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THE LOCUSTS OF BRITISH COLUMBIA.

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LOCUSTS or grasshoppers from an early date have been known to cause great losses to cultivated crops and to the native grasses in North America. The Rocky Mountain locust (**Melanoplus spretus**), which periodically appeared in dense clouds, flying from the breeding-grounds on the dry mountain-slopes to the lower lands in the valleys, was particularly feared by the early settlers. Arriving suddenly in a dense swarm, they would descend upon the cultivated portions of the valleys, and moving forward would leave the ground behind them completely cleared of vegetation, causing great losses. In Canada the Rocky Mountain locust is said to have been responsible for the great damage done during the severe locust outbreaks of 1868, 1870, 1872, and 1874. Since then, however, it has not occurred alone in sufficient numbers to do very serious damage. Its place, however, has been taken by several species, most of which are not migratory in their habits, but periodically become very numerous and destroy the crops in the neighbourhood of their breeding-grounds. As these species are often distributed over a large area, a sudden increase in their numbers will cause the destruction of crops and range grasses over that area, often resulting in an outbreak covering large tracts of land.

With the exception of **Camnula pellucida,** which belongs to the subfamily **Œdipodinæ,** the other species chiefly responsible for outbreaks in Canada belong to the subfamily **Acridinæ** and to the genus **Melanoplus**; these are: **M. atlanis, M. affinis, M. femur-rubrum, M. bivittatus, M. packardii,** and **M. spretus.** Species of other genera, and in some cases other families, have been recorded as present during outbreaks, but not in sufficient numbers to be of much importance.

The following brief outline of locust outbreaks in Canada is compiled from the reports of the Dominion Entomologist: In the years 1868, 1870, 1872, and 1874 serious locust depredations occurred in the Prairie Provinces, the Rocky Mountain locust (**M. spretus**) being chiefly responsible for the damage done. In 1893 the common red-legged locust (**M. femur-rubrum**) became very abundant in the Provinces of Ontario and Quebec. In 1894 a heavy outbreak of the lesser migratory locust (**M. atlanis**) caused great damage on Sable Island. In Ontario and Quebec the locusts continued to increase and in 1895 and again in 1896 caused great damage in these

Provinces, the species chiefly responsible being **M. atlanis, M. femur-rubrum,** and **M. bivittatus.** During these two years (1895 and 1896) these three species mentioned above were reported as injurious to crops and range grasses in several parts of Canada, especially where droughts prevailed. In 1896 the climax of this outbreak in Ontario and Quebec was apparently reached, for in 1897 these Provinces were comparatively free from locusts, the notable absence of locusts being probably due to the great abundance of their parasites in 1896. In 1898 a bad outbreak occurred in Manitoba, and this outbreak lasted until 1903. The commencement of this outbreak in Manitoba was important on account of the fact that in this year the Rocky Mountain locust (**M. spretus**), not an important species as regards damage done in Canada since the outbreak of 1868-1874, where it alone was responsible for most of the damage, was again the chief destructive specie. Three other species were recorded as present in lesser numbers—namely, **M. atlanis, M. minor,** and **Camnula pellucida.** In 1900 this outbreak in Manitoba was still serious; **M. spretus** was, however, not so much in evidence, but **M. packardii,** with **M. atlanis** and **Camnula pellucida,** were the chief destructive species. During the years 1901 and 1902 the Manitoba outbreak continued, but was controlled locally by the use of poisoned bran-mash. At this time **M. atlanis** was the chief species present; **M. spretus** and **M. packardii** were on the decrease, **M. bivittatus** and **Camnula pellucida** taking their places. In 1903 the same species as in the past three years were again numerous in Manitoba, but this appeared to be their final year in this particular outbreak, for in 1904, 1905, and 1906 no serious damage from locusts was reported. In 1909 and 1910 parts of Manitoba and Ontario and Quebec were again injured by locusts. In 1914 and 1915 Ontario suffered badly from the ravages of **M. atlanis** and **Camnula pellucida.** During the year 1916 no serious locust damage was reported.

Locust Outbreaks in B.C.

The accounts of these outbreaks are taken from the reports of the Dominion Entomologist, except that in the account of the 1914 outbreak in the Nicola Valley the report of Mr. R. C. Treherne, Field Officer, Dominion Entomological Branch, was the chief source of my information, and in 1919 I was able to visit the outbreaks myself. The earliest record of locust-injury in British Columbia contained in these reports is in 1890, where locusts are reported to have "caused complete havoc in the Nicola Valley. In 1895 **Camnula pellucida** was extremely abundant and destructive between Vernon and Kelowna."

The next outbreak we hear of in British Columbia is in 1898 in the Nicola Valley, and in a letter from Mr. Pooley to the Dominion Entomologist of September 7th, 1898, he says: "Injury done by the hoppers was principally to the ranges and bunch-grass pasture-fields; also considerable injury to the oats, by their eating off the small stem which connects the grain with the straw, and consequently all the oats were lodged on the ground. Injury to wheat, not any; peas scarcely perceptible. This is the second time the grasshoppers have appeared in our valley. The first time

(which was in 1890) they made complete havoc, and unless something happens to destroy the eggs before hatching it will be very little use putting in a crop next spring. The eggs are deposited on sandy and gravelly hills (about an inch below the surface). Some of the eggs seem to have become dried, but the majority are quite fertile. Nearly all the grasshoppers have disappeared and a great many have died."

Mr. S. J. Solomon, in a letter to the Dominion Entomologist, says: "Nicola Lake, December 31st.—I could not grow enough feed to keep any quantity of hogs. The grasshoppers were very bad last summer and laid their eggs, so that we are expecting our crops will be all eaten by them next year. I shall put in very little wheat or oats, but principally peas and potatoes, as they do not bother these crops so much.

"The early disappearance of the locusts mentioned by Mr. Pooley would indicate the probable presence of parasitic insects or some fungous or bacterial disease. The most numerous species was **Camnula pellucida,** which is sometimes extremely abundant and destructive in the West. This was the case between Vernon and Kelowna in 1895. The other species present were **Trimerotropis** (probably **cincta**), **Circotettix verruculatus,** and **M. atlanis.**" During the years 1900 and 1901 reports were received by the Dominion Entomologist of considerable damage to crops and range land in British Columbia. In 1900 it was in the Okanagan Valley where most of the damage was done, where **M. atlanis** and **C. pellucida** were numerous and attacked grain-crops and bunch-grass pasture lands.

In the following year, 1901, the locusts had increased in numbers and were doing considerable damage in several parts of the Province. **M. atlanis** damaged the foliage of fruit-trees and forage-crops on the Coldstream Ranch at Vernon. The Nicola Valley was another district which was badly damaged in 1901, and the range country between Nicola and Kamloops showed many instances of their destructiveness. Throughout this district the grasses on the ranges were severely damaged and the foliage of trees and shrubs in the gullies was attacked. Where cultivated crops occurred, grain-crops, turnips, and garden produce was destroyed by them. The locusts responsible for this destruction in the Nicola-Kamloops region were **Camnula pellucida** and **M. affinis** the former doing the most damage. Locusts were again noticed in numbers in the Okanagan Valley in 1903, and although no serious damage was reported, there was considerable anxiety felt by the ranchers in this region lest there be a repetition of the outbreaks of 1900-1901. The grey-spotted blister-beetle (**Epicauta maculata**) was abundant in 1903, feeding on wild plants, and as this insect is predaceous on the locust it was no doubt partly due to its presence that the locusts did not increase in the Okanagan Valley. The locust **Camnula pellucida** was fairly numerous in parts of the Dry Belt in 1904 and again in 1907, in which year it did considerable damage, but from this date until 1914 no serious outbreaks of locusts were reported from the Province.

In 1914 the locusts were again present in destructive numbers and young orchards of apple and pear trees were damaged in the Okanagan Valley by **M. atlanis.** The Nicola Valley was again attacked by locusts,

M. affinis being the most numerous species present. An investigation of the conditions was made by Mr. R. C. Treherne at the request of the Dominion Entomologist and Provincial Government Forestry Branch, and extracts from his report are given below:—

"It was reported from the Department at Ottawa that close upon 200,000 acres of bunch-grass had been laid waste during the summer of 1914 in the Nicola Valley owing to the outbreak of the locust **M. affinis.** The attacks from this insect had been increasing during the last three or four years. Mr. Cleasby, of Coutlee, near Merritt, Secretary of the Nicola Stock-breeders' Association, said 'that in his recollection the years surrounding the periods of 1898, 1907, and the past summer of 1914 were the most serious cases on record.' I gathered from Mr. Ward, of the Douglas Lake Cattle Company, that the locusts began around the Minnie Lake District, a point 25 miles south of Quilchena, and passed through, investing Quilchena to the west and Douglas Lake to the east, going north nearly to Stump Lake. This area approximately involved land 40 miles by 20 miles and was the centre of the outbreak, while outlying points such as Merritt suffered to a lesser degree. On the afternoon of November 6th I made a detour of the hills on foot around the house and buildings at Quilchena. On one small hill immediately behind the house I found innumerable eggs. I took an area 3 feet by 1 foot and carefully sifted over the soil by means of a hand-trowel. I should judge that between 300 and 400 eggs existed to the square foot of soil, 3 inches deep. Eleven predatory larvæ were taken in the area 3 feet by 1 foot; thus approximately four predatory larvæ demolish 300 eggs. The hill in question was just a slight rise off the general level of the land, dry, practically devoid of vegetation, and the soil mostly clay, but very plentifully mixed with loose rock and fine shaly stones. The greatest number of eggs were found at the summit of the hill, but eggs could be found easily on the sides and at the base of the hill. On the open slopes and level places eggs could be found here and there, but were scattered and not together in restricted areas, which was the case on slightly rising ground and hill-tops where the soil was gravelly or clay well mixed with small stones, etc. Larvæ of predatory beetles were found freely where eggs were thickest, while with the isolated clusters no beetle larvæ were found. Mr. Guichon, of Quilchena, said that, of course, locusts were with them every year, but that for the years surrounding 1889, 1898, 1907, and 1914, and for approximately three years surrounding these dates locusts did a great deal of damage. Probably the 1889 outbreak was the most serious.

"In 1919 locust outbreaks occurred in four widely separated points in British Columbia. The first outbreak reported was between Bridesville and Rock Creek, in the Boundary country, where a large swarm of **Camnula pellucida** which had been working north through Washington State since 1914 crossed the Canadian boundary in this section. Considerable damage was done to the grain-crops. An active campaign, however, was started in Washington in 1918 and continued in 1919, and the Canadian farmers

were enabled to obtain the poison-bran bait for distribution from the Washington authorities, with the result that this outbreak is, we believe, definitely checked. The next report was from Celista, on the Shuswap Lake. In this locality there was a clearing in the bush of 400 acres, and a large swarm of **Melanoplus atlanis** had been devouring everything that the settlers planted during the last three years. This year they were again bad, and when I visited the clearing in the middle of August I found that they had made a clear sweep of the vegetation in the clearing and were moving off into the bush on all sides in dense swarms. The third outbreak was reported from the Fraser Valley, between Huntingdon and Clayburn, where **Melanoplus femur-rubrum** was numerous and was doing some damage to grain and truck crops. The last report was from the Chilcotin District at a point situated 150 miles north of Ashcroft. I was not able to visit this point until the frost had killed all the grasshoppers, but from the remains found I do not think that there is any doubt that **Camnula pellucida** was the species causing the damage. In this district the ranges had been eaten bare by the grasshoppers over an area of several hundred square miles, and was by far the most serious outbreak that has occurred in British Columbia for some years."

CONTROL MEASURES.

Introduction.—There are several methods employed in controlling locusts which vary according to the stage the locusts have reached when the control is to be started. In some cases the eggs may be destroyed by ploughing the breeding-grounds in the fall, and thus exposing the eggs to the frost and enemies, such as birds, mice, etc. The eggs that are turned under by the plough will probably be buried deep enough to prevent the hoppers from reaching the surface in the spring when they hatch. This method is most often successful with the pellucid locust (**Camnula pellucida**), as this species lays its eggs in concentrated areas. With other species this method is often impossible owing to the fact that the eggs are laid in an irregular manner over a large area, and not collected together in certain definite breeding-grounds. In this case other methods have to be relied upon, such as poisoning the young adults or by the use of hopper-dozers and other hopper-catching machines. In the United States, where locust-control has been carried on for many years, a number of poison-bait formulas have been tried out with varying results.

Baits.—From the experiments conducted in Canada it has been found that up to the present time the most successful formula is the Kansas formula, though in some localities where considerable moisture exists in the air during the day, and the bait does not dry out too rapidly, the Criddle mixture has proved equally efficient and less expensive.

The Kansas formula consists of: Bran, 20 lb.; Paris green, 1 lb.; molasses, 2 quarts; oranges or lemons, 3 fruits; water, 3½ gallons.

The Criddle mixture is made by mixing: Horse-manure, 60 parts; Paris green, 1 part; salt, 2 parts.

In the dry climate existing throughout the Dry Belt of British Columbia the Criddle mixture would probably dry up too quickly to prove of much use, as the locusts will not eat it unless it is fairly fresh and moist. The Kansas formula, however, is eaten by them very readily when damp, and they will also continue to eat it dry, but not so readily. The substitution of sawdust in the place of bran has been tried and seems to have proved very successful. It is, however, harder to mix properly, as the sawdust does not absorb water so readily as bran, and in adding water the Paris green is apt to be washed off the sawdust. Some idea may be had of the effect of the poisoned formulas from the fact that in experiments conducted in Ontario and Quebec from 210 to 1,200 dead locusts were counted to the square yard. The count was made four days after the bait was spread, giving an average of 514.2 dead locusts to the square yard.

Preparation.—In mixing the bran-mash the bran and Paris green should be mixed together dry. This is best done by adding the Paris green slowly as the bran is stirred around in a tub or box. In the States, where they have had large areas to treat, the mixing has been done on large cement floors of barns, using shovels to mix the bran and Paris green; or, if done in the open, a good way is to put tarpaulin wagon-covers or canvas sheets on the ground, spread the bran on these in a thin layers, and, after scattering the Paris green over the bran as evenly as possible, roll the ingredients together by lifting the sides of the wagon-cover alternately until they are thoroughly mixed. A tight wagon-box is a good place to mix a few hundred pounds of bait. The molasses and lemon-juice should be added to the water and thoroughly mixed, the rinds of the lemons being chopped up fine and added to the mixture. The lemons may be best cut up by passing them through a mincing-machine. When the liquid materials are well mixed, sprinkle them over the bran as evenly as possible, a watering can being found most useful for large quantities. Care should be taken that the mixture is not made into a sloppy mass, but that each flake of the bran is moistened by the liquid. If the bait is made too wet it will stick together in lumps when spread on the fields.

Distribution.—This should be guarded against, as it is not nearly so efficient as a bait unless evenly distributed in flakes. When distributed in flakes it would be found and eaten by a far larger percentage of the locusts than it would if it were scattered in lumps here and there. Further, the risk of poultry or stock eating it and getting poisoned is obviated. The best time to poison locusts is when they are still immature and have not yet got their wings, the bait being spread broadcast over the areas most frequented by them. This should be done either overnight or early in the morning, so that it will be moist and most readily attract the locusts when they commence to feed in the morning. Where small quantities are to be used it may be broadcasted by hand, but where larger tracts are to be treated it can be most conveniently carried in barrels in a wagon and spread as widely as possible with a trowel or a shingle. In parts of the United States (Montana, Utah) where it was necessary to treat a large

tract of range land the farmers co-operate, and by meeting on a certain day they all help in mixing and spreading the bait. Boilers are used on such occasions to mix the liquids in; the hot water more readily mixing with the molasses and bringing out the full flavour from the chopped-up lemon-rinds. While the liquids are being prepared wagon-covers, sheets, etc., are spread on the ground and the bran and Paris green mixed ready for the liquids to be added. Some mixing is also done in wagon-boxes in the field. Towards evening, when all the mixing has been done and the poison bait put into the wagons, the mixture is spread broadcast by men standing in the back of the wagons. The wagons are lined up so that there would be no ground left uncovered and driven forward in line over the areas previously mapped out, spreading the bait at the same time. Men on horseback are employed to keep the wagons in line, and others to lead them through the places which had previously been located as the most frequented by the locusts.

As night came on the bait kept moist, so that on the next day there were very few locusts throughout the region who did not find and devour a few flakes of bran. In this way a very efficient control was maintained and the cost sustained by the farmers was not great. The ingredients are usually bought in quantity and the results amply justify the time or money spent. The cost of this Kansas mixture as used in Canada in 1915 and 1916 was found to be 21 cents per acre, including all labour, so that it will be seen that the expense is not great for the results obtained. It has been found that from 4 to 5 lb. of this mixture to the acre is sufficient, provided it is properly prepared and distributed as evenly as possible over the ground. A larger quantity per acre or a larger percentage of Paris green will undoubtedly kill more locusts, but the cost is greater, and 4 to 5 lb. properly applied has given a thoroughly satisfactory control. Two applications of this standard formula would certainly give better results than one application of a stronger mixture. As a rule there is no need for more than one or two applications of bran mixture, but cases have been recorded in the United States where a big swarm of locusts on the range lands, having reduced the food on the ranges, move down to the crops in the valleys. In such instances it is necessary to keep a constant supply of the bait spread in a narrow strip along the edge of the range lands adjoining the cultivated crops in the valley. In this way all locusts crossing this control belt would come in contact with the bait and the majority would eat some of it. In spreading poisoned bait in a field it is not necessary to be very particular to cover every yard of ground, as the locusts, being very active insects, with a good sense of smell, will find it. They will come from 15 to 20 yards to bait placed in heaps, which shows that they can detect its presence from some way off. The effect of poison on the locusts is not observed at once, and it is usually from three to four days after they have eaten it before they die. This is with the Kansas formula as given; a stronger percentage of Paris green will act quicker, but is unnecessary, as the locusts eat little, if any at all, once they have the poison in their systems.

Where cultivated crops are being attacked in scattered localities, and not by a general migration from the range lands, it is almost always due to the fact that there are favourable breeding-grounds for the locusts in the immediate vicinity. The places most often chosen for oviposition are compact, firm lands, soft cultivated fields being avoided, as are also damp localities. The favourite places are rough, dry roadsides, dry banks, old dried-out pasture lands, and alfalfa-fields which have become hard and baked owing to the lack of proper attention. In these places the locusts will congregate for oviposition, and it will be from these places that the swarms will migrate to destroy the alfalfa and other cultivated crops in the immediate neighbourhood.

Ploughing.—These fields if they are being used as breeding-grounds should be ploughed up in the fall after the eggs have been deposited. This will break the egg-capsules and bury them, so that very few locusts will hatch out in the spring. If these places cannot be ploughed, a careful watch should be kept on them in the spring, and as soon as the young hoppers are seen to be emerging in large numbers control measures should be started. Poison bait can be scattered, at any rate, along the side of the ground next to the crops. A stream of water in an irrigation-ditch forms an effective barrier to the hoppers while they are small. Once the locusts become full-grown and are winged their control is more difficult. When the locusts are winged they may still be poisoned, but it is done more economically when they are younger and have not spread far from the grounds where they were hatched.

Hopperdozers.—Hopperdozers and hopper-catching machines are used extensively in many parts of the United States for controlling the locusts, both in the immature stages and also when they are winged adults. Hopperdozers were the first form of hopper-catching machines used and were mostly home-made, and naturally varied considerably in structure, but the description of one will serve for them all, as the differences were only in size and material used, and the ultimate results were in most cases equally efficient.

"The hopperdozer consists of a galvanized-iron pan mounted on low runners and having a backstop of canvas or sheet tin. The pan was usually made about 12 feet long by 2 feet wide and about 4 inches deep. The back and ends of the pan have a 2-inch flange, the front a 6-inch flange. This pan is supported back and front by a 2- by 4-inch which is set into the runners at either end, which are made of a 2- by 8-inch and are 4 feet long. The flanges are nailed to this wooden frame. A runner in the centre helps to strengthen the frame and support the pan. The hitch is made direct to the runners. A backstop 30 inches high, with triangular pieces for the ends, made of canvas or tin nailed on a frame, is held in position by allowing cross-pieces of the frame to fit into bow-irons on the back of the pan-frame, and this arrangement allows the backstop to be removed when not in use or if the machine is to be loaded into a wagon for removal from field to field. The pan when in use should have about 2 inches of water in it,

with a coating of coal-oil on the top. A movable frame forming partitions in the pan will greatly aid in keeping the liquid from slopping over too much. With machines of this sort catches of 8 to 10 bushels of hoppers have been collected in less than three hours. When the hoppers are too thick in the pan they may be removed with a tin scoop with holes in it, which will remove the hoppers and allow the water to drain back into the pan. From time to time the pan will want replenishing with water and oil. As this machine is drawn up and down the fields, the hoppers, jumping to avoid it, strike the backstop and fall into the water and oil, and those that succeed in jumping out again die, as the oil on their bodies is apparently fatal to them."

Hopper-catcher.—The most successful machine is the hopper-catching machine, which catches the hoppers alive, and has the advantage that it can be used on steep hillsides and rough ground where a hopperdozer with its pan of water and oil would be impossible, and the hoppers when caught form excellent chicken-food. It is not so easily made as the hopperdozer, but once made is far more economical to use. A description of this machine, which is given below, is taken from Bull No. 138 of the Utah Experimental Station, by E. D. Ball, 1915.

"This machine can be run over hay and grain crops, sugar-beets and potatoes; in fact, over practically everything except corn and ripening grain. The principle of the machine is very simple—a box about 2 feet square and 16 feet long on runners, a 2-foot by 4-inch extending out 4 feet at each end, to which a horse is attached. The horses then travel 24 feet apart, driving the grasshoppers in until most of them are in front of the 16-foot machine. A rope fastened to the hame on the inside of each horse and dragged just in front of the machine causes the hoppers to jump just as the machine gets to them. The front of the machine is made of tin and is about 2½ feet high and slightly curved. This front does not extend quite down to the bottom, and about 2 inches in front of it and about 4 inches high there is a false front, a second piece of tin, which curves back down and into the box. A grasshopper hitting the tin cannot get a foothold and is perfectly helpless and slides down between the two pieces of tin, strikes the curve, and is thrown well back into the box, far enough so that he cannot see the opening through which he entered. The top and back of the box are made of wire mosquito-netting and the hopper immediately jumps towards the light and clings to the netting, never seeking the hole through which he came in. Several bushels can be gathered in this way before they will shake down into the bottom sufficiently to choke up the front opening. As soon as this happens the front opening should be closed with gunny-sacks or similar material, and the hoppers can be shovelled out into sacks and used to feed chickens or dumped into a trench and buried. The material will cost between $8 and $9 and any one with a saw and hammer can make one in a very short time. The runners should be spaced to fit sugar-beet or potato-rows, if the machine is to be used on these crops. A machine if protected will last for years, and as it takes 24

feet at a sweep will cover 40 to 50 acres in a day, and will thus handle a large area. As there is no expense to the operation except a team and a man to drive, or preferably two small boys to ride the horses, the cost per acre is trifling. If the tin front is kept bright and shining the grasshoppers are apparently not able to see it at all and fly against it readily. From 6 to 10 bushels in an hour have been collected with one of these machines where the hoppers were numerous and conditions favourable, and 30 to 40 bushels per day taken from fields where they did not appear to be very abundant.

Other Machines.—Another form of hopper-catching device used in the States, principally against the migratory swarms of the pellucid locust (**Camnula pellucida**), is also described by E. D. Ball in the same bulletin, and as **C. pellucida** is one of the most destructive species which occurs in swarms from time to time in this Province, it may be of interest if I give Mr. Ball's description of the contraption known as the balloon hopper-catcher.

"The balloon consists of a light frame 12 feet long and 2 feet high, with two or three cross-bars to give it more rigidity. This frame has attached to it a bag, of which it forms the mouth and which tapers back to a point about 10 feet back of the frame. The point is open and when in use is fastened with a string tied round it like a sack is tied. In fact, a seamless sack makes a good point to this big bag. The bottom of the bag, which drags on the ground, is often made of heavy canvas, while the upper side is of ordinary sheeting. The frame is usually made of 1-inch by 4-inch stuff and the whole thing is drawn by a single light rope, which forks to the two ends and forks again to each corner. This rope is either fastened to the pommel of a saddle or else to a light whiffletree of a light harness. The pony is started off at a fast trot. The air inflates the open-mouthed sack, which 'balloons' up and draws along the ground, over the meadow-grass or grain-crop. The bottom of the frame draws along on the ground, and as a young hopper jumps to avoid it it slides under him, and as he jumps again and again each time he finds himself farther and farther back in the sack until he comes to rest with his fellows in the tip. The rider of the pony starts off at a good pace, swinging back and forth across the swarm until his sack has a bushel or so of grasshoppers in the apex. Then he dismounts and helps his partner to lift up the frame and shake all the hoppers back into the apex of the sack; then another sack is held over the end, the string untied, and the hoppers sacked. Where the ground is rough the lower side of the frame catches and the top flops over and closes the mouth. To obviate this a rope is fastened to the top of the frame and a small fence-post is drawn along back of the sack, thus serving to pull the top back and keep the mouth open. Practically all the wear comes on the bottom of the sack, so this is made of heavier material, or, better still, a second strip is fastened to the frame and draws underneath the sack and protects it from injury. Old binder-canvas and such material make excellent material for this use."

In dealing with **Camnula pellucida,** which has the habit of congregating in a few concentrated areas for oviposition, although the adults may be scattered over large tracts of land, there are several methods of control which have been practised in the States. The limits of the breeding-grounds must be carefully ascertained during the egg-laying season, and this area may then be ploughed, if ploughing is possible. A trench may, further, be dug around the area, into which the tiny hoppers will fall when they begin to migrate, which they do as soon as hatched, hopping always towards the sun instead of remaining close to their egg-capsules, which is the case with most of the other species. If this trench can be flooded from some irrigation-ditch it will be still more effective. In some cases where the breeding-grounds are flat and hard, rollers have been employed and the ground gone over every two or three days during the period when the hoppers are hatching, as this species hatches in great numbers at one time, usually within a week or ten days. The young hoppers have also been sprayed at this time with oil. This proves a very expensive though effective method. Once the hoppers have left the breeding-grounds and are advancing in swarms they may be caught with the balloon catchers. **Camnula pellucida** is not easy to poison, as it is on the move most of the time, swinging about on their course, although the general tendency is to travel in a south and south-westerly direction following the sun. During these migrations the locusts never turn aside on account of food, and will pass through a field of alfalfa or grain, eating the plants in their course completely off, even eating down to the roots below the level of the ground, but leaving the rest of the field untouched. According to E. D. Ball, "If a swarm comes to a body of water, or even an irrigation-ditch, they will pile up against the bank and stay there for a long time, travelling up and down the bank as the sun swings round, but not turning aside or going back."

This habit of **Camnula pellucida** of travelling in compact swarms and always toward the sun has been observed by many writers in the United States and described in their bulletins. From my limited observations and from accounts given to me by people who have observed **Camnula pellucida** in British Columbia, I do not think that this habit is at all common in this Province. While this species certainly seems to keep together in swarms, more than do the species of **Melanoplus,** and these swarms travel from place to place, the tendency is to travel from the hatching-grounds to lower levels, where the feed is greener, while immature, and to return to the highest hill-tops for oviposition. There is apparently no tendency to travel toward the sun in this Province rather than away from it, the direction of travel being determined mostly by the position of the available food and the slope of the ground.