but a few were found with other insects in the hopper-dozers used in Otter Tail county, Minn. It varies greatly in color; some are almost uniform brown, with a darker longitudinal stripe on each side of head and pronotum, edged with a white line on their outer side on the pronotum. This white line seems to be found in all color-forms. In many specimens the color below this line is bright green, and the same color is found on the anterior edges of the wings and on the hind legs. Five darker spots, sometimes confluent, are found in the middle field of the wing-covers. The insect is illustrated in Fig. 68.



Fig. 68.—*Eritettix tricarinatus*. Original.

Length 21.75 mm.; of tegmina, 14 mm.; of posterior femora, 12.5 mm.

Syrbula admirabilis Uhl., which may also occur in the southern part of the state, and has been reported from Winona, has not been seen by the writer, and the occurrence at that place, though possible, is doubtful.

GENUS *Chloëaltis* Harris (1852).

Vertex triangular, a little declivent, not extending in front of the eyes as much as the distance between the eyes, convex, more or less sulcate, with the lateral carinæ little elevated and the median carina slight but never entirely

wanting. The lateral foveolæ are wanting. The frontal costa is more or less rounded above the ocellus, plain or very faintly sulcate below with the sides sub-parallel. The antennæ are decidedly flattened at the base and much longer than the head and pronotum together, in the male as long as the hind femora. The face seen from the side is nearly straight. The pronotum has the disk plain with the three carinæ equally distinct and cut much behind the middle with the last transverse sulcus. The lateral carinæ are plainly (male) or strongly (female) curved. The posterior margin of the metazone is straight or gently curved, not angulate. The lateral lobes of the pronotum are longer than high, with the anterior and posterior margins straight and strongly and equally oblique, and with the lower margins horizontal or slightly descending posteriorly, more decidedly ascending anteriorly. Mesosternal lobes separated by a space much broader than long, the metasternal lobes by a space broader than long (female) or about as broad as long (male). The tegmina are generally abortive (female) or well developed (male). The scapular area is unusually expanded, especially near and beyond the middle in the male (and in the female to a less extent when the tegmina are not abortive), and is filled with a series of strong oblique cross-veins. The discoidal is as broad as the ulnar area, and the intercalary vein is present. The posterior femora are rather slender or moderately robust and more or less distinctly banded above. The posterior tibiæ have the apical spurs on the inside about equal.

THE SPRINKLED LOCUST.

(*Chloëaltis conspersa* Harr.).

Light reddish-brown, sprinkled with black spots; a black line on the head behind each eye, extending on each side of the thorax on the lateral elevated line; wing-covers oblong-oval, pale yellowish-brown with numerous small

darker brown spots; wings about one-seventh of an inch long, transparent, with dusky lines at the tip; hind tibiæ pale red, with the spines black at the end. Length nearly nine-tenths of an inch. The male differs greatly from the female in coloration, having the lateral lobes of the pro-

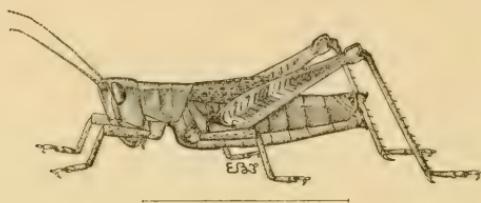


Fig. 69.—*Chloëaltis conspersa*, female. Original.

notum black. Wing-covers and wings are variable. Fig. 69 shows the female, and Fig. 70 the male.

This insect, although not common, is found throughout the state, and has been frequently caught in large numbers in hopper-dozers. It is found very early in the season (June 28), and lasts until late in the autumn (Oct. 3).

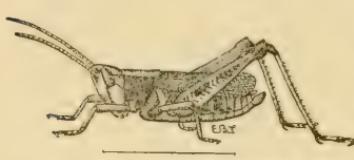


Fig. 70.—*Chloëaltis conspersa*, male. Original.

The Sprinkled Locust differs in its mode of oviposition very much from the majority of other species. Instead of laying the eggs in the ground, as is usual, it selects rotten stumps or other slightly decayed wood for this

purpose. Blatchley, in the Canadian Entomologist, writes as follows: "On Aug. 11, 1893, I discovered a female in the act of boring a hole in the upper edge of the topmost board of a six-plank fence. The abdomen was curved downward, and the forcipate valves of the ovipositor were used as pinchers with which small pieces of the wood were broken off. When discovered the abdomen was inserted nearly one-half an inch into the pine board and the upper edge of the opening about the sides of abdomen was covered with small pieces of wood, just as the dust or borings will accumulate about

the edge of a hole which a carpenter is boring. Many holes were found."

The females of this species can easily be confused with the brown females of the next species, the Short-winged Green Locust, from which they may be separated by the slight median carina of the vertex.

GENUS *Dichromorpha* Morse (1896).

Vertex much shorter than broad, somewhat declivent, convex, but more or less sulcate behind the distinct elevated lateral carinæ. These are straight or gently curved and meet at an angle of 90 degrees or more in a blunt point. The median carina is entirely wanting, as are the lateral foveolæ. The frontal costa is sulcate above and below the ocellus, with the sides gently divergent downward, more or less constricted just below the ocellus and near the vertex. The face seen from the side is nearly straight. The antennæ are a little longer (male) or scarcely as long as (female) the head and pronotum. The disk of the pronotum is plain with the three carinæ very nearly straight and parallel. All are cut distinctly behind the middle by the very faint principal sulcus. The first and second transverse sulci are not visible upon the disk. The lateral lobes of the pronotum are perpendicular, longer than high, with the anterior and posterior margins straightly oblique, the latter plainly sinuate and the lower margin a little descending posteriorly, more strongly ascending and sinuate anteriorly. The lobes of the mesosternum are separated by a space broader than long (female) or as broad as long (male). The lobes of the metasternum are separated in the female by a space as long as broad, in the male they are contiguous. The tegmina are generally abortive sometimes well developed, in which case the scapular area is not expanded. The anal field of the tegmina meets the discoidal field at an angle. The posterior femora are stout and not banded. The posterior tibiae are obscurely colored, with the apical spurs on the inner side not

very unequal. The valves of the ovipositor are moderately exerted.

THE SHORT-WINGED GREEN LOCUST.

(*Dichromorpha viridis* Scudder).



Fig. 71.—*Dichromorpha viridis*.
Original.

Wing-covers shorter than the body, a little longer than the wings. The insects vary greatly in color, the brown outnumbering the green ones. The top of head and pronotum green; sides of head and pronotum dirty brown, with a horizontal black band behind the eye, extending over the pronotum; front of head yellowish-brown; fore and hind legs reddish-brown; mesothoracic legs green, spines of tibiæ tipped with black; wing-covers above green, upon the sides brown; body beneath yellowish. The female varies from bright pea-green to a uniform rusty-brown, with a dark band behind the eye, as in the male; upon the top of the head a dark band extends from either side of the vertex, curving inwards and then outwards to midway between the median and lateral carinæ; hind tibiæ reddish-brown. The males are much smaller, have the back green and rest of body brown. Fig. 71 shows the female of this insect.

Length of male about 18.75 mm.

This insect has been found in a number of places in the central and southern portions of the state, but is not common. It occurs in open wet spaces covered with coarse grass, and has been taken as early as July 22 on Gray Cloud Island.

GENUS *Orphula*. Stål. (1873).

Vertex nearly horizontal, never extending in front of the eyes a distance greater than its own width, always more

or less sulcate, with or without a faint median carina. The lateral foveolæ are obsolete or distinct, elongate triangular, or linear, not visible from above. The frontal costa is plain or sulcate with the sides nearly straight and very moderately divergent. The face is nearly straight or a little arcuate, never at all sinuate. The antennæ are filiform, sometimes depressed and acuminate at the apex. The pronotum has the disk nearly plain, with the median carina cut in or behind the middle. The lateral carinæ are generally decidedly or strongly sinuate, rarely nearly straight and divergent from the front border, or from the first and second sulcus. Very rarely they are nearly parallel. The lateral lobes of the pronotum have the anterior border decidedly oblique and straight or a little arcuate, the posterior border is less oblique and more or less sinuate and the lower border is decidedly angulate in the middle. The mesosternal lobes are separated by a space broader than long (female) or about as broad as long (male), and the metasternal lobes by a space not broader than long (female) or they are contiguous (male). The tegmina and wings are well developed, a little shorter or much longer than the abdomen. The former are very narrow, with the scapular area not more expanded in the male than in the female. The discoidal area is destitute of the intercalary vein and the ulnar area in the male is sometimes much widened and regularly reticulate. The posterior femora are moderately slender or rather heavy. The apical spurs on the inner side of the posterior femora are never very unequal. The valves of the ovipositor are moderately exerted.

THE SPOTTED-WINGED LOCUST.

(*Orphula pelidna* Burm.).

This is the insect perhaps better known as *Stenobothrus maculipennis* Scud. It is very variable, and a description to cover all forms can not be well formulated. Head and

top of pronotum green (brown in others); a broad reddish-brown band extends from the eyes to the posterior side of

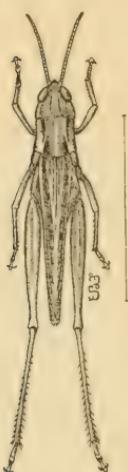


Fig. 72.—*Orphula pelidna*.
Original.

the pronotum, limited above by the lateral carinæ, which are white. Sides of the pronotum below the band brownish or dull yellowish. Wing-covers extending beyond the end of the abdomen green, with a row of square, black spots along the middle, and a few irregularly scattered smaller black spots.

It is a rather common insect in sandy or barren spots, and occurs in fairly large numbers along the bluffs of the Mississippi River, where it is fully grown about the first of August. Fig. 72 shows this insect.

The structural characters of the head, vertex and pronotum are the best means of separating it from others of the same genus.

Length, male, 16-19 mm., female, 20-24 mm.; tegmina, male, 14-17.5 mm., female, 18-20 mm.; antennæ, male, 7-10 mm., female 8.5-10 mm.; posterior femora, male, 9.5-11 mm., female, 12-14 mm.

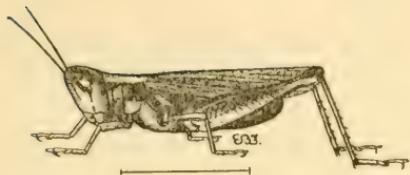
Orphula speciosa Scud.

(*Stenobothrus æqualis* Scud.).

This is also a rather common locust, found everywhere on dry soil; it is also variable in coloration. It was first described by Scudder from Minnesota specimens.

Vertex of the head quite broad; not expanding at the sides; apex not rounded; the sides of the angle straight; edges upturned considerably; a slight median groove; no lateral foveolæ. Sides of the pronotum approximate, constricted in the middle; lateral carinæ not so prominent and sharp as the median. Wings as long as the tegmina, extending beyond the tip of the abdomen.

Brown above, pale yellow beneath. Face yellowish-brown; parts of the mouth pale-yellow. Antennæ reddish-

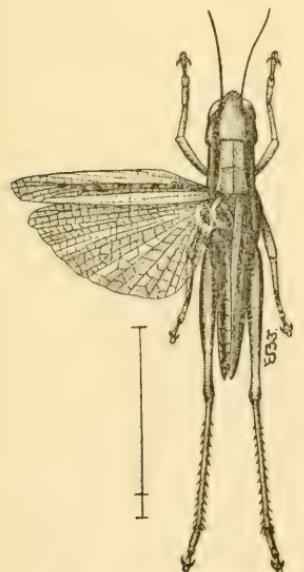
Fig. 73.—*Orphula speciosa*, male. Original.

from the eye to the lateral carinæ; the upper half of the sides of the pronotum brownish, darkest above. Legs yellowish-brown; spines of the tibiæ tipped with black. Tegmina brownish at base; apical half pellucid, with rosaceous nervures; costa with a dark streak beyond the middle.

Length, male, 14-15 mm., female, 20-21 mm.; tegmina, male, 12-13 mm., female, 12-16 mm.; antennæ, male, 5-6 mm., female, 6 mm.; posterior femora, male, 9 mm., female, 11 mm. Both sexes are shown in the illustrations (Fig. 73 male, Fig. 74, female).

GENUS *Stenobothrus* Fischer (1843).

Vertex triangular, obtuse (of the male acute), with the foveolæ, which are visible from above, narrow, oblong, rhomboidal. Antennæ filiform. Frontal costa convex. Pronotum with the disk almost plain, the median carina distinct and cut by the principal sulcus only, and the lateral carinæ straight or more or less arcuate or sinuate. The lateral lobes of the pronotum about equally high and long, with the lower angles somewhat obtuse. Tegmina fully developed, rarely abortive, with the mediastine area more or less extended, either narrow throughout or widened at the base, and sometimes including an adventitious vein. The scapular area is filled with oblique transverse veins and in the male is di-

Fig. 74.—*Orphula speciosa*, female. Original.

lated. The radial vein is composed of three principal branches; there is no intercalary vein. The ulnar vein is composed of two branches which sometimes unite again before the middle, the dividing vein is straight, and the plicate vein is free or united with the dividing. The wings are fully developed or rarely abortive, not fenestrated, rarely wanting. The posterior femora are frequently dull testaceous, rarely red. The sternum is rather broad, with the mesosternal lobes widely separated and the metasternal lobes distinct. The first abdominal segment is furnished with a closed tympanum. The anal segment is longitudinally sulcate with the supra-anal plate of the male obtusely triangular. The sub-genital plate of the male is recurved with the apex obtuse or acuminate. The valves of the ovipositor are short but exerted, and sometimes furnished with a lateral tooth.

THE SHORT-WINGED LOCUST.

(*Stenobothrus curtipennis* Harr.).

Olive-gray above, variegated with dark gray and black; legs and body yellow beneath; a broad black line extends from behind each eye on the side of the thorax; wing-covers, in the males, as long as the abdomen, in the female covering two-thirds of the abdomen; wings rather shorter than the wing-covers, transparent, and faintly tinged with yellow; hinder knees black; spines on the hind tibiae tipped with black.

This is a very abundant locust, found most commonly among tall grasses of low and damp prairies and among blue grass growing thickly in shaded situations. In such places they can be found from early July till late in October. They are very easily distinguished from all other locusts by their short and narrow wings, the yellow color of the body beneath, and by the prominent yellowish hind legs with black

knees. Their noiseless life is but poor and short, nor does this insect leap well. McNeill says that, like its allies, it can scarcely be said to either fly or jump, but it suffers little or nothing in lacking these accomplishments, as its astonishing facility as a tumbler and contortionist generally discourage all but the most determined efforts for its capture. It is as sprightly, wide-awake little "hopper," and an artful dodger.

"When about to stridulate these insects place themselves in a nearly horizontal position, with the head a little elevated. They then raise both hind legs together, the hind tibiæ bent back snugly against the femora during the movement and grate the thighs against the outer surface of the tegmina."

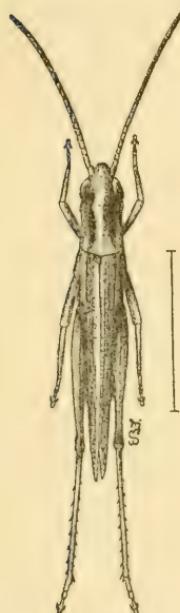


Fig. 75.—*Stenobothrus curtipennis*, male. Original.

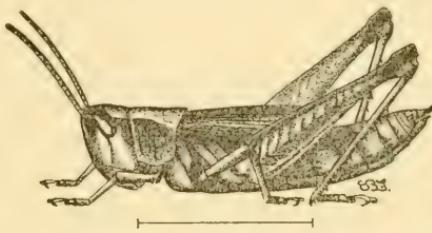


Fig. 76.—*Stenobothrus curtipennis*, female. Original.

Two forms occur, and several well-marked color varieties. The long-winged form was described as *longipennis*, Scudder; it is not as common in Minnesota as the short-winged one.

Total length male, 14 to 22 mm.; female, 12.4 to 23 mm.; of body, male, 13.5 mm. to 15.5 m.; of female, 15 to 24.5 mm.; of tegmina, male, 8.5 to 15 mm., female, 7 to 16.5 mm.; of hind femora, male, 10.5 to 11.8 mm., female, 11.5 to 14 mm.; of antennæ, male, 8.5 to 10.5 mm., female, 6.5 to 8 mm.

In Fig. 75 is shown a long-winged male, and in Fig. 76 a short-winged female.

GENUS *Gomphocerus* Thüm.

Similar to *Stenobothrus* except that the antennæ are furnished with a short depressed club at the apex, and (according to Brunner) the tympanum is partially open. Face almost vertical or sub-oblique. Antennæ long, multiarticulate, filiform for three-fourths of the distance from the base, the remaining joints forming a compressed expanded mass, not so large in the female as in the male, terminating in a point. Ocelli slightly visible. Eyes oval, slightly prominent. Pronotum short; its disk, flat, tricarinate; the lateral carinæ sinuous, curving inward or forming an entering angle near the middle; the posterior border rounded. Elytra and wings as long as or a little longer than the abdomen. Abdomen somewhat compressed; sub-anal plate of the male usually convex below, almost triangular. Prosternum unspined, smooth. Legs of medium length, and posterior femora of the usual form.

Gomphocerus clavatus Thomas.

This and *G. clepsydra* Scudder seem to be the same. This insect, easily distinguished from all members of the sub-family *Tryxalinæ* by its clavate antennæ, which are very prominent in the male, occurs everywhere in the prairies of Minnesota, from the Red River Valley in the north to the Pipestone quarries in the south; in the former region it was found in the adult stage as early as July 7. The description of *clavatus*, as given by Thomas, is as follows: Male.—Small size, antennæ clavate; elytra without spots. Vertex scarcely expanding in front of the eyes; the margins obtuse, elevated, meeting in front in an angle a little less than a right angle; apex obtuse; lateral foveolæ distinct, linear. Face oblique and slightly rounded; frontal costa very prominent, not sulcate at any point, gradually expanding below it and the entire face densely punctured; the lateral carinæ distinct; the sulcus that extends from the eye downward, sharp and distinct. Antennæ passing the thorax; the joints

in the middle portion somewhat distinct; the apex formed into a flattened club, very distinct; the cylindrical basal portion consists of about seventeen joints, usual form; the club of about seven joints, much shortened. Pronotum broadest and slightly swollen near the front, somewhat contracted posteriorly; the three carinæ about equally distinct, approximate, the lateral pair curve inward, making the nearest approach to each other a little in advance of the middle; sub-truncate in front, very obtusely rounded behind. Elytra and wings nearly as long as the abdomen; the nervules of the disk and lower field of the former scalariform. Sub-anal plate elongate, prow shaped, keeled, entire at the tip, which is sub-acute. Vertex and pectus densely punctured. Anterior tibiæ grooved externally, and broad toward the apex. Face and cheeks mottled with testaceous and brown (dried after immersion in alcohol); back of the head reddish-brown. Disk of the pronotum reddish-brown, with a brassy lustre; sides with the upper portion brown, the lower margin testaceous. Elytra pale-brownish, without spots. The abdominal segments marked on each side with a black spot, those on the basal segment largest, decreasing in size toward the apex, where they are almost obliterated. Ventral portion pale-yellow. Anterior legs carneous; posterior femora with the upper portion of the external face rufous, yellow beneath; internal face black near the base; tibiæ pale reddish-yellow, spines black.

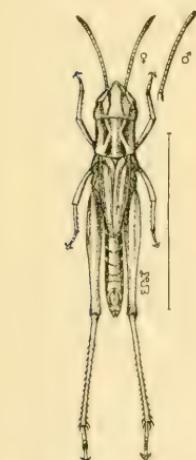


Fig. 76½.—*Gomphocerus clavatus.*

Measurements:—Length, male, 14 mm.; elytra, 9.25 mm.; posterior femora, 9.5 mm.; posterior tibiæ, 8 mm.

This species is illustrated in Fig. 76½.

GENUS *Eremnus* McNeill (1897).

Vertex somewhat declivent, broader than the frontal costa at the clypeus, sulcate, without a median carina, bounded by straight, sharp but slight carinæ, which meet at the front at an angle greater or less than a right angle. The lateral foveolæ are sub-quadrata, about twice as long as broad, very distinct and very apparent from above. The frontal costa is about half as wide at the vertex as at the clypeus, slightly sulcate with low broad carinæ along the sides. Seen from the side the face is moderately arcuate and moderately oblique. The antennæ are filiform, a little (female) or considerable (male) longer than the head and pronotum. The median carina of the pronotum is quite distinct and cut once behind the middle of the principal sulcus. The lateral carinæ are very strongly sinuate and the posterior margin of the metazone is roundly and very obtusely angulate. The lateral lobes of the pronotum are higher than long with the anterior and the posterior margins nearly straight and vertical. The mesosternal lobes are separated by a space several times as wide as long in both sexes. The metasternal lobes are separated by a space a little longer than wide in male and female. The tegmina and wings are well developed, not quite equaling or somewhat longer than the abdomen. The former have the scapular area transparent and filled with a single series of oblique cross-veins. The discoidal and the ulnar areas have each a false vein with a single row of cells on either side. The posterior femora have three usually well marked sub-triangular or irregular brown spots on the upper face. The posterior tibiæ are red or yellowish with the spurs on the inner side much elongated and very unequal. The ovipositor is very slightly exerted, only the extreme tip being visible.

Eremnus (Aulocara) Scudder Bruner.

General color dull brown, in some specimens inclining to ferruginous, the tegmina usually very heavily and evenly

mottled with dark brown quadrate spots, sometimes only confined to the disk. Some specimens have a light testaceous band reaching from the vertex backwards across the middle of the occiput and pronotum to the tips of the tegmina. Posterior femora faintly marked with bands and spots; hind tibiæ bright coral red with a whitish basal annulus, the knee black; antennæ ferruginous, testaceous or lavender usually the latter in living specimens. Lower surface dirty yellowish-white.

Length of body, male 14.5 mm., female 20 mm.

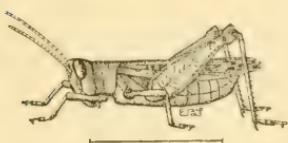


Fig. 77.—*Eremnus Scudderii*.
Original.

This insect (Fig. 77), is not common, but is found among the grass in our prairies. It prefers sandy spots, upon which it will settle very closely, evidently protected in this manner by its similarity of color to such surroundings. It leaps vigorously for several times in succession, and without noise. It is found from middle of July to early October.

SUB-FAMILY.

(*Œdipodinæ*.)

This sub-family includes two tribes, the *Œdipodini* and *Eremobiini*, but as no insects belonging to the latter occur in Minnesota it is not necessary to give its distinguishing characters, which have already, in part, been given in the classification.

Œdipodinæ include genera in which the head is rounded at the union of the vertex and front, and in which the front is perpendicular or nearly so. The antennæ are linear or sub-linear, and usually inserted nearer the mouth than the middle of the eyes; sometimes they are inserted just in front of the eyes, which are small or of medium size, and really longer than that part of the cheeks below the eyes. In the typical forms the posterior lobe of the pronotum is longer

than the anterior one, and the median carina is frequently entirely or partially crested. As in the preceding sub-family the last spine of the outer row of the posterior tibiæ is wanting.

We possess in the United States not less than twenty-three genera only found here or in Mexico. The insects belonging here are mostly large and showy, often possessing bright-red, yellow, or even blue wings with black bands. Nearly all the bright-colored locusts found in the United States belong to this sub-family; most of them are very conspicuous objects in flight, when they show their color, which is at other times entirely hidden. This seems to indicate that these bright colors of the wings are by no means protective, but are probably of some value in the mating of the sexes. The color of the wings varies greatly in the same species, and we can in some cases find individuals that show all the shades of color from dull white through yellow and orange to vermillion red. This greater intensity of color is partly due to age, and, perhaps, to higher temperature. *Œdipodinæ* are also very noticeable on account of the rattling noise which the males of most species produce in flight. Even some females produce such sounds, but in a less degree. Stridulation is produced also when the insect is sitting on the ground, by rubbing the hind thighs against the wing-covers, the intercalary vein of which is in most cases toothed or roughened.

Genera of Œdipodini found in Minnesota.

- A. Interspace between the metasternal foramina linear, or distinctly longer than broad in the male, narrower than the interspace between the mesosternal lobes in the females.
- B. Tegmina subcoriaceous, densely or irregularly reticulate, only at the apex remotely areolate; wings brightly colored, red or yellow at base; none of the veins incrassate and no costal stigma.....*Arphia*.

BB. Nearly the whole apical half of the tegmina membranaceous; traversed by straight veinlets; wings with dilute coloring; the veins next the costal margin and frequently, in the male, the median vein incrassate; costa with a dusky stigma.

C. The intercalary vein of the tegmina running midway between the median and ulnar veins, only apically a little approximating the former; veins of the wings slightly or scarcely incrassate.....*Chortophaga*.

CC. The intercalary vein of the tegmina distinctly nearer the ulnar than the median vein, the veins next the costal margin and the median vein distinctly incrassate in the male; antennæ long, slender.....*Encoptolophus*.

AA. Interspace between the metasternal foramina rather broad, in the male quadrate, in the female transverse.

B. Principal sulcus more or less obsolete or delicate in the lateral lobes.

C. Smaller forms. Pronotum not rugose; wings sub-vitreous*Camnula*.

CC. Larger forms. Pronotum rugose; wings colored.....*Hippiscus*.

BB. Principal sulcus distinctly developed on the lateral lobes.

C. Pronotal carina entire or intersected by but one sulcus. Pronotum crested or carinate, but not excessively.

D. Wings conspicuously marked, but not banded.....*Dissosteira*.

DD. Wings with a fuscous arcuate median band.....*Spharagemon*.

CC. Pronotal carina twice intersected by transverse sulci.

- D.* Inferior margin of lateral lobes oblique, the posterior angle thereby acute or posteriorly produced.
- E.* Lateral canthi of the metazona terminating at the principal sulcus, or, if continued, it is a different course; tegmina fasciate or maculate.....*Mestobregma*.
- EE.* Lateral canthi of the metazona acute, passing in the same course beyond the principal sulcus; proximal half of the tegmina densely coriaceous.....*Psinidia*.
- DD.* Inferior margin of the lateral lobes horizontal, but anteriorly oblique, the posterior angle rounded-rectangulate.
- F.* Radiate veins of anal field of wings normal.....*Trimerotropis*.
- FF.* Radiate veins of anal field of wings distinctly incrassate.....*Circotettix*.

GENUS *Arphia* Stål. (1873).

Body compressed; pronotum granulated; median carina either notched or entire. Wing-covers subcoriaceous, densely and irregularly reticulate, only at the apex remotely areolate; the intercalary vein nearer the median than the ulnar vein; of one color, but sprinkled with minute black dots. Wings brightly colored, red or yellow at the base, margined externally with black; none of the veins incrassate and no costal stigma; ulnar area not noticeably dilated.

THE YELLOW-WINGED LOCUST.

(*Arphia sulphurea* Fab.).

Foveola of the vertex in the female slightly transverse, divided by a median carina, triangular in front, the margins raised and connecting in front, or approaching near to each other in a right angle; in the male somewhat elongate; the frontal costa prominent, more or less bisulcate above the

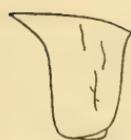


Fig. 79.—*Arphia sulphurea*, lateral view of pronotum.

ocellus, very slightly sulcate below it; face seen from the side decidedly arcuate. Pronotum (Fig. 79) scarcely constricted in the middle, but expanding slightly and regularly posteriorly; median carina prominent, sub-cristate or cristate, more or less arcuate on top; lateral carinae obsolete; surface somewhat roughened or rugulose; front margin obtuse-angled, slightly advanced upon the occiput; posterior margin right-angled or acute-angled. Elytra and wings passing the abdomen. Antennæ slender and filiform.

Uniform dusky brown, wing-covers rather paler than the pronotum, more or less distinctly spotted with dark brown. Wings deep yellow or sulphur-yellow next to the body, dusky at tip, the yellow portion bounded beyond the middle by a broad dusky-brown band, which curves and is prolonged on the hind margin, but does not reach the angle next to the extremity of the body; a very distinct ray running inward toward and nearly to the base near the front or

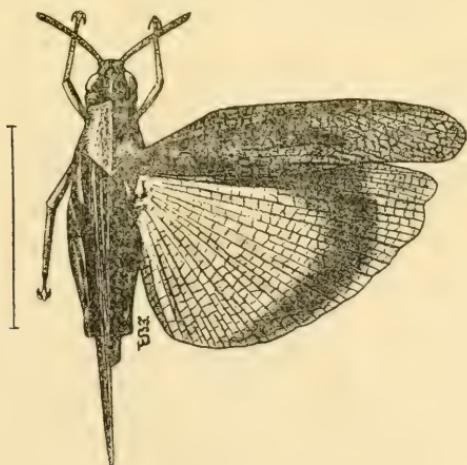


Fig. 78.—*Arphia sulphurea*. Original.

costal margin, leaving a narrow yellow strip along the costal margin. Posterior femora usually marked with alter-

nating bands of black and white, three of each; posterior tibiæ dusky, black or blue-black, with a pale ring near the knee; spines black. The male insect is illustrated in Fig. 78.

Measurements:—Male: Total length, 23-26.5 mm.; of body, 17-19 mm.; of tegmina, 17.5-20 mm.; of hind femora, 11-12.5 mm.; of antennæ, 6-7.5 mm. Female: Total length, 28-30 mm.; of body, 26-28 mm.; of tegmina, 20.5-23 mm.; of hind femora, 13.5-15.2 mm.; of antennæ, 6-7.5 mm.'

This is a very common species in all parts of the state visited by the writer at the proper time. As soon as the snow disappears and the ground becomes warm enough to start vegetation, this insect becomes active, and may be found as larva, pupa and adult. The latter, when disturbed, fly readily, and to some distance, making a loud clattering sound. They disappear about the middle of July. The colors of the wings vary greatly; in some the brilliant yellow is replaced by a very light yellow. This is our most common form near St. Anthony Park.

Arphia xanthoptera Burm.

Thorax, generally, though not always, darker than in *A. sulphurea*; sometimes with two yellow dots on the middle of the sides of the pronotum, one above the other, and the front and hind margins dotted with olive; but these markings are not uniform. The dark ray of the wings near the front margin,



Fig. 80.—*Arphia xanthoptera*, lateral view of prothorax.

not more than half as long as in *sulphurea*, extending but one-third the distance to the base; this is remarkably uniform. Posterior femora generally with two oblique dull yellowish bands on the exterior face, and also a paler and more distinct

ring near the apex. The yellow of the wings is usually much deeper and more inclined to a saffron color. It differs also in being larger, in some cases the length of the female from tip to tip of wings being two inches. The foveola of the ver-

tex is usually open in front, its margins continuous with the margins of the frontal costa; the median carina of the pronotum is higher and more distinctly arched, the angle of the anterior more distinct, and of the posterior margin more acute.

Measurements.—Male: Total length, 30-34 mm.; of body, 21-25 mm.; of tegmina, 22.5-27 mm.; of hind femora, 14.5-17.5 mm.; of antennæ, 10-11 mm. Female: Total length, 34.5-40 mm.; of body, 28-32 mm.; of tegmina, 26.5-30 mm.; of hind femora, 17-18.5 mm.; of antennæ, 9-11.5 mm.

This species is not common, at least has not been taken in as large numbers as the other species of *Arphia*. It varies very much in color, some specimens being almost black, others bright reddish or yellowish-brown; in the east it is entirely yellow-winged, in the central states frequently orange-winged. It is found in the same localities, among grass and low bushes in barren fields or pastures on dry soil, as the very common *sulphurea*, but is found much later in the season, not before the first of August. According to Morse the two specimens *xanthoptera* and *sulphurea* can be readily separated. The hind process of pronotum of the former is acute-angled in dorsal view, its sides concave. Carina of pronotum in a side view crest-like, high, arched and compressed, Fig. 80. Dusky band of wing with sub-frontal shoot usually extending one-fourth to one-third the distance across disk to base of wing. In *sulphurea* the hind process of pronotum is about right-angled in the male, or a little obtuse in the female; carina rather low. Dusky band of wing with sub-frontal shoot usually extending two-thirds of the distance to base of wing.

Arphia carinata Scudder.

Head blackish, profusely streaked and spotted with dull bluish-white; frontal carinæ and upper border of clypeus edged with whitish; palpi blackish, the joints tipped with

luteous. Pronotum (Fig. 80), dull, dark, brownish-fuscous, with a short pale streak behind the lower edge of the eye; hind edge of pronotum forming less than a right angle; median carina very prominent, whole, sharp, rounded. Basal third of tegmina dark brownish fuscous; beyond ash-gray, profusely and rather regularly sprinkled with small brownish spots; basal half of wings pale dull orange, bordered by a broad blackish fuscous band, occupying the rest of the wing, excepting the apex, and encroaching on the orange near the costal margin, as in *xanthoptera*; apex semi-pellucid, a little fuliginous, darker at the very tip. Hind femora dull, dirty, hoary without, black with three transverse white bands within, the tibiæ blackish-brown with black spines and a broad pale band near the base.

Length 30 mm.

This species occurs with the two others already described but is by no means common. It can be readily distinguished by the facial costa, which is acuminate towards the vertex in *sulphurea*, while in *carinata* the sides of the facial costa are nearly parallel from the median ocellus to the vertex. The carina of the pronotum of the latter is very high and strongly arched, while in the former it is but little elevated and nearly straight. This insect flies late in August.

Arphia tenebrosa Scudder.

Closely allied to *sulphurea*. Upper part of the head regularly convex; central foveola of the vertex sub-elongate, with a slender median carina, and a transverse sulcus across the hinder portion, generally truncate and closed in front; upper part of the frontal coxa sub-tricarinate; rest flat, arcuate below as seen from the side. Antennæ slightly flattened and somewhat enlarged toward the tip. Median carina of the pronotum distinct, somewhat prominent but less so than the *sulphurea*, nearly straight on top, cut near the middle by the transverse sulcus, but not notched; an-

terior margin of the pronotum obtusely rounded, apical angle about a right angle; lateral carinæ sub-distinct; disk of the posterior lobe nearly flat. Wing-covers and wings longer than the body.

Nearly uniform dark fuscous, often ash-color sprinkled over with fuscous dots, males sometimes almost black; face paler, dotted over with black points; mouth whitish



Fig. 81.—*Arphia tenebrosa*, dark variety. Original.

or pale; outer joints of the palpi usually whitish or pale; pronotum above is sometimes paler, almost yellowish-white, or of a dull dirty-yellow or partially of this color, usually dusky or brown. Elytra with paler spots, but varying in depth, sometimes almost uniform brown. Wings with the broad basal portion bright red, or orange-yellow; a broad black band around the outer margin, with a dark sub-costal ray extending towards the base; the extreme tip transparent, more or less clouded or spotted with fuscous.

Posterior femora usually crossed externally by three ill-defined pale bands; posterior tibiae black at the knee, below with a pale ring, middle portion varying from bluish-green to black. Two forms of this insect are shown; Fig. 81 represents a dark, and Fig. 82 a light-colored, male.

Length about that of *xanthoptera*.

This is one of the most common of our locusts with bright colored wings. A few are found early in the season

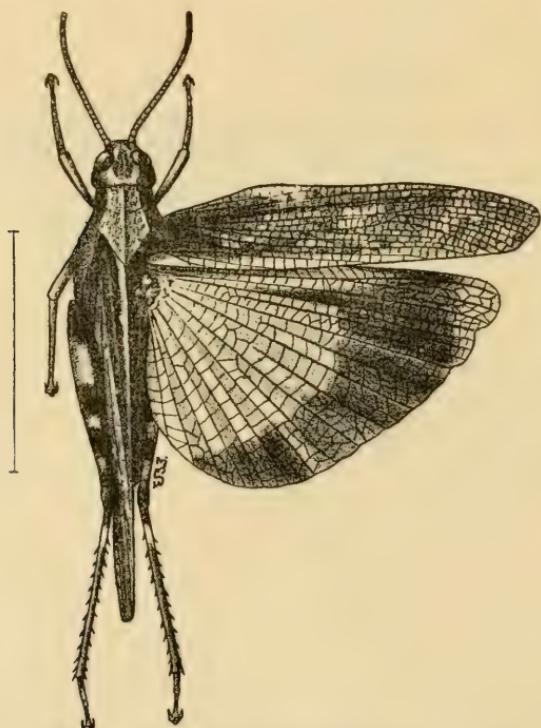


Fig. 82.—*Arphia tenebrosa*, light variety. Original.

(May 16), but they become very abundant in July, and are at that time very active. They fly with a clattering sound; the males have also the habit of remaining in one spot in the air, moving the wings so rapidly at that time that they can hardly be seen. On Sept. 13 the writer found a female of this kind mating with a male of the still more common Carolina Locust (*Dissosteira carolina L.*).

Arphia arcta Scudder.

Head grayish-brown above, yellowish elsewhere, the median carina of vertex broken at the posterior limit of the fastigium by the deeply impressed, arcuate, transverse furrow, which marks the same, extending through the frontal costa nearly to the ocellus, expanding and forming an oval loop at the extremity; lateral foveolæ strongly depressed, narrowing anteriorly. Pronotum grayish-brown, the upper surface unusually flat for an *Arphia*, rugulose, the median carina but little elevated, not laterally pinched in the middle, regularly, though but slightly, diminishing in height posteriorly. Tegmina profusely sprinkled with very small grayish-fuscous spots, less abundant apically, where it is pellucid. Wings yellow at the base, pellucid to an unusual extent at the tip (nearly one-third of the ante-anal field is included in the pellucid area), making the transverse dusky band narrower than in any other species of *Arphia*; the radial shoot towards the base is, however, unusually broad and long, equaling at its origin the entire breadth of that part of the wing, and scarcely stopping short of the base. Hind femora brownish-yellow externally, with two broad, a little oblique, dusky transverse bands; hind tibiæ pale yellow, with a broad fuscous cloud at the tip and just before the middle.

Length of body, 21 mm.; of antennæ, 5.5 mm.; of tegmina, 22.5 mm.; of hind femora, 11.5 mm.

Only two individuals of this interesting insect, first described from the vicinity of Denver, Colorado, were captured in St. Anthony Park, and no others have been seen.

Still another species occurs in the Park, but seems to be undescribed.

GENUS *Chortophaga* Saussure (1884).

Body compressed, somewhat slim, punctate or fine wrinkled, greenish, sub-glabrous, slightly pubescent. Legs remote, with scattered hairs on their surface. Antennæ rather short, and slightly flattened. Pronotum acute,

angled behind. Wing-covers narrow; costal half green, sutural half brownish. Wings with dilute coloring, nebulous; costa with a dusky stigma; ulnar area dilated. The intercalary vein of the tegmina running midway between the median and ulnar veins, only apically a little approximating the former; veins of the wings slightly or scarcely incrassate. In coloration, dichromatism, form of head and character of haunts it is intermediate between the *Œdipodinæ* and the *Tryxalinæ*, with which it was formerly classed.

THE GREEN-STRIPED LOCUST.

(*Chortophaga viridifasciata* DeGeer).

This common locust is exceedingly variable, and a number of varieties occur, which shade into each other. Two

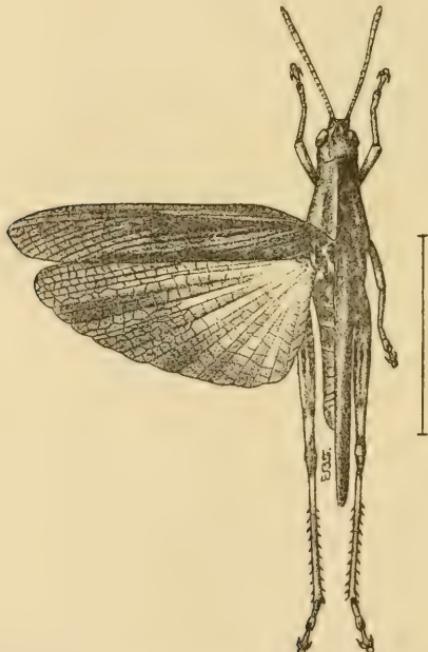


Fig. 83.—*Chortophaga viridifasciata*, form *virginiana*, male. Original.

well marked varieties are found, the green form (*virginiana* Fab.), and the brown form (*infuscata* Harris). This dichro-

matism is largely, but not entirely, characteristic of sex; most of the females being green, of the males brown.

The green variety is the typical one; wing-covers with a broad green stripe on the outer margin, extending from the base beyond the middle, and including two small dusky spots on the edge, the remainder dusky, but semi-transparent at the end; wings transparent, very pale, greenish-yellow next to the body, with a large dusky cloud near the middle of the hind margin, and a black line on the front margin. Antennæ, fore and middle legs reddish; hind femora green, with two black spots in the furrow beneath. This form is the larger one. Both sexes are illustrated in Figs. 83 and 84.

The dusky brown variety has the wing-covers faintly spotted with brown; wings transparent, pale greenish-

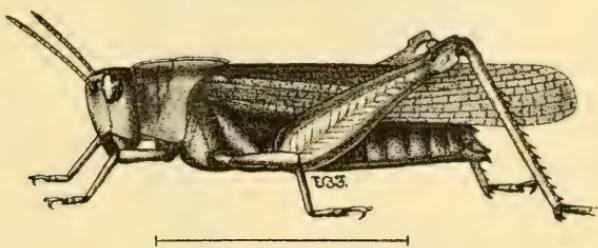


Fig. 84.—*Chortophaga viridifasciata*, form *virginiana*, female. Original

yellow next to the body, with a large dusky cloud near the middle of the hind margin; and a black line on the front margin; hind femora pale, with two large black spots on the inside; hind tibiae brown, with darker spines, and a broad whitish ring below the knees. The hind tibiae differ much in color in different specimens, being variously tinted with brown, blue, pink or purple, without regard to sex. Many intergrades occur, in which the head and pronotum are of a reddish velvety brown. This form is shown in Fig. 85.

Length of male, 25 mm.; of female, 30 mm.

This is a very common locust in our state, appearing very early in spring and continuing throughout the summer. It hibernates, and larvæ and pupæ are occasionally observed during a warm spell in winter. Early in spring (April 18), or as soon as the ground becomes warm, winged forms

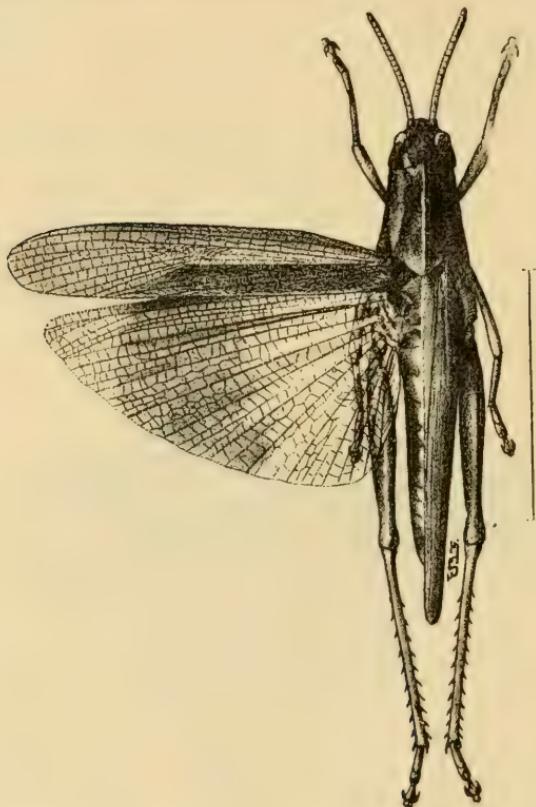


Fig. 85.—*Chortophaga viridifasciata*, form *infuscata*, Original.

appear, and these can readily be detected by their sharp clicking notes when flying. *Arphia sulphurea* and this species are the first locusts observed in spring, and usually both are found in the same localities, starting the chorus of grasshoppers, locusts and crickets that becomes so general later in the season. While taking wing readily its flight is

but short and it is not difficult to capture. The male flies in a circling course, and usually stridulates, producing a fine, sharp crepituation; the female flies farther and more directly. We have but a single brood in our state; the eggs hatch late in summer and the young do not mature until the following spring. The form *infuscata* is always more common than the green one.

GENUS *Encoptolophus* Scudder (1875).

Head but little swollen above, front vertical above-roundly sloping below, a little constricted above the antennæ; eyes separated by about their own width, moderately large, somewhat elliptical; antennæ rather short and flattened; top of pronotum nearly flat, the median carina abrupt, but not greatly elevated, cut into halves by a distinct though slight notch; lateral carinæ distinct but broken, very slightly curved; hind margin of pronotum forming a right angle; wing-covers reaching but little beyond the end of the abdomen. The intercalary vein of the tegmina distinctly nearer the ulnar than the median vein; the veins next the costal margin and the median vein distinctly incrassate in the male.

THE CLOUDED LOCUST.

Encoptolophus sordidus Burmeister.

Dusky brown; wing-covers pale, clouded and spotted in such a manner that two transparent spots or fasciæ are distinctly marked; wings transparent, faintly yellowish at base, dusky at tip, with a dark narrow edge on the front margin; hind femora brown, with the three black bands separated by four light-brown spaces; hind tibiæ brownish-black, with a white ring below the knees. Antennæ pale at base, fuscous at the apex.

Measurements:—Male: Total length, 21-28.5 mm.; of body, 19-21.5 mm.; of tegmina, 15-19.5 mm.; of hind femora, 11-12 mm.; of antennæ, 8-9 mm. Female: Total

length, 28-32.5 mm.; of body, 24-35 mm.; of tegmina, 20.5-24 mm.; of hind femora, 14-15.5 mm.; of antennæ, 8-9 mm.

This is a fairly common locust, which is found from the middle of August till frost, or late in October. Like the

males of allied species the male of this species always makes a sharp crackling noise when flying, which it does with amazing rapidity. It is especially common in the



Fig. 86.—*Encoptolophus sordidus*.
Original.

western part of our state. Its color, which is rather constant, varying from dull rusty, yellowish, or smoky brown, always protects the insect by its resemblance to the soil. It delights to live in old stubble fields. Fig. 86 shows a male.

GENUS *Cannula* Stål. (1873).

Head compressed; antennæ medium, a little stouter in the male; hind femora with an acute margin slightly crested; eyes small, rather prominent, rounded kidney-shaped. Pronotum not rugose, nearly level above with median and lateral carinæ. Wings subvitreous.

In the markings of tegmina form and color *C. pellucida* looks like a diminutive *Hippiscus*, to which *Cannula* is not distantly related.

Cannula pellucida Scudder.

Ash brown; face reddish-brown; antennæ yellowish at base, dark brown toward tip; a triangular black spot behind the eye, the apex touching it; a quadrate transverse black spot on the anterior upper portion of the sides of the pronotum; pronotum above sometimes with a dark band down the middle; wing-covers with the basal half dark brown, with small yellowish spots and transverse streaks, especially on front border; apical half clear, with dark

brown rounded spots prevalent along the middle, decreasing in size toward the tip; when closed, the upper surface is dark brown, with a rather broad yellowish line along each angle on the upper surface; wings pellucid, with black nervules; legs dark brown, the hind femora reddish or yellowish-brown, with two or three rather broad, diagonal, dark brown streaks, dark brown at the apex; hind tibiæ yellowish-brown, reddish toward the tip, with a narrow, generally faint, annulation of dark brown at the base; spines tipped with black.

This insect is sometimes exceedingly common, and becomes a destructive species. In this respect it is almost as bad as *Melanoplus atlantis*; both have appeared repeatedly together, and have caused great loss. The former, however, preferred higher land, the latter lower or more moist soil. This species varies considerably in size and tegminal markings—some tegmina are almost without marks—but is not likely to be confused with any other species found in Minnesota.

Measurements:—Male: Total length, 20.5-24.5 mm.; of body, 17-21 mm.; of tegmina, 15.5-18.5 mm.; of hind femora, 9.5-12.5 mm.; of antennæ, 7-9 mm. Female: Total length, 22-30 mm.; of body, 21-28 mm.; of tegmina, 19-23.5 mm.; of hind femora, 11-14.7 mm.; of antennæ, 6-8.5 mm.

This destructive insect, illustrated in Figs. 87 and 88, is not always found in our state; it belongs to the migratory



Fig. 87.—*Camnula pellucida*, female. Original.

species, and if occurring in the state it is found in its winged condition as early as July 1, and it does not disappear until the middle of September. Its flight is silent or but slightly

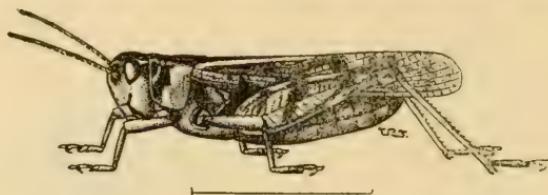


Fig. 88.—*Camnula pellucida*, male. Original.

rustling, usually low, short and direct. The illustration (Fig. 1) shows this insect and its eggs. Its life-history is given elsewhere.

GENUS *Hippiscus* Saussure (1861).

Large or medium sized, robust, glabrous. Top of the head with a small central ridge; pronotum with a granular surface, truncate in front, acute-angled behind, compressed centrally on the sides, and above on each side of the median carina; this last with one notch; lateral carinæ prominent only in the middle. Wing-covers extending considerably beyond the end of the abdomen.

This is a large genus, and has been subdivided into a number of sub-genera by Scudder and Saussure.

Hippiscus rugosus Scudder.

Head and thorax brown; two yellowish bands run from behind the eye backward and inward, nearly or quite meeting one another a little in advance of the middle of the pronotum, where they diverge and strike the hinder edge of the pronotum at the outer angles; there are two yellowish spots, one below the other, on the sides of the pronotum; wing-covers marked with large dark blotches, generally occupying the larger portion of the wing; the tip of the wing-cover pellucid, nearly free from spots; wings with the basal color pale yellowish or red, and the apical portion dusky.

Last, forked branch of the discoidal vein of the hind wings usually arising about three-fifths the distance from the base to the apex of the wing, and in the male usually well within the limits of the transverse fuscous belt; closed tegmina of male surpassing the abdomen by at least one-fourth their length. The very broad posterior femora crossed externally and internally by three black bands; posterior tibiæ reddish yellow, with a broad, pale ring near the base. This species is more slender than the others found in Minnesota.

Size about the same as *tuberculatus*.

This species is not common, at least but few have been collected, both with yellow or red wings. They prefer sandy spots, and fly as early as Aug. 14. It can readily be distinguished from *tuberculatus* by the form of the head and pronotum. The wings are usually yellow, often pale yellowish-white, sometimes orange or even red.

Hippiscus tigrinus Scudder.

Dark brownish fuscous, of robust form and medium size. Head narrowed above and rugulose; pronotum expanding considerably on the metazona, which is centrally a little tumid, the rugosities of the latter, which are considerable, ranged more or less distinctly into series parallel to the sides of the process; median carina subobsolete or at least depressed between the scutell, distinctly arched on the metazona; lateral canthi distinct and sharp in the middle of the pronotum, a faint rather broad ashen band next their inner side. Tegmina ashen gray, brownish at base, vitreous on apical third or more, the transverse bars dark brownish fuscous, mostly crossing the wing, those of apical half not at all rounded, with rare exceptions with ill defined irregular margins, and extending though fainter to the tip of the wing; sutural line testaceous. Wings very pale, citron-color at base, pellucid at tip, occasionally with one or two fuliginous cellular spots at tip, the veins and cross-veins blackish on apical portion, yellow on basal, with a broad,

sub-equal, arcuate, dark, fusco-fuliginous, median, scarcely tapering band, leaving four or five lobes free, separated by a yellow line from the humeral vitta which extends from very nearly as far out to the base of the wing, the costal margin fusco-testaceous. Hind femora externally brownish fuscous with only obscure, if any, darker very oblique bars, dirty

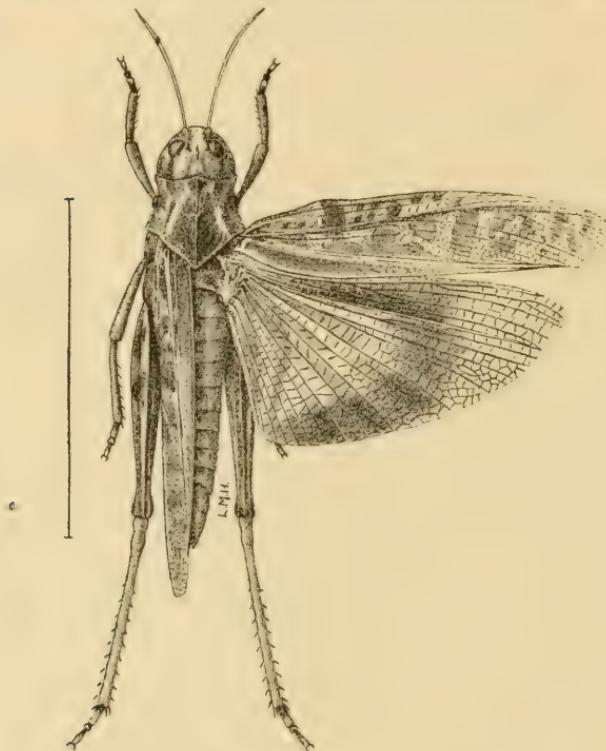


Fig. 92.—*Hippiscus tigrinus*, female. Original.

clay-yellow below, the under surface, like the tibiae and tarsi, luteous, the spines black tipped.

Length 37 mm.

Only two specimens found. This species is illustrated in Fig. 92. It seems to be a southern species. All the species of this large genus of locusts resemble each other so closely when in the field, or when flying, that only very careful collecting in all parts of the state will give a clear idea of the

species really found in it. Very little has been done as yet to ascertain how many species have their home with us.

Hippiscus tuberculatus Pal. de Beauv.

This is our common coral-winged locust, found so commonly in early spring in all parts of the state. The early stages, from the half grown larvae to the pupae, pass the winter under the shelter of leaves and grass; they mature

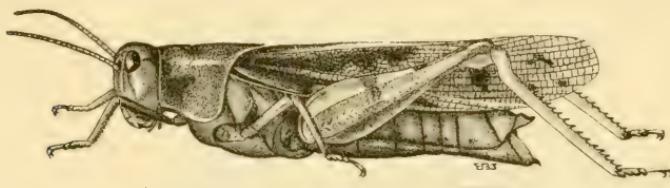


Fig. 89.—*Hippiscus tuberculatus*, female. Original.

very early in the spring, and are found flying about in the warm sunlight as early as the last week in April. Although found everywhere in Minnesota they still appear to be quite local and prefer certain localities, where they can always be found at the proper time. It is this insect that is mentioned as *H. phœnicopterus* in the reports about the

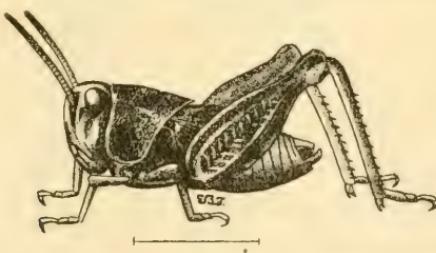


Fig. 91.—*Hippiscus tuberculatus*, young. Original.

Rocky-Mountain Locust; it is not uncommonly called the "King Grasshopper," as some people thought it to be the leader of the large and devastating armies of the above locust. The three illustrations, (Figs. 89, 90, 91,) show the adult insects and a young one.

There is considerable variety in this species, so much so that several varieties might be formed. Scudder's description of living females taken in Massachusetts fit our insect thoroughly well: Prevailing color a light ashy plumbeous, slightly darker above, speckled with dark plumbeous, tinged slightly beneath with reddish. Head uniform; mouth-parts

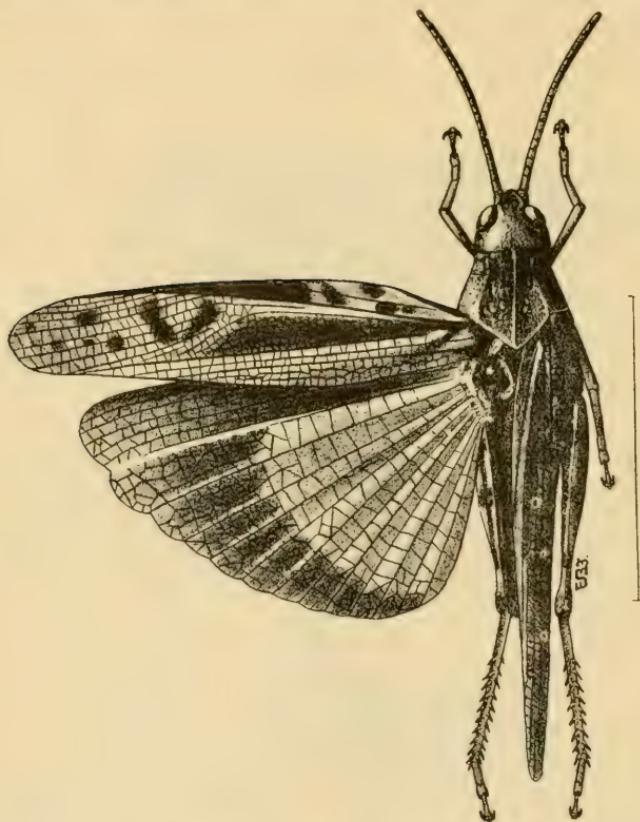


Fig. 90.—*Hippiscus tuberculatus*. Original.

uniform and tinted like under surface of body. Eyes dark brown, speckled with yellowish and with a narrow slightly curved transverse median streak of yellowish-brown, turning upwards posteriorly. Antennæ dirty yellowish at the base, beyond of the color of the head. Pronotum with a longitudinal dark brown streak with indistinct edges along

the middle of the lateral lobes, and from the middle of this a descending vertical streak scarcely paler than the ground; posterior edge of pronotum a yellowish-brown of the color of boxwood. Tegmina of the body color or blotched with fuscous and black, and with the axillary fold yellowish brown. Wings coral-red at base, the arcuate band fuscous deepening to black, the humeral line pale yellow and the apex nearly hyaline. Legs of the body color, the inside of the hind femora having the basal half a prussian blue, the distal half very dull lemon yellow with a transverse streak of deep blue at one third the distance from the middle; hind tibiæ dull lemon-yellow, hind tarsi tinged with reddish. Abdomen above tinged on the first three segments with reddish brown, especially toward apex; ovipositor of the color of the body when not black. Metazona without lateral oblique rugæ.

Total length of male, 32-38 mm., of female, 39-43 mm.; of body, male, 25-28 mm., of female, 36-44 mm.; of tegmina, male, 24-30 mm., of female, 30-32 mm.; of hind femora, male, 14-16 mm., female, 18.5-20.5 mm.; of antennæ, male, 10.5-12 mm., female, 11.5-13.5 mm.

Yellow-winged specimens of this species are very rare. Sometimes the head, pronotum and hind femora are greenish. The young insects, one of which is shown in the illustration (Fig. 91), can be found late in August; they are curious little depressed, toad-like objects, of a purplish leaden color. Though very conspicuous objects in flight, the adult insects are quite alert and active, so that they are not easily captured. If flushed the male flies to a considerable distance; the female is much less active, and is more difficult to flush more than once, as it tries to escape rather by hiding than by flying. The stridulation of the male is a rapid rattle, louder but similar to that of *Arphia sulphurea*, which flies at the same time and in similar localities, bushy pastures and untilled or elevated land of light soil.

Hippiscus Haldemanii Scudder.

Granules on dorsum of metazona by their confluence distinctly following lines forming oblique rugæ parallel to the hind margin; lateral canthi of pronotum as distinct and sharp on the hinder part of the prozona as on the front part of the metazona.

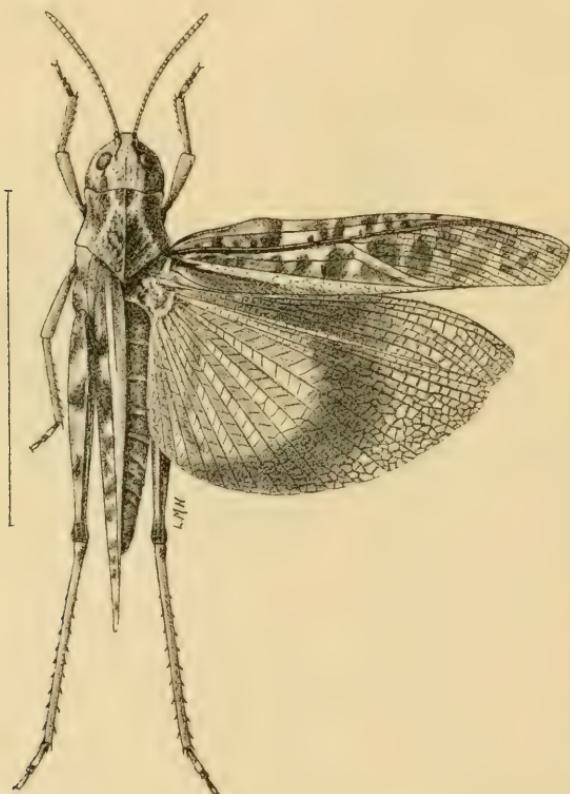


Fig. 93.—*Hippiscus Haldemanii*, female. Original.

This is a medium sized member of this genus, illustrated in Fig. 93, with yellow wings and pale red tibiae of hind legs. It has been reported from the Red River Valley, but no specimens have been secured by the writer.

Hippiscus variegatus Scudder.

Markings of tegmina distinctly pantherine, marginal field with numerous small blotches; wings of male fully twice as long as broad; hind margin of prothorax rectangulate. Basal color of wings varying from a pallid tint through pale lemon yellow to saffron and coral-red. Hind femora bright yellow within, thrice heavily banded trans-

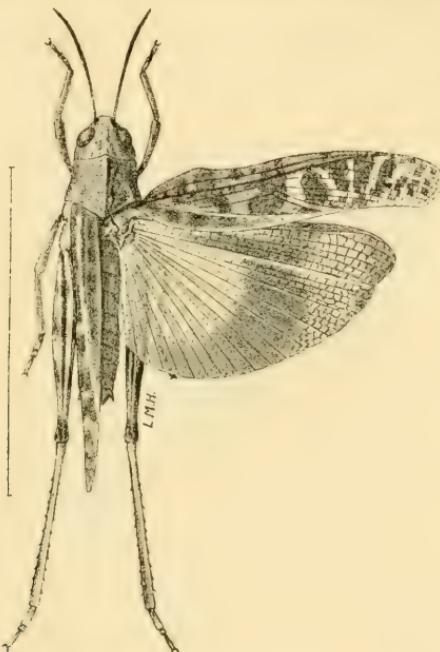


Fig. 94.—*Hippiscus variegatus*, male. Original.

versely with black; dull clay yellow without, very obliquely banded with blackish or fuscous; hind tibiæ yellow with an orange tinge sometimes infuscated a little just beyond a broad clear basal belt; spines black tipped.

Length of body, male, 28 mm., female, 37 mm.; of tegmina, male, 28 mm., female, 35.5 mm.

This species is uncommon in Minnesota, and but a very few specimens have been seen or captured. It is illustrated in Fig. 94.

GENUS *Dissosteira* Scudder (1876).

Head prominent, vertex elevated and tumid; antennæ of the male not thickened before, nor tapering at the tip; posterior lobe of the pronotum somewhat enlarged, median carina much elevated, deeply notched near the middle, the posterior lobe much arched. Insects of large size and prominent colors.

THE CAROLINA LOCUST.

(*Dissosteira carolina* Linn.).

This is a very common locust, and is found from early July until late in autumn. Few persons do not know its peculiar actions during the warmer portions of the day, when the males fly two to six feet in the air, and there remain almost stationary, producing a peculiar rattling, or rather rustling sound. This seems to be their love song. After pairing, which takes place early in August, and all through that month and September, the female deposits her eggs at the bottom of a cylindrical hole; the eggs do not hatch until spring. The female can greatly extend her abdomen, so that eggs can be found as deep as nearly two inches below the surface. The insect prefers warm and sandy situations, and is most commonly found upon sandy spots. Its upper wings vary greatly in color, but possess always that one which harmonizes best with the color of the sand upon which the insect is found, hence all shades of light or dark yellowish, brown, reddish, and even blackish can be seen by observing the insect upon sands possessing that shade of color. The usual color of this locust is a pale yellowish-brown, with small dusky spots, wings black, with a broad yellow hind margin, which is covered with dusky spots at the tip. From the prevailing brown tints of its coloring it has in some localities received the name of "Quaker." Though quite variable in appearance it is easily recognized by its black wings with pale border, which

varies from dull-white to yellowish-buff. The most striking variation, however, is the ground color of the body, which varies in specimens from the same locality from light yellow to dark fuscous or even bright reddish-brown. The tegmina are sometimes markedly trifasciate, sometimes evenly maculate or almost unspotted. Possessing large wings its flight is powerful and erratic; it is very alert and well able to take care of itself, and on warm days it is rather difficult to secure. The insect is shown in Fig. 95.

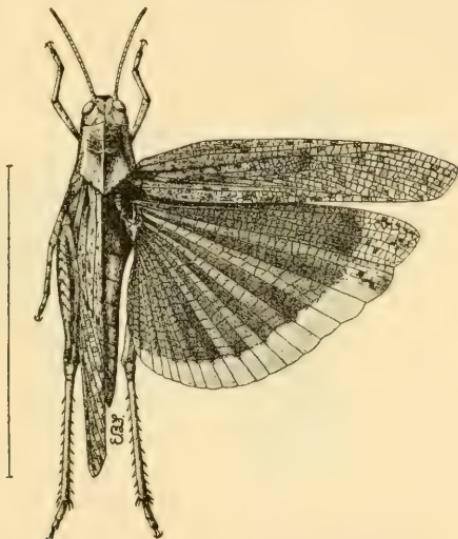


Fig. 95.—*Dissosteira carolina*, female. Original.

Measurements:—Male: Total length, 34.5-42 mm.; female, 43.5-53 mm.; of body, male, 24-28 mm.; female, 33-42 mm.; of tegmina, male, 28-33.5 mm.; female, 36-43 mm.; of hind femora, male, 12.6-14 mm., female, 15.5-20.5 mm.; of antennæ, male, 9.5-11 mm., female, 11.5-13 mm.

GENUS *Spharagemon* Scudder (1875).

Saussure united this genus with *Dissosteira*, but later studies by Scudder, Morse and others clearly show that it is a good genus, well separated from the former, as may be

seen by consulting the table of genera of the *Œdipodini*. Morse adds to the description of this genus by Scudder that the median carina of the pronotum is divided by the principal sulcus into two parts, the front portion a little shorter. The eyes of our species are of moderate size, and rather prominent in the males.

Spharagemon collare. Scudder.

Central foveola of the vertex rather broader than long in the female, in the male slightly elongate; frontal costa flat or convex above the ocellus, with a shallow sulcus below; sides nearly parallel. Median carina of the pronotum prominent, sub-cristate, with a very narrow but deep oblique notch a little in advance of the middle; the top slightly arcuate; lateral carinæ indistinct; sides of the disk ascending. Tegmina and wings pass the abdomen about one-third their length. Dark reddish-brown. Lower half of head and a broad band along the posterior edge of the pronotum a clay-yellow, sprinkled with a few fuscous dots. Tegmina mottled somewhat uniformly with fuscous blotches and dots, which form three irregular bands, one at the base, which is broad, the middle one narrowest, the apical one sometimes lost in the nearly equal mottling of the tip. Wings pale yellow at base; a broad median black band occupying the middle third, crossing the wing at right angles, decreasing along the posterior margin, around which it curves to the anal angle, throwing out a short, blunt, sub-frontal spur about one-third the distance to the base; apical portion transparent, nerves dusky, and tip clouded or with dusky spots. Hind femora clay-yellow, with two bands and apex fuscous externally and black internally; hind tibiæ reddish. Antennæ fuscous at the apex.

According to Prof. Morse the species described as *collare*, *Wyomingianum*, and *Scudderii* approach each other so closely that it is almost impossible to definitely limit them. Typical specimens of these forms can be readily distinguished,

while others cannot be referred to either of them with certainty, and for this reason he thinks it best to regard them as races of one composite species.

RACE *Collare* Scudder.

Only a single specimen of this race has been found in Minnesota, which seems to indicate that it is not common,

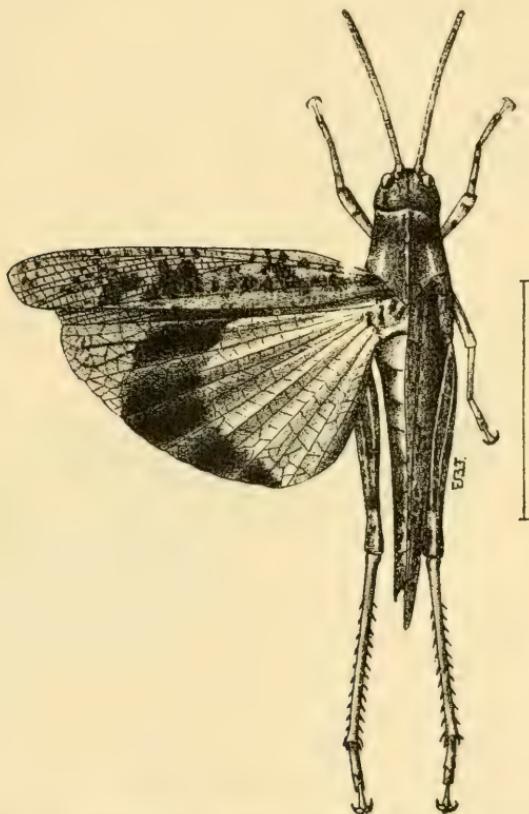


Fig. 96.—*Spharagemon collare*, race *Scudderri*, female. Original.

though it is a wide-spread form in the central part of the country. It differs greatly in color and size. The "collared" type of coloration is not common. The hind femora sometimes have the proximal two fuscous bands slightly connected internally, but never to such an extent or depth of tint as in the race *Scudderri*.

Measurements:—Length, 26.5-33 mm.; of tegmina, 21.5-26 mm.; of hind femora, 11.5-14.5 mm.; of antennæ, 12 mm.

RACE *Scudderii* Morse.

This race is very common upon sandy spots near the Mississippi River, and large numbers were taken on Gray Cloud Island. The specimens were named by Prof. Bruner *balteatum*; a male mailed to Prof. Morse was pronounced: race *Wyomingianum* Thos. (nearly typical), while a female, caught at the same time and place was pronounced as being probably the same, but in size, form of head, etc., closely approaching race *Scudderii*; in fact being nearer *Scudderii* than *Wyomingianum*.

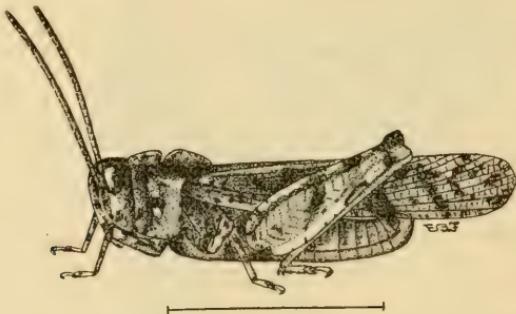


Fig. 97.—*Spharagemon collare*, race *Scudderii*, male. Original.

This locust is quite common in certain rather well defined localities. Nearly all specimens captured were found upon sandy spots near our rivers and lakes. Here they can be found as early as the 25th of June. Like the Carolina Locust described before they also remain flying stationary a few feet above the ground and likewise produce the dry rustling sound, which has something to do with their courtship. Frequently both species fly at the same time and in the same vicinity, and both are equally well protected by their colors if resting upon the sand. They delight to bask in this hot sand, yet are very vigilant and difficult to capture excepting with a net. When resting upon the sand, which always con-

tains small bits of bark brought down by the overflowing river, it is almost impossible to detect this insect, which, moreover, seems to be able to understand how to select a spot that exactly matches with its own color. Both sexes are shown in Figs. 96 and 97.

BARREN-GROUND LOCUST.

Spharagemon bolli Scudder.

This locust is very variable in color, but is usually brownish fuscous, the face with a grayish cinereous (in the male) or yellowish cinereous (in the female) tinge, distinctly marked with blackish dots, the pits dusky or blackish; antennæ brownish-yellow on the basal half, infuscated beyond, the whole more or less annulate with dusky yellow and blackish in the male. Wing-covers flecked throughout with minute blackish spots. Wings light greenish-yellow at the base with a broad median arcuate band, blackish in color, sending out a broad short shoot towards the base next the upper border. Beyond, the wing is at first hyaline, with broad blackish, fuliginous veins, while the extreme tip is more or less covered with black. Hind femora dull brownish; the basal two-fifths of the hind tibiæ blackish, with a broad whitish annulus beyond, coral-red. Crest of pronotum very high, that of the posterior lobe independently arched, much more elevated in front than behind.



Fig. 98.—*Spharagemon bolli*, male.
Original.

lobe independently arched, much more elevated in front than behind.

Measurements.—Male: Length of body, 20-22 mm.; of tegmina, 22-25 mm.; posterior femora, 12.5-13.5 mm.

Female: Length of body, 27-33 mm.; of tegmina, 23-28 mm.; posterior femora, 12.5-17 mm.

This species has been found in many parts of the state, but most frequently along the sandy shores of rivers and lakes, and on the tops of high and sandy hills. It is shown in Fig. 98.

GENUS *Mestobregma* Scudder (1875).

Head large; face horizontal; vertex tumid, but not so elevated as in *Psinidia*, broad between the eyes, the fastigium quadrate, depressed, with very high and abrupt lateral and frontal carinæ, which form the continuation of the sides of the equal, completely sulcate frontal costa; lateral foveolæ small, depressed, rudely semi-circular, the ocelli situated beneath their outer extremity; eyes small, moderately prominent, but little longer and not so broad as the space between them; antennæ (female) about as long as the hind femora. Pronotum posteriorly as broad as the head, somewhat constricted in the middle, the hind lobe scarcely longer than the front, the posterior border rectangular; median carina moderately conspicuous, slightly higher on the front than on the hind lobe, twice deeply cleft, the transverse sullcations extending into the lateral lobes; lateral carinæ of posterior lobe prominent; surface of hind lobe nearly flat, pretty smooth; front lobe with a few oblique rugæ and small tubercles. Tegmina and wings surpassing the abdomen, the axillary vein of the former free; hind femora as long as the abdomen.

Mestobregma cincta Thomas.

A few specimens of this interesting insect have been taken in various portions of the state, but mainly in the more wooded regions. This insect appears to be by no means common. The description given by Thomas follows: Female: The head, seen from the side, shows the crown somewhat elevated, the eyes also standing high. Vertex deflexed,

broad, sub-hexagonal; the front portion prolonged; the margins continuous with the sides of the frontal costa. Frontal costa narrow above, gradually expanding below, and sulcate throughout. Pronotum short, the length not exceeding the depth, strongly contracted a little in advance of the middle; the disk somewhat rugose, that of the posterior lobe nearly flat; the median carina slightly elevated on the front lobes, twice distinctly notched; the middle portion shortest and rounded; the whole of the disk, especially the posterior lobe, more or less covered with small tubercles; lateral carinæ obsolete on the anterior lobes, and obtuse and indistinct on the posterior lobe; the posterior angle a little larger than a right-angle. Elytra and wings extend beyond the apex of the abdomen. Posterior femora rather short, not reaching the tip of the abdomen in the female; broad at base, with a sharp, elevated upper carina, which suddenly decreases about one-third of the length from the apex; the lower edge generally hairy. Antennæ longer than the head and pronotum, filiform.

Color.—Fuscous and pale yellowish-brown, or ash, about equally distributed in stripes and spots, the ash or yellowish-brown portion more or less mottled with fuscous dots

and points. The dark on the head as follows: two stripes, running back from the eyes one from the upper, the other from the lower corner; the lower portion of the cheeks and the lower margin of the face; and some dots on the margin of the frontal costa. On the pronotum a broad pale stripe runs along each lateral carina, converging in front of the middle; the margins of the



Fig. 99 - *Mestobregma cineta*,
male. Original.

posterior portions are pale, jointed interiorly by a black stripe; the central space pale; the sides marked with alter-

nate stripes of pale and fuscous. Elytra fuscous at the base, becoming transparent a little beyond the middle, where the netted nervules suddenly cease; a narrow whitish line along the angle; the lower field has two sub-quadrata black spots separated by an elongate whitish spot. Wings transparent; base greenish-yellow; a narrow fuscous band across the middle; apex pellucid, with a few fuscous dots at the tip. Posterior femora ash-colored, with three black spots on the upper margin of the outer face; base and a band on the inside black. Posterior tibiae with a broad white ring near the base, rest blue. Tarsi yellow. Venter and pectus white.

Dimensions.—Length, 25 mm.; tegmina, 23 mm.; posterior femora, 14 mm.; posterior tibiae, 12 mm.

This insect, shown in Fig. 99, is quite different from any other orthopterous insect found in Minnesota.

GENUS *Psinidia* Stål. (1873).

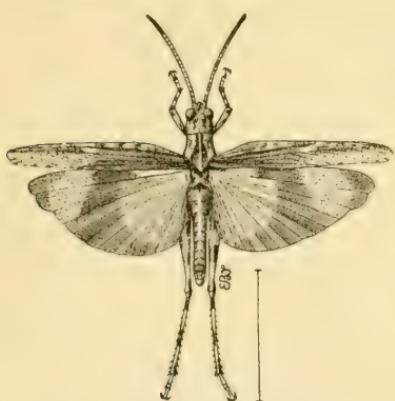
Head large; antennæ flattened; pronotum granulated, acute angled behind, very much compressed before the middle; median carina distinct with two notches; lateral carina distinct on posterior lobe, broken on the anterior lobes; wing-covers narrow, hind wings broad, both extending beyond the body.

LONG-HORNED LOCUST.

Psinidia fenestralis Serville.

This beautiful insect is not common in Minnesota, and only a single specimen was found late in August in a dying condition upon the hot sands of a sand bar in the Mississippi River opposite Gray Cloud Island. The insect is small, and when resting on the ground it is so much colored like it that it is not readily seen; when flying, however, it is a very conspicuous object with its large and crimson-colored wings.

Ash-colored, variegated with gray and dark brown; body beneath yellowish; hind femora grayish outside, black



Pig. 100.—*Psinidia fenestrata*, male.
Original.

at base inside, a band beyond the middle and black at the apex, these bands are repeated outside; hind tibiæ whitish, with a black ring at each end, and one of the same color before the middle; wing-covers ashen gray, variegated with brown and black, transparent at the apex; hind wings pinkish-red salmon color or pale orange-yellow

at the base, with a rather arcuate smoky black band; apex transparent in the female, more or less tipped with black in the male, the dark color usually connecting with the black band and enclosing a transparent patch.

Measurements.—Male: Length of body, 15 mm.; wing-covers, 19 mm.; posterior femora, 10 mm. Female: Length of body, about 25 mm.; wing-covers, 23 mm.; posterior femora, 13 mm.

This insect, (Fig. 100), is readily distinguished from the species of *Spharagemon* by the strongly constricted pronotum, the form of the antennæ, and the venation of the tegmina, which are narrow and have many of the cellules in hinder part of distal half two to four times as long as wide. The antennæ are unlike those of any other species of this sub-family, having depressed or prismatic joints, appearing almost ensiform next the base. Another peculiarity noticeable is that on the distal third of the tegmina the maculation is restricted to the costal half. The species varies greatly in general coloration, according to environment, from pale dust-color to bright reddish-brown or even black. The most interesting feature is the variation in the

color of the wings, which may vary in specimens from the same spot, from dull white through yellow and orange to vermillion.

GENUS *Trimerotropis* Stål. (1873).

Vertex continuous with the median sulcus of the face; body covered with very short hairs; pronotum compressed before the middle, narrower in front than behind; slightly angled in front and acutely angled behind; median carina slight and broken by two wide notches before the middle; lateral carina distinct on the posterior lobe and broken on the anterior lobes; wing-covers long and narrow; hind wings narrowing to a point at the apex.

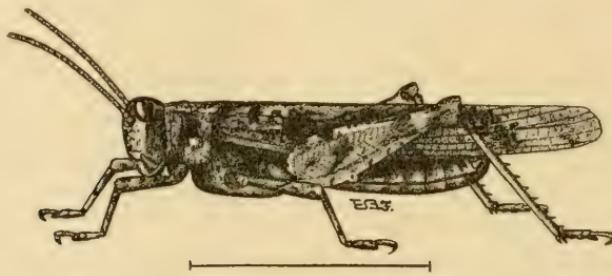


Fig. 101.—*Trimerotropis maritima*, male. Original.

Trimerotropis maritima Harr.

The Maritime Locust.

Head, pronotum, legs and posterior femora white, sprinkled with minute points and dots of black and brown; eyes ochraceous; inside of hind femora with two black spots; hind tibiae light yellow, spines tipped with black; wing-covers also whitish, sprinkled more or less with black and brown points and spots, apex transparent; hind wings at base semi-transparent, pale yellow followed by an arcuate, narrow black band, more or less broken by the veins, outer third of wing transparent.

Measurements.—Male: Length of body, 23 mm.; wing-covers, 24 mm.; posterior femora, 13 mm. Female: Length of

body, 32 mm.; wing-covers, 33 mm.; posterior femora, 16 mm.

This is an easily recognized species. The sides of the pronotum vary considerably, being sometimes almost rounded, sometimes with a distinct tooth-like projection. The color of the insect varies with the soil of the locality,

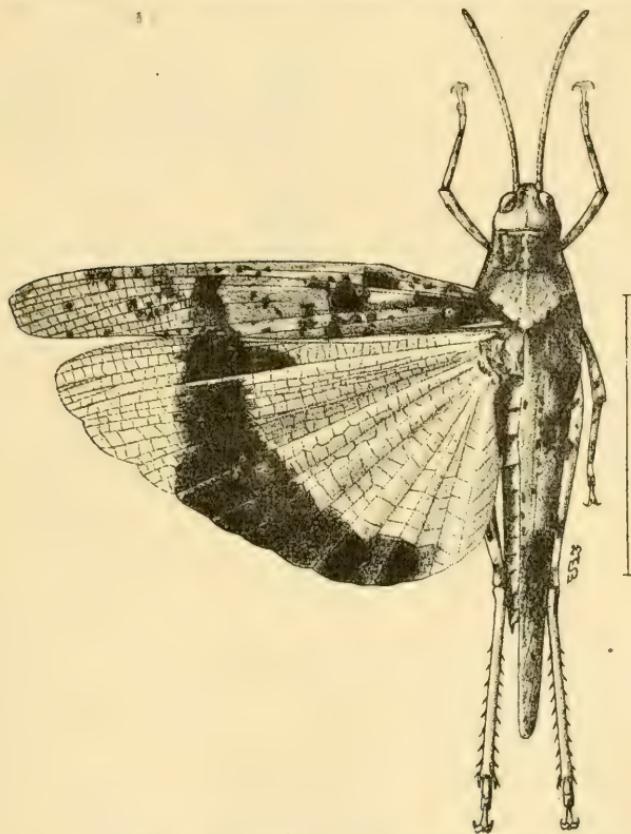


Fig. 102.—*Trimerotropis maritima*, female. Original.

the ground-color ranging from white to light brown, more or less sprinkled with dusky blotches, which are sometimes nearly obsolete, or again nearly confluent on the head, pronotum and base of tegmina. In places where the white sand of the river shores is mixed with small bits of bark the insects show numerous brownish spots agreeing with the color of the sand. Both sexes are illustrated in Figs. 101 and 102.

This beautiful insect is rather common in certain localities, like sandy shores of rivers and lakes. Its whole appearance shows it to be an inhabitant of white, or whitish sand. Here it delights to bask throughout the warmer portions of summer, and is especially numerous early in July. Though very common it is not easily detected, nor captured, as it is very vigilant, at least during the day. It is found with *Spharagemon collare* and *Dissosteira carolina*.

GENUS *Circotettix* Scudder (1876).

Eyes somewhat prominent; vertex channeled and continuous with the median sulcus of the face; head somewhat broader than the anterior lobes of the pronotum; posterior lobe of the pronotum broader and acute angled behind; median carina slightly elevated, with two rather deep notches before the middle; lateral carina indistinct on the posterior lobe, but not prominent. Wings and wing-covers longer than the body; the latter are of equal length throughout, with the apex oblique; the former are rather broad.

Circotettix verruculatus Kirby.

Ash gray, heavily mottled with black and gray; sometimes the black almost obscuring the entire head, thorax and wing-covers, thus giving the insect a very black appearance; abdomen black; hind femora with four more or less distinct black bands; hind tibiæ yellowish with a black band at the base, a broader one at the extremity and one before the middle; hind wings semi-transparent, light yellow at the base followed by a narrow, black, arcuate band; apex transparent, tipped with black; sometimes the transparent space is black, but of a lighter shade than the band.

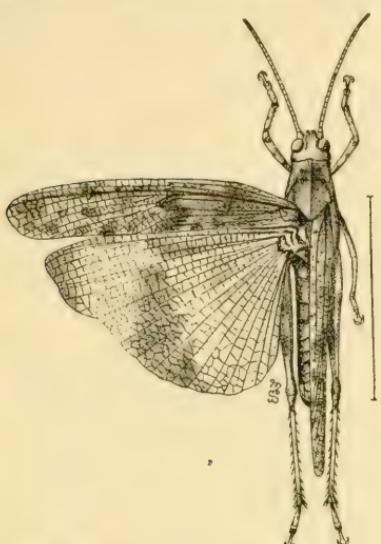
Measurements:—Male: Length of body, 22 mm.; wing-covers, 24 mm.; posterior femora, 11 mm. Female: Length of body, 30 mm.; wing-covers, 28 mm.; posterior femora, 13 mm.

A number of specimens were captured among the rocks at the State Park near Taylor's Falls. It may be common if

looked for at the proper time. It is readily confused with dark forms of *Spharagemon bolli*, but may be distinguished by the narrow wing band, enlarged radial veins, pale hind tibiæ, and distinctly two-notched pronotal carina. In color it varies from a dark gray or brown to black sprinkled with ashy, darkest on the head and pronotum, palest on base of hind thighs, and with the tegmina distinctly trifasciate. Its "song" in flight is the loudest produced by any of our locusts, and consists of

a series of separate notes, clicks or snaps, not a rattle, and is readily distinguished by this peculiar snapping quality. It is very shy and difficult to approach during the warmer part of the day, when it often flies away for a distance of several rods and circles about, returning to the place whence it started, like our common C-butterfly, or dances up and down in the air, snapping loudly. The female sometimes makes a soft flutter or shuffle of wings in flight, probably corresponding to the snapping of the male, and both sexes can fly silently at will. The male stridulates when at rest, by rubbing the hind thighs against the tegmina, producing a "scratching" sound, audible at a distance of three or four feet. The intercalary vein is toothed, in a low but continuous series, for its entire length in the male, and on the distal half or more in the female, in which the teeth are lower and barely perceptible. A male insect is illustrated in Fig. 103.

Fig 103.—*Circotettix verruculatus*.
male. Original.



SUB-FAMILY ACRIDIINÆ.

This sub-family of locusts, distinguished by an armed prosternum, is well represented in our state, and some of the most injurious insects known to our farmers belong here. Only two groups of Acriidiinæ occur here, the *Acridia* and *Melanopli*. To the former belong the very large locusts with the mesosternal lobes longer than broad, the inner margin straight, and to the latter smaller insects, with the mesosternal lobes transverse or equally long and broad, the inner margin usually rounded. The *Acridia* contain but one genus, the *Schistocerca*; several species of this genus occur in Minnesota.

GENUS *Schistocerca* Stål.

Large size, vertex concave; median carina of pronotum distinct; lateral carina rounded; prosternum provided with a long, stout, blunt spine; wings well developed, as long or longer than the body. Last segment of male not swollen.

A number of species have been reported from Minnesota, and the following ones were captured in 1896. *Sch. emarginata* Uhler, *Sch. rubiginosa* Harr., and *Sch. alutacea* Harr. *Sch. americana* Drury is a southern insect, yet they can extend as far north as Minnesota, as indicated by the capture of one of these insects in the southeastern corner of the state.

Schistocerca alutacea Harris.

This large insect occurred early in July in large numbers at Gray Cloud Island, in a stubble field, which was overgrown with large plants of Rudbeckia and other weeds. The insect, when fresh, is dirty olive-brown or green, with a rather broad, more or less bright yellow longitudinal stripe on the top of the head and pronotum; wing-covers brown, sometimes marked with darker spots and dots; along the inner margin is a bright yellow stripe which becomes lost near the apex; hind wings transparent, yellowish at the base and becoming brownish towards the apex.

Measurements.—Male: Length of body, 28-32 mm.; wing-covers, 25-27 mm.; hind femora, 16-20 mm. Female: Length of body, 48 mm.; wing-covers, 39 mm.; hind femora, 24 mm.

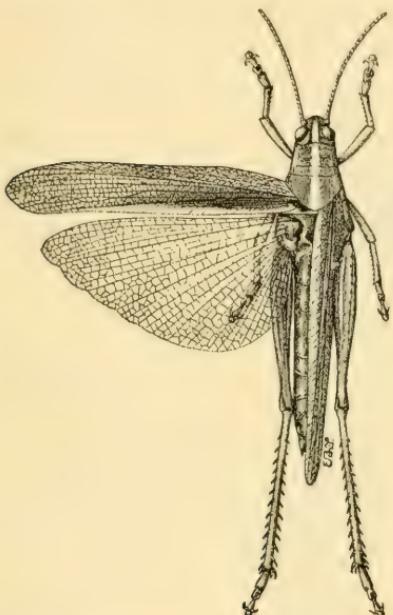
Schistocerca emarginata Uhler.

This species occurs with *alutacea*, but is decidedly more common. Both species are so closely allied, that forms occur

that seem to belong as much to the one species than to the other. It is shown in Fig. 104.

Color, a pale reddish-brown, tinged with green. A distinct median yellow stripe reaches from the vertex to the tip of the pronotum, and extends upon the suture of the elytra. A row of distinct black punctures on each margin of the frontal costa, and a row across the upper part of the clypeus. Palpi and antennæ yellow, and the sides of the pronotum sparsely sprinkled with yellow dots.

Fig. 104.—*Schistocerca emarginata*, female. Original.



Elytra translucent, pale reddish-brown; nerves darkest. Wings transparent, tinged with greenish-yellow at the base; nerves and nervules dull yellow, darkest near the middle of the outer border, slightly tinged with red near the anterior border. Anterior and middle legs greenish externally; striped with black internally. Posterior femora pale green; upper margin of the disk marked with a row of black dots. Posterior tibiæ with the inner face black; outer face greenish-purple. Posterior margin of each abdominal segment marked with a ring of black dots. Same size as *alutacea*.

Schistocerca rubiginosa Harris.

Only two specimens of this species have been seen, both captured in the southeastern part of the state among the wooded bluffs of the Mississippi River. It is light rust-red, rather uniform. Elytra opaque, rather paler on the overlapping portion, without spots, or very brightly sprinkled with small, darker colored spots. Wings transparent, yellowish at base, slightly reddish toward the tip; veins blackish. Posterior femora reddish; the flat disk whitish, with a row of black dots above and below; apex with a lunate black spot on the side. Spines of the tibiæ whitish, tipped with black.

It is slightly smaller than *alutacea*, and differs from it by its redder color, and the absence of the yellow stripe on head, pronotum and wing-covers.

Schistocerca americana Drury.

This fine and large locust is common in the south, where it sometimes assumes a migratory habit and becomes very injurious to crops. Its large wings enable it to fly long distances. This species is well known, being illustrated in almost every book on entomology. It is reddish-brown, with a slight vermillion tint. A yellow stripe extends from the

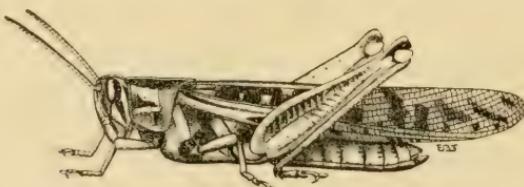


Fig. 105.—*Schistocerca americana*, male. Original.

vertex along the middle of the head and pronotum, and also upon the suture of the closed elytra as far as the tip of the abdomen. A dark brown line down the cheeks below the eyes. On the sides of the pronotum is a yellow stripe extending from the sub-marginal to the last cross-incision, directed a little obliquely downward; below this is a brown stripe;

then a narrow yellow stripe directed obliquely upward; lower margin yellow. The wing-covers opaque and reddish at base, rest semi-transparent; a narrow white stripe on the lower margin, next the base; the disk and apical half marked with large, cellular, fuscous spots. Wings transparent, nerves at the base and inner portion yellowish-

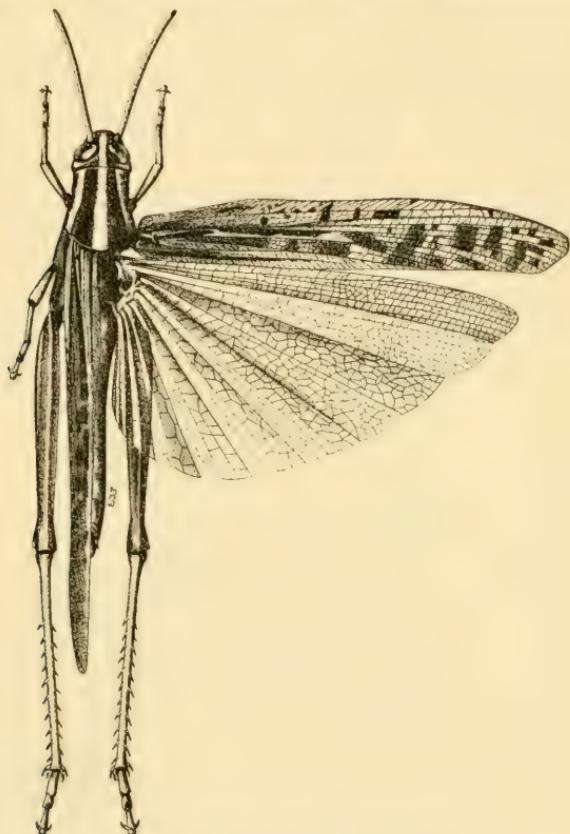


Fig. 106.—*Schistocerca americana*, female. Original.

white, of the other portions black. Legs bright vermillion. Posterior femora have a row of black dots along the upper and lower margins of the disk and one through the middle; spines of posterior tibiæ yellow, tipped with black. Each section of the abdomen has a ring of dusky dots on its posterior margin.

Measurements.—Male: Length of body, about 43 mm.; wing-covers, 45 mm.; posterior femora, 24 mm. Female: Length of body, 52 mm.; wing covers, 54 mm.; posterior femora, 28 mm.

Both sexes are illustrated in Figs. 105 and 106.

The group *Melanopli* contains only three genera found in Minnesota, viz. *Hesperotettix* Scudder, *Melanoplus* Stål, and *Phœtaliotes* Scudder.

A. Subgenital plate of male furnished with a distinct sub-apical tubercle (i. e. one in which the apical margin does not pass through and form a part of the summit of the tubercle, but where it is distinctly separated from the summit), but not otherwise tumescent.

Hesperotettix.

AA. Subgenital plate of male with no distinct sub-apical tubercle, but often apically prolonged or tumescent.

B. Head not large in proportion to pronotum, nor prominent, but little longer than the prozona; pronotum in no way sub-sellate, nor flaring in front; tegmina, when fully developed, narrow; venation sharp and clearly defined.....*Melanoplus*.

BB. Head large in proportion to pronotum, nearly half as long again as the long prozona; pronotum faintly sub-sellate, feebly flaring in front to receive the head; tegmina, when fully developed, broad; venation loose and ill defined.

Phœtaliotes.

GENUS *Hesperotettix* Scudder (1875).

Head not very prominent; vertex very narrow between the eyes, with a slight median pit; the fastigium broadening considerably in front, declivant, shallowly sulcate in the middle, the sides rounded; front straight, a little (female) or considerably (male) oblique; the frontal costa equal, scarcely contracted at the extreme summit; antennæ slightly longer than the head and prothorax together; eyes

slightly prominent, a little more so in the male than the female. Pronotum rather long, nearly equal, broadening a very little posteriorly, transversely arched, with a scarcely perceptible median teetiform carina and well rounded lateral margins; the hind scarcely longer than the frontal lobe; the hind border delicately marginate, obtuse angled; prosternal thorn rather long, conical, compressed, bluntly pointed, meso- and metastethia together much longer than broad. Tegmina and wings reaching the tip of the abdomen. Femora as long as the abdomen, the superior carina slight, unarmed; hind tibiæ slender, the spines of either side of equal length, scarcely diverging, the upper lateral margins smooth and rounded; first joint of hind tarsi scarcely longer than the third, the second small, with a large inferior apical lobe; pulvillus large, nearly twice as long as broad.

Hesperotettix pratensis Scudder.

(PALE-GREEN LOCUST.)

Head yellowish-green, sparsely punctate with fuscous in front, the lower portion of the face more or less obscured with purplish, a short fuscous stripe depending from the eye, in front of which the callosity is livid; vertex with a more or less distinct, rather narrow, fuscous or blackish stripe, narrowing anteriorly, and ordinarily with a median

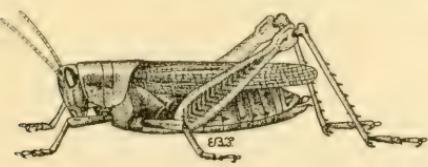


Fig. 107.—*Hesperotettix pratensis*, female.
original.

thread of yellow, the fastigium generally discolored, sometimes and especially in the female reddish. Pronotum scarcely (male) or slightly (female) increasing in breadth from the front backward, equally throughout and with no angle in the middle, yellowish-green. Tegmina of about the length of the abdomen in both sexes, green or yellowish green. Legs green, the fore

increasing in breadth from the front backward, equally throughout and with no angle in the middle, yellowish-green. Tegmina of about the length of the abdomen in both sexes, green or yellowish green. Legs green, the fore

and middle femora more or less plainly annulate with coral red; hind tibiæ pale bluish-green, becoming more or less yellowish apically, the spines pallid on their basal, blackish-brown on their apical half; hind tarsi pale green, more or less yellowish.

Length of body, male, 18.5 mm., female, 30 mm.; antennæ, male, 8.25 mm., female, 10.25 mm.; tegmina, male, 13 mm., female, 20 mm.; hind femora, male, 11.6 mm., female, 17.5 mm.

A female of this beautiful green locust is shown in Fig. 107.

GENUS *Melanoplus** Stål.

Head rounded on top, not large in proportion to pronotum, nor prominent, but little longer than prozona, unless the latter is distinctly transverse; vertex continuous with the median sulcus of the face, with the portion between the eyes channelled; face with the lateral carina sharply defined; eyes prominent, nearly straight in front and rounded behind, antennæ slender, extending to the tip of the pronotum in the female, and beyond in the male: pronotum with a distinct median carina, the lateral carina obtuse and the transverse incision more or less distinct. Tegmina, when fully developed, narrow, rarely rather broad, but then very distinctly tapering, more or less tapering in the distal half; as long, longer or shorter than the abdomen; hind wings somewhat shorter than the tegmina. First joint of hind tarsi as long as the last joint; pulvilli between the claws large; last joint of abdomen of the male much swollen, cerci of male very variable, very rarely styliform, and then the subgenital plate is either exceptionally broad or only moderately narrow, and the apical margin elevated.

This American genus of locusts is very well represented in Minnesota, and many more species will be found upon closer exploration. Besides those described the following species have been found in our state: *viridipes* Walsh;

*Black armor.

tasciatus Scudder; *extremus* Walker; *comptus* Scudder; *Packardii* Scudder; *infantilis* Scudder; *viola* Thomas; and *femoratus*, Burmeister, but no specimens have been seen by the writer.

- A. Tegmina conspicuously shorter than the abdomen, often no longer than pronotum; furcula* almost always developed feebly, generally no longer than the last dorsal segment from which it arises.
 - b. Cerci of male beyond the middle either equal or tapering, sometimes simply styliform throughout, the tip usually more or less pointed, but sometimes broad or truncate; metasternal lobes of male attigent or sub-attigent.
 - c. Prozona, at least in male, much longer than broad, the disk of the whole pronotum more than twice as long as the middle breadth, the median carina percurrent, equal; interval between mesosternal lobes of male twice as long as broad.....*Scudderi*.
 - cc. Prozona, even in male, transverse, sub-quadrata or slightly longitudinal, the disk of the whole pronotum less than twice as long as middle breadth, the median carina often subobsolete between the sulci; interspace between the mesosternal lobes of the male not more than half as long again as broad.....*Dawsoni*.
 - bb. Cerci of male more or less expanded apically, so as to be broader at some point below the middle than at the middle, spatulate or sub-spatulate; metasternal lobes of male separated by a variable interval.
 - c. Sub-genital plate of male short and broad, its apical breadth equal to or surpassing the length of its lateral margin*Blatchleyi*.

*Prof. Scudder calls the processes of last dorsal segment of the male abdomen the *furculæ*.

- cc. Sub-genital plate of male distinctly narrower than long, often narrowing apically...*gracilis*.
- AA. Tegmina nearly or quite as long as or longer than the abdomen; furcula usually well developed, generally at least a quarter as long as the supra-anal plate, but sometimes obsolete.
- b. Cerci of male rapidly expanding from the base towards the middle, as a whole broad and short, flabellate, rarely twice as long as broad, not expanded apically.....*occidentalis*.
 - bb. Cerci of male tapering from the very base towards the middle, rarely equal in basal portion, generally long and slender, and rarely as little as twice as long as broad.
 - c. Cerci of male beyond the middle either equal or tapering, the tip usually slender or acuminate, never bifurcate. Apical margin of sub-genital plate of male notched.
 - d. Tegmina extending beyond hind femora, if at all, by not more than the length of the pronotum, generally by much less than that; prozona of male quadrate or very feebly transverse; cerci of male generally almost or quite twice as long as broad.*atlanis*.
 - * dd. Tegmina extending beyond hind femora by the length of the pronotum or nearly as much, often by the length of head and pronotum combined; prozona of male generally strongly transverse; cerci of male not more than half as long again as broad.....*spretus*.
 - e. Sub-genital plate of male as broad or nearly as broad at apex as at base, generally elevated apically and often notched (generally narrowly); cerci usually narrowing but little on basal

half, the apical half equal and symmetrical, bluntly rounded (rarely truncate or angulate) apically.

- f. Interspace between mesosternal lobes of male distinctly longer, generally much longer than broad, and much narrower than the lobes; metasternal lobes attingent or sub-attingent in the male.
- g. Sub-genital plate of male broad, at least as broad as long; cerci incurved feebly and gently, or not at all.....*Dawsoni*.
- gg. Sub-genital plate of male rather narrow, narrower than long, although short; cerci abruptly incurved apically.....*Gladstoni*.
- ff. Interspace between mesosternal lobes of male quadrate, almost or a little transverse and but little narrower than the lobes; metasternal lobes of male only approximate.....*borealis*.
- ee. Sub-genital plate of male conspicuously narrower at apex than at base (generally only half as wide), rarely at all elevated at apex above the lateral margins and never notched; cerci always distinctly narrowing on basal half, the upper angle of the apex prolonged and often sub-acuminate.....*femur-rubrum*.
- cc. Cerci of male more or less expanded apically, so as to be broader at some point beyond the middle than at the middle, spatulate or sub-spatulate or apically bifurcate.

- d. Cerci of male simply spatulate or sub-spatulate, at most moderately broad, apically entire and no broader than at base; furcula always developed as distinct denticulations.
- e. Furcula of male not more than a third as long as the supra-anal plate; tegmina lightly maculate or immaculate.
angustipennis.
- ee. Furcula of male more than a third as long as the supra-anal plate; tegmina usually heavily maculate.....*impiger.*
- dd. Cerci of male apically bifurcate, or with an inferior sub-median process or abrupt angulation, or else expanded so as to be distinctly, generally much, broader apically than at the extreme base; furcula wanting or minute.
- e. Size smaller or medium; cerci of male always bifurcate or with an inferior sub-median process or angulation; supra-anal plate pretty regularly triangular with straight or feebly convex lateral margins: furcula usually distinctly developed; prosternal spine usually short.
- f. Furcula of male consisting of slender spines, longer than the last dorsal segment; base of lateral margins of sub-genital plate incurved.....*minor.*
- ff. Furcula of male consisting of brief triangular lobes; base of lateral margins of sub-genital plate not incurved.....*luridus.*

- ee. Size medium or large; cerci of male rarely bifurcate or with an inferior process (and then the insect is of a large size, which it never is in the alternate category, and the supra-anal plate is distinctly shield-shaped, the apical half tapering with much greater rapidity than the basal; or the furcula is absent; or the interspace between the mesosternal lobes of the male is three times as long as broad, which it never is in the alternate category); supra-anal plate of variable shape; furcula either absent or very minutely developed; prosternal spine usually long.
- f. Interspace between mesosternal lobes of male nearly, fully, or much more than twice as long as broad; of female generally as long as broad; rarely quadrate; prosternal spine generally long; tegmina usually clear, or with a marked distinction in color between the dorsal and lateral areas, or with the angle between the two marked by a conspicuous light colored stripe; head less prominent and with less prominent eyes than in the alternate category, the front margin of the pronotum in no way flaring to receive the head.
- g. Furcula of male entirely absent, or present only as a minute point or bead; hind tibiae generally yellow, but sometimes red.
differentialis.

- gg. Fureula of male distinctly present, though always very small, angulate, the angle rarely produced; hind tibiæ never yellow, usually red, rarely purplish or yellow at tip.....*bivittatus*.
- ff. Interspace between mesosternal lobe of male sub-quadratae; of female transverse; prosternal spines short; tegmina maculate with roundish fuscous spots; eyes of male and head prominent, the front margin of the pronotum flaring to receive the head.....*punctulatus*.

Melanoplus Scudderii Uhler.

Short winged, of medium or rather small size, ferrugineo-fuscous, a little lighter beneath. Head not prominent, dark testaceous, much mottled with fuscous, above almost wholly infuscated, with an obscure fuscous post-ocular band; vertex somewhat tumid, scarcely elevated above the pronotum; antennæ ferruginous, about four-fifths (male) or less than two-thirds (female) as long as the hind femora. Pronotum often heavily ferruginous on the disk, the lateral lobes with a post-ocular piceous belt; disk broadly convex,

passing by a distinct but everywhere distinctly rounded shoulder into the at first very steeply declivent and afterwards vertical lateral lobes; median carina distinct, delicate and equal throughout. Prosternal spine not very long, appressed cylindrical, tapering apically, bluntly pointed, erect. Tegmina about as long as the pronotum, broad ovate, overlapping; wings not half the length of the tegmina.

Fore and middle femora slightly tumid in the male; hind femora ferrugineo-testaceous, occasionally with an olivea-

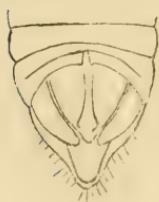


Fig. 108.—*Melanoplus Scudderii*, tip of male abdomen. Original.

ceus tinge, feebly bimaculate with fuscous above, the spots often extending half way across the inner face, the lower face castaneous, occasionally ruddy, the geniculars are black; hind tibiæ bright red sometimes feebly infuscated towards the base, and with a fuscous patellar spot, the spines black in the apical half, crowded, eleven to sixteen, usually twelve to thirteen, in number in the outer series. Extremity of male abdomen as shown in Fig. 108.

Length of body, male, 17 mm., female, 22 mm.; antennæ, male and female 8 mm.; tegmina, male, 5 mm., female, 5.25 mm.; hind femora, male, 10 mm., female, 12.75 mm.

This is not a common locust, but is sometimes found late in summer, in dry places.

Melanoplus Dawsoni Scudder.

Short or long wing, of medium or rather small size, obscure fusco-testaceous. Head slightly prominent in the

male only, olivaceo-testaceous, infuscated above with a broad piceous, post-ocular band; vertex tumid, distinctly elevated above the pronotum, the interspace between the eyes rather broad, at least twice as broad as the first antennal joint; eyes not very large and prominent; antennæ ferruginous, four-fifths (male), or three-fifths (female), as long as the hind femora. Pronotum sub-equal (male) or distinctly compressed above anteriorly (female), short, the disk transversely a little convex and passing into the vertical lateral lobes by a rounded angle, which is nevertheless so abrupt as to form, at least in the male, tolerably distinct lateral carinae; lateral lobes lighter colored below than the disk, above on the prozona a broad, lustrous, dark colored band, sometimes obsolete,



Fig. 110.—*Melanoplus Dawsoni*, female.
Original.

sometimes deepening to piceous; median carina slight; prosternal spine very short and blunt. Tegmina brownish-fuscous, more or less feebly flecked with fuscous, and either greatly surpassing the hind femora, moderately broad and sub-equal nearly to the well rounded tip, or ovate-lanceolate apically sub-acuminate, a little longer than the pronotum only; wings, when fully developed ample, hyaline, with pale brownish-fuscous veins. Fore femora of male greatly enlarged, hind femora luteo- or ferrugineo-testaceous, very obliquely and broadly bifasciate with blackish fuscous above and outside, with a basal patch of the same, the

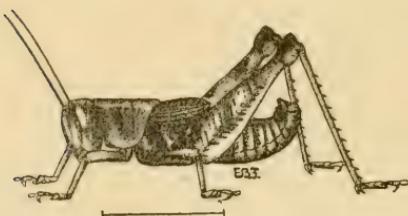


Fig. 109.—*Melanoplus Dawsoni*, male.
Original.



Fig. 111.—*Melanoplus Dawsoni*, tip of male abdomen. Original.

whole sometimes reduced to mere clouds, the genicular arc and sometimes the whole geniculation blackish fuscous; hind tibiæ wholly red, the spines black except at base, ten to thirteen in number in the outer series.

Extremity of male abdomen as shown in Fig. 111.

Length of body, male, 16 mm., female, 18.5 mm.; antennæ, male, 7.5 mm., female 6.25 mm.; tegmina, male and female, 5.25 mm.; hind femora, male, 9 mm., female, 10.5 mm.

The short-winged form of this species is found rather abundantly upon the flowers of the various species of golden rod. Both sexes are illustrated in Figs. 109 and 110.

Melanoplus Blatchleyi Scudder.

Short winged, of moderately large size, cinereo-fuscous with an olivaceous tinge. Head somewhat prominent, oli-

vaceo-testaceous variably but generally considerably infuscated, above dark fuscous, separated by a testaceous stripe from the broad piceous post-ocular band; vertex gently tumid, feebly elevated above the pronotum, the interspace between the eyes half as broad again (male) or twice as broad (female) as the first antennal joint; eyes moderately large and prominent; antennæ rufo-testaceous, scarcely shorter than (male), or nearly two-thirds as long as (female) the hind femora. Pronotum sub-equal, the sides with

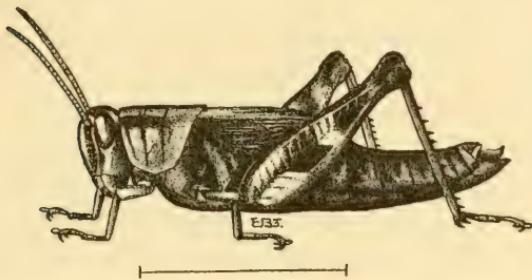


Fig. 113.—*Melanoplus Blatchleyi*, female. Original.

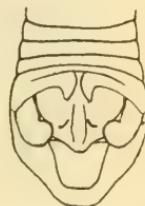


Fig. 114.—*Melanoplus Blatchleyi*, tip of male abdomen. Original.

a broad piceous post-ocular band confined to the prozona in the male, the same being wholly obsolete, obscure, or confined to the upper limits of the lateral lobes in the female; disk very broadly convex, passing by a distinct but blunt angulation forming feeble lateral carina into the inferiorly vertical lateral lobes; median carina distinct but not very sharp on the metazona. Prosternal spine long, appressed cylindrical, blunt retrorse. Tegmina abbreviate, a little longer than the pronotum, over lapping, very broad just beyond the base and rapidly narrowing, short sub lanceolate, the costal margin roundly angulate, apically sub-acuminate, brownish-fuscous the dorsal field often cinereous, the lateral often feebly flecked with fuscous. Fore and middle femora very tumid in the male; hind femora testaceous or flavo-testaceous, heavily and broadly but sometimes confusedly bifasciate with blackish-fuscous, the geniculation blackish, the inferior face pale flavous, pallid apically; hind tibiæ red,

blackish at the base, followed by an obscure pallid annulus, below which the red is feebly infuscated, the spines black on

their apical half, ten to eleven, rarely nine, in number on the outer series.

Extremity of male abdomen as shown in Fig. 94.

Length of body, male, 23 mm., female, 24 mm.; antennæ, male, 14 mm., female, 10 mm.; tegmina, male, 9.5 mm., female, 8.5 mm.; hind femora, male, 15 mm., female, 13.5 mm.

This insect, both sexes of which are illustrated in Figs. 112 and 113, is very common in Minnesota, and wherever it occurs it is found in large and destructive numbers. It prefers the edges of forests, or places overgrown with bushes and vines. The grape-vine especially is preferred by these locusts, and they soon destroy its foliage by eating big

holes in the leaves. It is an insect that can become very destructive. In 1896, during July, not a single entire leaf could be found upon Gray Cloud Island, as this locust was everywhere in large numbers.

Melanoplus gracilis Bruner.

Short winged, a little below the medium size, brownish-testaceous above, luteo-flavous, the whole tinged with green, with bright green hind legs. Head hardly prominent, luteo-flavous, generally tinted with green and somewhat embrowned, above brownish-testaceous with a greenish tinge, sometimes separated by a distinct slender flavous stripe from

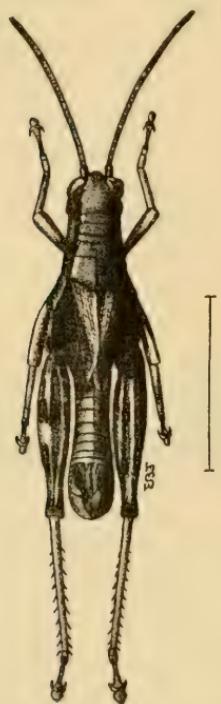


Fig. 112.—*Melanoplus Blatchleyi*, male. Original.

the broad post-ocular band. Frontal costa prominent; eyes moderate in size. Pronotum subequal, faintly enlarging posteriorly, above brownish-testaceous, the lateral lobes with a very broad and conspicuous piceous percurrent post-ocular belt above, below varying from bright flavous to flavo-testaceous, the disk very broadly sub-tectate, passing by an abrupt but rounded shoulder, forming feeble percurrent lateral carinæ, into the vertical lateral lobes; median carina low but distinct. Prosternal spine large, conical, blunt, suberect. Tegmina abbreviate, about the length of the prozona, lateral, lanceolate, the costal margin convex, the inner nearly straight, fully three times as long as broad, brownish fuscous. Fore and middle femora considerably tumid in the male; hind femora very slender, green, the whole geniculation blackish-fuscous, the under surface flavous; hind tibiæ green, with a basal, feeble, fuscous annulus, the spines black in the apical half, eleven to twelve in number in the outer series. Abdomen ferrugineo-fuscous, flavescent, compressed, with a distinct median carina, the extremity of the male abdomen considerably clavate, much recurved.

Length of body, male, 14 mm., female, 19 mm.; antennæ, male, 8.5 mm., female, 7.75 mm.; tegmina, male, 3 mm., female, 4 mm.; hind femora, male, 10 mm., female, 11.25 mm.

This species is also found in low and open woods, but is not common, only four females having been caught in July, in society with *Blatchleyi*.

Melanoplus occidentalis Thomas.

Of medium or rather small size. Head very slightly elevated, a very little arched; fastigium rather shallow, the margins in front of the eyes blunt; frontal costa more than usually prominent; eyes rather prominent, anteriorly truncate. Pronotum enlarging on the metazona, laterally subtumid in an irregular way on the prozona, the metazona faintly punctate; front margin feebly convex, with a feeble median emargination; hind margin roundly obtus-angulate;

median carina distinct on the metazona, faint on the prozona, obsolete between the sulci; sides of the pronotum hardly

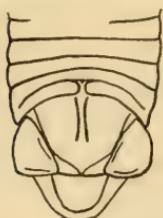


Fig. 115.—*Melanoplus occidentalis*, tip of male abdomen. Original.

shouldered, or with very rounded shoulders; transverse sulci of prozona pretty distinct and continuous. Prosternal spine rather short, appressed conical, broadly rounded on tip. Tegmina extending to or a little beyond the tip of the abdomen, slender, scarcely tapering, profusely maculate throughout. General color ferruginous brown above,

mottled strongly with blackish-fuscous, livid brown below; a blackish-brown median stripe, broadening posteriorly, passes from between the eyes to the back of the head, but seldom continues, and then less deeply, upon the pronotum; the face and genæ vary from yellow to testaceous and are seldom blotched by dusky colors, excepting on the genæ. Tegmina dark brownish cinereous with a slender median yellow stripe, frequently broken by quadrate fuscous or blackish spots, and similar spots are scattered rather distantly all over the tegmina, giving them an unusually speckled appearance. Hind femora variable, either with oblique pale patches on a dark ground or—and generally—the reverse; hind tibiæ glaucous, with black-tipped spines, ten or eleven in number in the outer series.

Extremity of male abdomen as shown in Fig. 115.

Length of body, male, 18 mm., female, 25 mm.; antennæ, male, 9.5 mm., female, 10.25 mm.; tegmina, male, 16 mm., female, 21 mm.; hind femora, male, 11.5 mm., female, 14 mm.

Only a few of this species were found in Otter Tail County.

Melanoplus atlantis Riley.

THE LESSER MIGRATORY LOCUST.

From medium to a little above medium size, dark griseofuscous, often tinged more or less heavily with ferruginous; head a little prominent, olivaceo-testaceous freckled with

fuscosus, above more or less infuscated, sometimes diffusing the whole, sometimes confined to two divergent longitudinal

stripes, with a broad, piceous, post-ocular band; vertex rather tumid, somewhat elevated above the pronotum, the interspace between the eyes nearly twice as broad as the first antennal joint in both sexes; fastigium steeply declivous, shallowly sulcate; frontal costa rather prominent, irregularly punctate; eyes moderate, rather prominent in the male.

Pronotum rather short, feebly and angularly constricted in the middle, the broad angulation at the principal sulcus and produced mostly by the posterior expansion of the metazona, more or less infuscated and often also ferruginous

above, the lateral lobes with a generally distinct and entire but sometimes broken or maculate, broad, piceous, post-ocular band, confined to the prozona; disk broadly convex and passing into the vertical lateral lobes somewhat abruptly but with a well-rounded shoulder, simulating but nowhere really forming distinct lateral carinæ; median carina distinct and well marked in the metazona, obscure and generally subobsolete on the prozona if not indeed obsolete, particularly between the sulci and in the female. Prosternal spine variable, usually short, conical, a little blunt, slightly appressed, erect (male) or short appressed subconical, very blunt, erect (female). Tegmina usually surpassing considerably the hind femora, occasionally and especially

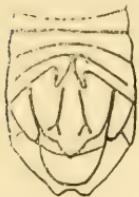


Fig. 116.—*Melanoplus atlantis*, tip of male abdomen. Original.



Fig. 118.—*Melanoplus atlantis*, female. Original.

in the female only a little, slender, feebly tapering, brownish-fuscous, nearly always flecked slightly with fuscous throughout the discoidal area; wings rather broad, hyaline, the veins mostly testaceous, the apex sometimes faintly infumate. Fore and middle femora of male somewhat tumid; hind femora luteo- or flavo-testaceous, obscurely broadly and obliquely biserrate with fuscous besides the fuscous base, the inner surface mostly flavous, more or less clouded with fuscous, the lower surface externally flushed with roseate, the geniculation mostly fuscous; hind tibiæ normally



Fig. 117.—*Melanoplus atlantis*, male. Original.

rather bright red, often feebly pallescent at base, with a faint fuscous patellar spot, but not infrequently pale red or pale green or pale yellow, or even dark blue, the spines black beyond the base, nine to twelve in number in the outer series.

Extremity of male abdomen as shown in Fig. 116; male and female shown in Figs. 117 and 118.

Length of body, male, 21.5 mm., female, 24 mm.; antennæ, male, 10 mm., female, 7.5 mm.; tegmina, male and female, 20 mm.; hind femora, male, 12.5 mm., female 12.75 mm.

This is one of our most injurious locusts, and almost always found in our state in destructive numbers. It and *Camnula pellucida*, have caused serious losses in many parts of the state; it prefers higher and dryer regions, or a wooded or mixed country, to the open prairies, where, however, it also occurs not infrequently in very large armies, while the latter species is fond of low and moist localities. As a general rule both species do not remain for a number of years in destructive numbers in the same locality; this is no doubt

owing to the large numbers of parasites which soon become so numerous as to almost annihilate their host. This insect is single brooded in Minnesota. Its life-history, with illustration, is given elsewhere.

Melanoplus spretus Uhler.

THE ROCKY-MOUNTAIN MIGRATORY LOCUST.

Of large size, but of slender form, light griseo-fuscous, more or less cinereous, and often tinged to a greater or less degree with ferruginous. Head somewhat prominent, light fusco-olivaceous, with a broad, piceous, post-ocular band, and above more or less infuscated or dulled in color, often with a pair of longitudinal fuscous stripes; vertex rather tumid, raised considerably above the level of the pronotum; fastigium steeply declivit, rather deeply (male) or shallowly (female) sulcate throughout; frontale costa moderately prominent, distinctly failing to reach the clypeus; eyes not very large nor very prominent. Pronotum very short, equal on the prozona, expanding somewhat on the metazona, light brownish fuscous, often ferruginous, the lateral lobes with a much broken and maculate post-ocular piceous or dark fuscous band confluent to the prozona, the disk broadly convex, passing into the vertical lateral lobes by a rounded angle forming a blunt shoulder on the metazona and posterior section of the prozona only; median carina distinct on the metazona, feeble and often subobsolete on the prozona. Prosternal spine rather long, appressed, feebly conical, very blunt, erect, shorter in the female than in the male. Tegmina exceptionally long, far surpassing the hind femora, not very narrow, sub-equal, brownish testaceous, heavily flecked with blackish fuscous, usually through the discoidal area but sometimes confined to the middle line; wings ample, hyaline, the

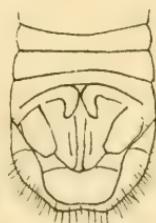


Fig. 119.—*Melanoplus spretus*, tip of male abdomen. ♂ Orig.
inal.

veins mostly fuscous. Fore and middle femora only a little tumid in the male; hind femora testaceo-ferruginous clouded with fuscous above, particularly in broad basal, pre-median and post-median patches, the geniculation mostly blackish-fuscous, the lower genicular lobe pallid-testaceous with a basal blackish bar, the inferior surface, especially externally, flushed with roseate; hind tibiæ bright red without, the spines black almost to the very base, ten to eleven, rarely twelve, in number in the outer series.

Extremity of male abdomen as shown in Fig. 119.

Length of body, male, 25 mm., female, 28 mm.; antennæ, male, 9 mm., female, 8.75 mm.; tegmina, male, 25.5 mm., female, 27.5 mm.; hind femora, male and female, 14 mm.

This is the well known "Rocky-Mountain Locust" or "Destructive Locust." The insect is not native in our state, but belongs to dry foot-hills on the eastern slope of the Rocky Mountains. Many sad experiences have shown that this insect can readily reach our state, however; and cause untold losses, even driving the farmers away from their homes. The life-history of this insect has been given elsewhere, hence it is not necessary to repeat it here.

Melanoplus Gladstoni Bruner.

Very dark testaceous, much infuscated, especially above. Head not prominent, luteo-castaneous, more or less clouded or blotched with fuscous, above wholly fuscous, with a narrow, posteriorly broadening, testaceous stripe, following the posterior edge of the eye and separating the vertex from a piceous or blackish-fuscous post-ocular band; vertex gently tumid, very slightly elevated above the pronotum; fastigium steeply declivent, broadly sulcate throughout; frontal costa rather prominent; eyes moderately large, not very prominent. Pronotum subequal, feebly enlarging on the metazona, ferrugineo-testaceous, much infuscated on the disk, the lateral lobes with a broad, more or less distinct, dark, sometimes piceous band crossing the prozona above; disk nearly

plane, passing by a tolerably distinct but rounded angle into the anteriorly slightly tumid vertical lateral lobes; median carina slight, percurrent, somewhat feebler and blunter on the prozona than on the metazona.

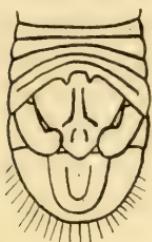


Fig. 120.—*Melanoplus Gladstoni*, tip of male abdomen. Original.

Prosternal spine rather stout, moderately long, appressed conical, blunt, feebly retrorse. Tegmina reaching and sometimes a little surpassing the tips of the hind femora, moderately slender, distinctly tapering, brownish-fuscous, distinctly but not conspicuously maculate in the discoidal area; wings hyaline, with mostly brownish-fuscous veins. Fore femora of male not greatly tumid; hind femora flavo-testaceous, twice broadly and very obliquely banded with blackish fuscous, with a basal patch of the same, all sometimes confluent on the outer face, which it then nearly fills, the lower face and lower half of the inner face immaculate, the genicular are black; hind tibiæ faintly valgate, red with an inconspicuous fuscous patellar spot, the spines black except their pallid bases, ten to twelve, usually eleven, in number in outer series.

Extremity of male abdomen as shown in Fig. 120.

Length of body, male, 20 mm., female, 23 mm.; antennæ, male and female, 9 mm.; tegmina, male and female, 16 mm.; hind femora, male, 12 mm., female, 13.25 mm.

A number of these locusts were captured in October in the western part of the state (Brown's Valley); they vary from typical specimens by possessing red tibiæ.

Melanoplus temur-rubrum DeGeer.

COMMON RED-LEGGED LOCUST.

Of medium size, brownish-fuscous, often with a more or less feeble ferruginous tinge, particularly in the female. Head a little prominent, olivaceo-plumbeous, above much infuscated, especially in a pair of widening stripes behind the lateral margins of the fastigium, and with a piceous post-ocular

stripe; fastigium strongly declivous, more or less sulcate; frontal costa just failing to reach the clypeus, subequal, as broad as the interspace between the eyes, sulcate at and below the ocellus, bi-seriately punctate above; eyes moderately prominent in the male, not at all so in the female. Pronotum feebly and rather regularly expanding posteriorly, the disk faintly convex and passing by a well-rounded shoulder

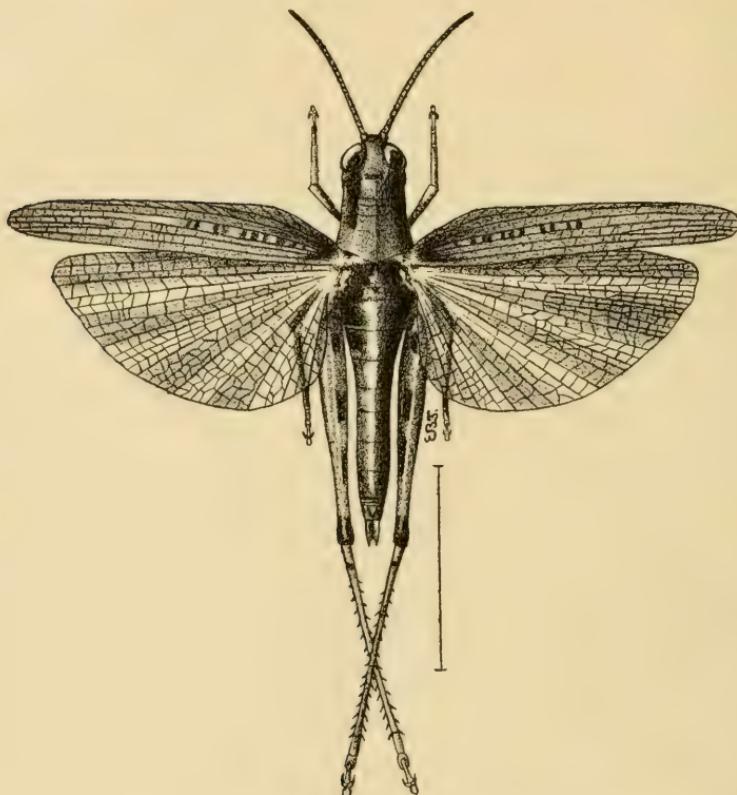


Fig. 122.—*Melanoplus femur-rubrum*, female. Original.

into the anteriorly tumid vertical lateral lobes, the disk generally darker than the lower portion of the lateral lobes, sometimes irregularly marked with luteous, the upper part of the lateral lobes crossed by a broad piceous band on the prozona, the lower portion more or less closely copying the

coloring of the face but usually a little darker; median carina slight, percurrent, a little less distinct on the prozona than on the metazona. Prosternal spine rather large, appressed-cylindrical, very blunt, often mesially constricted a little, feebly retrorse. Tegmina almost invariably surpassing, sometimes but slightly, more often considerably, the hind femora, of moderate breadth, distinctly though very gradually tapering, browish fuscous, sometimes immaculate, sometimes sprinkled with fuscous dots of greater or less depth and distinctness throughout the greater part of the discoidal area, but rarely to any considerable extent or conspicuousness beyond the middle; wings moderately broad, hyaline, glistening with fuscous veins and cross-veins darkest apically and anteriorly. Thoracic pleura piceous or blackish fuscous, the metathoracic episterna with a mesial streak of flavous of greater or less clarity. Fore and middle femora distinctly but not greatly tumid in the male; hind femora olivaceous-testaceous, more or less heavily and very variably obscured or clouded with fuscous, the fuscous coloring generally confined to the upper half, and above generally concentrated in two fasciae, which sometimes extend partly in an oblique direction on the outer face, but generally in a very obscure

fashion, if at all, while the whole under surface and at least the basal half of the inner surface is more or less impure flavous, sometimes deepening, especially beneath, to ferruginous or even carmine; hind tibiae normally red, sometimes with a slight fuscous patellar spot, occasionally more or less tinged

with yellowish, very rarely pale green with a yellowish tinge, the spines black nearly to their base, ten to thirteen, usually eleven, in number in the outer series.

Extremity of male abdomen as shown in Fig. 121.

Length of body, male, 23.5 mm., female, 24.5 mm.; an-

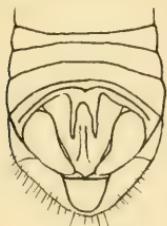


Fig. 121.—*Melanoplus femur-rubrum*, tip of male abdomen. Original.

tennæ, male, 10 mm., female, 8.5 mm.; tegmina, male, 21.5 mm., female, 19.75 mm.; hind femora, male, 13 mm., female, 14.25 mm.

This is our most common locust, found everywhere, and usually in very large numbers. If favored by dry summers this insect becomes very destructive, in fact it is controlled greatly by climatic conditions and parasites. It prefers low ground, cultivated fields and places abounding in rank and tender vegetation. This is the reason why dry hillsides are free of its presence, while lower meadows near by may be swarming with multitudes. The female is illustrated in Fig. 122.

Melanoplus angustipennis Dodge.

Of medium size, dark fuscous, head prominent, plumbeo- or ferrugineo-testaceous, often mottled with fuscous, above much infuscated, except at the margin of the eyes, and with a post-ocular piceous band; vertex gently tumid, slightly excavated above the pronotum; fastigium strongly declivent, distinctly (male) or feebly (female) sulcate throughout; frontal costa equal, percurrent, as broad as the interspace between the eyes, faintly sulcate at and below the ocellus, biseriately punctate; eyes moderately large and prominent. Pronotum dark fuscous, lighter on the lateral lobes, with a sub-luteous median streak, bordering a broad postocular piceous band on the prozona; disk feebly enlarging posteriorly, very broadly convex, passing into the vertical lateral lobes by a roundly angulated shoulder, forming tolerably distinct lateral carinæ on the posterior half of the pronotum; median carina distinct on the metazona, obsolete (male) or sub-obsolete (female) on the prozona. Prosternal spine not very long, erect, conico-cylindrical, blunt. Tegmina reaching or slightly surpassing the tips of the hind femora, slender, tapering, brownish-fuscous, immaculate or with very obscure and feeble maculations along the middle line. Fore and middle femora distinctly but not greatly tumid

in the male; hind femora olivaceo-luteous, more or less infumated or infuscated excepting below, the inner half of the upper face feebly bifasciate with fuscous, and the geniculations more or less infuscated; hind tibiæ glaucous, apically growing feebly lutescent, the spines black apically, pallid basally, nine to twelve in number in the outer series.

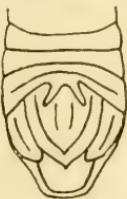


Fig. 123.—*Melanoplus*' *angustipennis*, tip of male abdomen. Original.

Extremity of male abdomen as shown in Fig. 123.

Length of body, male, 20 mm., female, 22.5 mm.; antennæ, male, 10 mm., female, 8.75 mm.; tegmina, male, 16 mm., female, 16.5 mm.; hind femora, male, 11.5 mm., female, 13 mm.

A few specimens of this species have been found in Minnesota. It seems to be uncommon, at least in regions visited by the writer.

Melanoplus impiger Scudder.

Of moderately large size, above rather light brownish fuscous with a ferruginous tinge, below luteo-testaceous. Head slightly prominent, dull luteo-testaceous, often punctate with olivaceous, with a post-ocular piceous band, and above much mottled or marmorate with fuscous; vertex gently tumid, considerably elevated above the level of the pronotum; fastigium steeply declivent, shallowly and broadly sulcate; frontal costa percurrent (male) or scarcely percurrent (female), feebly contracted above but otherwise sub-equal, as broad as the interspace between the eyes, punctate throughout; eyes rather large, not very prominent. Pronotum subequal, feebly enlarging posteriorly, with a very broad post-ocular piceous band, occasionally maculate, especially in the female, rarely surpassing the prozona and broadening and decidedly weakening on the metazona: disk very broadly convex, passing by a blunt shoulder nowhere

forming distinct lateral carinæ, into the vertical, anteriorly feebly tumid, lateral lobes; median carina distinct on the

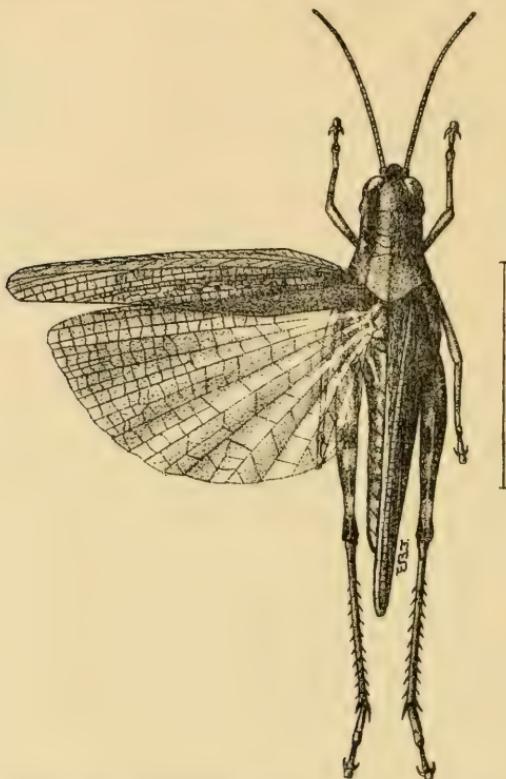


Fig. 125.—*Melanoplus impiger*, female. Original.

metazona, sub-obsolete on the prozona, sometimes wholly obsolete between the sulci. Prosternal spine conical, bluntly pointed (male) or appressed-cylindrical, very blunt (female), moderately long, erect. Tegmina surpassing considerably the hind femora, of normal breadth, feebly tapering, brownish fuscous, usually with very distinct and prominent maculation of quadrate blackish spots, interrupting a median luteous or pallid stripe on the basal half, becoming a sprinkling of blackish dots beyond, sometimes found also more or less obscurely in the other areas. Fore and middle legs only a little tumid in the male, luteo-testaceous flecked with fuscous; hind fem-

ora luteo-testaceous, twice barred above with blackish fuscous besides a basal spot, and more or less deeply infuscated geniculation, the bars liable on the middle of the outer face to fuse more or less completely into a median stripe, which

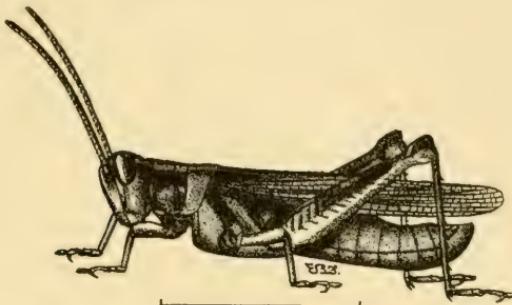


Fig. 124.—*Melanoplus impiger*, male. Original.

sometimes suffuses the whole face; lower face sometimes feebly roseate; hind tibiæ glaucous, occasionally feebly infuscated, the base and tip feebly lutescent, with a narrow post-basal fusco-glaucous annulus, the spines rather short, black beyond their pallid bases, ten to eleven in number in the outer series. Both sexes are shown in Figs.

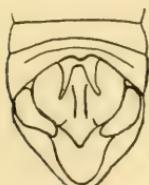


Fig. 126.—*Melanoplus impiger*, tip of male abdomen. Original.

124 and 125.

Extremity of male abdomen as shown in Fig. 126.

Length of body, male, 26.5 mm., female, 27 mm.; antennæ, male, 11 mm., female, 10.5 mm.; tegmina, male, 22 mm., female, 21 mm.; hind femora, male, 15.5 mm., female, 16 mm.

This insect has only been found upon Gray Cloud Island. It was mature as early as July 4, and proved quite destructive to garden plants.

Melanoplus minor Scudder.

Of medium size, dark brownish-fuscous, often with a ferruginous tinge, especially on the disk of the pronotum, luteous beneath. Head very feebly prominent, testaceous, ob-

surely mottled with fuscous at least above, where there is generally a broad median blackish stripe and a post-ocular piceous band; vertex gently tumid, scarcely elevated above the pronotum; fastigium steeply declivent, narrow, equal, deeply (male) or shallowly (female) sulcate, the lateral margins sharp; frontal costa percurrent; eyes moderately large, a little prominent. Pronotum short, distinctly but not greatly expanding on the metazona, the post-ocular stripe of the lateral lobes extending over the prozona, broader and more distinct than on the head, the disk very broadly convex, passing into the sub-vertical lateral lobes by a distinct but always rounded shoulder nowhere forming lateral carinae; median carina slight, scarcely less distinct on the prozona than on the metazona, cut only by the principal sulcus. Prosternal spine not very long, conico-cylindrical, more or less appressed, sub-erect. Tegmina reaching about to the tips of the hind femora, sometimes a little short of, sometimes surpassing them, rather slender and sub-equal, brownish fuscous, more or less distinctly but never heavily maculate with fuscous along the discoidal area. Fore and middle femora a little tumid in the male; hind femora luteo-testaceous, outside (excepting below) more or less deeply infuscated, the infuscation sometimes consisting of more or less well marked, very oblique, dusky fasciations, which also cross the upper face, the lower face generally dull orange; hind tibiae very variable but generally nearly uniform in color, pale red or glaucous being the prevailing color, but they are sometimes plumbeous or yellowish; spines black tipped, ten to twelve, usually eleven, in number in the outer series.

Extremity of male abdomen as shown in Fig. 127.

Length of body, male, 19 mm., female, 24 mm.; antennæ, male 8 mm., female, 9 mm.; tegmina, male, 14 mm., female, 16.5 mm.; hind femora, male, 11.25 mm., female, 13 mm.

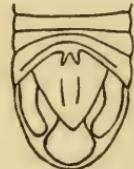


Fig. 127.—*Melanoplus minor*, tip of male abdomen. Original.

A number of this species occurred with *spretus* during the local outbreak of the Rocky-Mountain Locust in Otter Tail county in 1889.

Melanoplus luridus Dodge.

Rather small in size, brownish fuscous, more or less ferruginous. Head not at all prominent, dull pallid testaceous, feebly flecked with fuscous, above with widening dull fuscous stripes and a narrow post-ocular band; vertex gently tumid, slightly or not at all elevated above the pronotum; fastigium steeply declivous, plane, with well elevated and rounded lateral margins; frontal costa just failing to reach the clypeus, subequal, sulcate at and below the ocellus, biseriately

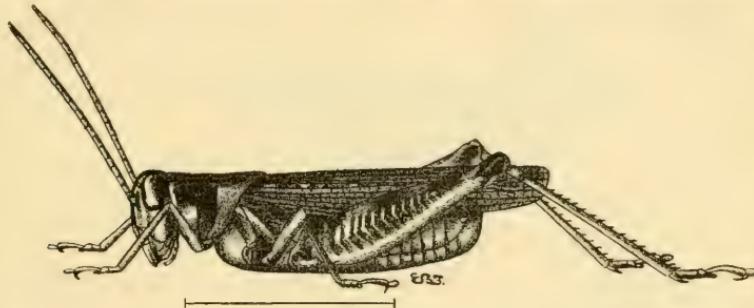


Fig. 128.—*Melanoplus luridus*, male. Original.

punctate above; eyes of moderate size, not prominent. Pronotum sub-equal, feebly and gradually enlarging posteriorly, the disk nearly plane, passing by distinct but abruptly rounded shoulders forming subobsolete lateral carinæ into the vertical lateral lobes, which have only an obscure, rarely a distinct, dark post-ocular band, always limited to the prozona; median carina percurrent but blunt and a little obscure on the prozona. Prosternal spine short, conical, blunt, erect, in the female a little appressed. Tegmina reaching or a little surpassing the tips of the hind femora, moderately narrow, very gently tapering, brownish-fuscous, either scarcely or distinctly though feebly maculate in the proximal part of the discoidal area. Fore and middle femora tumescent in the male; hind femora long and slender,

luteo-testaceous, above rather broadly bi-fasciate with blackish fuscous, often confluent along the middle of the outer face and then more or less suffusing the whole face excepting below, which with the under surface is dull luteous, occasionally tinged more or less distinctly with orange, the sides of the geniculation almost wholly fuscous; hind tibiæ red, rarely with a very narrow, basal, fuscous annulus, the apical half of the spines black, ten to twelve in number in the outer series. Extremity of male abdomen as shown in Fig. 129.

Length of body, male, 19 mm., female, 27 mm.; antennæ, male, 8.5 mm., female, 9.5 mm.; tegmina; male, 14 mm., female, 17 mm.; hind femora, male, 10.75 mm., female, 13.5 mm.

Many specimens were captured near the Experiment Station at St. Anthony Park; a male is shown in Fig. 128.

Melanoplus differentialis Uhler.

The largest of our species of Melanoplus and heavy bodied; excepting the hind legs and the lateral lobes of the pronotum, the general color is nearly uniform, brownish testaceous. The head has sometimes a pair of dusky, divergent stripes, passing from the posterior corners of the fastigium backward across the vertex and, when these are present, there are often other but irregular streaks of similar tint on the genæ and clouds

over parts of the face; the vertex is gently arched, more gently in the female than in the male, with a broad interval between the eyes, the fastigium broadly and not very deeply impressed; frontal costa broad but narrower than the interspace between the eyes, percurrent, equal except for a slight ex-

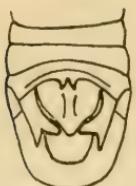


Fig. 129.—*Melanoplus liridus*, tip of male abdomen, Original.

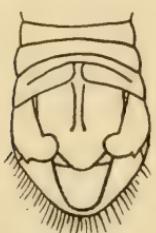


Fig. 130.—*Melanoplus differentialis*, tip of male abdomen, Original.

pansion below, broadly and shallowly sulcate below the ocellus, punctate; eyes moderately prominent, short, not a great deal longer than broad. Pronotum sub-equal, the metazona expanding somewhat, the disk of the prozona sometimes very feebly tumid, the median carina distinct and sharp on the metazona, less prominent but distinct on anterior half of the prozona, still less distinct between the sulci. Prosternal spine rather long, conical as seen from the side, bluntly cylindrical as seen from the front, a very little retrorse. Tegmina at least reaching (female) or distinctly surpassing (male) the hind femora, absolutely free from maculation, the narrowest apical portion about half as

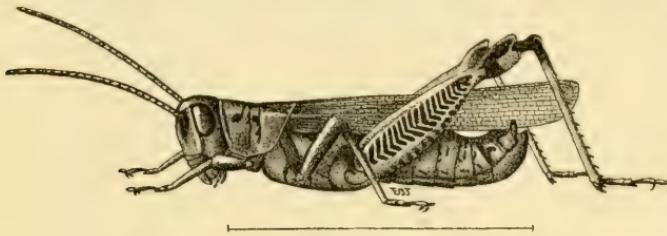


Fig. 131.—*Melanoplus differentialis*, male. Original.

broad as the broadest sub-basal portion. Fore and middle femora of male heavily bullate, the hind femora stout and rather short, moderately tumid, generally fulvo-testaceous, sometimes flavo-testaceous beneath, the outer face with alternate, fulvo-testaceous and black, narrow, equal fish-bone markings, the black rarely interrupted in the middle, the upper inner face with small basal and large median and post-median black patches, the genicular arc black on both inner and outer sides; hind tibiæ yellow or fulvous, with a post-basal narrow black annulus, the spines black to their very base, ten to eleven, rarely twelve, in number in the outerseries. Extremity of male abdomen as shown in Fig. 130, and the sexes in Figs. 131 and 132.

Length of body, male, 39 mm., female, 41 mm.; antennæ, male, 18 mm., female, 16 mm.; tegmina, male, 32 mm., female, 34.5 mm.; hind femora, male, 20 mm., female,

23 mm. Some specimens are much smaller.

This locust is but rarely found in Minnesota; if found it is only of local occurrence.

Melanoplus bivittatus Say.

Varying in general ground-color from fusco-testaceous to very dark brownish fuscous, striped with fulvo- or pallid-testaceous. Head flavo-testaceous, more or less infuscated, the summit with a broad, median, widening, blackish-fuscous stripe, which extends backward from the front of the fastigium but avoids the eye; vertex gently tumid, the fastigium broadly, equally and very shallowly sulcate; frontal costa broad, sub-equal, with roundish margins, feebly sulcate at and below the ocellus, feebly punctate laterally. Pronotum enlarging a little from in front backward, more feebly in the male than in the female; the median carina slight but distinct throughout. Tegmina attaining, or a little surpassing the hind femora, generally longer in the male than in the female, brownish or blackish fuscous, the anal vein marked by a slender flavous stripe, the discoidal area not darker than the rest, generally almost clear but frequently with faint and delicate mottling. Fore and middle femora ferruginous, more or less heavily infuscated above; hind femora rather long and moderately stout, ferrugineo-testaceous, the outer and generally the inner faces black above, flavo-testaceous below, the inner half of the upper face thrice very broadly banded with black, the genicular

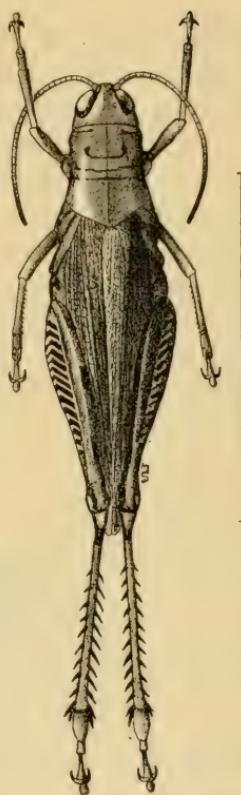


Fig. 132.—*Melanoplus differentialis*, female. Original.

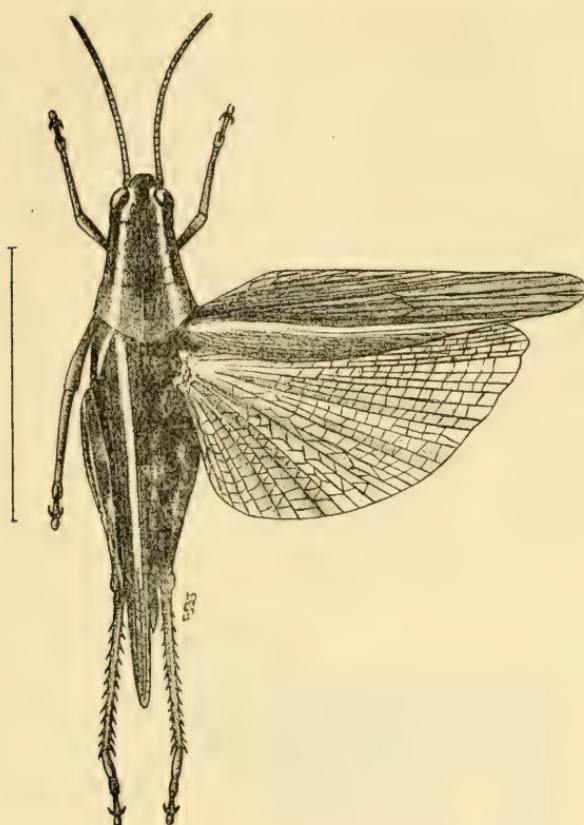


Fig. 133.—*Melanoplus bivittatus*, female. Original.

arc and a basal transverse stripe across the lower genicular lobe black on both sides; hind tibiæ passing more or less gradually, at varying points but generally near the middle, from purplish at the base to greenish yellow (very rarely red

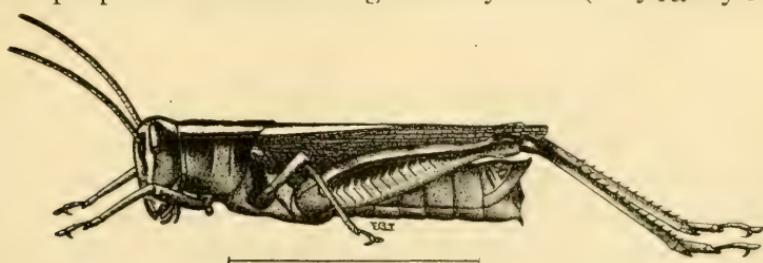


Fig. 134.—*Melanoplus bivittatus*, female. Original.

or reddish) at the tip, the patella of the lighter color, followed in lighter examples by a narrow black annulus, the spines black almost or quite to their base, ten to thirteen in number in the outer series. The adult insect and the pupa is shown in Figs. 133, 134 and 135.

Length of body, male, 27 mm., female, 37 mm.; antennæ, male, 14.75 mm., female, 13 mm.; tegmina, male, 20.5 mm., female, 26.5 mm.; hind femora, male, 15 mm., female, 20 mm.

This is a very common and destructive species. It is found in all parts of the state, preferring bottom lands, edges of cultivated fields and other places with a rank vegetation. It sometimes becomes very numerous, and spreads over cultivated fields, where it causes great damage, feeding upon grasses and grains. Though appearing in the winged state as early as the tenth of July, it deposits no eggs until late in August. Any compact soil, free of roots, and well

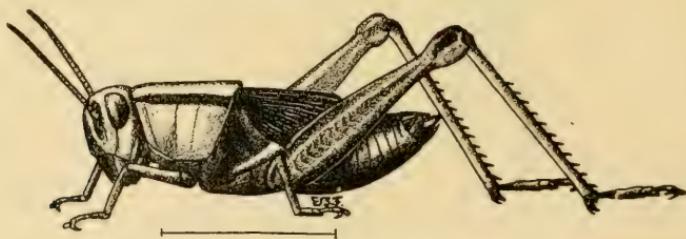


Fig. 135.—*Melanoplus bivittatus*, pupa. Original

drained, is chosen for this purpose. As many as eighty eggs have been counted in a single egg-pod, though the usual number varies from 54 to 70. The illustrations shown in the chapter giving the anatomical features of a locust were made from this species.

Melanoplus punctulatus Uhler.

Dark brownish-fuscous much mottled with blackish and often tinged with dull olivaceous, beneath ferrugineo-testaceous. Head varying from pale dull olivaceous to ferrugineo-testaceous, irregularly mottled with widening median stripe of the same upon the summit; vertex tumid; fastigium rap-

idly declivous, sulcate throughout, the margins much raised between the eyes, which are separated by a space less than the width of the frontal costa; the latter prominent above, moderate in breadth, sub-equal, sulcate below the ocellus, sparsely punctate throughout, each point marked by a dark olivaceous dot; eyes large and in the male very prominent, in both sexes much longer than the infra-ocular portion of the genæ. Pronotum sub-equal, widening a little at the metazona in the female, slightly flaring in front to receive the head, especially in the male, varying from luteo-testaceous to brownish fuscous, often much flecked and punctate with black or blackish fuscous, the lateral lobes more heavily marked above with black on the prozona, forming generally a broken or maculate band. Tegmina somewhat surpassing the hind femora, very gradually tapering to a well-rounded apex, fusco-testaceous, sprinkled with moderately large roundish or quadrate fuscous spots. Fore and middle femora luteo- or olivaceo-testaceous, heavily flecked with black, showing a tendency to form a triple belting; hind femora similar, the black forming moderately narrow basal, pre-median, post-median and apical belts, which do not touch

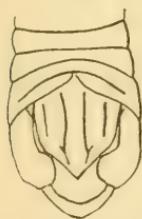


Fig. 136.—*Melanooplus punctulatus*, tip of male abdomen. Orig.

the coralline under and inner surfaces, except the latter in a partial way; hind tibiæ dull red, with a post-basal obscure flavous annulus, before which they are sometimes blackened, and beyond which, above and on the sides, often flecked or suffused with plumbeo-fuscous, the serial space between the spines often dull luteous, the whole pilose; spines black nearly or quite to their base, except on the inner side, ten to twelve in number in the outer series, none arising very near the base of the tibiæ. Extremity of the male abdomen as shown in Fig. 136.

Length of body, male, 21 mm., female, 28 mm.; antennæ, male, 14.5 mm., female, 12 mm.; tegmina, male, 17 mm., female, 18.5 mm.; hind femora, male, 10.5 mm., female, 12 mm.

Only a single specimen was found among the trees on Gray Cloud Island. The insect seems to be quite local. It has been found elsewhere in tamarack swamps, on pine and oak trees, and in cranberry bogs.

*Melanoplus fasciatus (borealis) Scud.**

Rather small, dark fusco-plumbeous above, dark clay yellow below. Head not prominent, dull plumbeous, flecked with griseous, above very dark fuscous with a broad post-ocular piceous band; vertex moderately tumid, distinctly elevated above the pronotum, the interspace between the eyes as broad (male) or nearly half as broad again (female) as the basal antennal joint; fastigium strongly declivit, shallowly depressed, but with distinct and somewhat abrupt though rounded bounding walls, which diverge a very little in front of the eyes and then converge; frontal costa as broad as the interspace between the eyes, scarcely contracted above where its face is plain (male) or feebly tumid (female), at and below the ocellus rather narrowly sulcate, deeper in the male than in the female, percurrent, punctate, eyes rather small, not prominent, longer than the infra-ocular portion of the genæ; antennæ ferruginous, growing lutescent toward the base, dusky toward the tip, nearly or quite as long (male) or about two-thirds as long (female) as the hind femora. Pronotum sub-equal, feebly expanding posteriorly, especially in the female, the disk plano-convex, separated by a well-rounded but distinct shoulder from the vertical lateral lobes, brownish fuscous, sometimes fusco-testaceous, and then generally punctate with ferruginous, the upper part of the lateral lobes with a broad piceous band crossing the prozona and sometimes continued as a feeble dusky cloud on the metazona; front border truncate, hind border broadly obtuse angulate, the angle rounded; median carina distinct only on the metazona and at the front of the prozona, elsewhere obsolete or sub-obsolete; prozona feebly longitudinal

* Discovered since printing table of *Melanoplis*.

(male) or feebly transverse (female), a very little longer than the minutely rugulose metazona. Prosternal spine short, stout, blunt, conical, erect; interspace between mesosternal lobes nearly half as long again as broad (male) or considerably transverse but shorter than the lobes (female). Tegmina either abbreviated, being one and a half or two and a half times as long as the pronotum, and not nearly reaching the tips of the hind femora, tapering considerably beyond the basal expansion, sub-lanceolate and bluntly sub-acuminate (form *curtus*), or far surpassing the hind femora, broad and sub-equal, very feebly tapering in the apical half, and well rounded at tip (form *volatile*), wholly brownish-fuscous, or cinereo-fuscous, occasionally maculate to a greater or less degree, but generally slightly in the discoidal area, the anal area sometimes more cinereous than the rest, especially apically; wings in both forms hyaline, with a scarcely perceptible yellowish tint, more or less densely but always feebly infumated at the tip, the veins and cross-veins of the apical half blackish fuscous. Hind femora relatively longer in the female than in the male, dull luteo-testaceous, black at apex and at extreme

base, and bifasciate with black or blackish fuscous more or less broadly and obliquely, rarely transversely, the whole often confused and more or less blended on the outer face; beneath pale or dull reddish, hind tibiæ red, usually growing paler toward the base and sometimes almost wholly pale greenish luteous, feebly reddening apically, the base generally pale or at least paler, with a small fuscous patellar spot, the spines black except at extreme base, nine to twelve, generally eleven, in number in the outer series.



Fig. 136½.—*Melano-plus fasciatus*, tip of male abdomen. Original.

Extremity of male abdomen illustrated in Fig. 136½.

Only the short-winged form has been found in St. Anthony Park.

Measurement.—Length of body, male, 18.5 mm., female,

22 mm.; antennæ, male, 10 mm., female, 8 mm.; tegmina, male, 10 mm., female, 9.75 mm.; hind femora, male, 10 mm., female, 11.75 mm.

GENUS *Phœtaliotes** Scudder.

Body elongate, rather slender, a little compressed, very feebly pilose, including faintly the tegmina and legs. Head large, full, prominent, relatively elongate, nearly half as long again as the prozona, the space behind the eyes fully half as long as the breadth of the eyes, the genæ a little tumescent, the head apart from the eyes slightly broader than the pronotum; vertex prominent and well arched both longitudinally and transversely; face a little oblique; eyes rounded, broad oval, moderately prominent, sub-truncate anteriorly, moderately distant, somewhat farther apart than the greatest width of the frontal costa; fastigium very faintly sulcate, almost plane; frontal costa prominent, markedly narrower above than below the ocellus; antennæ slender, moderately long, but shorter than the hind femora, though fully twice as long as the pronotum. Pronotum of moderate length, faintly sub-sellate but otherwise equal, feebly flaring in front to receive the head; disk rounded sub-tectate, with broadly rounded very indistinct lateral carinæ, and a sharp, equal, and percurrent median carina; prozona longitudinal, nearly half as long again as the metazona, with indistinct transverse sulci; front margin sub-truncate, hind margin extremely obtuse-angulate. Prosternal spine rather large, erect, conical, blunt. Tegmina either abbreviate, broad lanceolate, acuminate, attingent, slightly longer than the pronotum, or fully developed, surpassing the hind femora, rather broad and equal, well rounded at tip, hardly tapering in the distal half. Hind femora long and slender, hind tibiæ glaucous, with eleven to thirteen spines in the outer series. Abdomen compressed, recurved in the male, the sub-genital plate narrow and long, with lateral margins ampliate at

*A roamer.

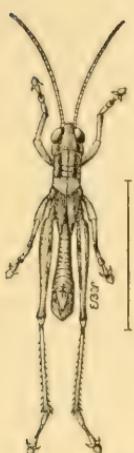


Fig. 137.—*Phœtaliotes nebrascensis volucris*, male. Original.

base; furcula delicately developed; cerci compressed styliform, rather small; ovipositor of female normally exserted.

This genus is closely allied to *Melanoplus*, from which it differs by its large tumid head and sub-sellate equal pronotum.

Phœtaliotes nebrascensis volucris
Scudder.

This is the short winged form, the only one found thus far in Minnesota. Fusco-testaceous, flavous beneath. Head flavo-testaceous, in fresh specimens more or less fusco-olivaceous, much infuscated above, with a broad piceous post-ocular band, and often with a pair of divergent fuscous or ferruginous stripes on the summit; vertex very tumid, distinctly elevated above the level of the pronotum; eyes moderately large, rather prominent. The male of this curious insect is shown in Fig. 137.

Measurements.—Length of body, male, 22 mm., female, 23 mm.; antennæ, male, 9.5 mm., female, 7 mm.; tegmina, male, 6 mm., female, 6.5 mm.; hind femora, male and female, 11.75 mm.

FAMILY VI. *Locustidæ*.

LONG-HORNED GRASSHOPPERS AND KATYDIDS.

All the members of this family are readily recognized, differing very greatly from the true locusts or short-horned grasshoppers (*Acrididæ*) by their long and slender antennæ, which are longer than the body. From the next family, the *Gryllidæ*, which possess also slender and long antennæ, they differ by the form of their ovipositor, which is compressed and sword-like. *Locustidæ* have four-jointed tarsi; the musical apparatus of the male, situated at the base of the

wing-covers, is smaller than in crickets; at rest the tegmina, excepting basal areas, are vertical.

Prof. Scudder gives the following sub-families of *Locustidæ*, four of which occur in Minnesota.

SUB-FAMILIES OF LOCUSTIDÆ.

- A. Body generally winged, tarsi more or less depressed.
- b. Fore tibiæ furnished with foramina near the base; male tegmina, when present, furnished with a tympanum.
- c. First two joints of tarsi smooth laterally; hind tibiæ with an apical spine on each side.

Phaneropterinæ.

- cc. First two joints of tarsi longitudinally sulcate laterally; hind tibiæ with an apical spine on outer side only or on neither.
- d. Fore tibiæ without apical spines.
- e. Fastigium of vertex short, crowded by the prominent antennal scrobes; pronotum crossed by two distinct transverse sulci.

Pseudophyllinæ.

- ee. Fastigium of vertex extended and free from the not prominent antennal scrobes; pronotum without, or with only one, transverse sulcus.

Conocephalinæ.

- dd. Fore tibiæ with an apical spine on the outer side. (Body generally sub-apterous).

Decticinæ.

- bb. Fore tibiæ without foramina near the base; male tegmina without a tympanum.....*Gryllacrinæ.*

- AA. Body apterous; tarsi distinctly compressed.

Stenopelmatinæ.

The first sub-family, *Phaneropterinæ*, contains three groups of insects found in Minnesota.

- a. Fore and middle tibiæ sulcate or plane above, but acutely margined, the outer margin spinulose or unarmed.
 - b. Fastigium of vertex scarcely deflexed, acuminate, no broader than the first antennal joint.....*Scudderiae*.
 - bb. Fastigium of vertex deflexed, obtuse, much broader than the first antennal joint; metasternum truncate or with rounded lobes.....*Amblycoryphæ*.
- aa. Fore and middle tibiæ smooth above, without angular margin, generally unarmed above; metasternum with elongated lobes.....*Microcentra*.

Prof. Blatchley gives the following key to genera of *Phaneropterinæ*:

- a. Wing-covers of equal breadth throughout; supra-anal plate of male with a long decurved spine which is notched at the end.....1. *Scudderia*.
- aa. Wing-covers widest in the middle; supra-anal plate of male not as above.
 - b. Hind femora but little if any shorter than wing-covers; ovipositor well developed, curved gradually upwards.....2. *Amblycorypha*.
 - bb. Hind femora much shorter than the wing-covers; ovipositor very short, turned abruptly upwards.
 - 3. *Microcentrum*.

The four species of *Scudderia* described in the text are distinguished as follows:

- a. Length of posterior femora 28 or more millimeters.
- b. Notch of supra-anal spine of male square with a slight median tooth, almost as wide as the middle of the upturned sub-anal spine; the lateral processes slender and compressed....*curvicauda* DeGeer.
- bb. Notch of supra-anal spine of male acute and much narrower than the middle of the upcurved sub-anal spine; the lateral processes (at side of notch) broadly rounded with the lower margin thinner.
 - furculata* Brunner.

aa. Length of posterior femora 22 or 23 mm.

furcata Brunner.

aaa. Length of posterior femora less than 20 mm.

angustifolia Harris.

GENUS *Scudderia* Stål (1873).

Head oval; eyes round and protruding, vertex pinched; antennæ longer than the wings, first joint cylindrical, stout, second joint smaller, remaining joints hair-like. Thorax longer than broad, narrower in front than behind; lateral carinæ sharply defined. Wing-covers shorter than the wings and of nearly equal width throughout, apex rounded. Hind legs very long and slender. Male with the anal plates provided with two curved spines, the one from the supra-anal plate curved downward and notched at the end, and the one from the sub-anal curving upwards and grooved above. Female with the ovipositor short, broad, flat and turned upwards, with the apical portion very finely serrate.

Four species have been found in Minnesota, but it is very likely that a fifth will be detected upon a closer search. They are all very similar, but can readily be distinguished by studying the structure of the anal plates of the males.

Scudderia curvicauda DeGeer.

THE NARROW-WINGED KATYDID.

This is one of the most common of our Katydids, found in many places during August and until cold weather. It is es-

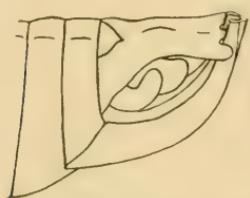


Fig. 138.—*Scudderia curvicauda*, tip of male abdomen. Enlarged. Original.

pecially common among low bushes in damp places. When approached it flies readily in a zigzag, noiseless manner for a long distance to another clump of weeds, or to the lower branches of an oak, a tree in which it delights to dwell.

Wing-covers, legs and thorax pale green; head and under-side of body paler; pronotum

much longer than broad, narrower in front than behind, and with a yellow line along the lateral carinæ. The notch of the supra-anal spine is square, with a minute median tooth, the lateral parts of notch compressed. Posterior femora very slender, armed beneath on inner carina with three or four minute spines. The tip of male abdomen is shown in Fig. 138.

The eggs of this species, as well as of several others, are laid one or more, in the edges of leaves, between the upper and lower cuticles, in the same manner as a saw-fly deposits eggs. The eggs, are loosely inserted in these pockets made by the ovipositor of the mother, and as they swell in coming in contact with the ruptured tissues of the plant they are held tightly in place.

Measurements.—Length of body, 22-25 mm.: wing-covers, 33-37 mm.; posterior femora, 25-27 mm.

Scudderia furculata Brunner.

Somewhat larger, very much like *curvicauda*, but readily distinguished from it by the notch of the supra-anal spine of the male, which is acute, and by the sides of the notch being rounded, flattened at the end and compressed beneath into a small flat process. The female is almost like that of *curvicauda*; it lacks, however, the black color at the basal fold of the ovipositor. The general color is the same, but the yellow carinal line of the pronotum is less distinct or wholly wanting in *furculata*, and the apical third of wings

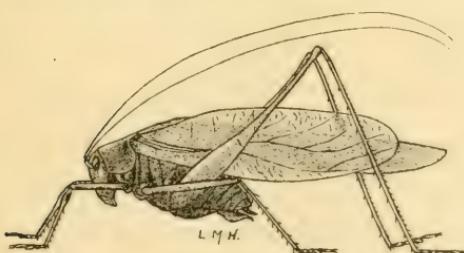


Fig. 139.—*Scudderia furculata*, male. Natural size. Original.



Fig. 140.—*Scudderia furculata*, tip of male abdomen. Enlarged. Original.

is usually a transparent reddish-brown. The wing-covers of the latter are broader, and the posterior femora proportionally a little shorter. The male is shown in Fig. 139 and the tip of the male abdomen in 140.

Measurements.—Male, length of body, 20-23 mm., wing-covers, 34-38 mm., posterior femora, 24-30 mm. Female: Length of body, 22 mm.; wing-covers, 34 mm.; posterior femora, 27 mm.

This species, though not very uncommon, is not observed as frequently as others; it seems to prefer the borders of marshes and tamarack swamps, where it can be found during the month of August.

Scudderia furcata Brunner.

THE FORKED-TAILED KATYDID.

Grass green; wing-covers narrower and of equal width throughout, apex rounded; lateral carina of pronotum without trace of a yellow line. The anterior margin of the pronotum is but slightly narrower than the posterior, whereas in the two preceding species the difference in width is plainly perceptible. The notch of the supra-anal spine of the male is very deep, and the lateral pieces very much swollen. The tip of male abdomen is shown in Fig. 141.

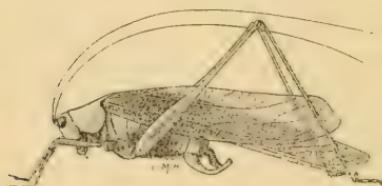


Fig. 142.—*Scudderia furcata*, male. Natural size. Original.



Fig. 141.—*Scudderia furcata*, tip of male abdomen. Enlarged. Original.

Measurements.—Male: Length of body, 16 mm.; wing-covers, 31 mm.; posterior femora, 23 mm.; pronotum, 5 mm.; width of wing-covers, 6 mm. Female: Length of body, 20 mm.; wing-covers, 30 mm.; posterior femora, 22 mm.; ovipositor, 5 mm.

The Forked-tailed Katydid, both sexes of which are shown in Figs. 142 and 143, is one of the smallest and at the same time most common of the katydids; it frequents thickets along fences, coarse grasses and weeds. Prof. Riley gives the following account of the egg-laying habits of *furcata*: “The female stations herself firmly by the middle and hind legs on twigs or leaves contiguous to the one selected to receive the eggs. This leaf is then grasped by the front feet and held in a vertical position, while the edge is slightly gnawed or pared off by the jaws to facilitate the entrance of the point of the ovipositor. When this is done the abdomen is curved under and brought forward, and the ovipositor is seized on its convex edge by the mandibles and maxillæ, which, with the aid of the palpi, guide the point to that portion of the leaf prepared to receive it. After gentle, but repeated efforts, the point of the instrument is finally inserted between the tissues of the leaf, and gradually pushed in to more than half its length. As soon as the cavity is formed, the egg is extruded, and passed slowly between the semi-transparent blades of the ovipositor. As the egg leaves the ovipositor the latter is gradually withdrawn, while the egg remains in the leaf, retained in its place probably by a viscid fluid that is exuded with it. As many as five of the eggs are sometimes deposited in one row in the same leaf, but more often they are single.”

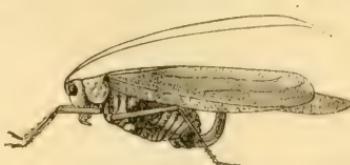


Fig. 143.—*Scudderia furcata*, female.
Natural size. Original.

Scudderia angustifolia Harris.

THE NARROW-WINGED KATYDID.

In size, general appearance and structure of anal spines of male it is very similar to *furcata*, but may readily be known by its short posterior femora, and by its narrower wing-covers.

Measurements.—Male: Length of body, 14 mm.; of tegmina, 26 mm.; of posterior femora, 19 mm.; of pronotum, 4 mm.; width of tegmina, 5 mm. Female: Length of body, 19 mm.; of tegmina, 25 mm.; of ovipositor, 5.5 mm.

Prof. Scudder, who has so carefully studied the songs of most of our orthoptera, gives the following pleasing account of its song: "It is more noisy by night than by day; and the songs differ considerably at these two times. The day song is given only during sunshine, the other by night and in cloudy weather. I first noticed this while watching one of the little creatures close beside me; as a cloud passed over the sun he suddenly changed his note to one with which I was already familiar, but without knowing to what insect it belonged. At the same time all the individuals around me, whose similar day song I had heard, began to respond with the night cry; the cloud passed away, and the original note was resumed on all sides. Judging that they preferred the night song to that of the day, from their increased stridulation during the former period, I imitated the night song during sunshine, and obtained an immediate response in the same language. The experiment proved that the insects could hear as well as sing. The note by day is *b z r w i* and lasts for one-third of a second. The night song consists of a repetition, ordinarily eight times, of a note which sounds like *t c h w*. It is repeated at the rate of five times in three-quarters of a second, making each note half the length of the day note."

Scudderia pistillata Brunner.

This species also occurs in Minnesota. It is found late in summer in the same localities as *curvicauda*. It can be readily recognized by its relatively broad tegmina.

Apex of vertex concave; pronotum narrower in front than behind; wing-covers very broad, wider at the middle than at the base and apex, with radiating veins; anterior margin curved, inner margin quite straight, apex rounded;

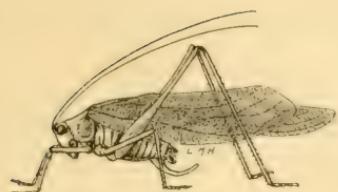


Fig. 144.—*Scudderia pistillata*,
male. Natural size. Original.

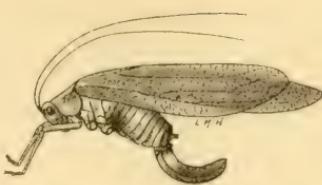


Fig. 145.—*Scudderia pistillata*,
female. Natural size. Original.

supra-anal process notched at the apex, with rounded lobes; sub-anal process extending a little beyond the upper process.

Measurements.—Male: Length of body, 16-20 mm.; wing-covers, 29-31 mm.; posterior femora, 21-23 mm. Female: Length of body, 18-20 mm.; wing-covers, 27-30 mm.; posterior femora, 21-23 mm.

Both sexes are illustrated in Figs. 144 and 145.

GENUS *Amblycorypha* Stål. (1873).

Head with the vertex flat; eyes elliptical or oblong oval; antennæ thread-like, first joint large and thick, second joint but slightly smaller, third joint slender. Wing-covers broad and rounded at the tip. Male with the supra-anal plate truncate; sub-anal plate short and broad at base, narrower at apex, with a deep triangular notch, each tip with a short blunt spine-like process. Female with a long, flat, curved ovipositor, deeply serrated towards the end.

Species in this genus can readily be recognized by the broad, oblong and rounded wing-covers.

At least two species are found in Minnesota.

- a. Tegmina about 37 mm. in length; exceeding the tip of posterior femora.....*oblongifolia* DeGeer.
- aa. Tegmina less than 30 mm. in length; sometimes reaching but not exceeding the tip of posterior femora.
 - b. Greatest breadth of tegmina contained less than three times in their length; ovipositor strongly curved.....*rotundifolia* Scudder.
 - bb. Greatest breadth of tegmina contained from $3\frac{1}{4}$ to $3\frac{1}{2}$ times in their length; ovipositor but moderately curved.....*Uhleri* Brunner.

Amblycorypha rotundifolia Scudder.

ROUND-WINGED KATYDID.

Wing-covers oblong-oval, pale pea-green; body somewhat smaller; hind wings transparent, with the veins and

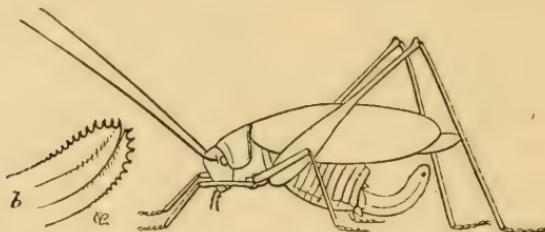


Fig. 146.—*Amblycorypha rotundifolia*, outline of female, with enlarged end of ovipositor (b). After Riley.

apical patch green; posterior femora with four or five small spines and reaching to the tip of the wing-covers; ovipositor strongly curved upwards and strongly serrated at the apical portion. The female is illustrated in Fig. 146.

Measurements.—Length of body, about 30 mm.; wing-covers, 27 mm.; posterior femora, 23 mm.

Amblycorypha oblongifolia DeGeer.

OBLONG LEAF-WINGED KATYDID.

Similar to *rotundifolia*, but longer and broader. The wing-covers extend beyond the posterior femora, and the an-

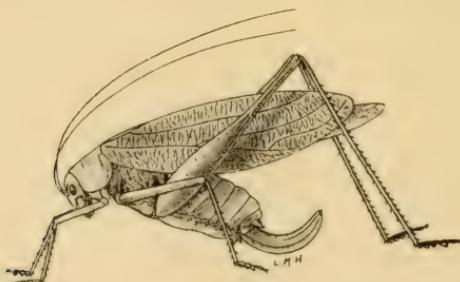


Fig. 147.—*Amblycorypha oblongifolia*, female.
Natural size. Original.

terior portion of the thorax is considerably narrower than the posterior. Color pale pea-green, sometimes wholly rose-color. Lower carina of posterior femora with about ten strong teeth.

Measurements.—Length of body, 21 mm.; wing-covers, about 38 mm.; posterior femora, 30 mm.; expanse of wings, 75-85 mm.

Both species occur abundantly in Minnesota, frequenting bushes and tall weeds in low places. They are very similar, but the latter, besides being larger with longer wing-covers, has also the ovipositor less serrate and less curved. Fig. 147 shows the female insect.

Amblycorypha Uhleri Brunner.

This insect, quite common in Maryland, New Jersey and the District of Columbia, has also been found in Indiana, and a specimen in the collection of the writer is marked: Minnesota, Aug. 17. No locality is given, however.

Measurements.—Male: Length of body, 25 mm.; of tegmina, 42 mm.; of posterior femora, 22.5 mm.; of pronotum, 6 mm.; width of tegmina, 13 mm. Female: Length of body, 30 mm.; of tegmina, 46 mm.; of posterior femora, 24 mm.; of ovipositor, 5 mm.; width of tegmina, 14 mm.

GENUS *Microcentrum* Scudder (1862).

Size large. Wing-covers moderately expanded in the middle, much longer than the posterior femora, and with the outer border sloping off quite sharply, thus causing the tip to be more pointed than in *Amblycorypha*. Vertex much as in that genus, slightly furrowed. Eyes broadly oval, very prominent. Hind legs slender and very short, the femora but little more than half as long as the tegmina. Ovipositor very short, bent abruptly, bluntly pointed, and with the apical third finely serrate above. Anal plates of male not prolonged.

Microcentrum lauritolum Linn.

LARGER ANGULAR-WINGED KATYDID.

General color light grass green, the body yellowish-green, lighter beneath. Vertex quite broad, with the center hollowed out so as to form a shallow pit, which is more prominent in the male. The pronotum is about as broad as long, its anterior margin a little concave and usually possessing a slight median tooth, though this is sometimes obsolete, or is replaced with a shallow notch. The overlapping dorsal surface of the wing-covers form a sharp and prominent angle with the lateral portions, hence the common name "angular-winged."

This insect, very common in the southern states, has been found near Winona, but will very likely occur also elsewhere. It is sometimes attracted to the electric light. Wherever it occurs it is most commonly called "the Katydid," though the sounds produced by it are quite different, being something like the syllable "tic" repeated from eight

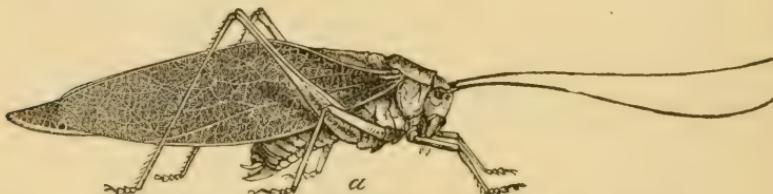


Fig. 148.—*Microcentrum laurifolium*, male. After Riley.

to twenty times at the rate of about four to the second. The grayish-brown eggs, long oval in shape, very flat, meas-

uring 5.5x3 mm., are usually glued in double rows on the sides of tender twigs, or on the edge of leaves, which have been previously roughened with the jaws and otherwise



Fig. 149.—*Microcentrum laurifolium*; a, ovipositor, nat. size; b, tip of same, enlarged. After Riley.

prepared for a place of deposit. The two rows are contiguous

and the eggs of one alternate with those of the other; those of the same row overlap about one-fourth of their length. They are deposited in September, and frequently attract the attention on account of their remarkable regularity. The three illustrations, Figs. 148, 149 and 150 show this insect.

The sub-family *Pseudophyllinæ* is represented by a single genus, *Cyrtophyllus*, Burm.

GENUS *Cyrtophyllus* Burmeister (1838).

It is doubtful whether this genus is found in Minnesota or not, but as it has been captured just south of the state



Fig. 150.—*Microcentrum lauritola*, female ovipositing. After Riley.

the possibility of its occurrence is not excluded.

Head large and stout; eyes hemispherical and comparatively small, vertex spine-like; antennæ almost twice as

long as the wings; pronotum as broad as long on top with two transverse furrows; lateral carina well rounded, lobes of sides parallel, with angles acutely rounded; wings concave; wing-covers longer than the hind wings, a little more than twice as long as broad, and of almost equal width, with the apex obtusely rounded. Anterior pairs of legs long and rather stout, and well adapted for climbing; hind legs almost twice the length and also stout. Supra-anal plate longer than broad, and bluntly rounded at the tip; sub-anal plate of male very long, paddle-shaped, and grooved on the upper side; ovipositor of female quite long and curved upwards beyond the middle.

The members of this genus are at once distinguished from all other *Locustidæ* by the broad leaf-like form of the tegmina, which are longer than the wings, obtuse and rounded at the end, and concave or hollowed within. The "shrilling" organ of the male is brown in color with the central portion as transparent as glass, and is set in a strong half-oval frame.

Cyrtophyllus concavus Harris.

TRUE KATYDID. BROAD-WINGED KATYDID.

This is the true Katydid. Wing-covers and thorax bright dark green; head, legs and body much paler; hind wings green and transparent. When the insect is at rest the wing-covers curve around the body, so that their edges touch above and beneath; pronotum roughly punctured and somewhat wrinkled; head smooth. The main veins of the wing-covers are very prominent with numerous reticulating branches, giving that organ the appearance of a leaf. Posterior femora short, slender and armed on apical half of lower outer carina with about six small spines. The ovipositor is almost as long as the abdomen, cimeter-shaped, sharp-pointed, and with but slight serrations on the lower edge of apical third. Below the curved anal cerci of the

male is a spine, resembling in appearance the cerci, which curves beneath the projecting sub-anal plate.

Measurements.—Length of body, 30-35 mm.; wing-covers, 33-36 mm., posterior femora, 19-21 mm.

The true Katydids, Figs. 151 and 152, of which several species occur in the United States, differ greatly from other Katydids by having the wings shorter than the wing-covers,



Fig. 151.—*Cyrtophyllus concavus*, male. After Harris.



Fig. 152.—*Cyrtophyllus concavus*, female, *a*, ovipositor, nat. size, *b*, tip of same, enlarged. After Riley.

which latter are very convex, thus giving the insect an inflated appearance. The whole shape of the insect indicates that it can produce a large volume of sound, being almost a sort of sounding board. The structure of the insect also shows that it is decidedly arboreal in habit, the green color well blending with the foliage of the tops of trees where it

dwells. If found in Minnesota it will very likely occur in small colonies; it is most active during August and September.

Prof. Scudder, in describing the loud notes of this insect, writes: "The note, which sounds like *x r*, has a shocking lack of melody; the poets who have sung its praises must have heard it at the distance that lends enchantment. In close proximity the sound is exceedingly rasping and grating, louder and hoarser than I have heard from any other of the *Locustarians* in America or in Europe, and the *Locustarians* are the noisiest of all Orthoptera. Since these creatures are abundant whenever they occur, the noise produced by them, on an evening especially favorable to their song, is most discordant. Usually the notes are two in number, rapidly repeated at short intervals. Perhaps nine out of ten will ordinarily give this number; but occasionally a stubborn insect persists in sounding the triple note (*Katy-she-did*); and as Katydids appear desirous of defiantly answering their neighbors in the same measure, the proximity of a triple-voiced songster demoralizes a whole neighborhood, and a curious medley results; notes from some individuals may then be heard all the while, scarcely a moment's time intervening between their stridulations, some nearer, others at a greater distance; so that the air is filled by these noisy troubadours with an indescribably confused and grating clatter."

The sub-family *Conocephalinæ* contains two tribes, separated as follows:

- a. Fore and middle femora spined beneath...*Conocephalini*.
- aa. Fore and middle femora unarmed beneath....*Xiphidiini*.

Only one genus represents the tribe *Conocephalini* in Minnesota.

GENUS *Conocephalus* Thunberg (1815).

Head with the vertex more or less prolonged forward and upward into a cone, with a pointed tooth beneath; face

very oblique; pronotum flat, narrower in front than behind; lateral carina quite sharp, lobes of side curving obliquely backwards in front and well rounded behind. Wing-covers narrow, broader at the base than the apex. Hind wings long and quite narrow. Cerci of male swollen, curved inwards and toothed. Ovipositor very long and straight. The stridulating organ is opaque and of a coarse texture in the left wing-cover, but transparent at the center of the right.

The chief characters by which this genus is recognized are the cone-like process of the vertex, the narrow wings, and the sword-like ovipositor. These insects, not very common in our state, are frequently called "Cone-heads" or "Sword-bearers." Prof. McNeill says about the habits of these insects: "All the species of *Conocephalus* seem to possess more intelligence than is usual in Orthoptera, and they are the most difficult of the order to approach. In escaping they usually slip or fall into the grass instead of jumping or flying; but they seem to fully understand that they are very well protected by their color and form. If approached very cautiously they often remain quite still upon the stem of grass upon which you have surprised them with the usually well founded expectation that you will not be able to distinguish them from the green herbage around. If they think it worth while to make some active movement to escape they will frequently slip around on the other side of the stem and walk down the stem to the ground or off upon another plant. Unlike most Orthoptera they do not use their front legs in holding to the mouth the thing upon which they feed. Instead of biting they seem to wrench or tear away pieces from the stems or leaves."

A number of species occur in Minnesota, but how many is as yet unknown, as but few specimens have been captured, the insects being by no means common.

a. Cone of vertex slender, about 3.5 mm. in length, and with either the margin or lower face black.

- b. A black line on each margin of cone extending from the apex half way or more to base; inner, lower carina of posterior femora with four or five minute spines.....*ensiger* Harris.
- bb. Cone of vertex entirely black beneath; posterior femora armed on both of the lower carinæ with a number of plainly visible spines.
.....*nebrascensis* Bruner.
- aa. Cone of vertex rather stout, less than 3 mm. in length, devoid of black markings.....*robustus* Scudder.

Conocephalus ensiger Harris.

THE SWORD-BEARER.

A slender-bodied species, the general color of which is usually grass green, the body and face paler; the posterior

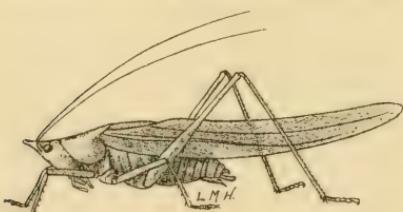


Fig. 153.—*Conocephalus ensiger*, male.
Natural size. Original.

tibiæ and tip of ovipositor infuscated. Lateral carinæ of pronotum sometimes with a faint yellow line, more plainly visible in the dried specimens. Tegmina very long and slender. Cone of vertex with a small tooth projecting downward from the front of its base. Ovipositor of excessive length, straight, the apex pointed.

Measurements.—Male: Length of body, 26 mm.; of tegmina, 42 mm.; of posterior femora, 21 mm. Female: Length of body, 28 mm.; of tegmina, 47 mm.; of posterior femora, 23 mm.; of cone of vertex, 3.25 mm.; of pronotum, 7.5 mm.; of ovipositor, 31 mm.

This is the best known species of Sword-bearers in Minnesota, and it is by no means very common. It is found among the tall grasses along ditches and swamps. Here in St. Anthony Park it is most frequently observed upon the stems of a coarse grass (*Andropogon*), which grows in dry

and sandy places. The eggs are deposited between the stem and root-leaves of this grass. Other eggs, probably of this insect, are not infrequently found below the scale-like leaves of a common cone-gall on our obtuse-leaved willow. In this case the peculiar shape of the long ovipositor is of great use. Prof. Scudder, who has set the note of the male to music, says of the song: "This insect has but a single song and stridulates only by night, or during cloudy weather. It begins its song as soon as the sky is obscured or the sun is near the horizon. It commences with a note like *b r w*,

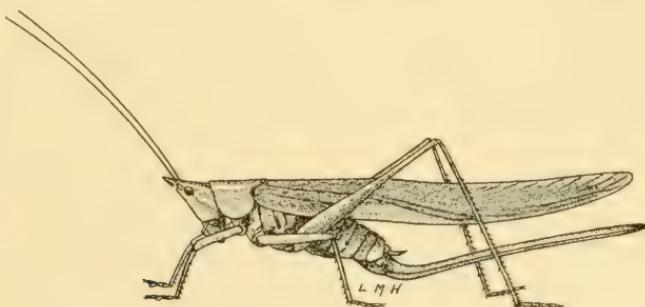


Fig. 154.—*Conocephalus ensiger*, female. Natural size. Original.

then pauses an instant and immediately emits a rapid succession of sounds like *c h w i* at the rate of about five per second, and continues them for an unlimited time. Another writer likens its note to the syllable "*ik-ik-ik*" as if sharpening a saw, enlivening low bushes and particularly the corn patch, as it seems to especially delight in perching near the top of a corn-stalk and there giving forth its rather impulsive song."

The illustrations (Figs. 153 and 154) show both sexes of this peculiar insect.

Conocephalus nebrascencis Bruner.

A shorter winged but heavier bodied insect than *ensiger*. The cone of the vertex projects more strongly upwards, with the apical half more tapering; basal tooth quite prominent. Anal cerci of male stout, with strong internal hooks.

Ovipositor long and slender, lanceolate, a little curved upwards and extending about one-fourth of an inch beyond the closed tegmina. General color bright grass green, rarely a yellowish-brown or tan, with narrow yellowish lines along the lateral carinæ of the pronotum. Posterior tibiæ with all the feet more or less infuscated.

Measurements.—Male: Length of body, 28 mm.; of tegmina, 37 mm.; of pronotum, 8 mm.; of cone of vertex, 3.5 mm.; of posterior femora, 21 mm. Female: Length of body, 33 mm.; of tegmina, 42 mm.; of posterior femora, 23 mm.; of ovipositor, 29 mm.

This insect occurs in the same localities as *ensiger*, and resembles it very closely. It tries to escape by burrowing beneath the dead grass.

Conocephalus robustus Scudder.

A much larger insect, with broader tegmina. Cone of the vertex like that of *ensiger*, but with apex more obtuse; the frontal basal spine blunt and distinct. Posterior femora armed beneath on both carinæ with a number of weak spines. Wings of male equalling the tegmina in length, in the female a little shorter. Ovipositor shorter than in either of the above species. General color either pea-green or dirty brown, or a mixture of both. The cone rarely with a black spot at apex, its sides often with a narrow yellowish line.

Measurements.—Male: Length of body, 30 mm.; of tegmina, 44 mm.; of hind femora, 23 mm.; of pronotum, 8 mm.; of cone, 2 mm. Female: Length of body, 31 mm.; of tegmina, 48 mm.; of hind femora, 26 mm.; of ovipositor, 26 mm.

These large and very noisy insects are found occasionally during September near the shores of Lake Minnetonka and White Bear Lake. But as they seem to inhabit trees they are not readily captured. Besides their loud notes they produce a buzzing sound like the humming of a bee.

The tribe Xiphidiini contains two genera with numerous species.

- a. Larger and stouter species. Ovipositor short, falcate.
Orchelimum.
- aa. Smaller and slenderer species. Ovipositor straight and scarcely curved.....*Xiphidium.*

The insects belonging here are usually called "Meadow Grasshoppers."

GENUS *Orchelimum** Serville (1831).

Size medium, body short and stout; face oblique; vertex with a blunt tubercle at the apex, and meeting a small and similar projection from beneath; antennæ very long, thread-like; first joint very stout and cylindrical; second joint considerably smaller; pronotum flat on top, lateral carina well rounded, lobes of sides almost parallel, then forming more or less of a triangle at the bottom. Wing-cases of the male narrow, broad to about the middle, then suddenly but gradually narrowing; stridulating organ well developed. In the female the wing-cases are of about equal width; cerci with a sharp tooth-like hook inside, directed inward; ovipositor slightly curved, and terminating in a sharp point; anterior pairs of tibiae with a number of spines.

Many specimens of Meadow Grasshoppers are found in Minnesota, and three at least are common, or fairly so, viz., *vulgare*, *glaberrimum* and *nigripes*. Our species have an ovipositor with a very evident curve, not straight or nearly so, and the face without a median brown stripe.

- a. Posterior femora unarmed beneath.
- b. Tegmina broader at base; the apical third narrower; body robust.
- c. Tegmina and wings sub-equal in length; size medium *vulgare.*
- cc. Tegmina distinctly shorter than wings; size large.....*glaberrimum.*

*Literally, "I dance in the meadows."

- bb. Tegmina of equal width throughout; body slender.
campestræ.
- aa. Apical half of posterior femora armed beneath with several small spines.
 - b. All the tibiæ and tarsi black or dark brown..*nigripes.*
 - bb. The tibiæ and tarsi green or reddish-brown.
silvaticum.

Orchelimum vulgare Harris.

COMMON MEADOW GRASSHOPPER.

It is a medium sized, robust insect, with the general color green or light reddish-brown. Face light green or light brown without fuscous marks. The occiput and disk of pronotum with a reddish-brown band, widening on the latter, where it is often, especially in the male, bordered on each side with a darker line. The male (as in most of our species) with two short, black dashes on each wing-cover, the four forming the angles of an assumed square, enclosing the tympanum. The legs usually pale brown, the tarsi dusky. Pronotum long, its posterior lobe but slightly, if at all, upturned above the plane of the anterior, its hind margin rounded. Tegmina reaching to or very slightly beyond the apex of hind femora, and equalling or very little shorter than the wings. Cerci of male rather long, the apex bluntly rounded, a little depressed; the sub-basal tooth somewhat flattened, with the tip sharp and decurved.

Measurements.—Male: Length of body, 18 mm.; of pronotum, 6 mm.; of tegmina, 21 mm.; of hind femora, 18 mm. Female: Length of body, 19 mm.; of pronotum, 6.2 mm.; of tegmina, 21 mm.; of hind femora, 18.5 mm.; of ovipositor, 7.5 mm.

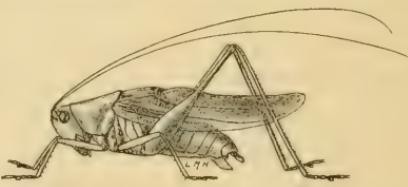


Fig. 155.—*Orchelimum vulgare*, male.
Original.

This is our most abundant meadow grasshopper, and can be found from the end of July until frost. It seems to prefer the higher and dryer meadows and clover and timothy fields. Both sexes are shown in Figs. 155 and 156.

This species is a powerful musician, or rather a noisy

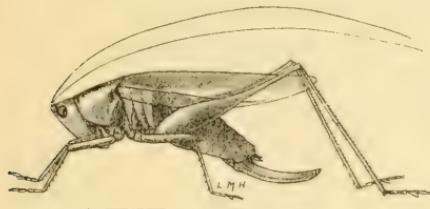


Fig. 156.—*Orchelimum vulgare*, female.
Original.

one. Prof. Scudder says: "When about to sing on a hot sunny day, the male mounts a stalk of grass about a foot from the ground, where it clings with its four front legs, allowing its hind legs to

dangle on either side of the stalk, that they may not interfere with the wing-covers. Beginning with *ts* it changes almost instantly into a trill of *zr*. At first there is a crescendo movement, which reaches its volume in half a second; the trill is then sustained for a period varying from one to twenty seconds, but generally from six to eight seconds, and closes abruptly with *p*. This strain is followed by a series of very short staccato notes sounding like *jip, jip, jip*, repeated at half-second intervals; the staccato notes and trill alternate *ad libitum*. The staccato notes may be continued almost indefinitely, but are very rarely heard more than ten times in direct succession; it ordinarily occurs three or four times when the phrase is repeated."

Orchelimum glaberrimum Burmeister.

Very similar to *vulgare*, perhaps only a larger form. The general color is the same, but the brown line on the disk of pronotum is, in the female, more plainly margined with black, while in the male the black dashes at ends of tympanum are larger and more completely enclose that organ. The tegmina of the male exceed the hind femora by about 4 mm., and are exceeded by the wings about the same distance; those of the female are proportionately a little shorter.

Measurements.—Male: Length of body, 22.5 mm.; of pronotum, 6 mm.; of tegmina, 25 mm.; of hind femora, 19 mm. Female: Length of body, 23 mm.; of pronotum, 6.5 mm.; of tegmina, 24 mm; of hind femora, 19 mm.; of ovipositor, 8.5 mm.

A few specimens of this species were found among the tall grass growing near a pond in St. Anthony Park. The insect appears to be not common.

Orchelimum campestre Blatchley.

This insect, of less than medium size, with narrow and almost uniformly wide tegmina, with the posterior femora unarmed beneath, and with a short and narrow ovipositor, has been reported from the south-eastern part of the state, but no specimens have been seen by the writer.

Orchelinium nigripes Scudder.

THE BLACK-LEGGED GRASSHOPPER.

Somewhat smaller than *vulgare*; the body moderately robust. Pronotum short, the posterior lobe, especially in the male, rather strongly upturned. Tegmina a little shorter than the wings, surpassing slightly the hind femora. The shrilling organ of the male is unusually large and prominent with strong cross veins, and behind it the tegmina taper rapidly on both margins; their shape and the size of the tympanum causing the male to appear somewhat peculiar and much more robust than it really is. Hind femora armed on apical half of lower outer carina with from one to four small spines. Cerci of male slender, tapering, the apex a little obtuse; the sub-basal tooth long, slender and a little curved. Ovipositor rather long, broadest in the middle, tapering to a delicate point. The males vary much in size. General color green or reddish-brown, the former prevailing in the male, the latter in the female. Occiput and disk of pronotum with the usual brown markings. Front and sides

of head, and four front femora, reddish-yellow. All the tibiæ and tarsi, together with the apical third of hind femora, black or dark brown.

Measurements.—Male: Length of body, 18 mm.; of pronotum, 5 mm.; of tegmina, 21 mm.; of hind femora, 16 mm. Female: Length of body, 19 mm.; of tegmina, 22 mm.; of hind femora, 17 mm.; of ovipositor, 9 mm.

Not uncommonly found in low places along the Mississippi River, where it seems to prefer to dwell on such plants as the Smartweed.

GENUS *Xiphidium* Serville (1831).

Very closely allied to the genus *Orchelimum*, from which it can hardly be separated. The species, however, are much smaller and more graceful, and the ovipositor is straight instead of curved. Wings as long, longer or shorter than the abdomen. Wing-length in this genus, and in *Orchelimum*, is a character not to be relied upon as a specific or even a varietal difference.

These light-green grasshoppers are found in large numbers in our meadows and moist pastures. Here they give concerts from the middle of summer till the autumn. Insects belonging to this genus possess no conical projections upon their heads.

We have in Minnesota several species of these insects, and no doubt still others will be found.

- A. Ovipositor shorter than the body.
 - b. Ovipositor straight.
 - c. Wings a little longer than the wing-covers; the latter always fully developed.....*fasciatum*.
 - cc. Wings shorter than the wing-covers; the latter variable in length.....*brevipenne*.
 - bb. Ovipositor a little curved; tegmina constant in length, covering about two-thirds of the abdomen in the male; shorter in the female.....*nemorale*.
- AA. Ovipositor equal to or longer than the body.

- b. Length of posterior femora almost equal to that of ovipositor.
- c. Body rather stout; the tegmina always covering more than half the abdomen.
 - d. Abdomen with the dorsal surface light brown, the sides green, or greenish-yellow.
ensiferum.
 - dd. Abdomen with the dorsal surface a fuscous brown, the sides shining-black.
nigropleurum.
 - cc. Body very slender; the tegmina exceedingly short, pad-like, covering only one-third of the abdomen *modestum.*
- bb. Posterior femora much shorter than the ovipositor; the latter of excessive length.
 - c. The common form with the tegmina very short, less than half the length of the abdomen; the sides of the body green..... *strictum.*
 - cc. The common form with the tegmina covering three-fourths or more of abdomen; sides of body dull reddish-brown..... *antennatum.*

Xiphidium fasciatum DeGeer.

THE SLENDER MEADOW GRASSHOPPER.

Pale green, with a broad reddish-brown, longitudinal band on its thorax, extending to the top of the head, where it becomes much narrower; face entirely green; abdomen above reddish, green beneath. Wing-covers and wings extending much beyond the body, reaching the tip of the ovipositor in the female. Hind wings somewhat longer than the wing-covers.

Measurements.—Length of body, 13.5 mm.; wing-covers, 17 mm.; hind femora, 11 mm.; ovipositor, 8 mm.

This is one of the most slender bodied species, and the only one whose wings are never shorter than the

body. It is found abundantly everywhere in timothy and clover fields, and especially in low pastures. It reaches maturity very early, and about July 10 the first notes of the males can be heard; they are a kind of *zr-r-r-r* long drawn out.

Both sexes are shown in Figs. 157 and 158.

Xiphidium brevipenne Scudder.

Smaller and somewhat stouter than *fasciatum*. Color light green or pale brown, with the band on the thorax and head the same as in *fasciatum*, wings almost as long as the body, and not extending beyond it. Antennæ about three times as long as the body. Posterior femora rather short, and stout, unarmed beneath,

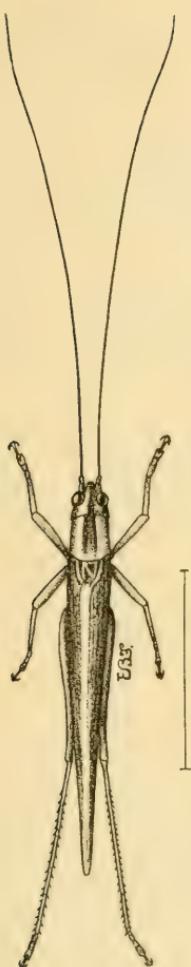


Fig. 157.—*Xiphidium tasmaniense*, male. Original.

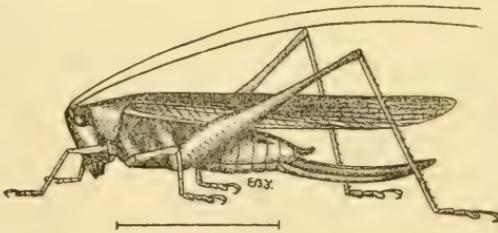


Fig. 158.—*Xiphidium fasciatum*, female. Original.

or rarely with one to four minute spines. Cerci of male swollen, the apex strongly compressed and obtuse, armed below the middle with a rather flat, sharp-pointed tooth. Ovipositor reddish-brown throughout.

Measurements.—Length of body, 9-12 mm.; wing-covers, 6-8 mm.; posterior femora, 11-12 mm.; ovipositor, 9-12 mm.

This common species occurs in the same localities as *fasciatum*, but reaches maturity about a fortnight later.

Xiphidium nemorale Scudder.

Greenish-brown; wing-covers greenish with the front margin blackish, nearly as long as the abdomen in the male, somewhat shorter in the female; top of head and pronotum with a broad, very faint, reddish, longitudinal stripe margined with a whitish line on each side; legs greenish with many red dots; wing-covers with prominent cross-veins; ovipositor as long as the abdomen, slightly curved upwards apically.

Measurements.—Male: Length of body, 14 mm.; wing-covers, 8 mm.; hind femora, 12 mm. Female: Length of body, 15 mm.; wing-covers, 5.5 mm.; hind femora, 13 mm.; ovipositor, 9 mm.

This rather common species prefers the borders of our forests, and seems to be at home amongst the low bushes found in such localities.

Xiphidium ensiferum Scudder.

Very similar to *brevipenne*; general color more of a green, the face, sides of pronotum and abdomen, and the four anterior femora being of that hue. Tegmina and wings light reddish-brown, as are the tibiæ and ovipositor, the latter becoming a deeper brown towards the apex. Cerci of male rather stout, with the apical half curved slightly outward and depressed. Ovipositor slender, straight.

Measurements.—Male: Length of body, 13.5 mm.; of tegmina, 9 mm.; of hind femora, 13 mm.; of pronotum, 3.5 mm. Female: Length of body, 14.5 mm.; of tegmina, 8.5 mm.; of hind femora, 14 mm.; of ovipositor, 15 mm.

This peculiar grasshopper is common in many parts of the state. It has the peculiar habit of selecting the common cone shaped willow-gall as the place in which to deposit the eggs. Prof. Wheeler published an excellent account of the

oviposition of this species. He writes: "On September 8th I observed a female in the act of oviposition. She was perched with her head turned toward the apex of the gall. Slowly and sedately she thrust her sword-shaped ovipositor down between the leaves, and, after depositing an egg, as slowly withdrew the organ in order to recommence the same operation, after taking a few steps to one side of where she had been at work. She soon observed me and slipped away without completing her task. The number of eggs found in a gall varies considerably. Sometimes but two or three will be found, more frequently from fifty to a hundred. In one such gall I counted one hundred and seventy." The egg is cream colored, very thin, elongate-oval in outline, and measures 4x1 mm. The young emerge about the middle of May and reach maturity toward the middle of August. Long-winged forms are found occasionally.

Xiphidium nigropleurum Bruner.

THE BLACK-SIDED GRASSHOPPER.

A medium sized, rather robust species, easily distinguished from all others of the genus by its peculiar coloration. Two forms occur, one having the pronotum, tegmina and legs bright grass-green, the other with these parts brownish-yellow, the green entirely absent. Both forms have the stripe on the occiput and the sides of the abdomen shining black; the former narrowing in front to the width of the tubercle, and bordered on each side with yellowish-white. In the green forms the usual brown stripe on the disk of the pronotum is but faintly defined; in the other it is very evident. The tegmina are usually abbreviated, reaching only four-fifths of the length of the abdomen, but an occasional specimen is to be found in which the wings are fully developed and then reach to the extremity of the ovipositor of the female. Ovipositor straight, quite broad and heavy. Male cerci of medium length, rather stout, tapering gently toward the apex, and with a strong sub-basal tooth.

Measurements.—Male: Length of body, 14 mm.; of tegmina, 9 mm.; of hind femora, 13.5 mm.; of pronotum, 3.5 mm. Female: Length of body, 15 mm.; of tegmina, 8.5 mm.; of hind femora, 14 mm.; of ovipositor, 16 mm.

This species is found, rarely, in low and swamp places.

Xiphidium modestum Bruner.

This small species, of a dull reddish-brown color, has been reported from the southern part of Minnesota, but no specimens have been seen by the writer. It is said to be common west of the Mississippi River.

Xiphidium strictum Scudder.

Body rather slender, of more than the average length. Two forms, constant in color, but dimorphic as far as the length of wings is concerned, are found. Sides of head and body together with all the femora green. The usual reddish-brown stripes on occiput and pronotum narrowly edged with whitish. Tegmina reddish-brown; in the females exceedingly short and pad-like, or well developed and reaching almost to knees; when the former, a little longer than the wings; when the latter, 5 mm. shorter than the wings. In the short-winged males the tegmina are somewhat less than half the length of the abdomen. There is a reddish-brown band on the dorsal surface of abdomen, darker where it meets the green on sides. Ovipositor pale red, straight, one and a half times the length of the posterior femora. Cerci of male long, the apical half acuminate, curved slightly inward near the tip.

Measurements.—Male: Length of body, 14 mm.; of tegmina, 5.5 mm.; of pronotum, 3.5 mm.; of hind femora, 13.5 mm. Female: Length of body, 17 mm.; of tegmina, short-winged form, 3.5 mm.; long-winged form, 16 mm.; of hind femora, 15.5 mm.; of ovipositor, 23 mm.

Rather common in the south-western part of the state, in the dry prairies.

Xiphidium attenuatum Scudder.

THE LANCE-TAILED GRASSHOPPER.

A medium sized grasshopper, with the sides of the head and body dull reddish-brown. Vertex, disk of pronotum, and tegmina greenish-brown in life, the former with the

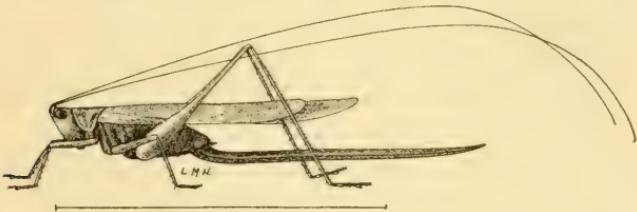


Fig. 159.—*Xiphidium attenuatum*, female. Original.

usual dark-brown median stripe. Femora greenish-brown, very rarely bright green, the tibiae and tarsi darker. Tegmina and wings either abbreviated or fully developed—when the former, covering about three-fourths of the abdomen, when the latter considerably surpassing its tip in both sexes. Antennæ with the basal third reddish, the remainder fuscous, longer than in any other member of the genus belonging to our fauna. Ovipositor also longer than in any other; slender and nearly straight, the apex very acuminate; cerci of male long, with the apical third gently tapering, the basal tooth minute, slender.

Measurements.—Male: Length of body, 14 mm.; of pronotum, 3 mm.; of tegmina, short form, 10 mm.; of hind femora, 14.5 mm.; of antennæ, 73 mm. Female: Length of body, 16 mm.; of tegmina, 9.5 mm.; of hind femora, 15 mm.; of ovipostor, 26-30 mm.

A few specimens of the short-winged form have been taken in Minnesota (Fig. 159 shows a long-winged female). Prof. Blatchley says: "The males of *attenuatum* are, as far as my experience goes, the most active leapers among the winged Locustidæ, jumping a half dozen or more times without pause when flushed, and in the net leaping so rapidly from side to side as to prevent capture with the fingers.

The females are evidently handicapped in their leaping powers by the excessive length of the ovipositor, and so more often endeavor to escape by burrowing beneath the dense masses of fallen grass and reed-stems which are always found in their accustomed haunts."

He also finds that the length of the ovipositor among the different species of *Xiphidium* is not at all dependent upon the age of the insect. In *attenuatum* it is almost as long after the third, and fully as long after the fourth molt as it is in the imago.

The eggs of *attenuatum*, as the length of the ovipositor indicates, are laid between the stems and leaves of tall grasses.

The sub-family *Decticinæ* contains a large number of genera, of which only two occur in Minnesota, and very sparingly at that.

- a. Prosternum armed with two erect spines. Large but not bulky insects *Atlanticus*.
 aa. Prosternum unarmed. Large and very bulky insects. *Anabrus*.

GENUS *Atlanticus* Scudder.

Head rounded; face broad, but slightly oblique; vertex compressed, with a blunt, decurved projection between the antennæ, which is slightly excavated on the sides; pronotum flattened on top with the lateral carinæ sharp and abruptly bent down at the sides. The pronotum is narrower in front than behind, and slightly pinched before the middle; it also extends backwards over the first abdominal segment. Wing-covers of the female rudimentary and hidden under the pronotum; those of the male about half as long as the body; ovipositor stout at base, straight, flattened, and pointed obliquely upwards; as long as the body. The shrilling organ, which is covered by the pronotum, is circular, and rather large for the size of the tegmina.

Atlanticus pachymerus Burmeister.

SHIELD-BACKED GRASSHOPPER.

Grayish-brown, with the wing-covers of the male marked with black. The abdomen and femora are sprinkled with minute blackish dots. The extreme lateral edge of the pronotum with a yellowish border, preceded by a black streak at the posterior edge.

Measurements.—Male: Length of body, 20 mm.; of pronotum, 10 mm.; of hind femora, 16 mm. Female: Length of body, 22 mm.; of pronotum, 9 mm.; of hind femora, 18 mm.; of ovipositor, 17 mm.

Only a few of these wingless and dull-colored grasshoppers were found. The insects are very striking, owing to the large size of the pronotum, which is so enlarged as to extend back over the two other thoracic segments. The ovipositor of the female is also greatly developed and almost straight.

The fully-grown insect (Fig. 160, male) is found early in

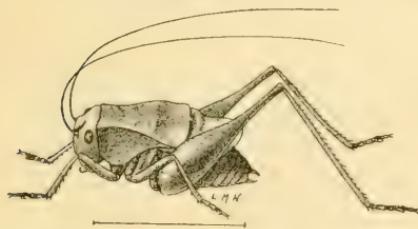


Fig. 160.—*Atlanticus pachymerus*, male.
Original.

July; it seems to prefer the dry hill-sides. The young appear very early in the season, and are much more active during this period than in their mature state, when they crawl rather than leap. In captivity

they feed as readily upon animal as upon vegetable food, and in the natural state probably feed upon the dead bodies of such small animals as they can find. The adults are far less numerous than the young, being probably killed by ground-feeding birds, as they do not hide by day as do the various kinds of *Ceuthophili*. The adults are sometimes found resting on the leaves and stems of low shrubs and weeds, but seldom climb over two or three feet from the ground. Their song resembles that of *Orchelimum vulgare*. It is a

continuous *z-e-e-e*, with an occasional short *ik*, caused by the insect getting its wing-covers ready for action after a period of silence.

A second species (*A. dorsalis* Burm.) may possibly be found in our state. The two species can be separated by the characters given in the following table:

- a. Front margin of pronotum much shallower, but little more than half as wide as hind margin, the latter broadly rounded.....*pachymerus*.
- aa. Front margin of pronotum but little narrowed, almost three-fourths the width of the hind margin, the latter almost square.....*dorsalis*.

GENUS *Anabrus** Haldeman.

Bulky and large insects. Pronotum extending over the basal portion of the abdomen concealing the rudimentary, squamæform elytra; without distinct lateral carinæ, and the median carina wanting or visible only on the posterior portion; dorsum of pronotum smooth. Prosternum unarmed. Anterior tibiæ with six to eight spines in front, in two rows; tarsi broad, soles concave, the third articulation cordate. Styles of sub-genital plate of males articulated. Ovipositor nearly straight, sword-shaped, two-thirds the length of the body.

The genus resembles *Atlanticus* in the shield-like pronotum and large size of the ovipositor, but differs in having the prosternum unarmed, while in the former genus there are two spines between the base of the front legs.

Anabrus purpurascens Uhler.

This dark purplish-brown insect, mottled with yellow, occurs in the Red River Valley, where at least one specimen was found near Argyle. Further west, where the insects belonging to this and other species are very much more com-

**abros*, with the negative prefix *an*, in allusion to the unprepossessing appearance of the insect.

mon, they are called "Western Crickets." They sometimes become very destructive to crops. The insect deposits in August and early September from 50 to 75 eggs, which have a cylindrical, long-oval shape, and have their pearly white surface minutely pitted; they hatch late in spring.

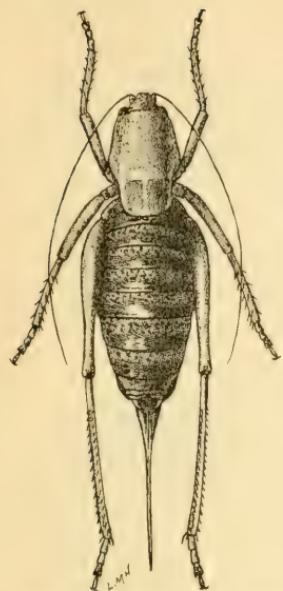


Fig. 162.—*Anabrus purpurascens*, female. Original.

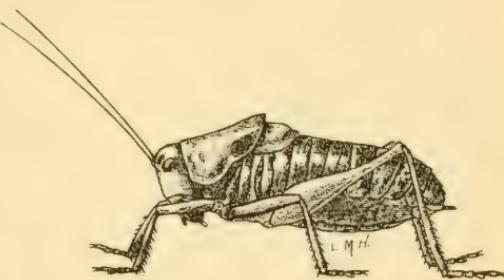


Fig. 161.—*Anabrus purpurascens*, male. Original.

Both sexes are illustrated (Figs. 161 and 162) in natural size.

The sub-family *Gryllacrinæ* is not represented in the fauna of Minnesota, and the sub-family *Stenopelmatinæ* by only one tribe, the *Rhaphidophorini*, which contains a number of genera belonging to the group of *Ceuthophilii*.

- a. Palpi long. Hind tibiæ usually considerably longer than the hind femora. Third hind tarsal joint only half or less than half as long as the second.....*Ceuthophilus*.
- aa. Palpi short. Hind tibiæ shorter, or at most but little longer than the hind femora. Third hind tarsal joint hardly shorter than the second.....*Udeopsylla*.

GENUS *Ceuthophilus* Scudder (1862).

Wingless, medium or large, head large, oval, bent downwards and backwards between the front legs; vertex not tuberculate; last joint of palpi longer than the third, and

grooved beneath at the apex; antennæ very long, usually two or more times as long as the body; pronotum not extending over the meta- and mesothorax as in *Atlanticus*, and well rounded on top; prosternum unarmed; abdomen arched; legs long, slender, with a few spines; hind femora swollen at the base, channeled beneath, and more or less spined; hind tibiæ with more than four pairs of spurs, first tarsal joint almost as long as the rest together; ovipositor straight, more or less swollen at the base.

All members of this and allied genera live in dark and moist places, under rotten logs, stones, mole-hills, in cavities, or in cellars. A related insect, the "Cave Cricket," is found in our large caves; it is colorless and blind, but possesses long legs and antennæ. Another species lives in Florida in the burrows of a turtle, the "Gopher." All are wingless grasshoppers which, on account of their resemblance to genuine crickets, are called "Cricket-like Grasshoppers" or "Stone Crickets." Their color, which is a pale brown, dirty white, or quite dark and almost black, harmonizes well with their surroundings, and the mottled appearance of some adds to their protection.

The males of these peculiar beings are readily separated by the size, number and relative positions of the spines on the under side of the hind femora, as well as by the degree of curvature of the corresponding tibiæ. The females, having neither the spined posterior femora nor the curved tibiæ, are less readily distinguished. As the two sexes are colored alike, and are usually found together in some hiding place, there will be little difficulty in placing the female after determining the male by the characters given.

These insects are almost omnivorous in their choice of food, and like most *Locustidæ* feed upon meat whenever they can obtain it.

Ceuthophilus maculatus Say.

SPOTTED WINGLESS GRASSHOPPER.

Glabrous, mottled with luteous and blackish, the darker markings predominating; on the pronotum a luteous, medio-dorsal stripe, also traces of such a stripe along the dorsum of the meta- and mesothorax; the hind femora are strongly infuscated outside and inside; the anterior pairs of femora infuscated at the apex and all the tibiæ at the base; posterior tibiæ infuscated along the upper side; fore femora a little



Fig. 163.—*Ceuthophilus maculatus*, female. Original.

more than a fourth longer than the pronotum and much less than half as long as the hind femora; hind femora as long as the body, three and a half times as long as broad, moderately stout

at base, and with no raised points on the upper or inner surface; outer carina with about thirteen unequal coarse spines in the male, and minute distant inconspicuous spinules in the female; inner carina with similar but uniform spines, none so long as on the outer carina (male) or with a few minute spinules on the apical half (female), the intervening sulcus not very broad. Hind tibiæ feebly undulate in the basal half in the male. Ovipositor nearly two-thirds as long as the hind femora.

Measurements.—Male: Length of body, 14 mm.; pronotum, 5 mm.; fore femora, 6.6 mm.; hind femora, 15.25 mm.; hind tibiæ, 16.25 mm. Female slightly larger; ovipositor, 10 mm.

This is our most abundant species, quite common under decaying wood, loose bark, and under stones. It is illustrated in Fig. 163.

Ceuthophilus Blatchleyi Scudder.

Dull yellowish or reddish, heavily mottled with dark dusky, leaving a narrow medio-dorsal streak on pronotum;

the flecking is made up of small more or less confluent dots, which assume a certain longitudinal regularity only on the abdomen; legs varying from luteous to testaceous, more or less infuscated. Fore femora no stouter than the hind femora, much less than half as long as the fore femora, fully a third (male) or scarcely a fourth (female) as long again as the pronotum, the inner carina with 2-3 spines, the sub-apical long. Middle femora armed on the front carina much as in the fore legs, the hind carina with a long genicular spine sometimes accompanied by 1-3 other spines, often minute. Hind femora nearly two and a half times as long as the fore femora, longer than the body in both sexes, slender and tapering, nearly the apical third sub-equal, three and a half times as long as broad in the male and fully three and three-quarters in the female, the upper portion of the apical half of the inner surface and to a less degree the upper surface near it with numerous raised points, the outer carina with wider intervals between the larger spines and the spines less stout (male), or with 2-3 scarcely noticeable spinules near the apex (female), the inner carina with about 12-14 serrulations unequally placed, slight, less numerous and distinctly slighter in the female than in the male, the intervening sulcus only moderately broad. Hind tibiæ with a hardly noticeable arcuation or sinuation in the male, hardly (male) or much (female) longer than the femora, slender, armed beneath with two median sub-apical spines besides the apical pair. Hind tarsi about two-fifths as long as the tibiæ, the first joint longer than the other joints together, the second much more than twice as long as the third and with it longer than the fourth. Cerci stout at base, beyond slender, about as long as the femoral breadth. Ovipositor straight, almost two-thirds as long as the hind femora, very little enlarged at base, tapering almost throughout but very gently, the tip upturned a little and finely acuminate.

Length of body, 13-13.5 mm.; pronotum, 4.5-4.7 mm.; fore femora, male, 6.4 mm., female, 5.5 mm.; hind femora,

male, 15.75 mm., female, 13.5 mm.; hind tibiæ, male and female, 16.25 mm.; ovipositor, 8.5 mm.

Ceuthophilus lapidicola Burmeister.

This species is closely allied to *maculatus*, but differs



Fig. 164.—*Ceuthophilus lapidicola*, female. Original.

from it in the style of mottling of the upper surface, and in that the males do not have the posterior tibiæ waved. A female is shown in Fig 164.

Ceuthophilus gracilipes Hald.

Ground color of body varying from luteous to dark castaneous, very heavily marked with blackish fuscous so that the latter is often the prevailing tint; the darker colors prevail always on the hinder half of all the segments but the pronotum; the anterior edge of the dark posterior markings of each segment, especially in the front portion of the body, is exceedingly irregular and broken, and the lightest parts are more or less irregularly clouded with fuscous; the femora are usually of the prevailing tint of the body. Antennæ moderately coarse at the base, tapering with great regularity, 3-4 times the length of the body. Legs very long and slender. Fore femora no stouter than the middle femora, more than half as long again as the pronotum, especially in the male, distinctly less than half as long again as the fore femora, the inner carina usually with 2-3 spines, often rather long in old individuals. Middle femora with 3-4 spines on either carina, the hind carina with a not very long genicular spine. Hind femora as long as or longer than the body, considerably more than twice the

length of the fore femora, very stout at base, but gradually diminishing in stoutness so that the distal third is slender and sub-equal and the whole less than three and a half times longer than broad, the surface mostly glabrous, but on the darker portions above beset not very sparsely with feeble raised points, the outer carina with about thirteen distant unequal rather coarse spines, the longest shorter than the tibial spurs (male) or almost unarmed (female), the inner carina much less elevated than the outer, with equal abortive denticulations numerous in the male, infrequent and equidistant in the female, the intervening sulcus moderately broad. Hind tibiæ rather slender, straight, nearly a sixth longer than the femora. Hind tarsi much less than half as long as the tibiæ, the first joint not so long as the rest together, the second nearly three times as long as the third and with it fully as long as the fourth. Cerci stout at base, tapering throughout. Ovipositor with the basal third rather stout, beyond equal and rather slender, nearly three-fourths the length of the hind femora.

Length of body: Male, 19 mm., female, 23 mm.; pronotum, male, 5.75 mm., female, 6.75 mm.; fore femora, male, 10 mm., female, 10.6 mm.; hind femora, male, 21.5 mm., female, 22 mm.; hind tibiæ, male, 24.75 mm., female, 25 mm.; ovipositor, 15.5 mm.

GENUS *Udeopsylla* Scudder.

Body heavier and stouter than in *Ceuthophilus*, with a larger head. First joint of antennæ larger and stouter than the rest, as broad as long, compressed anteriorly; third joint twice as long as second; remainder unequal; eyes small; sub-pyriform, docked on the antennal border, globose; maxillary palpi rather long; first and second joints equal and small; third, more than equal to the preceding together; fourth, little more than half as long as third; fifth, a little longer than third, somewhat curved, split along the whole underside; as in *Ceuthophilus* the pro-, meso- and meta-

nota nearly conceal the epimera of the thoracic segments; coxae differing but slightly from *Ceuthophilus*; hind femora very heavy, thick, and especially broad; in the males the hind femora are spined beneath; the fore and middle femora are shorter and heavier than in *Ceuthophilus*; tarsi, with the first and fourth joints equal and longest; second and third equal and small, the second overlapping the third above; the ovipositor is rather short, thick at base, slender at apical half.

Two species are found in Minnesota.

Body piceous, occasionally with faint rufous spots.

nigra.

Body varying in color from dark testaceous to mahogany brown.....*robusta*

Udeopsylla nigra Scudder.

Shining black, with a faintly indicated, narrow, reddish dorsal line, a reddish tinge on the front of the face, the basal half of the inner surface of hind femora and the terminal half of the ovipositor, reddish. The hind femora of the male have upon either edge of the under surface, but especially on the inner, short but heavy spines, not crowded; the third tibiae are furnished on either edge of the upper surface with four or five opposite, long, and slender spines, between each two of which are placed three or four suppressed spines; there is a single row of short spines upon the under surface, which become double towards the tip; the inner valves of the ovipositor have five teeth, growing longer and more curved towards the tip, where they are very long and slender.

Measurements.—Length of body, 20-23 mm.; of hind femora, female, 14 mm., male, 18 mm.; of ovipositor, 8.25 mm.; of antennæ, 25 mm.

A specimen was found on June 28 in an old cellar in Hamline; others in the Red River Valley under some rubbish lodged against an old log.

Udeopsylla robusta Hald.

"Uniform dark fuscous, dorsum and upper surface of the femora sparsely scabrous; feet rather short; posterior femora of female very robust, rather suddenly contracted inferiorly at the extremity; inferior margin with a row of robust spines upon the inside; tarsi tetramerous. Length thirteen lines."

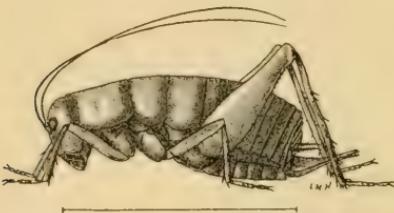


Fig. 165.—*Udeopsylla robusta*, female.
Original.

a gopher hole in a small prairie, but near a grove of trees. It is shown in Fig. 165.

Among the curious insects which are from time to time introduced in various ways from other countries, one species, illustrated in Fig. 166, has succeeded in finding a new home in the conservatory of the State University at Minneapolis.



Fig. 166.—*Diestrammena marmorata*, male. Original.

Prof. O. W. Oestlund has kindly furnished the following note in regard to it: "All the facts that I can obtain regarding this insect (Fig. 166) are that they have been now in the conservatory for the last three years, and that they multiply freely. They were at first noticed in connection with a shipment of plants from Florida, consisting mostly of the Japanese Umbrella-plant. There was also a great deal of straw used in packing, which no doubt aided in the transportation of the insect. At the same time there also appeared a cater-

pillar very destructive to ferns, but which was exterminated the first year." The latter was a Florida species.

Dr. S. H. Scudder has kindly determined the former insect, and he pronounces it *Diestrammena marmorata* (De Haan) of Japan. This instance shows how easy it is for insects to reach new quarters, and, if these should suit their requirements, to find a new home.

FAMILY VII. *Gryllidæ.*

CRICKETS, ETC.

The members of this family of jumping orthoptera resemble the members of the previous family, *Locustidæ*, in possessing long, slender and delicately tapering antennæ; they differ from them in the form of their wing-covers, the number of joints in the tarsi, and in the form of the ovipositor. The tegmina in the *Gryllidæ* are horizontal, with the outer portion bent abruptly downwards; the tarsi are three-jointed, with the exception of *Oecanthus*, in which the hind tarsi are four-jointed; and the ovipositor is usually long and spear-shaped. The sexes differ greatly in structure, the female having a long ovipositor and the venation of the tegmina simple, while the male has the veins upon the horizontal part of the tegmina so modified as to admit of their being used as a musical organ.

Prof. Scudder uses the following table to distinguish the sub-families:

SUB-FAMILIES OF GRYLLIDÆ.

- A. Tarsi compressed, the second joint minute, compressed.
 - b. Fore legs fossorial; female without ovipositor; tympanum of male tegmina (when present) without speculum.....*Gryllotalpinae*.
 - bb. Fore legs gressorial; female with ovipositor, though it is sometimes rudimentary; tympanum

of male tegmina (when present) furnished with a speculum.

- c. Hind tibiæ biseriately serratulate but not spined, or, if spined (*Myrmecophila*), then the body is sub-spherical and the hind femora exceptionally gibbous..... *Myrmecophilinæ*.
- cc. Hind tibiæ biseriately spined, the body always sub-elongate, with relatively slender hind femora.
- d. Hind tibiæ rather short, armed with stout spines, not serrulate between them.

Gryllinæ.

- dd. Hind tibiæ slender, armed with delicate spines, and serrulate between them.

Ecanthinæ.

AA. Second joint distinct, depressed, corditorm.

- b. Hind tibiæ biseriately spinose, not serrate, the apical spurs, two in number on the inner side.

Trigonidiinæ.

- bb. Hind tibiæ biseriately spinose and also serrate, the apical spurs, three in number, on both sides.

Eneopterinæ.

The sub-family *Gryllotalpinæ* contains two tribes.

- A. Head furnished with two large ocelli; fore tibiæ dilated, markedly digitate; hind femora scarcely saltatorial; tarsi three-jointed..... *Gryllotalpi*.

- AA. Head furnished with three small ocelli; fore tibiæ scarcely dilated, three to four spined apically; hind femora strongly saltatorial; tarsi uniarticulate or aborted..... *Tridactylini*.

GENUS *Gryllotalpa* Latreille.

Head oval; thorax convex, sub-elliptical, sides rounded; body rounded and about twice as long as the thorax; an-

terior legs very stout and strong, broad and flattened, with two spines at the tip and a movable claw-like organ outside, with two spines; middle legs short and slender; hind legs longer. Wing-covers about half as long as the abdomen; wings half as long or longer than the abdomen.

Two species of these curious insects are found in Minnesota, but both are rather uncommon, at least as far as known.

Gryllotalpa borealis Burmeister.

THE NORTHERN MOLE-CRICKET.

Cinnamon brown, covered with short, fine hairs of the same color. The wing-covers are less than one-half as long as the abdomen, and the wings extend a little beyond the wing-covers. Length, about 30 mm.

Fig. 167, *b*, shows the enlarged claws, from the side.

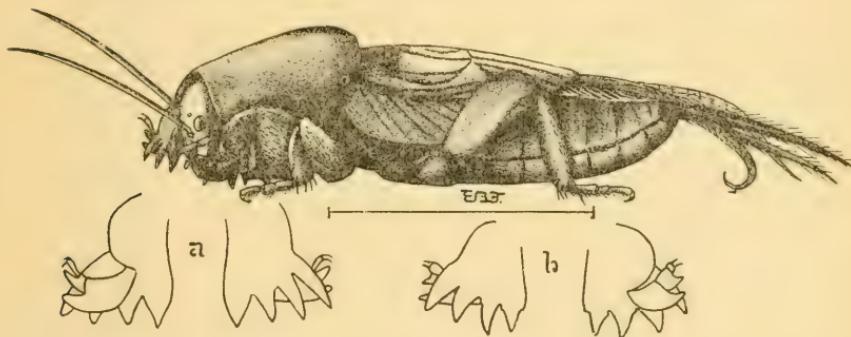


Fig. 167.—*Gryllotalpa columbia*: *a*, side view of anterior claw; *b*, the same of *G. borealis*. Original.

Gryllotalpa Columbia Scudder.

THE LONG-WINGED MOLE-CRICKET.

Differs but slightly from *borealis*, but has the upper wings somewhat longer, and the hind wings extending beyond the tip of the abdomen.

This curious insect is shown in Fig. 167. The anterior claws, Fig. 167, *a*, differ but little from those of *G. borealis*.

These fossorial crickets, like the members of the following genus, burrow in the ground, but especially the former are preeminently burrowers. Like the true mole they are well equipped for such a life. Unity of habits will produce similar modifications in the organs specially needed, and the front tibiæ of the mole-crickets are very similar to the broadened hand-shaped front feet of the mole, or of the pocket-gopher, because they are used for the same purpose. Mole-crickets live in rather damp places, near lakes, ponds or rivers, where they form long channels with raised ridges, which resemble a miniature mole-hill. Some of their burrows are from six to eight inches below the surface, and in making them the roots of plants above are greatly injured. Mole-crickets, though they feed upon tender roots of plants, are by no means strictly vegetarians, but devour greedily any insect they are able to catch. In fact most of the members of Crickets and Long-horned Grasshoppers are cannibals whenever an opportunity should offer, and some eat more animal than vegetable matter. In Europe the mole-cricket becomes sometimes a very serious pest, especially among young plants of trees in forest nurseries. In the West Indies, and in Java, other species are very destructive to the sugar-cane.

Mole-crickets, like true moles, are by no means social beings, and except at the love season only one adult insect is found in each burrow. The mother deposits from 200 to 300 eggs in a round cavity deeper in the ground. Wherever mole-crickets occur they are not very difficult to capture, as they can be located in their burrows by their songs. Captive specimens, if placed on the ground, will at once begin to dig; if put on a piece of paper, or on a handkerchief, they invariably go through all the motions of digging. Both species of mole-crickets are sometimes attracted by lights.

GENUS *Tridactylus* Oliver.

Body glossy. Head and pronotum convex; eyes oval; antennæ short; wing-covers not reaching the end of the body; wings longer or shorter, folded lengthwise like a fan. Anterior tibiæ broad and flat, armed at the end with three spurs; all the tarsi very slender; posterior femora long and broad, with a rounded shallow depression at the end. Body narrower than the thorax.

Tridactylus terminalis Scudder.

Head and thorax pitchy black, glossy, sometimes with reddish-brown spots. The hind femora are black with two white spots or fasciæ. The wings reach to the tip of the abdomen, or extend a little beyond, in both sexes. Length about 7 mm.

Tridactylus apicalis Say.

Body deep black, head and thorax with some white markings, tegmina with outer edge and a spot behind the middle white. Hind femora whitish, with three faint, dark cross bars. Wings of male extend 3 mm. beyond tip of abdomen. Length 8 or 9 mm.

This is the largest species occurring in the U. S. Only a single specimen was captured as late as Oct. 14 on the bank of a little stream near Ft. Snelling. It is illustrated in

fig. 168.

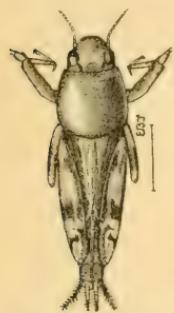


Fig. 168.—*Tridactylus apicalis*. Original.

Tridactylus minutus Scudder.

This insect has not been found as yet in Minnesota, but very likely occurs here as well as further south.

The generic name *Tridactylus* is based upon the peculiar structure of the anterior tibiæ, which are much dilated and armed at the end with three strong and slightly curved spurs. The insects forming this genus resemble mole-crickets in form and general appearance, but are very much

smaller and brighter colored. Like the mole crickets they burrow, but are not so helpless away from their tunnels, as they can jump as well as the true crickets. It is not easy to capture them, as their power of leaping is so marvelous that they seem to disappear most mysteriously, the eye not being able to follow them in the air.

The sub-family *Myrmecophilinæ* is represented by a single genus in Minnesota.

GENUS *Myrmecophila* Latreille.

Besides the characters already given in the table this genus is distinguished by the absence of compound eyes; ocelli present; hind femora ovate; hind tibiæ dilated, with only three or four apical spurs.

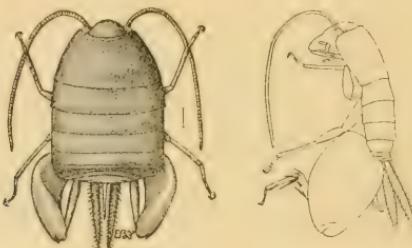


Fig. 169.—*Myrmecophila nebrascensis*. Original.

No doubt a number of species occur in our state. The insects are found only in the nests of ants, and consequently are not readily observed. Yet a number have been seen when searching for other insects in such nests. When moving about quietly the insects resemble very closely young cockroaches, also found in similar surroundings, but as soon as disturbed they prove the usefulness of the tremendous muscles located in their swollen hind femora. Males are exceedingly rare, in fact unknown in the European species. *Myrmecophila nebrascensis* Brun., is shown in fig. 169.

The sub-family *Gryllinæ* contains two genera in Minnesota.

- A. Hind tibiæ furnished with long, mobile, pilose spines; first joint of hind tarsi unarmed above or with one row of serrations.....*Nemobius*.
- AA. Hind tibiæ armed with strong fixed spines; first joint of hind tarsi sulcate, with two rows of serrations.
Gryllus.

Most crickets, if not having a home in cracks, in walls, or below stones, make burrows in the ground in which they live. The eggs are laid in the autumn, and usually in the ground, after which the greater number of the old crickets die; a few survive, however. The eggs hatch quite early in the spring. The insects are omnivorous, feeding upon all kinds of decaying matter as well as upon living plants, hence must be classed among the injurious insects; they eat also many insects, and freshly dropped cow dung seems to be especially attractive to them. Those crickets that make burrows in the ground can become quite injurious by exposing the roots of plants to the drying influence of the air.

GENUS *Nemobius* Serville.

Small sized species. Head and thorax with comparatively long hairs; first and second joints of maxillary palpi minute, third and fifth joints of about equal length, fourth joint smaller. The venation of the wing-covers of the female differs from *Gryllus*, the veins running longitudinally, while in *Gryllus* they run obliquely from both sides, thus forming lozenge-shaped spaces between. Hind tibiæ with long spines of unequal length. Ovipositor straight, longer or shorter than the abdomen.

Nemobius fasciatus DeGeer.

SMALL STRIPED GROUND-CRICKET.

Dusky brown to almost piceous, with head and thorax hairy; the wing-covers and legs sometimes paler. On the head are four black longitudinal stripes, which are only

faintly visible in dried specimens. A black line, also on each side of the thorax, continuous with a line of the same color along the sides of the wing-covers. Body above black, with indications of two rows of pale spots. Underside pale brown with a broken, blackish, spot-like stripe on each side. In the male the pale portion of the under side of the body is usually reduced to a stripe along the middle. The ovipositor is straight and pointed obliquely upwards, and is about as long as the hind femora. Spines on tibiæ of hind legs rather long. The wing-covers in the male are as long or almost as long as the abdomen, and in the female they are about half as long. The hind wings are over twice the length of the wing-covers, and project beyond like tails.

Length from 9-11 mm.; ovipositor, 8 mm.

Nemobius fasciatus, form *vittatus* Harris.

This form only differs from *fasciatus* in having the hind wings aborted; in color, size and markings it is the same.

It is very abundant in open woods and meadows near by, and is found from July until severe frost. Even in early winter, during warm days and in sunny spots, these insects are active. Like the larger insect forming the genus *Gryllus* they are chiefly solitary and nocturnal, yet may be seen in large numbers together in fields and during the day. They are very pugnacious, and not alone fight among themselves but savagely bite a straw if irritated with it. Especially during their love season they are very quarrelsome, and pitch into each other while keeping up a constant stridulation. Prof. Scudder gives the following pleasing account of the sounds made by this species, which is shown in fig. 170:



Fig 170.—*Nemobius fasciatus*, form *vittatus*, female. Original.

"The chirping of the striped cricket is very similar to that of the black field cricket; and may be expressed by *r-r-r-u*, pronounced as though it were a French word. The note is trilled forcibly, and lasts a variable length of time. One of these insects was once observed while singing to its mate. At first the song was mild and frequently broken; afterwards it grew impetuous, forcible and more prolonged; then it decreased in volume and extent until it became quite soft and feeble. At this point the male began to approach the female, uttering a series of twittering chirps; the female ran away, and the male, after a short chase, returned to his old haunt, singing with the same vigor but with more frequent pauses. At length finding all persuasions unavailing, he brought his serenade to a close."



Fig. 171.—*Nemobius spec.*, female. Original.

his serenade to a close."

Fig. 171 shows another *Nemobius*, a few of which were found in Minnesota.

Nemobius exiguus Scudder.

THE LESSER STRIPED GROUND-CRICKET.

This also occurs in Minnesota, and is found in company with *vittatus*, from which it may be known by its much smaller size, lighter color, and by the last two segments of the maxillary palpus being white. Its ovipositor is much shorter, being only one-half to two-thirds the length of the hind femora, whereas in *vittatus* it is fully as long.

Length of body, male, 7 mm., of female, 8 mm.; of hind femora, 6 mm.; of ovipositor, 3-4 mm.

Nemobius socius Scudder.

A few very small crickets were captured near the electric light in St. Paul. Prof. Bruner pronounced them to be this species, which is, however, a southern one.

GENUS *Gryllus* Linnæus.

Body short; head large and globose; eyes large and rounded; antennæ thread-like, longer than the body; thorax broader than long, about as wide as the head; hind femora powerful, well developed and adapted for leaping; hind tibiæ with a double row of long spines growing longer towards the tip; anal cerci long and tapering; ovipositor as long or longer than the abdomen; wing-covers as long or shorter than the abdomen, bent down at the sides. Wing-covers of male provided with a well-developed organ for stridulation; hind wings as long, longer or shorter than the abdomen, sometimes aborted.

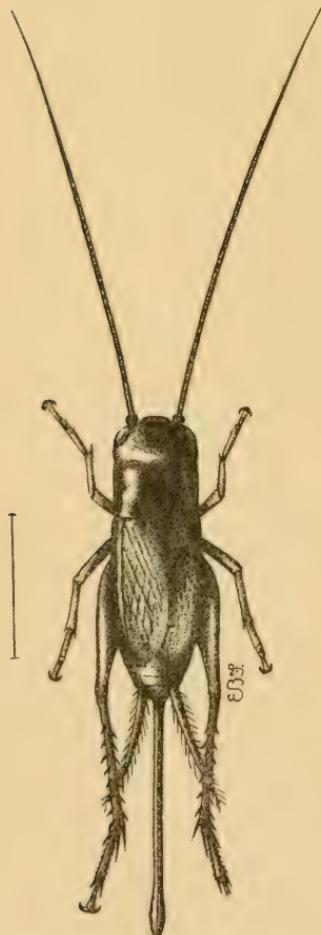


Fig. 172.—*Gryllus abbreviatus*, female, original.

Gryllus abbreviatus Serville.

COMMON CRICKET.

Head, thorax and body shining black. The legs vary from reddish-brown to pitchy-black. Wing-covers fusco-testaceous and as long or nearly as long as the abdomen. Hind wings shorter than the wing-covers. The ovipositor is very long.

Length, 18-23 mm.; length of ovipositor, 18-21 mm.

Illustrated in Fig. 172.

Gryllus pennsylvanicus Burmeister.

Wholly shining, jet black, covered with a very fine grayish pubescence on the thorax, legs

and underside of body. In older examples this pubescence becomes abraded, and the insect is then very glossy. The wing-covers are as long or more or less shorter than the body, and vary in color from ochraceous brown to pitchy black. The hind wings are shorter, or as long, or extend considerably beyond the wing-covers, as tail-like projections.

Length, 10 to 20 mm.; ovipositor, 12 to 15 mm.

This description includes a number of forms or varieties. *G. luctuosus* Serv. is the form with the hind wings projecting like tails beyond the wing-covers; *G. neglectus* Scudder is the form with the wing-covers as long or shorter than the abdomen in the female and as long as the abdomen in the male; *G. nigra* Harris is the form with a somewhat shorter ovipositor. This insect is not common in Minnesota.

Fig. 173 shows a female of *Gryllus pennsylvanicus*, and Figs. 174 and 175 both sexes of *Gryllus assimilis*.

No doubt other species occur in our fauna, but they have not as yet been studied. Many of the immature crickets hibernate under stones and other shelters; if they are placed together in a box they speedily fight and the weaker ones are eaten.

There is, however, an European species that is getting too common in some houses, so that complaints are made about it by tenants. This is the European House-Cricket, or "Cricket of the hearth."

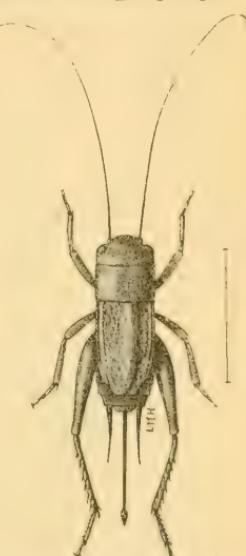


Fig. 173—*Gryllus pennsylvanicus*, female, original.

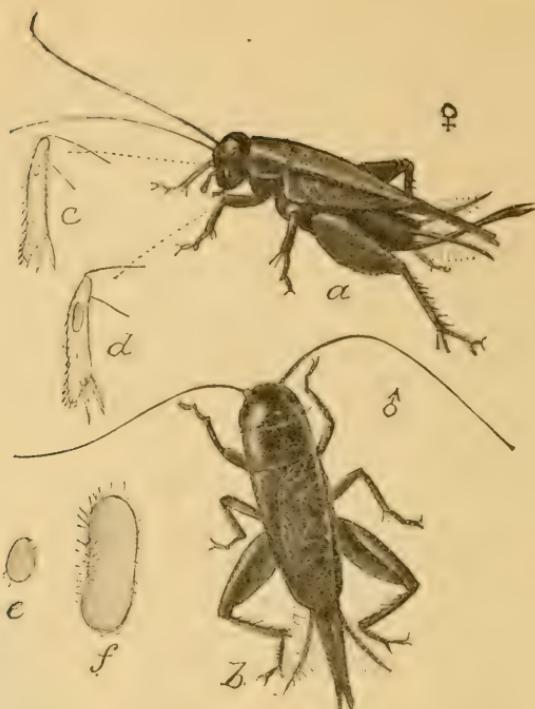


Fig. 174.—*Gryllus assimilis*: a, female; b, male; c, d, fore tibiae, inner and outer views, showing drums of ear; e, f, drums or tympana. Enlarged. From "Household Insects," by Div. of Entomology, Dept. Agriculture.

Gryllus domesticus Linn.

EUROPEAN HOUSE-CRICKET.

Pale brown, with chestnut-brown markings on the head and thorax. The wing-covers extend to the end of the abdomen, and the hind wings extend considerably beyond. It is illustrated in Fig. 176.

Length, 21 mm., ovipositor, 12 mm.

All crickets are musicians, that is the males. Prof. Comstock writes: "During the latter part of the summer and in the autumn, the air is filled with the cries of the crickets. With care it is easy to observe these little fiddlers calling their mates. The common field-crickets lurk in



Fig. 176.—*Gryllus domesticus*, female, original.

holes in the ground and under stones, or, emerging from these retreats, run through the grass in search of food. At the season indicated above, the male crickets spend much time at or near the entrance of their burrows, making their peculiar calls. So intent upon this are they, that by moving quietly one can approach sufficiently near to watch them carefully. And even when they are disturbed they retreat into their holes only for a short time, if all remains still. At night they can be observed by means of a lantern, as light does not disturb them. In order to understand the manner of making these calls, it is necessary to study the structure of the tegmina, which in the males (Fig. 175, b) differ greatly from the simple form seen in the

necessary to study the structure of the tegmina, which in the males (Fig. 175, b) differ greatly from the simple form seen in the

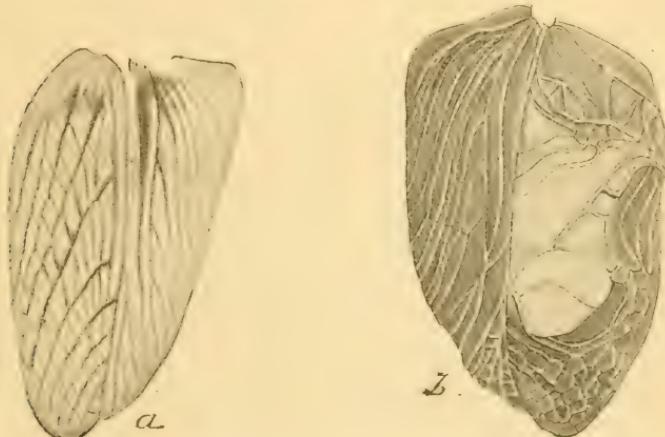


Fig. 175.—*Gryllus assimilis*: a, wing of female; b, wing of male, showing the more irregular and coarser veins. Enlarged. From "Household Insects," by Div. of Entomology, Dept. Agriculture.

female (Fig. 175, a)." As has been mentioned elsewhere, only the tegmina of the males are used to produce sounds. When the cricket wishes to make his call, he elevates his tegmina

at an angle of about forty-five degrees with the body; then holding them in such a position that the scraper of one rests upon the file of the other, he moves the tegmina back and forth laterally, so that the file and scraper rasp upon each other. This throws the tegmina into vibration, and produces the call.

Crickets, and especially the House Crickets, may readily be destroyed by taking advantage of their liking for sweet liquids, and any vessel containing beer or other fluids placed about will usually collect and drown large numbers of these insects. They can also be killed by distributing uncooked vegetables, as ground-up carrots or potatoes, which are strongly poisoned with arsenic. Of course great care must be exercised in the use of any poison in and about dwellings.

The sub family *Œcanthinæ* is represented by a single genus.

GENUS *Œcanthus* Serville.

Thorax elongated, narrow, sides deflexed, anterior portion somewhat narrower than the posterior portion. Antennæ about twice as long as the body. Hind legs long and slender, with weak spines on the tibiæ. Wings of female wrapped around the body. Wing-covers of male flattened, transparent, much firmer and broadly spread out, causing such a difference of appearance between the two sexes that collectors consider them frequently widely different species.

The members of this genus are well known insects, usually called "tree-crickets." They are delicate yellowish-green or greenish-white insects found abundantly about low bushes and tall plants. They are strictly arboreal. About the time that our golden-rods are in full bloom these insects can be found upon almost any of these plants, and usually in pairs. They remain almost motionless in such places during the day, but become very active during the night. Though belonging to plant-feed-

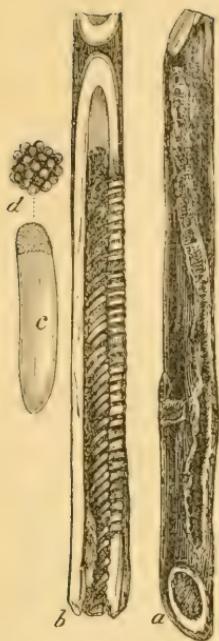


Fig. 177.—Eggs of *Oecanthus spec.*,
a, twig showing punctures; b, twig
split open to show eggs; c, a single
egg; d, cap of egg, enlarged. After
the infected cane early in spring
is a good remedy.
Riley.

Oecanthus niveus DeGeer.

THE SNOWY TREE-CRICKET.

Wholly pale, ivory-white, tinged with delicate green, with two slightly elevated black dots on the underside of each antenna, one on the first and one on the second joint (Fig. 178).



Fig. 178.—*Oecanthus niveus*: two basal joints of antennæ.
Original

Top of head and first joint of antenna usually pale yellowish-brown. Tip of ovipositor black. Wing-covers almost twice as long as the abdomen; hind wings as long as the wing-covers. The maxillary palpi are longer in this than in any other species

of the genus, and the wing-covers of the male broader in proportion to their length than in any other except *latipennis*. Average length, from head to end of wings, 16 mm.;

ing insects they prefer in reality other insects, and especially the injurious plant-lice. They would, consequently, belong to the beneficial insects, if they did not possess the bad habit of selecting the cane of useful plants for the purpose of inserting eggs into them. The female, by means of her strong ovipositor, thrusts her eggs into the pith of the cane selected, and as a large number of eggs are thus laid side by side, as shown in the illustration (Fig. 177), the cane is usually killed beyond this point, and if the insects are at all numerous great injury can be caused. Burning

the infected cane early in spring is a good remedy.

body, 11 mm.; width of male wing-covers, 6 mm.; of female, 3 mm.

This is one of the most abundant of our tree-crickets, and can be found during August and September in our gardens and orchards. Even if not seen the insect can not escape detection, as its stridulation is very shrill. Though usually heard at night it is sometimes also heard on cloudy days, but only faintly. This stridulating is continuous, and is a pulsating sound like *re-teat, re-teat*, or *a-beat, a-beat*.

The female of *niveus* cause much injury by ovipositing in the tender canes or shoots of various plants, as the raspberry, grape, plum, peach, etc. Prof. Blatchley counted no less than 321 eggs in a raspberry cane 22 inches in length. The eggs are laid in autumn and at first the injury is shown only by a slight roughness of the bark, but afterwards the cane frequently dies above the puncture, or is so much injured as to be broken off by the first high wind. If the injured and broken canes containing the eggs are collected and burned in early spring the number of Snowy Tree-crickets for that season can be materially lessened. If, however, our trees harbor many leaf-lice it is best not to apply such a heroic treatment; it would be best to bring the canes containing such eggs to places where lice abound; as these crickets possess carnivorous propensities, they can be utilized to greatly reduce the numbers of injurious leaf-lice. Miss Mary E. Murtfeldt, of St. Louis, Mo., has given a most interesting account of some experiments and observations with this insect, and the following extract is given: "Some leaves of plum infested with a delicate species of yellow aphid were put into a jar with the young of *Oecanthus niveus*, but attracted no immediate attention. As twilight deepened, however, the crickets awakened to greater activity. By holding the jar against the light of the window or bringing it suddenly into the lamp light, the little nocturnal hunters might be seen hurrying with a furtive, darting movement over the leaves and stems, the head bent down, the antennæ stretched

forward, and every sense apparently on the alert. Then the aphides provided for their food would be caught up one after another with eagerness and devoured with violent action of the mouth-parts, the antennæ meanwhile playing up and down in evident expression of satisfaction. Unless I had provided very liberally not an aphis would be found in the jar the next morning and the sluggish crickets would have every appearance of plethora."

Œcanthus angustipennis Fitch.

Wholly ivory-white, rather deeply tinged with greenish; wings transparent and sometimes with a pale yellowish-brown patch on top of the head. Head and prothorax less



Fig. 179.—*Œcanthus angustipennis*—two basal joints of antennæ. Original.

prominent, and the latter much narrowed anteriorly. Antennæ with two elevated black marks on the under side, the one at the first joint hooked at the base, with the hook turned inward and the mark on the second joint oblong. (Fig. 179.) Readily distinguished by the narrowness of the wing-covers

of the male, their breadth being just about one-third their length.

Average length from head to end of wing-covers, 14 mm.; body, 10 mm.; width, 3.5 mm.

This is not a common species, and only a few have been collected during August. It seems to prefer the taller trees, hence is not readily found. Its stridulation is very different from that of *niveus*, being a continuous faint *reeeeeeee'*, lasting about five seconds and terminating abruptly, with an equal interval of rest.

Œcanthus faciatus Fitch.

Two forms occur in Minnesota, one of which is very much darker than the other. The species is readily distinguished by the markings on the first two joints of the antennæ. As seen in

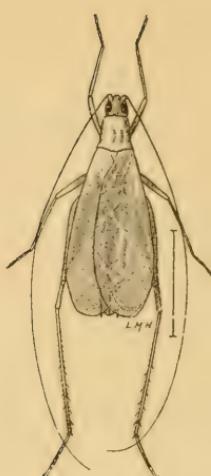


Fig. 180.—*Oecanthus fasciatus*, male. Original.



Fig. 182.—*Oecanthus fasciatus*—two basal joints of antennæ of dark form. Original.



Fig. 183.—*Oecanthus fasciatus*—two basal joints of antennæ of light form. Original.

the illustrations (Figs. 182 and 183) these markings are confluent in the darker variety, and well separated in the lighter one. This cricket is always darker in color, varying from a deep black to ivory-white with fuscous markings. Most specimens, however, are greenish-white, with three black stripes on the head and pronotum, and a broad dusky line along the center of the abdomen beneath. The wing-covers of the male are less broad in proportion to their length than in *niveus*; while the ovipositor is longer and more distinctly turned upward at the end. Both sexes are shown in Figs. 180 and 181.

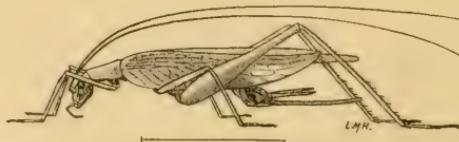


Fig. 181.—*Oecanthus fasciatus*, female. Original.

This is almost as common as the "Snowy Tree-cricket." Its stridulation is a long and comparatively loud continuous whir often lasting several minutes.

Œcanthus latipennis Riley.

Pale yellowish-green, with the wing-covers very much broader in the male than in any other species of the genus. The antennæ are destitute of black marks on the underside of the first two joints, which are characteristic of the other species of *Œcanthus*. The basal joints of the antennæ (Fig. 184) and the top of head are of a distinct pink color. The



Fig. 184.—*Œcanthus latipennis*—four basal joints of antennæ. Original.

wing covers extend considerably beyond the abdomen, and the wings in the male are much shorter than the wing-covers, and in the female about as long.

Average length from head to tip of wing-covers of male, 16.19 mm.; width of wing-covers, 7.8 mm.; female, 14-17 mm.; width, 3-4 mm.

This is quite a distinct looking insect, easily distinguished by the pink color of the basal joints of the antennæ and top of head. It is a rather uncommon insect, at least in places visited by the writer. The insect prefers low plants in damp places.

Upon closer search it is very likely that other species of these interesting insects will be found. As a general rule different species do not inhabit the same bushes or trees.

The sub-family *Trigonidiinae* is also represented by a single genus.

GENUS *Anaxiphus* Saussure.

Somewhat closely allied to *Nemobius* in general appearance, but differing by having the ovipositor sabre-like and curved upwards, with the end compressed. The antennæ are very long, about five times as long as the body, and the spines of hind tibiæ are of equal length. Wing-covers of male almost encasing the abdomen, with a round glassy patch on top near the end of the wing. Hind wings absent.

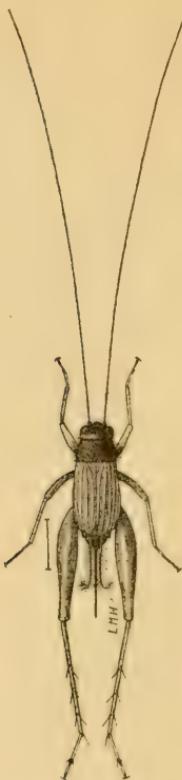


Fig. 185.—*Anaxiphus pulicarius*, female. Original.

Anaxiphus pulicarius Saussure.

Head and pronotum brick-red in color, sparsely clothed with long hairs; wing-covers and legs very light brown; abdomen and ovipositor darker.

Both sexes are wingless, but the wing-covers of the male are well developed, fully covering the abdomen, while those of the female reach but little beyond its middle. The cerci are exceedingly long, tapering, and covered with fine yellow hairs. The hind femora of the males are proportionately much larger than those of the females, as will be seen by the following measurements: Length of body, male, 6.5 mm.; female, 8 mm.; length of posterior femora, male, 6.5 mm.;

female, 6 mm.; length of ovipositor, 3.5 mm.; of antennæ of male, 32 mm.

This insect (Fig. 185) has twice been captured among the tall weeds near the Mississippi River, but is not common. Its habit of living mostly on bushes and rarely on the ground also distinguishes it from the members of the genus *Nemobius*, which all prefer the ground.

The sub-family *Eneopterinae* is represented in Minnesota by one genus with one species, the *Orocharis saltator* Uhler (Fig. 186). But as this insect belongs in the South, where it inhabits trees and bushes, it is doubtful whether it really occurs here or not. The table of sub-families gives the characters of the genus, to which should be added that no more than two oblique veins traverse the median area of the tympanum of the male tegmina, and are found in the proximal portion only, and that the fore tibiae possess auditory foramina on both faces. The insect resembles a stout brown tree-cricket.

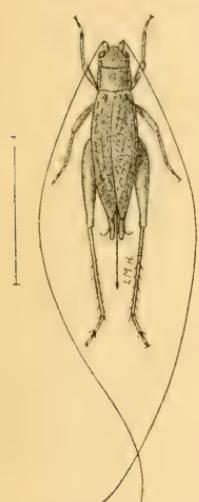


Fig. 186.—*Orocharis saltator*, female. Original.



Fig. 187.—Field-crickets; 1 and 2, adults; 4, active pupa or nymph; below 1 crickets just hatched

EXPLANATIONS
OF
TERMS USED IN TEXT.

A.

- A*, as prefix of a word means wanting, without.
abbreviated, shortened, not extending to the extremity of a given part.
abdomen, posterior part of the body (Fig. 21).
aborted, imperfectly developed.
abraded, scraped or rubbed off.
acuminate, becoming gradually narrower; tapering to a point; a point lengthened out.
acutely, sharp; sharply pointed.
adult, grown up; sexually mature.
adventitious, accidentally; casually acquired.
alary (ala, alatus), relating to wings or wing-like parts.
ampliate, enlarged; dilated.
anal, situated at or near the anus.
analogue, differing as to structure but of similar function.
annulus, annulation, annulate, a colored ring around a body.
ante, a prefix meaning before.
antennæ, two jointed sense-organs situated on the head; feelers (Fig. 21).
anterior, anteriorly, near the head; situated more to the front.
anus, the posterior opening of the alimentary canal.
apex, the terminal portion of any organ or part of the body.
aphis, plant-louse.
apical, apically, applied to a part rising at the tip of a body.
apodemata, apodema, plates of chitine supporting internal organs.
appressed, pressed closely against; fitting closely to.
approximate, near to; near together.
apterous, wingless.
arboreal, living on or among trees.
arcuate, arcuation, arched; bowed.
area, areola, areolate, wing-cells; cellules; the membranous spaces between the nervures.
articulated, divided into distinct joints.
auditory organ, ear; hearing-organ (Fig. 37, 38).
attingent, touching; coming in contact with.
axillary, arising from the angles, as *axillary vein*.

B.

- basalis, basal*, relating to the base; arising from the base.
bifid; cleft; cloven in two.
biturcate, a part not over the half of its length divided into two dull points.
biseriately, in two series.
bullate, a blister (*bulla*); blister-like.

C.

- cæcum, cæcal*, a tube open at one end only (Fig. 40, 41).
callosity, callosus, an elevated rounded portion of the surface, generally smooth, appearing like a swelling; an elevated substance harder than the surrounding matter.
canthus, one of the upper and lower or interior and posterior extremities of the compound eyes of insects.
cardo, cardines, a hinge (Fig. 27).
carneous, flesh-colored.
carina, carinæ, a keel or ridge.
castaneous, chestnut-brown; bright reddish-brown.
cercus, cerci, the appendages issuing from the sides of the last abdominal segment (Fig. 38).
chitine, the corneous substance of the skin of an insect.
cimeter-shaped, like a short, curved oriental sword.
cinereous, ash-colored; gray tinged with blackish.
clavate, having a thickened, club-like extremity.
clypeus, a part of the head (Fig. 22).
coleopterous, relating to beetles.
colon, largest part of the intestine (Fig. 40, 41).
confluent, running into each other.
concave, when the surface gradually declines toward the center, which thus becomes the deepest.
convex, when the surface gradually rises toward the center, which thus becomes the highest.
cordiform, cordate, heart-shaped.
coriaceous, leather-like, tough and somewhat rigid.
corneous, a horny substance; resembling horn.
corpus adiposum, fatty substance.
costa, median carina of the face; also the front margin of wings and tegmina.
costal, anterior; (margin of wing) (Fig. 33).
coxa, the globular or oblong basal piece of the leg (Fig. 35).
crest, a sharp ridge.
cristate, with a prominent longitudinal carina on its upper surface.
cylindrical, a round body, equally thick throughout.

D.

- declivous*, steep; precipitous.
decurved, bowed downwards.
deflexed, bent downwards.
depressed, pressed downwards; more or less flattened vertically.
dentate, furnished with a tooth or teeth.
denticulations, with tooth-like notches.
dichromatism, the quality of possessing two color varieties.
digitate, finger-like.
dilated, distended.
dimorphic, existing in two forms.
discoidal area (Fig. page 155).
disk, the middle of a surface; the surface within the margins.
distal, farthest distant, opposite of proximal.
diurnal, active during the day.
dorsal, pertaining to the upper surface.
dorsum, the upper surface or back of thorax, abdomen, etc.

E.

- elliptical*, elongate-oval.
elongate, more stretched than usual.
elytra, the wing-covers; tegmina; anterior or upper wings (Fig. 33).
emarginate, *emargination*, edged; notched; terminating in an acute notch at tip.
embryo, the living being within the egg (Fig. 5).
ensiform, sword-shaped.
epicranium, the upper part of the head, from the front to the back (Fig. 22).
epimera, narrow or triangular pieces at the sides of the under surface of the thorax (Fig. 31).
episterna, large pieces just in front of the epimera (Fig. 31).
excavate, having a depression.
extruded, thrust out; expelled.
exuded, discharged slowly, through pores, etc.

F.

- facets*, the surface of the ocelli of the compound eye.
fascia, *fasciae*, transverse bands or broad lines.
fastigium, the extreme point of the front or apex of the head when it is produced in a conical prominence.
tauna, the animals of a locality.
femora, the thighs (Fig. 35).
fenestrated, with transparent spots like small windows.
feruginous, rusty-brown; brownish-red with some yellow.
filiform, slender, thread-like.
fissure, crack; crevice.

flabellate, fan-shaped.

flavous, yellow like a lemon or like sulphur.

foramina, *foramen*, opening at an apex; small openings.

fossa, a deep pit or depression serving for the point of attachment of an organ (Figs. 22, 30, 31).

fossorial, fit or used for digging or burrowing.

foveola, a cavity or small depression (Fig. page 156).

front, *frons*, the upper forward part of the head (Fig. 40).

frontal, relating to the front.

fuliginous, sooty; dark brown with a little red.

fulvous, tawny, or light yellowish-brown.

furcula, the process of the last abdominal segment of the male.

fuscous, dark brown; a plain mixture of black and red.

fusion, union.

G.

galea, helmet; a dilated, unarticulated, membranous piece of the maxilla (Fig. 27).

ganlion, *ganglia*, a nervous mass or enlargement (Fig. 40).

gena, cheek (Fig. 22).

geniculat, knee-jointed; bending abruptly in an obtuse angle.

genicular arc, a curved dark marking on the posterior knee-joint.

genital chamber (Fig. 38.)

gibbous, protuberant; marked with elevations.

glabrous, smooth or polished, not hairy.

glaucous, whitish-blue, inclining to gray.

globose, like a ball.

gressorial, fitted for walking.

griseous, light gray (white and black).

gula, throat, concave portion below the head.

H.

hemispherical, shaped like half a ball.

hexagonal, six sided.

hibernate, to pass the winter in seclusion or sleep.

host, the individual furnishing food to a parasite.

humeral, situated on or near a *humerus* or anterior corner of the thorax or wing-cover.

hyaline, transparent with a greenish tinge.

I.

ilium, small intestine (Fig. 41).

imago, an adult insect.

immaculate, not marked.

incrassate, thickened; swollen at some particular point.

included, hidden partly or entirely (the opposite of *extruded*).

infra-ocular, below the compound eyes.

infumate, clouded slightly with brownish-black; shaded as if with smoke.

infuscated, clouded with brown; darkened with a fuscous shade or cloud.

ingluvies, crop (Fig. 41).

inosculate, to unite.

integument, outer covering; skin.

intercalary vein (Fig. on page 155).

internal, inside.

interspace, space between.

J.

joints, segments; places of union.

L.

labial palpus, (Fig. 26).

labium, lower lip (Fig. 26).

labrum, upper lip (Fig. 22).

lacinia, the cutting portion of the maxilla (Fig. 27).

lamina, a callous plate; a hard, slightly elevated surface.

lanceolate, lance-shaped.

larva, the stage in the existence of an insect following the egg-stage.

lateral, laterally, situated on the side.

lateral lobes of the pronotum, the deflexed portions that cover the sides of thorax.

ligula, superior part of the labium (Fig. 26).

line, one-twelfth of an inch.

linear, very slender.

longitudinal, lengthwise.

lozenge-shaped, rhomb-shaped.

luteous, unmixed yellow; color of clay.

M.

maculate, spotted; marked with spots.

malpighian tubes, (Fig. 41).

mandible, hard and horny jaws (Figs. 22, 25).

marginal, situated on or near the margin.

marginate, with an elevated margin.

marmorate, marbled; veined like marble.

maxilla, (Figs. 22, 27).

maxillary palpi, (Figs. 22, 27).

median, medial, occupying the middle.

mediastine, being in the middle.

membrane, membranous, a thin tissue; consisting of a thin tissue.

mentum (Fig. 26).

mesial, mesially, median; middle; dividing into two equal parts.

mesonotum, the upper or dorsal surface of the mesothorax (Fig. 32).

mesosternum, the under surface of the mesothorax (Fig. 30).

mesothoracic epimerón, (Figs. 30, 31).

mesothoracic episterna, (Figs. 30, 31).

mesothorax, the middle part of the thorax, to which the wing-covers and middle pair of legs are attached (Figs. 30, 31, 32).

metamorphosis, changes an insect undergoes (Figs. 42, 43).

metanotum, the upper or dorsal surface of the metathorax (Fig. 32).

metasternum, the under surface of the metathorax (Fig. 30).

metastethia, metathorax.

metathorax, the posterior part of the thorax, to which the wings and hind pair of legs are attached (Figs. 30, 31, 32).

metastoma, tongue.

metathoracic epimeron, (Fig. 30, 31).

metathoracic episterna, (Fig. 30, 31).

metazona, the posterior part of the pronotum (Fig. on page 156).

millimeter (mm.), the thousandth part of a meter, equal to 0.03937 inch, or nearly $\frac{1}{25}$ inch.

N.

nebulous, clouded; with uneven, cloudy markings.

nerves, the large ribs or veins of wing and wing-covers, extending from the base towards the apex.

nervules, the smaller connecting veins of the wings and wing-covers.

nocturnal, active at night.

nymph, an immature insect active and feeding in the larval and pupal stage.

O.

obconic, conical, with the vertex pointing downward.

oblique, slanting.

oblong, with the transverse diameter much shorter than the longitudinal.

obsolete, no longer functionally active.

obtuse, obtusely, blunt.

ochraceous, brownish-yellow; of the color of ochre.

ocelli, ocellus, the three simple eyes (Fig. 22).

occiput, back part of head (Fig. 40).

œsophagus, passage for food to digestive tract (Figs. 40, 41).

omnivorous, eating everything eatable.

oötheca, a case enclosing eggs (Fig. 51).

opaque, without any lustre; impenetrable by light rays.

orifice, an opening.

oval, egg-shaped.

ovarioles, one of the ovarian tubes or glands of which a composite ovarium may be composed.

ovate, egg-shaped.

oviduct, the passage through which the eggs reach the outside.

ovipositor, the organ for depositing eggs (Fig. 39).

oviposition, the act of laying eggs (Fig. 3).

P.

- pallid, pallescent*, pale or whitish-yellow.
palpi, palpus, articulated and movable organs attached to the maxillæ and mandibles (Fig. 26).
palpiger, a process bearing a palpus (Fig. 26).
pantherine, with markings like those of a panther.
parasite, an animal which grows and lives upon another.
patellar, pertaining to the *patella* or knee-cap.
pectus, the breast or under surface of the thorax.
pellicle, a thin skin or film.
pellucid, transparent; translucent, but not necessarily colorless.
penis, the genitals of the male (Fig. 40).
pentagonal, five-sided.
percurrent, running through the entire length.
piceous, piceus, pitchy; the color of pitch.
pigment, coloring matter.
pilose, having long, sparse hairs.
pit, a pronounced cavity.
plane, a level surface destitute of elevations or depressions.
pleurite, lateral sclerites which connect the tergites to the sternites (Figs. 31, 36).
plicate, having parallel raised lines; plaited or folded.
plumbeous, pale blue-gray, like lead.
podical plates, two plates (Figs. 38, 39).
polygonal, many sided.
post, a prefix meaning behind.
posterior, behind in position.
post-scutellum, (Figs. 28, 32).
prescutum, anterior division of a thorax (Fig. 28).
process, an outgrowth from the body of a sclerite.
pronotum, the shield which covers the front part of the thorax (Fig. 28).
prosternum, the under surface of the thorax (Fig. 30).
prosternal spine, a spine projecting from the underside of the thorax (Figs. 28, 29).
prothorax, the anterior division of the thorax to which the head is joined (Fig. 28).
proventriculus, gizzard (Fig. 41).
proximal, nearest; opposite of *distal*.
prozona, the anterior dorsal part of the pronotum (Fig. page 156).
pubescent, covered with soft, short, and not crowded hair, wool or down.
punctate, punctured; containing numerous small, point-like depressions or *punctures*.
pupa, pupal, the second state of an insect after leaving the egg (Fig. 1, f.).
pulvilli, pulvillus, the little pads between the claws (Fig. 35).
pyloric, relating to the opening from the stomach to the intestine (Fig. 41).
pyriform, pear-shaped.

R.

- radial vein*, (Fig. page 155).
rectum, posterior part of alimentary canal (Fig. 40).
reticulate, with net-like veins or markings.
retrorse, pointing backward.
roseate, rosaceous, rose-red; a pale blood-red.
rudimentary, not sufficiently developed to be of use.
rufous, rufescent, reddish.
rugose, rugosity, rugæ, wrinkled; wrinkles.

S.

- salivary*, relating to saliva; secreting or conveying saliva.
saltatorial, fitted for leaping.
scabrous, covered with small, slight elevations; rough like a file.
scraper, a part of the stridulating organ (Figs. 46, 48).
scrobes, pits or depressions in which are placed the bases of the antennæ.
scutel. um, the third division of a thoracic tergite (Figs. 28, 32).
scutum, the second division of a thoracic tergite (Figs. 28, 32).
sebific, fat-secreting.
segment, ring-like division or joint.
semi, a prefix meaning half.
serrate, saw-toothed.
serrations, teeth like a saw.
serrulate, finely serrate; having minute serrations.
setaceous, bristle-shaped.
shrilling organs, (Fig. 48).
sinuate, indented; cut into a series of deep sinuses with a wavy border.
sinus, a curvilinear indentation, more or less profound; an excavation as if scooped out.
solitary, single.
spatulate, paddle-shaped.
speculum, a mirror-like, transparent, shining surface on the tegmina of male grasshoppers and crickets used as a sounding board (Fig. 45).
spermatheca, a receptacle for semen; the seminal receptacle in the female insect.
spinose, armed with spines.
spinulose, furnished with *spinules* or diminutive spines.
spiracle, an external opening of the respiratory system.
spurs, the strong spine at the apex of the tibiæ.
squamæform, shaped like a scale.
sternal plate, the ventral plate of a body segment.
sternum, the ventral part of a body segment.
stipes, the second joint of the maxilla (Fig. 27).
stridulate, to make a shrill sound; to grate, scrape or creak with the stridulating organs.
style, a small non-articulated process near base of abdomen.

styliform, shaped like a style.

sub, a prefix meaning nearly; almost; somewhat; under, etc. It signifies either that the term is not exactly applicable in its strict sense and that it must be understood with some latitude, or that the object described occupies an inferior position, i. e. lower than some other object.

sub-costal vein, (Fig. 33).

sub-median vein, (Fig. 33).

subulate, awl-shaped.

sulcate, grooved; furrowed; marked with broad, concave, parallel lines.

sulcus, a linear groove or channel; a groove-like excavation.

supra, a prefix meaning above.

suture, a seam or impressed line; generally used in reference to the junction of two pieces or plates.

T.

tarsus, tarsi, (tarſal), the jointed foot (Figs. 21, 35).

tectiform, ridged in the middle and sloping down on each side.

tegmina, the elytra, fore wings, upper wings or wing-covers (Fig. 33).

tegument, any natural covering or envelope.

tempora, temples; the sides of the head just in front of the eyes.

tergite (tergum), the dorsal part of a body segment (Fig. 36).

testaceous, dull yellowish-brown; tile or brick colored.

testes, glands secreting seminal fluids (Fig. 40).

tetramerous, having four joints as the tarsus of some insects.

thorax, the part of the body of an insect to which are fastened wings and legs (Fig. 21).

tibia, tibiæ, the part of the leg between the thigh and the foot (Figs. 21, 35).

trachea, tracheæ, air-tubes.

translucent, transmitting very little light.

transparent, transmitting light.

transverse, crosswise.

tricarinate, having three keels or carinæ.

triquetral, with three flat sides.

trochanter, the second joint of the leg (Fig. 35).

truncate, cut off square at the tip.

tubercle, a little solid pimple or excrescence.

tuberculate, covered with tubercles.

tumid, tumescent, slightly inflated.

tympanum, the membrane closing the ear (Fig. 37).

U.

unarmed, without a spine.

uniarticulate, having but one joint; single-jointed.

ungues, the curved hooks terminating the tarsus (Fig. 35).

ulnar vein, (Fig. on page 155).

V.

- vagina*, a sheath-like plate enclosing an organ.
valgate, enlarged at the bottom; club-footed.
valves, four horny appendages forming the ovipositor (Figs. 2, 39).
vein, nerves; ribs of a wing (Figs. 33, 34).
veinlets, nervules; very small cross-veins of the wings.
vena radialis, (Fig. on page 155).
venation, method of distribution of veins (Figs. 33, 34).
venter, the inferior portion of the abdomen composed of sternites.
ventral, pertaining to the under surface of the abdomen.
ventriculus, stomach (Fig. 41).
vertex, the front portion of the upper surface of the head between and in front of the eyes (Fig. 40).
viscid, covered with a slimy, sticky, or greasy matter.
vieta, a band; a streak or stripe, of color or texture; a fascia.

W.

- wing-covers*, front wings; elytry; tegmina (Fig. 33).
wing-pads, undeveloped wings as in the pupa or nymph.

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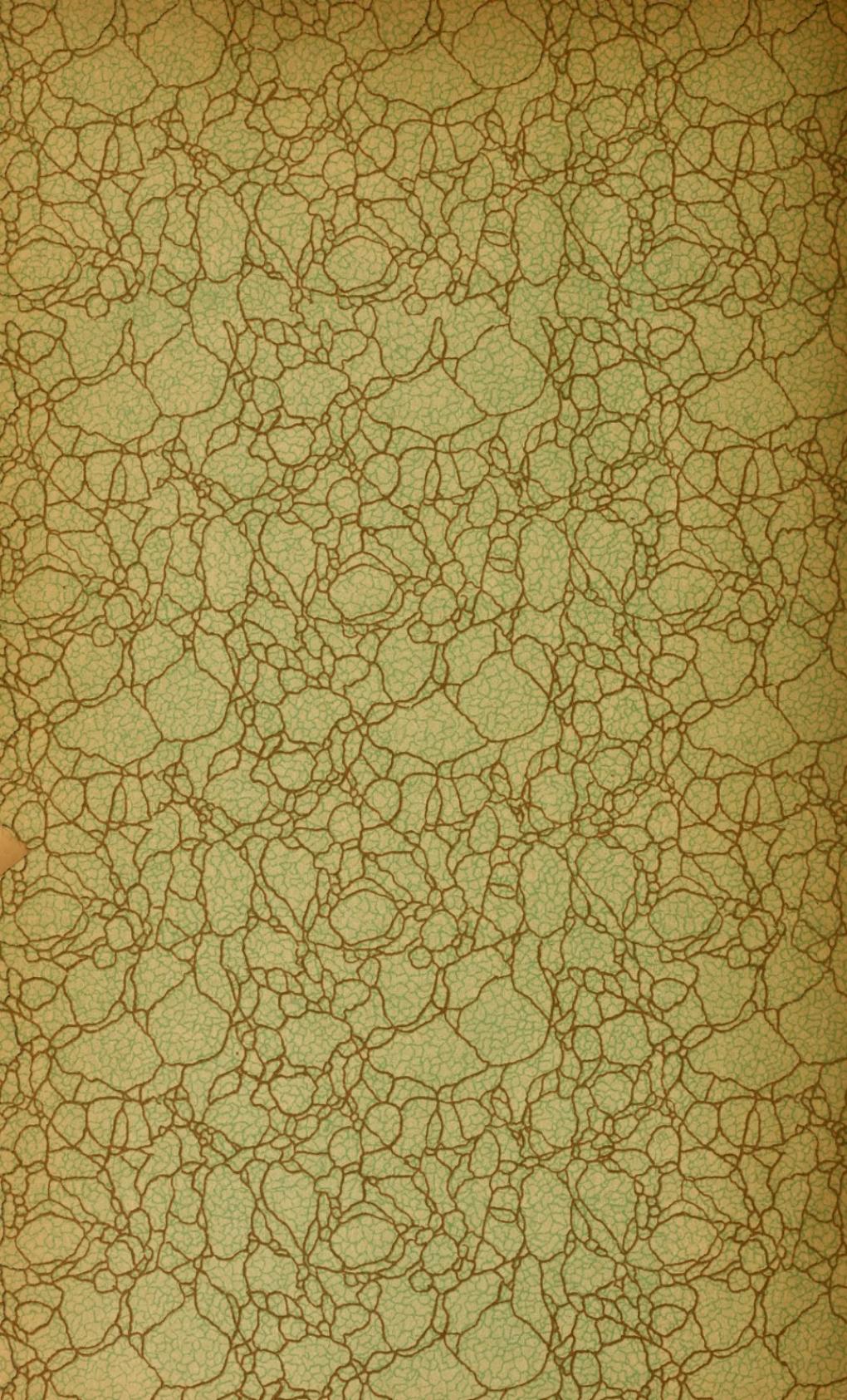
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