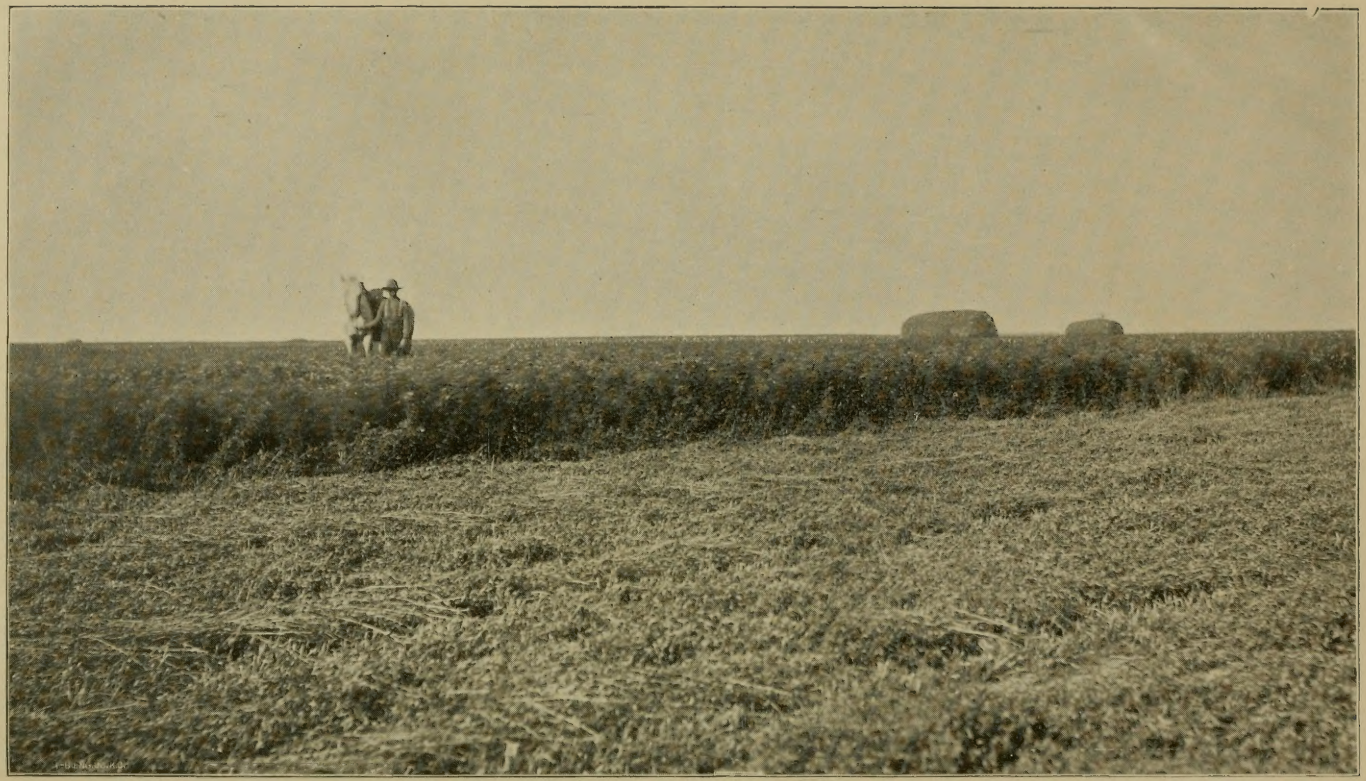
UNIVERSITY OF KANSAS,
LAWRENCE.

BULLETIN
OF THE
DEPARTMENT OF ENTOMOLOGY.

ALFALFA, GRASSHOPPERS, BEES:
THEIR RELATIONSHIP.

BY
S. J. HUNTER.



SECOND CROP OF ALFALFA ON EXPERIMENTAL QUARTER-SECTION IN FORD COUNTY. (Photo by Hunter.) See pp. 51-53.

UNIVERSITY OF KANSAS,

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ALFALFA, GRASSHOPPERS, BEES:

THEIR RELATIONSHIP.

A REPORT OF THE FIELD-WORK OF THE DEPARTMENT OF ENTOMOLOGY, SUMMER OF 1898.

Contribution from Entomological Laboratory.

No. 65.

By S. J HUNTER.

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DEPARTMENT OF ENTOMOLOGY,

UNIVERSITY OF KANSAS.

F. H. SNOW, Ph. D.,
Professor.

S. J. HUNTER, A. M.,
Assistant Professor.

HUGO KAHL,
Curator and Systematic Entomologist.

MISS ELLA WEEKS,
Artist.

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ACKOWLEDGMENTS.

Referring to Part I, my thanks are due Mr. C. E. McClung, of the Department of Zoology, for the sketch from which figure 4 was made and for the paragraphs upon the egg of *Melanoplus differentialis*. Plates I, V, VI, VIII and figure 1 are from photographs taken by the author for this publication. Plate VII and figure 30 are produced from photographs by Mr. Earl Cass, under direction. Figures 2 and 3 are from photographs made to be here used by Mr. F. E. Marcy. Figure 11 is from a photograph taken by Mr. E. S. Tucker in this laboratory. All the other plates and figures are produced from original drawings made by Miss Ella Weeks, under the author's direction. In the execution of this work the zeal and fidelity of the artist is worthy of special mention.

In will be noted from the above that all the illustrations in Part I, both text and plate, have been prepared expressly for this volume from original subject-matter.

Referring to Part II, I am indebted to Prof. W. C. Stevens, of the Department of Botany, for directing the work of the artist, Miss Weeks, in the preparation of figures 3 and 4, and for the use of the photograph, taken by himself, from which figure 7 was made. Plate I is made from four photographs. Plate II is produced from original drawings made by Miss Weeks, under direction. Plate III is from a drawing made after Cheshire. Plate IV—figures 5 and 6 are from photographs made by Mr. F. E. Marcy, under the immediate direction of the author. Figures 1 and 2 show in the explanations where taken from; they were kindly loaned by Chas. Dadant & Son. Figures 8 to 29, inclusive, are from photographs taken under the author's direction and with the coöperation of Mr. A. H. Duff. There should have appeared in the explanation after each figure the word "(Original)."

With the exception of plate III and figures 1 and 2, the illustrations were especially prepared for this publication from original drawings and photographs.

PREFACE.

IF the products of the season's labor are damaged by an insect foe, the cause of its appearance can be ascertained and means of prevention made prominent factors in subsequent calculations. While the insect tribe contains some foes, it has among its members many insect friends. The grain producer and fruit-grower will do well to cultivate their acquaintance.

It is with the desire that intelligent action may be directed against one of our aggressive herbiverous insects, and a more intimate acquaintance formed with our melliferous insect friend, that this publication is sent forth. Paradoxical as it may seem, the former insect when properly dealt with proves a blessing in disguise. The latter calls upon the alfalfa blossom for its nectar to enrich our table, and by its visit increases the seed crop twofold.

It is expected that experiments begun one year ago and continued this summer will be carried on during the coming season, and information upon operation and results will be given at a later date to those interested.

In the preparation of this work I am indebted to Chancellor F. H. SNOW and Dr. S. W. WILLISTON for valuable suggestions.

During the field-work, a report of which this is, an expression of my appreciation is due Supts. G. W. WATSON and J. H. SMART, of the firm of BALL & GODDARD, Kinsley, and Co. Treas. C. H. HUMPHREY and Hon. THOMAS H. FORD, of Syracuse, for valuable assistance.

In behalf of this department, grateful acknowledgment is made to the Atchison, Topeka & Santa Fe, Chicago, Rock Island & Pacific, Union Pacific and Missouri Pacific Railway Companies for material coöperation.

Part I.

ALFALFA AND GRASSHOPPERS.

INTRODUCTION.

THE culture of alfalfa has reached such proportions in Kansas that those directly interested are devoting their energies toward making the returns as large as possible. Farmers in some parts of this state are counting their alfalfa fields by the section plats. Whenever such areas are devoted to one particular plant the course of natural events is changed. Nature intends that there shall be an equal distribution of plant life and animal life. Wherever one plant predominates those forms of animal life which thrive best upon it as a food-plant increase in undue proportion. This has been the case with the chinch-bug and wheat, the corn-root worm and corn; each have thriven amidst superabundance of their favorite food-plant.

That the relation between alfalfa and insect life might be more fully understood, the writer was called upon to visit Edwards county last fall. He then made note of the conditions, and published, in connection with Professor Snow, a report giving methods of cultivation that would eliminate objectionable insects from alfalfa lands. He was asked to continue these studies at the beginning of this year again, and, with the proffered coöperation of those interested, to conduct such investigations and experiments as he saw fit in the alfalfa regions. In acceptance of that request, believing that the best laboratory was the field, the writer went into camp fifteen miles southwest of Kinsley, on the line between Edwards and Ford counties, with tent and full laboratory equipments, prepared to study the entomological conditions of that region with special reference to the alfalfa plant.

My first work might be termed a general survey of the territory adjoining the camp. Accordingly, in company with Supt. J. H. Smart, I drove over the alfalfa-producing region of Edwards and Ford counties, and obtained a general knowledge of the situation. I was soon struck with the prevalence of one species of grasshopper, and also the possibilities of bee-keeping in this region, an injurious and a beneficial phase of entomological research. To these two subjects I determined to devote my undivided attention, to the exclusion of all others.

While at work here invitations came to visit Finney and Hamilton counties, where grasshoppers were making inroads upon the growing

crops. Accordingly, upon the 18th of July I reached Syracuse, in Hamilton county, and visited agricultural regions where grasshoppers were at work. Upon the 20th and 21st I investigated affected fields on the north, east and west of Garden City. I returned to my camp upon the 22d. Being convinced that the damage by the grasshoppers was due to the prevalence of one species, I concluded to devote my attention to the life-history and habits of this one. Accordingly, observations were largely confined to this one species. The camp was maintained in Edwards county until this form had reached the adult stage, when, having already received reports of flights of grasshoppers on the western line of the state, and also of the prevalence of grasshoppers in certain localities, I determined to make a survey of all this region, to ascertain the numbers present and causes governing their presence, and also to visit the beekeepers of this region and make such observations upon the actions of their bees toward alfalfa as might seem practicable.

Accordingly I left camp for Syracuse, and from Syracuse by team drove north through Hamilton, Greeley and Wallace counties to Sharon Springs; from Sharon Springs by rail to Oakley, where conditions were noted, and from Oakley by slow train to Colby. Conditions were again noted from Colby to Goodland. Reports had reached me from this point of the prevalence of grasshoppers on the tracks. Here, I made special examinations of the cow-catchers of engines entering the roundhouse to ascertain the species of grasshoppers caught along the track. Upon leaving Goodland I was given the opportunity to occupy a favorable position where flights of grasshoppers rising in front of the engine could be easily noted. This observation was continued as far as Norton. At Norton, the agricultural regions were visited, and the existing state of affairs noted. This survey covered eleven of the twenty-four counties west of the 100th meridian, and two east of this meridian.

The pages which follow contain the practical results of the observations made, extending over a period from July 5 to September 4, as well as a fully illustrated summary of the experiments conducted with the coöperation of the farmers during the past year. The hearty manner with which all interested have entered into this work, and the many opinions expressed concerning the favorable results, cause me to believe that the work has not been in vain. Since my return numerous inquiries have been received, examples of which are herewith given:

VERA, KAN., August 27, 1898.

MY DEAR SIR: I read with much interest the article in the Kansas City *Star* of August 19, 1898, about your experimenting with alfalfa by disk harrowing, etc. I have quite an acreage of alfalfa that has not done very well this year owing to the wet weather, with perhaps other causes, and the crab-grass and sand-

burs have come in badly. I would like the benefit of your experience as to what is best to do: but let me state first, there is a good deal of alfalfa on the field. Now please advise me whether it is best to plow up the field this fall and sow in the spring, or wait until spring and rake off all the dead crab-grass, etc., and disk harrow the fields, sowing where it is needed, or, after the heavy frosts of October, this year, will it be advisable to burn off the crab-grass? If that were done the alfalfa left might winter-kill. Is there any probability that the disk harrow will cut the crown off the alfalfa and kill it; did it kill any in your experiments? Would it be advisable to disk harrow the ground in June after the first crop has been cut off? How much of an angle do you set the wheels of the harrow when doing the work? If you will kindly give me the benefit of your experience in the matter, you will greatly oblige me. Very truly yours,

ALBERT F. THAYER.

LEROY, KAN., October 21, 1898.

DEAR SIR: I notice in the *Capital* that you advise farmers to disk and cross-disk alfalfa fields to rid them of grasshoppers. I have four small fields of alfalfa, sown in 1895, 1896, 1897, and 1898; the grasshoppers are stripping them in spots. I am afraid to use the disk without some instructions. Is there any danger of setting a sharp disk at such an angle as to cut off the alfalfa roots and kill the plant, or is there any danger of disking too deep? Hoping you will be kind enough to give me some light on this subject, I am,

Very truly yours, JOHN H. SILSBY.

P. S.—How old must the plants be before it is safe to use the disk on them?

ST. JOSEPH, MO.

DEAR SIR: I have over 500 acres in alfalfa [in Norton county, Kansas,] and intend raising that number of acres as soon as I get the ground in order. Some of this alfalfa is over six years old and some was put out as late as last spring. I believe that the oldest of my alfalfa yields the most, and I think that it takes at least three years before a full crop can be harvested. The grasshoppers favor alfalfa fields on account of the tenderness of the plant, which grows so fast during the season. They certainly prefer alfalfa to corn and other cereals, and only leave alfalfa fields when they are destroyed, and then take to the corn-fields or whatever other cereals adjoin the alfalfa fields. I believe the conditions concerning alfalfa appear to be conducive to the multiplication of grasshoppers, as they generally lay their eggs there before leaving. I would like to have you advise me what headway has been made toward destroying the pest when it is small, and if you know any implement or tool made for that purpose, or have any idea to present, I will gladly receive it, as I am anxious to save the second and third crops of alfalfa. They do not bother the first crop, as it is generally ready to cut before the grasshoppers do any damage. Kindly let me hear from you at your earliest convenience, and oblige, Yours truly, A. J. BRUNSWIG.

That these and many other letters might be clearly answered, and those concerned be informed more fully upon benefits not yet enjoyed from alfalfa, this publication is sent forth.

It has been deemed convenient and wise to present the subject in two parts; the first will treat of alfalfa and grasshoppers, the second of alfalfa and bees. It is highly gratifying to state that the conclusions of Part I show that the best methods of alfalfa culture are those

which are the most conducive to the prevention of grasshoppers, and that the deductions of Part II show that while alfalfa is one of the first of our forage plants, its choicest product is not to be found in the hay-rack, but upon the farmer's table, carried thither by the busy bee.

S. J. H.

JANUARY 9, 1899.

GRASSHOPPERS IN GENERAL.

IN the minds of some there exists an opinion that among states Kansas alone has suffered most, is most subject to injury from grasshoppers, that these grasshoppers are migratory, that there is no means of checking them—hence, they are a necessary evil, and the less said about them the better.

For the benefit of such, as well as for general information, it may be well to give the situation as it is. Since the Rocky Mountain Locust is the most renowned, we have placed in brief form, as taken from Riley, Bruner, Packard, and others, the data following, showing number of annual visitations the Rocky Mountain Locust has made, and the states which these locusts visited. These insects doubtless occurred frequently prior to dates given, but no records were retained, since these regions were at that time uninhabited by record-keeping people. The record from 1866 is full; the completeness of the record from 1866 is due, not necessarily to greater prevalence of the locust, but to better facilities for securing such data.

I have placed after each state here named the number of annual appearances of the Rocky Mountain Locust within the twenty-eight years between 1851 and 1878. Before 1851 we have no authentic records, and since 1878 this locust has committed little damage in this state. For this reason this period has been chosen.

Number of annual visitations of the Rocky Mountain Locust to states named, during the period 1851–1878:

Arkansas, 2.	Kansas, 14.	New Mexico, 3.
British N. America, 10.	Minnesota, 18.	Texas, 15.
Colorado, 12.	Missouri, 8.	Utah, 26.
Dakota, 17.	Montana, 18.	Washington, } 4.
Idaho, 5.	Nebraska, 13.	Oregon, }
Indian Territory, 5.	Nevada, 4.	Wyoming, 10.
Iowa, 15.		

While Kansas has been free from the attacks of these insects since 1878, it has not been so with some of the other states named, notably Minnesota, where, in 1891, the crops of several counties were completely taken by this locust. From a glance at the list, it can be seen that, up to 1878, seven states had a greater number of visitations from this locust than Kansas. Further, it may be well to note that there were only three seasons in Kansas when this grasshopper's damages

were severe or general. To these facts add the statement that other states have been visited since the migratory grasshoppers made their last pilgrimage to Kansas, and it can be readily seen that Kansas by no means stands first nor second, but stands eighth in rank as host for this far-famed locust.

This list does not take into account the presence of native grasshoppers. These have made their appearance at times in destructive numbers in all of the territory named in this table. Not only over this western territory, but the New England states as well have suffered from the voracious appetites of resident locusts. Grasshoppers are spoken of historically in the East; they can be made "past tenses" in Kansas. The purpose of this article is not to treat of the migratory locusts, but those which flourish and die in the vicinity of their birthplace.

Grasshoppers belong to the order of insects known as Orthoptera, or straight-winged insects, such as the cricket, katydid, and praying horse. This order is divided into several families, of which the Acrididæ or grasshoppers form one. Since the subdivisions or subfamilies are classed according to habits as well as structure, it might be well to mention them briefly, so that the casual observer may know from the insect in hand whether or not it is a highly injurious form.

One group, found more generally in low and marshy land, is characterized by a very receding front, forming a sharp angle at vertex of the head. This subfamily, *Tryxalinæ*, is not abundant enough to cause serious damage.

Common along the sides of roads and field is a dusky grasshopper, showing as it flies a dark hind wing with white border. Frequently it pauses in the air, flitting its wings before alighting. This is the Carolina Locust (*Dissosteira carolina*), or "dust-hopper," so called from its fondness for roadsides and dusty places. This familiar insect belongs to the subfamily *Œdipodinæ*, a group characterized by rough prominent ridge on crest of prothorax, the hood-shaped part immediately behind the head. While these are injurious at times, they do not, in this country, possess migratory instinct to any great extent.

The next group, the *Acridiinæ*, contains our most injurious forms. The prothorax is usually smooth on top, the breast between front legs usually extended into a tubercle. To this group belong those grasshoppers that migrate, and those that thrive well on cultivated crops in the locality of birth.

NATIVE GRASSHOPPERS IN KANSAS.

The native grasshopper has made himself felt in Kansas, and is liable to do so again unless he becomes the subject of intelligent attack. In a trip for observation, Professor Osborne, in 1891, reported these grasshoppers as causing considerable damage to crops along the Arkansas valley, in the western part of this state. Since that time larger areas of cultivated ground have furnished more food and the possibility of a greater production of resident locusts. This matter was brought directly to the notice of the writer, by letters received in August and September, 1897, from Supt. Geo. W. Watson, of the land department of the Alfalfa, Irrigation and Land Company, Kinsley, Kan. These letters were referred to us by Mr. F. D. Coburn, secretary state board of agriculture. From the nature of this correspondence, it was thought advisable to visit that locality, to obtain, in detail, existing conditions. Upon returning, a report was issued, by Professor Snow and myself, an extract from which I herewith give, to show the state of affairs:

On the morning of the 30th, Mr. R. E. Edwards, president of the Kinsley Bank, took us to a large tract of alfalfa southwest of Kinsley. There are about 400 acres of alfalfa in this piece, all the property of Mr. Edwards. Here we found a few of the Rocky Mountain Locust,* but many more of what is known as the Differential Locust, or *Melanoplus differentialis.* The farmers speak of them as "those big yellow fellows." Mr. Edwards stated that the grasshoppers had not been so injurious in that tract as farther west. Yet wherever the alfalfa was young and tender from recent sowing nothing appeared above ground but stubble. Where the plants were older and tougher, the damage was not so noticeable. In the afternoon and the next forenoon we visited a number of alfalfa fields, and found conditions much the same as upon the first day.

In the afternoon of the 30th, Hon. A. C. Dyer, county attorney for Edwards county, took us to a locality west of Kinsley where the damage had been great. Here the small Rocky Mountain Locust† was more abundant, with a goodly number of the Two-striped, *Melanoplus bivitattus*, but, as before, the Differential Locust was by far the more abundant. Adjacent to one piece of alfalfa there had been a piece of corn which they entered after the alfalfa had been cut and completely stripped it, killing it before tassels had appeared.

It was not, however, for the purpose of observing the amount of damage done that the visit was made so much as to note existing conditions. These will be discussed farther on under the head of "Alfalfa and the Grasshoppers." Here we will say that everywhere we were glad to observe that of the Differential Locust (*M. differentialis*) there were apparently as many dead as alive to be seen. Natural enemies were at work, but too late to be of any assistance in preserving this year's crop, though certainly of benefit in curtailing the number of eggs which

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*This was in accordance with a determination made for us. Specimens afterward sent by request to Mr. W. D. Hunter, Nebraska State University, were correctly determined as the Lesser Migratory Locust, *Melanoplus atlanis.*

†These were afterward determined by Dr. Hough as *Sarcophaga cimbicis* Town.

would hatch to destroy next year's growth. In many cases the cause for death was apparently the work of a fly which deposits its eggs upon the back of the grasshopper. The larvæ—small, whitish, worm-like creatures, or maggots—soon find their way into the interior of the grasshopper and produce the death of the insect. These larvæ were found in a number of the specimens taken, and later two of them changed in the laboratory to adults. They proved to be flesh-flies (*Sarcophaga* sp.) Many of the 'hoppers had been deprived of one or both wings—the work of the locust mite.

As previously stated, by the request and with the coöperation of a number of the leading alfalfa growers of this locality I resumed my investigations upon this subject on the 5th of July. That the situation may be more clearly understood, it is probably better to give by counties the conditions existing in the territory studied:

Edwards County.—In the immediate vicinity of Kinsley no great damage was done. A drive over the greater part of Edwards county, in company with Superintendent Smart, showed the greatest damage to be about fifteen miles southwest of Kinsley. Here large areas of alfalfa are grown. There were 3000 acres in one tract in the immediate vicinity of my camp. The first crop of alfalfa was being cut, and by this time the wingless nymphs were moving into adjacent cornfields. The numbers were by no means general over the entire quarter-sections of alfalfa, but appeared to be very thick in spots. Lying on the south of one quarter-section which was being cut was about thirty acres of good corn just beginning to tassel. Insects moved into this, and instead of eating the leaves they ascended the stalks and ate the tender young tassels. In some cases where the ear of corn was shooting they devoured that before attacking the leaves. They did not seem to work rapidly, but within two weeks had prevented an ear of corn from forming upon that piece of land. Upon another larger piece of corn directly east of this, they entered at one corner and stripped that corner in the shape of a triangle including about ten acres. In Edwards county, I had not observed nor did I hear of damage being done to oats, wheat, or barley. Four quarter-sections of alfalfa in that locality, having a rather thin stand, were kept stripped throughout the season, so that at no time was the forage worth the cutting. In the midst of these was where experiments were conducted last winter, of which extended mention will be made in this report. And here also practical applications of the "hopper-dozer" were conducted, concerning which discussions and descriptions will appear later in this report. Mulberry trees and other fruit-trees in the vicinity of the alfalfa fields were, after the first cutting of the alfalfa, entirely stripped of their leaves. Weeds such as the sunflower and lamb's-quarters were denuded, leaving only the bare, white, stripped stalks standing.

FORD COUNTY.—In Ford county the conditions were much the same as in Edwards county. Damage was local. In one field there would be large numbers of grasshoppers and in other fields near by there would not be an unusual number. An examination of the species doing the damage showed that the one which by its numbers was the cause of a great part of the injury was the yellow grasshopper,* *Melanoplus differentialis.* There was also present the Two-striped Locust, *Melanoplus bivitattus.* When I first entered the county this Two-striped Locust was everywhere in the adult stage. While upon the first day of my investigations I did not see more than half a dozen adult individuals of the yellow locust. At different times during my investigations I tried to ascertain the relative numbers of these two species, by catching grasshoppers just as they came, and concluded that there were about twenty-five yellow locusts for every one of the Two-striped Locust. More will be said in another place concerning the different species in cultivated grounds and adjoining pastures.

FINNEY COUNTY.—By request, I went to Finney county to make an investigation of the condition there. In company with Mr. C. S. Hambleton, of Garden City, I drove first west of Garden City, to the ranch of Mr. John A. Stevens, where on the north side of the road was a fine alfalfa field, bringing forth its second crop, while on the other side of the road was another alfalfa field whose first crop was being stripped by the native grasshoppers. About two miles farther west we came to a large apple, peach and plum orchard on the north side of the road. The apples were on the north boundary of the orchard, the peaches in the middle, and the plums on the side near the road. The apple orchard had been stripped of leaves, and in some places three or four grasshoppers could be found eating at a single apple. The peaches had been eaten off, leaving the bare pits clinging to the twigs. The young twig growth of peach trees had been eaten in preference to the foliage. A man was there at work building smudges to turn the locusts from the plums, which were almost ready to gather. Upon inquiry, I learned that this farm had been largely seeded to alfalfa, but during the last two years had been pastured. The damage done to this place was the greatest that I observed in any of the thirteen counties that I visited. I believe the cause is so evident that at this point will say no more than simply to call attention to the fact that the ground upon this plat had not

* This was the term commonly applied by the farmers of that region. Another locust bears this common name, and this one is generally spoken of as the Differential Locust. In this report, however, I have frequently used the term yellow locust, and wherever used it has reference to *Melanoplus differentialis.* I do this because this insect is quite generally known over the region covered by this report as the "yellow grasshopper." The words locust and grasshopper are used interchangeably.

been disturbed for more than two years past. The previous cultivation had left the alfalfa as a food not only for the cattle, but for the native grasshopper, which flourished undisturbed. Returning by another route, and going out east of town, we found the damage nowhere general, but all alfalfa fields showed the effects of grasshoppers in places.

HAMILTON COUNTY.—Being also requested to visit Hamilton county, I went there upon the 18th of July. Mr. C. M. Humphrey, county treasurer, being aware of my coming, took me to a number of farms in the vicinity of Syracuse. While in his office I met Hon. Thomas H. Ford, who gave me a cordial invitation to accompany him home to his ranch, about five miles east of Syracuse. Having been previously informed that he was one of the largest alfalfa growers in the county, I readily accepted. On our way out we observed grasshoppers glistening, as Mr. Ford termed it, from the tops of the alfalfa stalks growing in fields adjoining the road. I walked through all of these fields, to make sure of the species most prevalent, and in every case found the Differential Locust by far the most numerous. In one corner of a field, comprising less than an acre, I found a fungous disease, *Empusa grilli*, at work. Here were goodly numbers of locusts clinging in the tops of the alfalfa stalks. I was much interested here, as this was the first time I had observed the disease this season. Upon reaching Mr. Ford's place, I was told the grasshoppers had been so bad that he saw the only way to save so large a crop of alfalfa was to cut it all down as fast as possible. Accordingly, at that time the whole alfalfa crop—more than 400 acres in all—was either in the windrow, swath, or shock, except a small piece that he had allowed to remain, hoping to secure seed. His young orchard was being rapidly stripped by the grasshoppers which had been driven out of the alfalfa. His neighbor on the east, Mr. Price, was also suffering a great loss of peaches in satisfying the appetites of these creatures. Here was the first time I had had the opportunity to observe the work of the locusts in the irrigated districts. Former reports have stated that these native locusts deposit their eggs along the irrigating ditches, and that along these the damage is the greatest. My own observation, and the testimony of all the farmers consulted, did not bear out the above facts. On the contrary, the most luxuriant growth of alfalfa is on the sides of the ditches. Many of the farmers here were of the opinion that these locusts come down from the prairies. I mention this fact here, because in my subsequent investigations I gave this point special attention. Before leaving the subject of Hamilton county, I might state that I returned two weeks later to observe the action of the fungus disease, *Empusa*

grilli, in the corner of the field before mentioned. and, while plenty of grasshoppers were still in that corner of the field, *I could see no perceptible increase in the number of dead ones clinging to the branches of the alfalfa.* From Syracuse I drove due north through Hamilton county, passing Stowell post-office, two miles and one-half on the east, and continuing north into Greeley county. I was very much interested in noting the species prevalent on these high plains. The Differential Locust, the one to which I gave the closest attention at all times, was found few in numbers among those weeds that thrive only on ground which has previously been broken. Near Stowell I came upon a large peach orchard standing out unprotected on the plain, and found therein some peaches, but not a single yellow grasshopper. An occasional Lubber grasshopper, *Brachystola magna*, and a number of the smaller species of the genus *Melanoplus*, were all that were common on the open prairie away from those weeds which are wont to grow upon cultivated lands.

Greeley County.—I entered Greeley county, six miles north and two and one-half west of Stowell, and found a few grasshoppers between that point and Horace, where I spent the night. Those that I did find were the same as in Hamilton county, and existed under like conditions. North of Horace, in the valley of White Woman creek, there are a number of farms growing corn, Kafir-corn, barley, and sorghum. I visited these and conversed with the owners. From these farmers I learned that grasshoppers were not troubling them, and that they had suffered no serious damage from these insects in recent years. Leaving this valley, I proceeded north in the direction of Sharon Springs. Near the north line of Greeley county, and extending over into Wallace, is a settlement of Swedish farmers, in the vicinity of Stockholm. I found them at this date, 27th of July, in possession of excellent crops of corn and barley, and fine patches of melons and garden vegetables. At no place were the grasshoppers at all numerous. Some of these farmers had been residing here for ten years, and they told me that in that time they had never had serious trouble with these insects. My experience with these native grasshoppers has been that they are exceedingly fond of garden vegetables and melons. And from what I have learned of their foraging propensities, I believe that, had they been hatched in any numbers upon the plains adjoining these farmers, they would certainly have found the way to these toothsome vegetables and tender melon vines. Mr. C. J. Momyer, Hurt, Greeley county, Kansas, wrote me that native grasshoppers were doing slight damage around the edge of his corn and cow-peas. He spoke also of the Lubber grasshopper, *Brachystola magna*, working upon the vines. He also spoke of the habit, already noted, of the yellow grass-with a heavy roller before sowing the wheat. In substantiation of

hopper eating the tassels and silk of the corn before attacking the leaves. Native grasshoppers have troubled him somewhat for five years. Farmers of this vicinity do not, as a rule, plow their ground every year. It was his opinion that the best wheat could be secured only from ground thoroughly cultivated before sowing. Specimens of grasshoppers received from him proved to be the Differential Locust, *M. differentialis.*

WALLACE COUNTY.—Conditions continued the same on the road into Sharon Springs. The valley of the Smoky Hill river contains considerable alfalfa. I met a number of farmers of this valley who were in Sharon Springs trading. From them I learned that the grasshoppers had cut down the alfalfa in patches in the fields, but there was no general or sweeping destruction being caused by them.

LOGAN COUNTY.—From Sharon Springs I went on a slow train over the Union Pacific through Logan county as far as Oakley. From what I could see from the train and ascertain from farmers boarding the train at the smaller stations, I was satisfied that conditions were in no way different from the counties previously visited. From Oakley I went north by train to Colby.

THOMAS COUNTY.—Inquiries made at Colby gave answers much the same as those previously received, and made me believe that a drive out through the country would not add any new facts concerning the actions of the grasshopper under consideration.

SHERMAN COUNTY.—Press reports having been sent out from Goodland concerning the prevalence of grasshoppers along the railroad, their numbers being reported such as to interfere with the action of the drive-wheels upon the rails, I decided to go out and investigate. Upon reaching Goodland, I was taken out in the gardens and yards of the city by Attorney G. L. Calvert, and shown the actions of the locusts upon the gardens. From Mr. Calvert I also learned that the damage from grasshoppers in Sherman county had been almost entirely confined to the crops of small grains; that the grasshoppers had eaten off the heads of the wheat, oats and barley to a considerable extent, in some fields. In the current issue of the Goodland *Republican*, I noticed that a correspondent from one of the outlying post-offices mentioned the fact that grasshoppers were injuring gardens seriously. In conversation with Mr. William Walker, a hardware merchant of Goodland, and also owner of farm lands managed under his direction, I learned that it was a custom there to sow the wheat upon the ground without giving the land previous cultivation. It was Mr. Walker's opinion that better yields could be secured if the surface of the ground was thoroughly pulverized and then packed this, he gave the instance of a man who, this year, had sown wheat upon ground so prepared and secured a heavier yield of wheat which

tested over sixty pounds to the bushel. Later, I went to the roundhouse of the Rock Island railroad, at Goodland, and examined a number of the cow-catchers of the engines, as they came in off their runs, in order to ascertain the species of grasshoppers caught along the track. I found the species which were most common there to be the Long-winged Locust, *Dissosteira longipennis*, the Carolina Locust, *Dissosteira carolina*, and the yellow locust, *Melanoplus differentialis*. Through the courtesy of General Foreman Loy and his assistant, I was enabled to meet a number of the engineers and learn from them the state of the case. From Engineer Maclellan I learned that the trouble with the grasshoppers was always at night, and that at no time were they so plentiful but that an engine having forced sand draft could easily pass over them in safety; and further, that they had experienced some difficulty on the run between Goodland and Norton. So, when leaving Goodland, I placed myself in a favorable position to view the grasshoppers as they flew by in front of the engine, and noted that no grasshoppers arose except as the train was passing between fields where the crop was being harvested on the one side and corn or some other crop standing on the other side. The numbers at these places were not great. It was evident, however, that the grasshoppers, in moving into the new feeding ground in the evening when the ground had become cool, were attracted by the steel rails which retained the heat longer than the ground, and when thus collected caused the trouble to the trains. It seemed conclusive that the interference on the track was not because of the number of grasshoppers, but because those in the vicinity of the track were drawn to the rail by the heat. Some of the newspaper accounts which I read would lead one to believe that they were creeping over the track in a continuous mass. Letters received in answer to inquiries, from Messrs. D. A. Long, of Ruleton, and T. W. Simmons, of Goodland, gave the following facts: Mr. Simmons stated that they severely damaged his oats, corn, potatoes, and garden vegetables. He stated that those big yellow grasshoppers mined out the pie-plant: he feared that some of his trees, being stripped so early, are permanently injured. Mr. Simmons said that this was the first year that grasshoppers had ever committed any serious depredations, and that the damage this year was quite local in its extent. He also said it is the belief there among many that ground plowed dried out worse than when not plowed, and that it was the custom to drill the wheat in the stubble year after year. Specimens received from Mr. Simmons were as expected—the Differential grasshopper. Mr. Long's letter is as follows:

DEAR SIR: In reply to yours of the 18th, in regard to grasshoppers, I would say that they did a great deal of damage here this year in spots, mostly in the fields of wheat, barley, and oats, by cutting off the heads of the grain. Some

fields suffered one-fourth, some one-third; the 'hopper seems to breed right in the field. There was no effort put forth to destroy them. The farmers do not plow their ground; they generally disk or drill in the grain. I think deep plowing would be a success, and in fact it has proven to be the case here this year, as some of the farmers had plowed deep, and then drilled their wheat in deep, and almost doubled the yield, and increased quality as well. The 'hoppers, I have observed, appear about the middle of June, and do their work in the month of July. Last year they were killed off by a little red bug or mite so small one could hardly see it with the naked eye. I will send you a few specimens in a few days. They are now working on the corn-fields, on the outer edge only.

Yours truly, D. A. Long,
Ruleton, Sherman county, Kansas.

Decatur County.—Reports had been sent me of trouble from grasshoppers in Decatur. Observations that I took in the vicinity of Dresden and Jennings showed conditions similar to those already stated. At Dresden I noted a field of forty acres of corn, lying north of a field of oats just harvested, almost entirely stripped, while just across the road was another field of equal size entirely free from attack. Such instances could be observed in every county where I was.

Norton County.—It was my intention to visit a number of agricultural localities of Norton county. I was fortunate, however, in meeting in the office of Judge Case, County Surveyor J. C. Newell, whose work had recently taken him over all parts of the county. Mr. Newell stated that the damage in Norton was almost wholly confined to alfalfa. He said of thirty pieces of alfalfa, ranging in size from ten to eighty acres, he had noticed that the effects of grasshoppers were noticeable more or less in all. He had observed no alfalfa fields that had been entirely stripped. In some the blooms and seed had been taken off, and in others spots here and there in the field had been eaten to the ground. Mr. E. E. Ames, of Norton, also told me that grasshoppers were doing slight damage in 100 acres of alfalfa which he owned. Mr. A. J. Brunswig has large alfalfa interests in this county, and on page 7 I have taken the liberty to quote a letter from him, giving his observations.

Light damages were being reported by the press from other localities, but I decided that the territory covered gave me a clear idea of the situation in this state. So, after leaving Norton county, I returned to my field laboratory in Edwards county to complete observations upon the life-history of the Differential grasshopper.

SPECIES OF GRASSHOPPERS PREVALENT.

It has been previously stated that the Differential Locust, *Melanoplus differentialis*, was by far the most abundant. *Melanoplus atlanis*, the Lesser Migratory Locust, and *Melanoplus bivitattus*, the Two-striped Locust, were numerous. The Red-legged Locust, *Melanoplus femur-rubrum*, was taken occasionally, generally along the roadside. The Packard Locust, *Melanoplus packardi*, was not uncommon. On September 1, I saw females of the Packard Locust ovipositing in an alfalfa field in Edwards county. The Rocky Mountain Locust, *Melanoplus spretus*, was also taken.

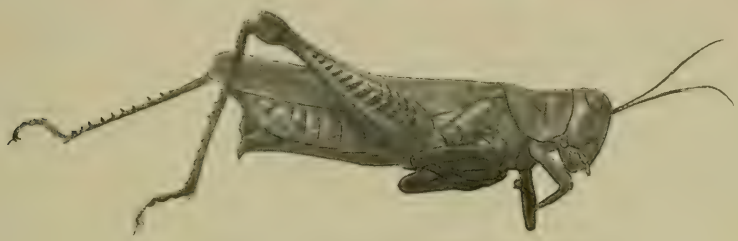

FIG. 1. (Original.) *Melanoplus differentialis;* female.

FIG. 2. (Original.) *Melanoplus differentialis;* male.

It is of interest to note the relative numbers of *M. spretus* and *M. atlanis* present. With this object in view, I captured, just as they came, a number of these allied species, and found among that number sixty-eight specimens of *M. atlanis* and nineteen specimens of *M. spretus*. This observation was made in the western part of Edwards county. The Long-winged Locust, *Dissosteira longipennis*, was abundant in one locality, southwestern part of Edwards county; here, in September, the females deposited their eggs in the alfalfa fields. The Carolina Locust, *Dissosteira carolina*, was numerous along the roads.

The determination of these species was made by the writer, and for the accuracy of the work he is responsible.

LIFE-HISTORY OF THE DIFFERENTIAL LOCUST.

Melanoplus differentialis Thos.

This term, in its biologic sense, refers to the cycle of the individual from the embryo until the fulfilment of its mission in the perpetuation of its species and its retirement in favor of its progeny. The life of the locust may be said to begin with the egg, in which the following changes take place, and are noted under the head of—

EMBRYOLOGY.

By Mr. C. E. McClung, Department of Zoology. Instructor in Embryology.

Description of the egg.—The arrangement of the eggs in the ovary and the formation of the capsule have already been described; it is therefore only necessary to add a decription of the individual egg. This, at the time of oviposition, is an ovate cylindrical body, about 5 mm. by 1.25 mm. in size, and of a bright yellow color, gradually becoming darker with age. The cylindrical form is not perfect, being modified in such a manner that the anterior side of the egg, as it lies in the mother insect, is flattened or even concave, while the opposite side is equally convex (fig. 3). The two ends are very similar in shape, each being bluntly pointed.

Fig. 3. Eggs of Melanoplus differentialis. (About five diameters.)

The egg is protected by two coats, the exterior (chorion), a secretion of the follicular epithelium; and the interior (vitelline membrane), the external, indurated portion of the egg substance. The chorion is a close fitting shell, completely enclosing the ovum. It is usually of a dull yellow color, and is marked over its entire surface by ridges that cross each other in such a manner as to form an irregular hexagonal pattern. This is merely a cast of the lining of the ovarian follicle, registered in its secretion. The chorion is, at first,

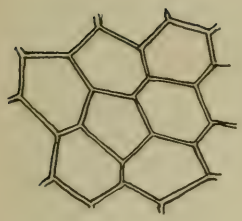

FIG 4.

tough and resistant, but, on exposure to the elements, becomes friable and easily separable. Upon the removal of this external covering, the clear, bright yellow of the underlying egg substance is seen.

The structureless vitelline membrane forms an efficient protection for the enclosed egg. It withstands drying, and is broken only by the application of considerable pressure. Immediately beneath it is a layer of protoplasmic material, the real living matter of the egg, and within this a considerable quantity of nutritive material, the yolk.

My observations upon these eggs, manner of placing in the ground and the actions of the female during the time of oviposition are herewith given. A female in quest of a suitable position for placing the eggs generally moves slowly about for some time testing the ground over which she passes. During this time the tip of the abdomen is turned downward and, stopping momentarily, the ovipositors (plate II) are applied to the ground. I observed one female spending thirty minutes in this way: a crevice in the soil being selected and worked upon for a time, then abandoned for solid ground. Some, however, begin digging and complete the work where the first attempt is made. Small elevated spots on the surface appear to be much chosen. Frequently these little hillocks were not noticeable until marked by a locust digging into the crest. From plate III, figures *g*, *g'*, *g''*, it is evident that there has been a consensus of opinion in these cases concerning the suitability of the place for oviposition. Sandy soil, when present, seems preferable.

That field observations might be corroborated in the laboratory, I brought home 130 of the yellow locusts, more than 100 of these being females, for study in the vivarium.

In one cage sixty were placed, and blue-grass sod, clover sod, sand and dirt mixed, and pure sand: each class of soil occupied a certain part of the floor, the whole floor being well packed by sprinkling. In this cage, the pure sand was chosen by all except eight, which placed their eggs in the sand and dirt mixed. Refuse from the vegetation given them for food seemed in no way to intefere with their work. I saw three of them hid away in this trash busily engaged in ovipositing.

A suitable place chosen, the locust forces a hole in the ground by means of the two pairs of horny-tipped ovipositors at the end of the abdomen. These are opened and closed and the full weight of the body is brought to bear on them. In this way a receptacle is made, often in extremely firm ground, for the eggs.

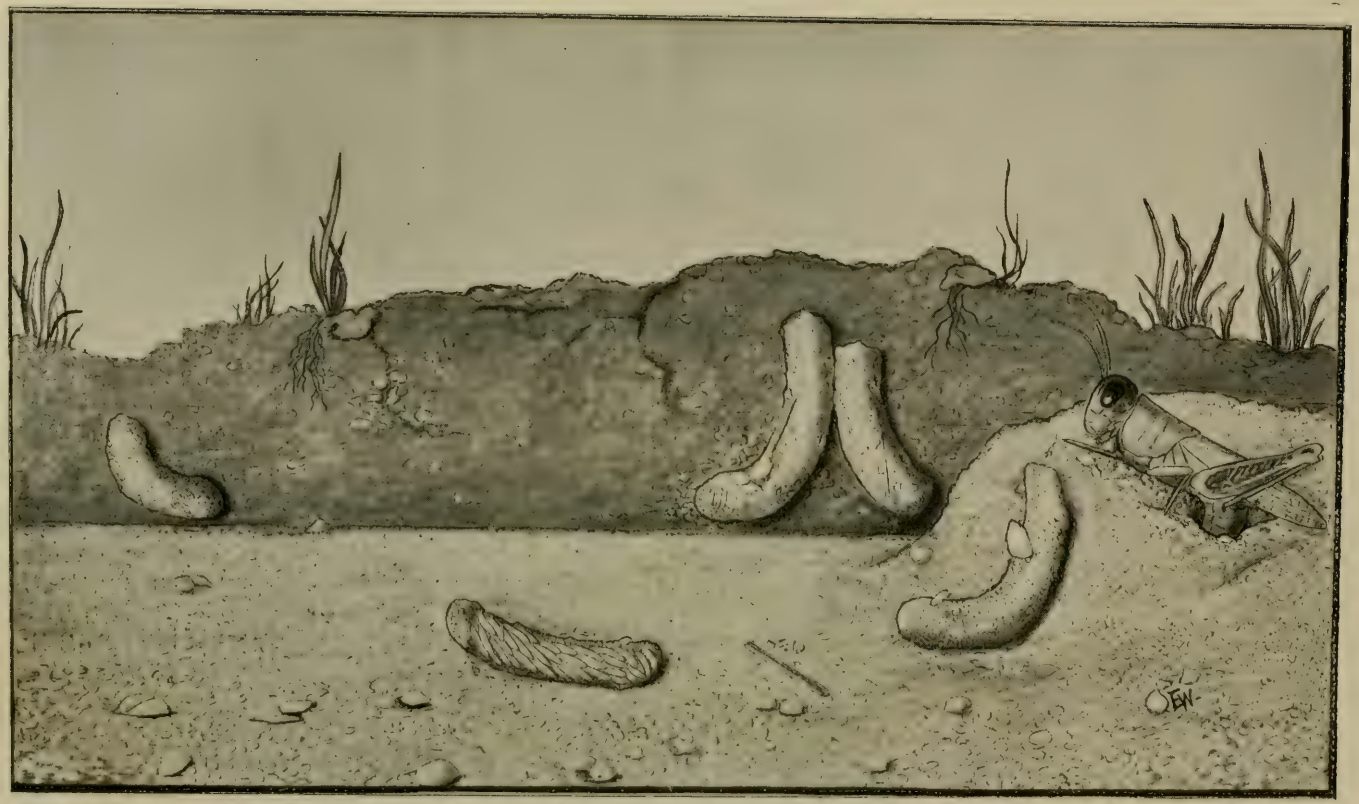

PLATE II. (Original.) For Description, see Bottom of Opposite Page.

Each egg is preceded by a light-colored mucous fluid. Part of this fluid passes through the walls of the cavity and causes surrounding particles of dirt, sand and in some cases small clods (see plate III, fig. *d*) to adhere, so that the pods when removed from the ground are protected first by a coat of this sticky substance and an outer layer composed of particles of surrounding earth. This forms a brittle crust which, when pressed, often scales off, as shown by plate III, *c*. When the ground is firm, the walls of the pod are generally broken away when the earth is disturbed, thus exposing the naked eggs.

This substance before hardening is quite plastic; after hardening it is somewhat fragile. It is insoluble in water. A pod which remained in water thirty days appeared to be as firm as when placed there. When the eggs are all deposited the female covers them with a small amount of this sebaceous fluid. This hardens into a honeycomb structure, as shown is cross-section of top of pod *Fr* in plate III. The cross-line near top of pod, at *b'* in plate III, shows depth of this covering. The whole pod is finished about one-quarter inch below the surface of the ground, and the ground covered over, leaving no trace of work, as shown on ground surface in plate II.

The arrangement of the eggs is shown in the longitudinal section of the pod in the foreground of plate II.

Number of eggs in pod is about 100, and in the ovary about the same number can be counted.

Plate II is from nature. The writer had made a section through the vivarium, showing egg pods in position, and, while the artist was sketching this, a locust very accommodatingly came forward, began and completed the work of oviposition.

Where the eggs are laid is of greatest interest to the farmer. The alfalfa fields with no intervening weeds between the alfalfa plants furnish excellent open spots for oviposition. Here I saw many species placing their eggs, and was surprised to find the Long-winged Locust, *Dissosteira longipennis*, among the number. Mr. Wm. Weber, who was with me and rendered valuable assistance during the summer, gave this point careful attention. He was able to cover considerable territory in the southwest portion of Edwards county. This territory included pastures, alfalfa fields, and cultivated lands. He found the yellow grasshoppers depositing eggs in all these places. They were far more abundant, however, in the alfalfa fields, and remarkably so in the

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DESCRIPTION OF PLATE II.—*Melanoplus differentialis*, female, ovipositing: egg-pods of same species exposed to view. Grasshopper at right is depositing eggs. Three egg-pods in section of soil show position of pods and depth from the surface. Egg-pod in sand near grasshopper. Egg-pod in foreground, opened on one side to show position of eggs within; this one contained 109 eggs.

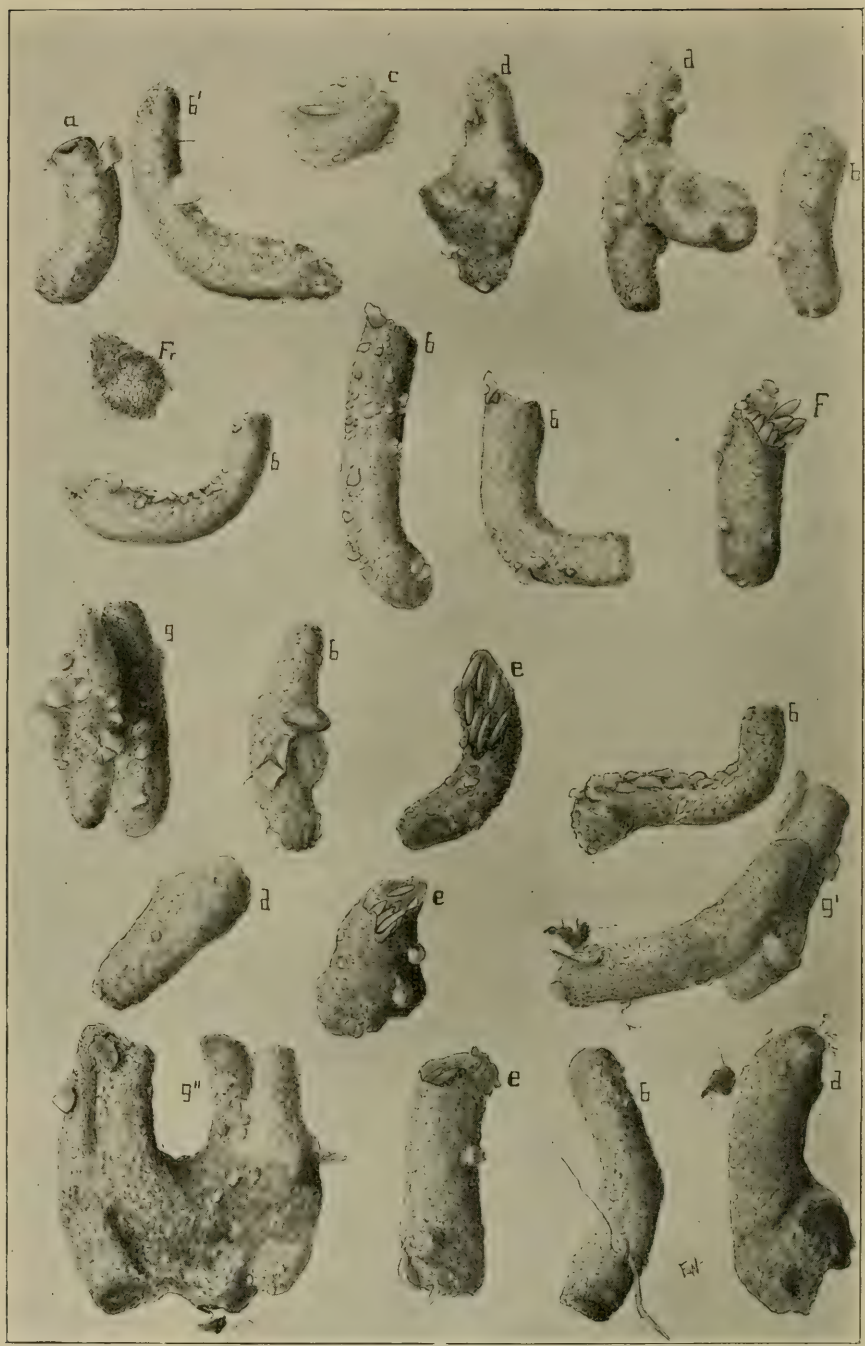

PLATE III. (Original.) See Bottom of Opposite Page.

middle ridge of roads passing through the fields. In one place he saw, on a road ridge, in a space about twenty inches wide by three rods long, one grasshopper per every two inches square of ground, ovipositing.

The first oviposition that I observed occurred September 10, and after making a large number of dissections I feel reasonably certain that few eggs were deposited before that time. Ovipositions were not of general occurrence until September 20, and egg laying was continued until cold weather.

Eggs placed in the ground at this late season of the year will not receive heat sufficient to hatch, so that the species pass the rigorous period of winter in the egg-pod. During the first warm month of spring their eggs begin to hatch; then come consumption of food and growth of body. Growth means expansion. The insect is surrounded from birth by a rigid skeleton. This, instead of enlarging, yields to another; that is, the outer skin is shed; an under one, at first soft and accommodating, makes allowance for the increase in size. This skeleton soon becomes fixed and the insect's size soon requires a new armament. This change, commonly called "shedding the skin," is technically known as molting. Observations upon the number of molts this insect undergoes are not yet completed.

The most interesting molt is the last one, the one in which the grasshopper brings out from the wings pads of the skin, which is being cast off, fully developed wings. The best place for watching this transformation was in standing corn, in fields adjacent to alfalfa fields. Plate IV was made, under direction, from the author's sketches and a large number of alcoholic specimens taken in every stage of the transformation.

The full-grown nymph ceases to eat and, with the head almost invariably downward and the antennæ drooping, fastens the claws firmly into the stalk or blade, remains quiet for a short period, during which it can be handled without being disturbed; a pulsating motion begins in the center of the back of thorax; this increases until the whole

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DESCRIPTION OF PLATE III.—Egg-pods of *Melanoplus differentialis* taken from a sandy soil, showing variations in shape. *a*, pod with top broken off; *b*, pods made of sand with larger grains of sand or stone adhering; *c*, small portion of outside shell broken off; *d*, specimens made of sand and dirt with stones or small dead rootlets; *d'*, specimens composed of sand and dirt, with clod of dirt firmly fixed to the side; *e*, specimens broken off near the top; *f*, shows an unfinished pod—the grasshopper was disturbed while depositing eggs, and the pod taken in this unfinished state; *g* and *g'*, specimens taken showing two pods firmly fixed to each other, composed of sand; *g''*, four pods of sand and dirt with small stick and dead rootlets adhering; *Fr*, cross-section of top of pod, showing honeycomb structure made by the sebaceous fluid when dry.

PLATE IV. (Original.) See Bottom of Opposite Page.

thorax moves up and down; soon the skin splits along the back from top of the head to line crossing the base of front wings; the upheaving action of the thoracic muscles continues until the body drops to the ground, leaving the nymph skin clinging to the leaf; the antennæ lie one on each side of the face and are thus drawn out from under the body; the wings come straight out of the pads as narrow, much-wrinkled portions of cuticle. They are about five-eighths of an inch long when the insect falls to the ground. Inside of an hour, depending upon the weather and time of day, the wings attain their full length, one inch to one and one-quarter inches. The legs are not brought into use in discarding this skin. Frequently the claws of the old skeleton break away from their attachment and the insect falls to the ground. This in no way interferes with the transformation. The insect, when free from the old covering, though its limbs are quite soft and unable to maintain its weight well, crawls to some secluded place where it awaits the hardening of the bones and the expansion of the wings. Before this is fully completed the insect begins eating again.

This change occurs more frequently in the morning, though I have observed it at all hours from sunrise until five o'clock in the afternoon. The complete change from beginning of molt until the insects are fully developed occupies about one hour and a half on a bright, warm day. Frequently I observed Sarcophagid and Tachinid flies flitting nervously about the newly transformed insect. While I did not observe one light upon the locust, it occurred to me that at this time parasitic diptera might well place their eggs thereon.

The first instances of the last molt observed were on July 6, and from the number of adults then apparent I feel safe in saying that none had reached the adult stage prior to July 1. At this time (July 1) adults of the Two-striped Locust, *Melanoplus bivitattus*, were common, and some of them were pairing.

These notes were taken in the midst of nymphs in every state of change, and frequently five or six were in view at one time. While nearly all changed in July, there were some still changing as late as September.

Description of Plate IV.—Various stages of the last molt of *Melanoplus differentialis*. *1*, nymph just before the breaking of the skin along back of thorax; *2*, nymph beginning to come out; *3*, mature insect dropping to the ground; *4*, cast-off skin, still clinging to the leaf; *5*, grasshopper climbing up, spreading wings to dry, and getting ready to eat; *6*, fully developed grasshopper on corn-stalk.

HABITS.

Food.—What this insect will eat depends entirely upon its necessities. It is a lover of good food, and knows how to find it when procurable. For instance, it will eat the peaches before attacking the tree; it eats the shooting ear and tassel before touching the hardening blade. A list of food-plants as personally observed are: Trees—cottonwood, mulberry, cherry, apple, peach, apricot, plum; herbs—alfalfa, Kafir-corn, corn; all cereals; all garden vegetables, including melons; sunflowers, lamb's-quarters, hogweed, Russian thistle. Handles of hay-forks left in the field were frequently roughened by the nibbling of these locusts. Farmers in Edwards and Hamilton counties mentioned the fact that gloves left about the mowing-machines were cut by the insect. Binding-twine has been cut by them so much that a twine prepared by recipe not in accord with their tastes is now much used. In confinement these locusts will feast upon one another.

Actions.—Before sunrise nymphs and adults begin to climb to the top of weeds, growing crops, fence-posts, or any object standing above ground, and remain there until about ten o'clock If the object upon which they rest is edible, they amuse themselves nibbling away. I have frequently seen a portion of an alfalfa field fairly glisten with the bodies of these insects resting on the tops of the plants. About ten o'clock they descend and feed lower down, but ascend about three P. M. again. If the day is cloudy and cool the insects are sluggish, and remain the whole day upon the ground; so true is this that we had to abandon work with the "hopper-dozer" upon one cool, cloudy day. If the day be cloudy and sultry, they eat much the same as upon bright, warm days.

This habit, I believe, accounts in some instances for the belief among farmers that this locust comes in flights. One day the blades of corn will be ladened down with grasshoppers; the next day not a locust will be in sight as the farmer passes by to his work. They are upon the ground. Several instances of this kind were brought to my notice, where the farmers had reported 'hoppers having left their corn, or reappeared, when the conditions were caused by this movement. Grasshoppers sitting upon the ground, especially when partially obscured by weeds, do not appear so numerous or so formidable as when arrayed against a growing crop.

Why the borders of the field are stripped.—Damage to alfalfa is most apparent around the edges. This has led to the belief that the insects enter the alfalfa from outside territory. I observed the same conditions around long ricks of alfalfa, along division fences, where the alfalfa joined cane sown broadcast, and around large breaks in the "stand" of alfalfa.

It seems evident to me that, while some may enter from surrounding fields, this stripping of alfalfa at places designated is caused by the insects being checked in their progress; that is, this grasshopper, when not feeding, moves, walks awhile, rests, walks, jumps, in no evident hurry, each one keeping a somewhat direct course. This action obviously takes it to the borders of the alfalfa field. Here, finding its food-plant extending no farther, it stops; it may turn back, may travel around the field, feeding as it goes. It is evident that this congregating along the borders reduces the vegetation, and alfalfa once cut down furnishes in its young, tender shoots extra attractions, so that the insects remain here and new growth can make no advancement.

Around the obstructions above mentioned many more grasshoppers could be seen than in the open parts of the fields. I spent much time in the vicinity of ricks of alfalfa and noted the movements, in many cases following the insects from the open field up to the ricks, and saw them in many cases continue their course until they had reached the rick, then jump off, and finally find their way past the rick. The number seemed to be about the same on every side of the rick. I speak of this matter in detail, for it was the one argument everywhere advanced in favor of the theory of the insect's entrance from outside territory. And that they do come from outside territory is generally supposed to be the case.

Length of Flight.—The flight of this insect is low and heavy, being sustained for only a short distance. It is readily taken in the hopper-dozer having sheet-iron back three and one-half feet high. I have never seen one carry itself 200 yards at a single flight, though aided by strong winds. Riley and Thomas state that this locust has been seen, though seldom, at considerable heights, apparently migrating.

Habitat.—The range of this species, as given by Scudder, embraces the Mississippi valley north of latitude 43°, south to the Gulf, west to the Pacific, south to central Mexico. It has not been found above 6000 feet. Recently it has been taken in Camden county, New Jersey. Its range in Kansas is defined by the cultivated districts. I have seen it upon the streets of our largest cities, and on the tilled soil of the high western plains.

NATURAL ENEMIES.

VERTEBRATE. All domestic fowls feed upon locusts; chief among these, and highly commendable, is a drove of turkeys. I have seen a cat spend a whole day catching grasshoppers. A whole drove of blackbirds would sometimes light down where these hoppers were plentiful, and hold high carnival. The meadow-lark is a persistent locust catcher, and this lark abounds in the localities visited. The plover picks a locust to pieces now and then, seemingly preferring

smaller forms. I came, however, upon a plover on the high plains in Greeley county, busily dissecting a large western cricket, *Anabrus* sp. The major part of the food found in stomachs of quails and prairie-chickens examined was composed of insects belonging to this family. It is safe to say that many birds not generally accredited aid in reducing the number of locusts. Professor Snow first ascertained that the red-headed woodpecker (*Melanerpes erythrocephalus*), yellow-billed cuckoo (*Coccyzus americanus*), cat-bird (*Galeoscoptes carolinensis*), red-eyed vireo (*Vireo olivaceus*), great-crested flycatcher (*Myiarchus crinitus*), and crow blackbird (*Quiscalus versicolor*) feed upon the locust. Prof. Samuel Aughey has found by not less than 630 cases of dissection that ninety species of birds are partial to locusts as food. Many winter birds seek the egg-pods for food.

Mr. F. E. L. Beal* states that grasshoppers are favorite food with the yellow-billed cuckoo. Several stomachs examined contained from ten to twenty of these insects, a good meal for so small a bird. Katydids and their eggs were found in the stomachs of these birds. The snowy tree-cricket is also used as food. Collectively, this group, *Orthoptera*, were found in 86 of the 155 stomachs examined, and furnish thirty per cent. of the year's food. Three per cent. of the food in May is composed of these insects, and over forty-three per cent. in July.

Mr. S. D. Judd† states that the greater part of the insect food of the loggerhead shrike is composed of grasshoppers and crickets, and in summer grasshoppers are given preference as food. The bird at this season impales upon barbed-wire fences and hedges more insects than it utilizes, so that an examination of the stomachs would not give a correct estimate of the insects destroyed.

I saw a notice in some paper concerning an observation upon snakes, made by Maj. Frank Holsinger, member of the editorial staff of the *Western Fruit Grower*. I wrote Mr. Holsinger for details. His letter, a part of which follows, is of great interest:

"Some years ago, while haying, I had a rake in my hands, when an immense blacksnake ran from the windrow. I placed my rake on it to hold it, but not wishing to kill it. It immediately disgorged an immense amount of grasshoppers, of a kind common in Kansas, a large yellow-legged variety that sometimes becomes destructive to our meadows. I think the discharge was fully one-half pint, and I could discover in it nothing but grasshoppers. I look upon them as our friends — rattlers and copperheads excepted. I believe they should

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* Bulletin No. 9, U. S. Dept. Agr. Biological Survey, June 15, 1898, p. 12.

† Ibid, p. 22.

be protected, as their food is from insects deleterious to farming interests."

From the description given, it is very probable that the yellow grasshoppers referred to belonged to the species now under consideration.

INVERTEBRATE. The locust finds, however, its most unrelenting enemies within its own class. The accompanying figure 5 shows the immature stage of the locust mite, *Trombidium locustarum*, Riley. These were found, in some instances, in such numbers on the under side of the wings of the Differential Locust as to cause the wings to stand out from the body. Locusts with one wing or both wings eaten off were found. The wings of many were rendered useless for flight by this mite. According to Riley, this mite drops from the wings when nearly full grown, passes through the pupal state, and comes forth an eight-legged mite to spend the winter, a part of its food being locusts' eggs. In the spring, the females deposit from 300 to 400 eggs, which hatch out as young, six-legged mites, that attach themselves to some host, the one chiefly chosen being the locust. This is one of the most effectual enemies of the locust. It is familiar to all. Newspaper reports concerning locusts, this year, nearly always contained some reference to a "little red bug found under the wings."

FIG. 5. (Original.) Red mite, Trombidium locustarum, on membrane of wing of locust.

Beetles.—Predacious beetles and the larvæ of beetles are known to prey upon the egg-pods of this species.

Flies.—Last fall, the numbers of this locust seen dead in the fields, destroyed by internal parasites, made me desirous of procuring an estimate of the interruptions that parasites of this class cause. Accordingly, I collected a large number of living forms, retaining and feeding them in closed boxes. I did the same again this year, collecting 130 for this purpose. The computations upon these observations have appeared elsewhere, and are herewith given.

PARASITIC INFLUENCES ON MELANOPLUS.*

The relation existing between the host and its parasite is an ever-interesting source of study from a biologic standpoint. Multiplied numbers of the former tend toward greater increase of the latter. When the parasites predominate, the individuals of the host tribe decrease; should the host disappear, the parasite must follow or adapt itself to new environments. Absence of the parasite grants license to the increase of the host. The prevalence of one is directly dependent upon the other.

In order that an estimate of the influence of this condition upon *Melanoplus differentialis* might be gained, the writer, while conducting the summer field-work of this department during the two seasons past, collected a number of the Differential Locust. Fifty were taken the first week of October, 1897; 130 were collected September 3, 1898. Twelve per cent. of those captured in 1897 had been parasitized by diptera. Of those taken in 1898, 20 per cent. had been attacked by parasitic diptera. When it is taken into consideration that the dates of capture were before the close of the active season of the parasites, and that by reason of capture and confinement, some of the locusts taken were doubtless saved from attack, the estimate can be regarded as conservative. The duration of observation and number of individuals considered will not yet allow favorable deductions to be made from the eight per cent. increase recorded this year. In localities where this locust was superabundant in October, 1897, the number of dead forms showing an unmistakable evidence of the work of dipterous parasites was nearly equal to those moving about. The number of *Melanoplus differentialis* that appeared in the same localities this season was equal to, if not greater than, those existing the year previous. This species of locust has been of economic importance annually in those regions for some years past. This is, in a measure, due to the peculiarly favorable condition existing there, environments which appear to be highly suitable to the rapid multiplication of this species. The ultimate effect of parasitism upon *Melanoplus differentialis* with such surroundings is yet to be demonstrated.

Observations on this subject will be continued by the department. It is the purpose of this paper to record the data observed and diptera concerned. Dr. S. W. Williston and Dr. Garry de N. Hough have very kindly examined the specimens bred. The descriptions and determinations of the Sarcophagidæ made by Doctor Hough appear below, The description of the Tachinidæ which appear to be new will shortly be given by Doctor Williston in a paper on the museum types of Tachinidæ.

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* Kan. Univ. Quar., vol. VII, No. 4, Oct., 1898, series A, pp. 205–210.

Concerning the life-history of the diptera described in this article, the following notes have been made. Careful and continued watching for the act and time of oviposition was not fully rewarded. During the period of the last molt of *Melanoplus differentialis*, when frequently a dozen individuals could be seen at one time in various stages of this change, the writer noted numbers of Sarcophagidæ flitting nervously over and about, alighting near the soft, viscid locust, then taking wing again. While no act of oviposition or darting downward was observed, as is the case with many parasitic Hymenoptera when placing their eggs, it is the writer's opinion that some at least of the eggs are placed upon the locust at this time. This belief is strengthened by the fact that the insect during the molt is quiescent, is soft, and lightly coated with a sebaceous fluid, and therefore is an easier prey and a greater attraction for parasitic flies in quest of a host than the active and fully chitinized insect.

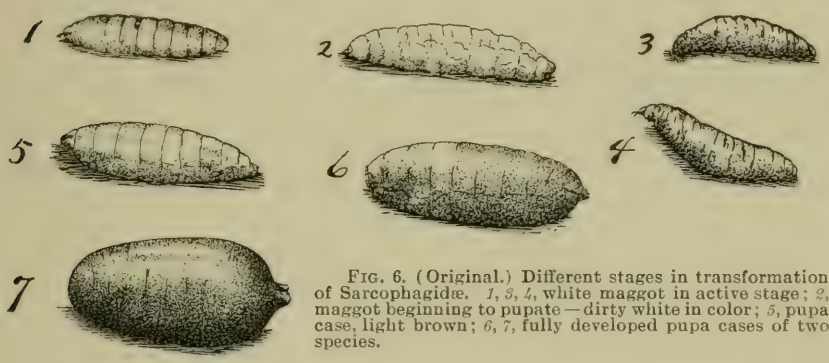

FIG. 6. (Original.) Different stages in transformation of Sarcophagidæ. *1, 3, 4*, white maggot in active stage; *2*, maggot beginning to pupate—dirty white in color; *5*, pupa case, light brown; *6, 7*, fully developed pupa cases of two species.

The lot of specimens from which *Sarcophaga cimbicis* was bred was collected on September 30, 1897; the larva came forth from the host four days later. It emerged October 23, 1897. The material from which *Sarcophaga hunteri* was bred was taken on September 1, 1898. Three of these dipterous larvae pupated on the 3d, one on the 6th, and the last of the five on the 9th of September. They emerged in the following order: Two on September 6, one on September 8, the remaining two, a male and female, now in Doctor Hough's collection, hold the labels giving date of emergence, a copy of which I did not retain. There elapsed, however, in each case but a few days between pupation and maturation.

Sarcophaga cimbicis Town.; Can. Ent., vol. 24, pp. 126, 127, 1892.

This specimen, a female, was determined by Doctor Hough from material in his collection. He wrote that the description by Townsend was not then accessible. Upon looking up the list

of types in our collection, I found the material, a male and female, upon which Townsend based his description. A careful comparison with literature at hand, made by Doctor Williston, shows the three specimens to be without doubt identical. It is interesting to note, as showing the range of adaptibility of this species, that the types were bred from cocoons of *Cimbex americana.*

FIG. 7. (Original.) Sarcophaga cimbicis Town. Female. Its own pupa case by its side.

FIG. 8. (Original.) Sarcophaga hunteri Hough. Male.

Here follows Doctor Hough's description:

Sarcophaga (*Tephromyia*) *hunteri* nov. sp. Three males and two females, bred from *Melanoplus differentialis* by Mr. S. J. Hunter, in whose honor I have named it. Habitat, Kansas.

Length, five and one-half to seven millimeters. Color, gray; the male rather brownish, the female whitish. Abdomen without the usual variable spots of a *Sarcophaga*, but with three black stripes—a median, and on each side a lateral. In the female the lateral stripes are quite faint, and can only be seen well with a favorable incidence of light. Anal segments gray, retracted within the fourth segment in the males. Palpi yellow to yellowish brown. Antennæ brown, with the apex of the second joint and the base of the third yellow to a varying extent. Squamulæ white. Wings grayish hyaline; first longitudinal vein not spinose; third spinose for two-thirds to three-fourths of the distance to the small cross-vein. Legs black; in the male more or less brownish gray pollinose; in the female whitish gray pollinose. Hind tibiæ of male not bearded.

Head.—Front of male at narrowest point one-sixth the width of the head. From this point, which is about at the junction of the dorsal and middle thirds, the front widens both dorsad and ventrad. Front of female of uniform width, six-twentieths the width of the head. The exact measurements are: Male, front 0.4 mm., head 2.5 mm.; female, front 0.6 mm., head 2 mm.

Antennæ.—Third joint more than twice as long as the second. Arista fully as long as the second and third joints together, composed apparently of but two joints, of which the basal is very small and about as long as broad: the terminal tapering as usual (its basal and apical thirds black, its middle third whitish), and feathered for rather more than half its length with rather long, fine hairs. The yellow, or perhaps I should say reddish yellow, color is more extensive on the antennæ of the female than of the male.

The vibrissal angle is a little above the mouth edge, and slightly but distinctly narrows the clypeus. Dorsad the principal vibrissa, the vibrissal ridge is beset with small bristles its entire length. Ventrad the principal vibrissa are about three smaller vibrissæ.

The dorso-ventral diameter of the bucca is one-third that of the eye. It is quite evenly beset with small bristles, which are larger toward the edge of the mouth opening, where they form a distinct bordering row.

Macrochætæ of vertex, front, etc. Male: By far the largest of the vertical bristles is the inner vertical; the outer vertical is scarcely if at all larger than the cilia of the posterior orbit. The greater ocellar are small; the lesser ocellar very small. Of the latter there are several pairs, and they extend over upon the occipital surface of the head, beyond the post-vertical pair, which is small, and very evidently a member of the ocellar group, The occipito-central is present, and is about as large as the post-vertical. There are two or three ascending and about eight decussating transverse frontals. The latter extend down upon the gena about as far as the apex of the second antennal joint. Upon the geno-plate laterad the frontals there are no large bristles, but an irregular row of exceedingly minute hairs, which begins at or a little dorsad of the middle of the geno-vertical plate and extends ventrad on the geno-vertical plate and on the gena nearly or quite to the ventral end of the latter. On the gena this row has a tendency to become double and the last three to five members of the anterior row are much larger than the rest, thus forming a rather prominent little group near the lower corner of the eye. The ciliæ of the posterior orbit are small, closely set, and well aligned. Parallel to them is a second distinct row of bristles of about the same size.

Female: The bristles of the head of the female differ from those of the male as follows: The outer vertical is almost as well developed as the inner vertical. The transverse frontals number but five or six. The row of minute hairs on the geno-vertical plate and gena has a lesser tendency to become doubled on the gena. Two good-sized orbital bristles are present.

Thorax.—The thorax is striped as is usual in *Sarcophagæ*. The stripes are very distinct in the male, and quite faint in the female. The chætotaxy of the thorax is alike in the two sexes, and is indicated in the accompanying diagram. The female has a smaller number of minute bristles than the male, and consequently its chætotaxy is more easily made out. In the diagram I have indicated three posthumeral bristles. The two smaller ones are in but one specimen large enough to be distinguished from the other hairs or microchætæ. This variation of the posthumerals is common in *Sarcophagæ*.

FIG. 9.

Abdomen.—The macrochætæ of the abdomen are marginal only. Each segment has a complete row. On the first and second segments they are all of insignificant size, except two or three at the lateral border. On the third segment all are of good size and they number twelve to fourteen. On the fourth segment all are of good size and they number fourteen to sixteen.

The bristles of the legs are arranged as is usual in *Sarcophagæ*. I can make out nothing worthy of special notice here.

Wing.—First longitudinal vein not spinose. Third vein not spinose for two-thirds to three-quarters of the distance to the small cross-vein. Elbow of fourth almost exactly rectangular and provided with an apparent appendix, which, however, is not a stump of a vein but a slight fold or wrinkle of the wing. Hind cross-vein sinuous, longer than, but hardly twice as long as, that segment of the fourth vein between it and the elbow. Hind cross-vein and apical cross-vein almost exactly parallel.

This species belongs to Brauer's subgenus *Tephromyia* of *Sarcophaga* (sens. lat.) In this subgenus the vibrissal angles are distinctly above the mouth edge and, projecting somewhat mesad, distinctly narrow the clypeus. The abdomen does not have the changeable spots, maculæ spuriæ, of *Sarcophaga*, but is either unicolorous or marked with fixed spots or lines. The European species of this group are *T. grisea* Meig., *T. lineata* Fall., *T. affinis* Fall., and *T. obsoleta* Fall. As far as I am aware *hunteri* is the first *Tephromyia* to be observed outside of Europe. Through the kindness of Herr Paul Stein, of Genthin, Germany, I have now in my possession specimens of *grisea*, *affinis* and *obsoleta*. From these specimens and the accessible descriptions of *lineata*, I am able to construct the following table for separating the species of this group.

A.—Abdomen unicolorous, squamulæ yellow, wings strongly yellow at base—*grisea* Meig.

AA.—Abdomen with distinct black markings, squamulæ not yellow, wings not strongly yellow at base. B.

B.—Palpi black. C.

C.—Each abdominal segment with a black dorsal line, and on each side with a narrow, oblique, black spot: these spots often united so that the abdomen presents three black stripes. Front of male one-third the width of the head *lineata* Fall.

CC.—First abdominal segment blackish: other segments each with a dorsal black line, and on each side with a large, irregularly shaped black spot. Front of male one-fifth the width of the head: of female, one-third the width of the he d—*affinis* Fall.

BB.—Palpi yellow or brownish yellow.

D.—Front of male one-fourth as wide as head: third antennal joint less than one and a half times as long as the second; no intra-alar bristle in front of the suture—*obsoleta* Fall.

DD.—Front of male one-sixth, of female less than a third, as wide as the head; third antennal joint more than twice as long as second, with an intra-alar bristle in front of suture—*hunteri* n. sp.

Dr. S. W. Williston has kindly examined the *Tachinidæ*, and will give descriptions in a paper upon Kansas university museum types of *Tachinidæ* in a future number of the Kansas University Quarterly.

Among these parasitic Diptera, the female fly deposits the eggs, sometimes two, upon the back of the grasshopper, frequently when locust's wings are spread in flight. The egg soon hatches, and the larva feed until full-grown upon the locust's vitals. It comes forth as a white maggot; soon its skin turns brown and forms a hard pupa case, from which the flies above mentioned emerge in adult form in from ten days to two weeks (see fig. 6).

FIG. 10. (Original.) Erax cinerascens. One and one-half times natural size.

An Asilid fly, *Erax cinerascens*, was seen pouncing upon the young grasshoppers.

Locust fungus, Empusa grilli Fres. This disease can be readily detected when present, by the general observer, by the numbers of dead locusts clinging to the tops of the alfalfa, weeds, or grass. On the 21st of July I found this fungus, for the first time this year, at work in one corner of a small alfalfa field three miles east of Syracuse, Hamilton county. The grasshoppers were very abundant upon this piece of ground. I returned to this place two weeks later, hoping to attain some valuable data upon the natural spread of this

disease. This second visit showed that there had been no noticeable spread of the disease. Dead grasshoppers, in about the same numbers, in practically the same corner of the field, were to be seen. I did not find the disease working in any other portions of this field. I found a few dead grasshoppers that had died from this disease in two spots in two different alfalfa fields in Edwards county. In no place, however, did I note anything that could be in any way considered an epidemic, nor any evidences that would induce favorable conclusions concerning this disease as a valuable check to the increase of this locust.

FIG. 11. (Original.) Melanoplus differentialis killed by fungus. On Goldenrod.

Observations Made in Widely Separated Localities.

In the vicinity of St. Louis, Missouri, the first specimens of this locust were observed to become winged July 19. Eggs were laid September 9. As a deviation from the usual egg-laying habits of the genus, the eggs are sometimes very numerously placed under the bark of logs that have been felled on low lands. The eggs of this species, unlike those of *spretus*, *atlanis*, and *femur-rubrum*, are not quadrilinearly but irregularly arranged. The head ends of the eggs in the pod point mostly outward. One hundred and seventy-five eggs have been counted in a single mass.*

In California, they acquired wings from the last week in June to the last week in July, and began laying eggs July 23. A single female occupied seventy-five minutes in depositing an egg mass. The situation chosen for egg laying was invariably the edge of one of the basin-like hollows (for irrigation?) at the foot of a tree. This locust is not easily startled; its ordinary flight is rather heavy, and sustained only for a distance of twelve to thirty feet.†

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* Riley, Summary from First Report U. S. Ent. Com.

† Coquillett, Report Dept. of Agr. 1885, pp. 295, 296.

This insect has very frequently multiplied in such numbers in limited areas over its range as to do considerable injury to cultivated crops growing upon low, moist ground; and has even been known very frequently to spread over higher and dryer lands adjoining these, its customary haunts. It is one of the few species of locusts that has thus far shown a tendency toward civilization. This it has done readily, since its habits are in unison with the cultivation of the soil. It is only since the settlement of the country where it originally occurred that it has multiplied so as to become sufficiently numerous to become a serious pest.

The eggs are laid in cultivated grounds that are more or less compact, preferably old roads, deserted fields, the edges of weed patches, and well-grazed pastures adjoining weedy ravines. Egg laying begins about the middle of August and continues into October, varying, of course, according to latitude and climatic conditions. Usually, but not always, only a single cluster of eggs is deposited by each female. Frequently there were two, and in extreme cases perhaps even three, of these clusters deposited by a single female.*

ANATOMY.

It is believed that a brief general discussion accompanied by figures of the Differential Locust, *Melanoplus differentialis*, will be of practical value. Such a treatise will enable the farmer to understand more readily the direct action of the external and internal remedies used.

External Anatomy. A word, in beginning, concerning skeletons. These are of two kinds: skeletons within the body and surrounded by muscles, and those without the body, having all muscles on the interior. The skeletal structure of man comes under the first class; the rigid outer structure of insects under the second class. Every one who has studied human physiology remembers, among the first topics, "Uses of the Skeleton," and if he were permitted to use another's language, instead of his own, he would say, in answer: "To protect the delicate organs, to furnish attachment for the muscles, to give form to the body, to furnish levers for the movements of the body." And, if this same scholar was to take up comparative anatomy later, he would find that the skeleton of the grasshopper serves identically the same purposes as the human skeleton. The integral parts of the human skeleton we call bones; the separate pieces of the grasshopper skeleton we term sclerites; that constituent which gives bones their firmness we commonly speak of as lime; that which lends rigor to the

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*Bruner, Report of Ent. to Neb. St. Bd. of Agr., 1896, pp. 120, 121.

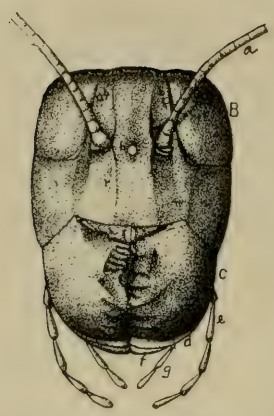

FIG. 12. (Original.) Front view of head, with clypeus and labrum removed to show mandibles in position. *a*, antenna; *b*, ocelli; *B*, compound eye; *C*, mandible; *d*, maxilla; *e*, maxillary palpus; *f*, labium; *g*, labial palpus. Enlarged about five times.

sclerite is a horny substance called *chitine*. An examination of the body wall shows it to be composed of a number of distinct pieces, or sclerites; the lines separating these pieces are known as *sutures*. Sutures here, just as in the anatomy of the human skull, are not freely movable joints. The term, "joint," is reserved for those articulalations where free motion is permitted, as is the case at the connections of the parts of the locust's leg.

An examinination of the whole body will readily show three divisions—the head, thorax, and abdomen. The head, apparently one piece, contains the mouth, eyes, and the long horns, known as antennæ; the thorax is the heavy central part of the body, furnishing attachments for the wings and legs; the abdomen is the slender portion extending backward from the base of hind wings.

The head.—The accompanying figures show the head with mouth closed (fig. 12), but upper lip, labrum, removed to reveal comparative size of jaws and head. Fig. 13, with mouth open, illustrates the tongue, hypopharynx in the center, mandibles, and part of the maxillæ on each side beneath mandibles. With such tools and the power to use them, is it to be wondered that this insect is omnivorous.

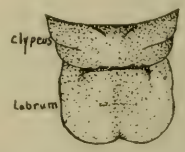

FIG. 16. (Original.) Clypeus and labrum. Enlarged about five times.

FIG. 13. (Original.) Front view of head, with mandibles spread out. *c*, mandible; *d*, maxilla; *e*, maxillary palpus; *f*, labium; *g*, labial palpus; *H*, hypopharynx. Enlarged about five times.

The compound eyes, one on each side of the head, are the most conspicuous divisions of the head. Their surface is made up of a large number of hexagonal plates. Each of these plates forms the surface covering for a simple eye admitting but one ray of light. The compound eye is but a collection of these simple eyes.

The simple eyes.—Just above the base of each antenna can be found a small simple eye; between the bases of the horn-like antennæ is another simple eye.

The many jointed antennæ extend from

the upper part of the face. The *clypeus* and upper lip (*labrum*) are drawn in full in figure 16. The powerful toothed *mandibles* are shown open and closed (figs. 12, 13). The movements of the mandibles are confined to the lateral action from the median line outward and back again. Just behind them are the smaller, more strongly toothed *maxillæ*, with appendages. These are drawn and described in figure 15. Between the maxillæ, and rising from the back wall of mouth, is the tongue-like organ known as hypopharynx. The under lip (labium) is shown as it appears from the back of the head. Its subdivisions are given with figure (fig. 14). The large sclerite composing the front part of the head, in which are situated compound eyes, simple eyes, and antennæ, is known as the *epicranium*. The upper part is called the vertex, the anterior portion the front, and the sides, extending downward from the compound eyes, the cheeks or *genæ*. *The thorax* consists of three divisions — the prothorax, bearing the front pair of legs; the mesothorax, bearing the front wings and the middle pair of legs; the metathorax, bearing the hind wings and last pair of legs.

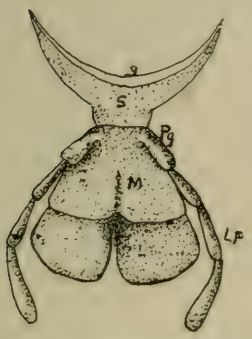

FIG. 14. (Original.) Labium. *g*, gula; *S*, submentum; *M*, mentum; *Pg*, palpiger; *Lp*, labiapalpus. Ligula consists of the two flaps below mentum. Enlarged seven and one-half times.

FIG. 15. (Original.) Inner view of maxilla. *Lc*, lacinia; *gl*, galea; *p*, palpus; *m*, membrane. Enlarged about five times.

FIG. 17. (Original.) Side view of thorax. Enlarged three times.

A, Mesothorax.	*B*, Metathorax.
a, parapteron.	*b'*, episternum.
b, episternum.	*c'*, epimeron.
c, epimeron.	*d'*, wing.
d, wing.	

FIG. 16½. (Original.) Side view of prothorax with leg. *a*, præscutum; *b*, scutum; *c*, scutellum; *d*, post scutellum; *e*, episternum; *m*, membrane, connecting head with prothorax, containing the jugular sclerites; *f*, coxa of leg; *g*, trochanter; *h*, femur; *i*, tibia; *j*, tarsi; *k*, pulvillus and two claws. Enlarged three times.

The prothorax is made most conspicuous by the pronotum—the large sunbonnet-shaped piece covering the back—extending out over the back of mesothorax and covering the greater portion of the sides of the prothorax as well. The subdivisions of the hood are given beneath

figure 16½. The sternum of the prothorax is a sclerite having a small tubercle situated between the front legs. On the membrane connecting head and prothorax, on each side underneath the prothorax, are a pair of sclerites looking somewhat like two links in a chain; these are called the jugular sclerites. They are represented in figure 16½, as is also the episternum of the prothorax and prothoracic leg.

Mesothorax.—The middle part of the thorax, when viewed from above, shows the front wings (tegmina) and mesonotum between the wings (fig. 19). The mesonotum consists of two subdivisions—the scutum occupying the front half and scutellum the back half of this division. The form of each is shown in figure 19. From the side can be seen two sclerites named and referred to in figure 17, also the place of attachment of the middle leg. The ventral portion (mesosternum)

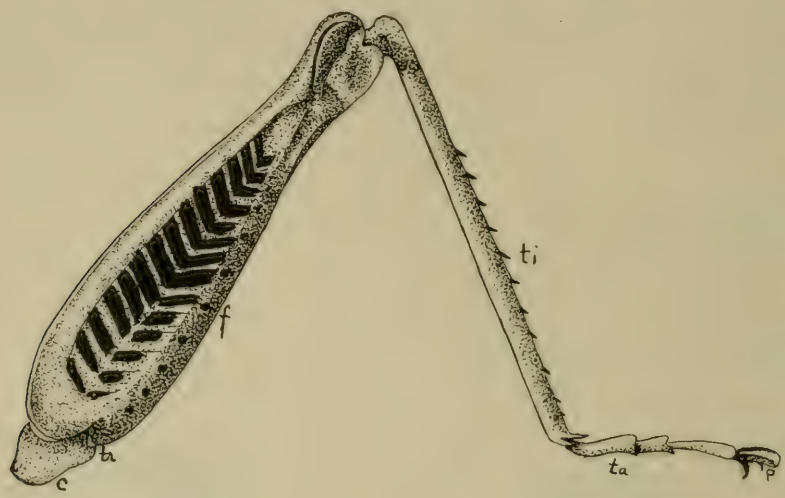

FIG. 18. (Original.) Metathoracic, or jumping leg. *c*, coxa; *tr*, trochanter; *f*, femur; *ti*, tibia; *ta*, tarsi; *p*, pulvillus and two claws. Enlarged four times.

of the mesothorax is a large, flat, nearly rectangular piece, having the corresponding sclerite of the metathorax dovetailed into its caudal margin (fig. 20).

Metathorax.—This part resembles both in structure and function the mesothorax. Reference to figures 17, 19, 20, will give names of parts and appearances in structure. Between the mesothorax and metathorax, on the side just above the leg socket, is the largest opening in the body for the transmission of air. These openings are called spiracles. See figure 27 for illustration of structure and position.

Appendages of the thorax.—These are the legs and wings. The first and second pair of legs are used in walking and grasping; the

third pair in walking and jumping. The function of the third pair differs, and yet the parts of each are the same, and these are given, together with their relative forms, in figure 18.

The wings differ in structure and texture. The front wings (tegmina) are large, narrow, and retain the same form whether in flight or at rest. The hind wings, when not in use, are folded like fans and rest under the tegmina.

The membrane of the wings is supported by longitudinal veins and short cross-veins.

Abdomen.—The first abdominal segment fits accurately into a notch in the metasternum

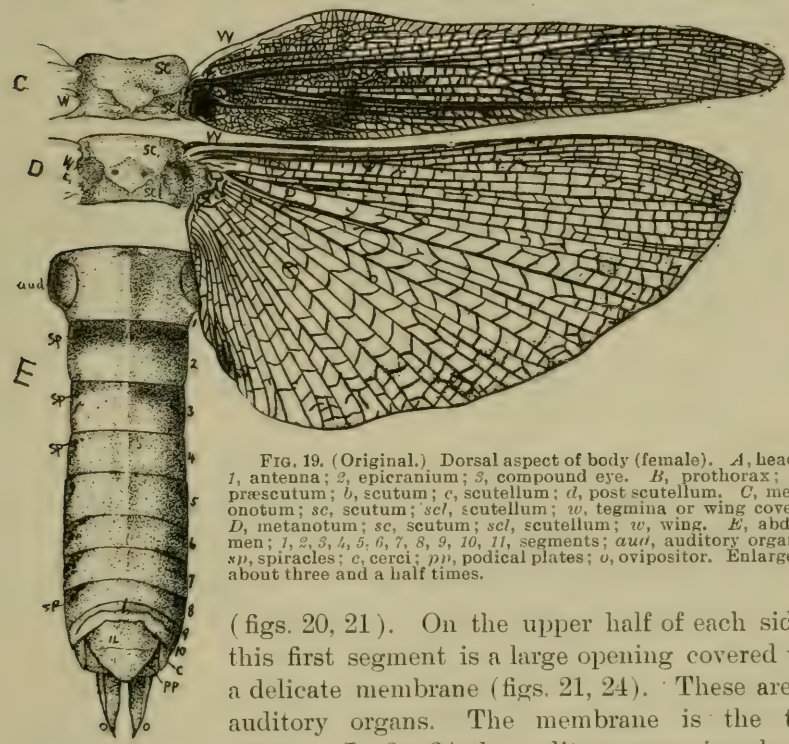

FIG. 19. (Original.) Dorsal aspect of body (female). *A*, head; *1*, antenna; *2*, epicranium; *3*, compound eye. *B*, prothorax; *a*, præscutum; *b*, scutum; *c*, scutellum; *d*, post scutellum. *C*, mesonotum; *sc*, scutum; *scl*, scutellum; *w*, tegmina or wing cover. *D*, metanotum; *sc*, scutum; *scl*, scutellum; *w*, wing. *E*, abdomen; *1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11*, segments; *aud*, auditory organ; *sp*, spiracles; *c*, cerci; *pp*, podical plates; *o*, ovipositor. Enlarged about three and a half times.

(figs. 20, 21). On the upper half of each side of this first segment is a large opening covered with a delicate membrane (figs. 21, 24). These are the auditory organs. The membrane is the tympanum. In fig. 24 the auditory organ is enlarged. The margin is the thickened tympanum. The dark structure at the right on tympanum is the cone-shaped prominence which is situated just beneath the tympanum. The dark spot near center is the triangular chamber situated just beneath the tympanum.

Just in front of each auditory organ is a spiracle (figs. 21, 24). The next seven segments contain breathing spores (spiracles) on the

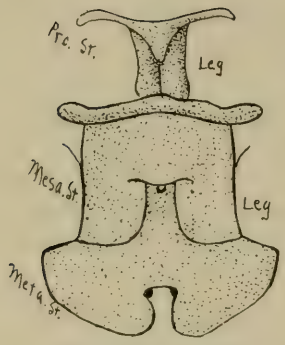

FIG. 20. (Original.) Ventral view of thorax. *Pro. st.*, prosternum; *Meso. st.*, mesosternum; *Meta. st.*, metasternum. Enlarged about three times.

sides, at points indicated in fig. 21. The exact use of these will be more fully discussed later.

Beginning with the ninth segment, the abdomen is modified, and in the structures which follow are to be found the characteristics which distinguish the sexes. In the female the four long, horny-tipped ovipositors are prominent. How such small instruments can execute so much work, is a matter not easily explained. Their uses were discussed under "Life-History." A better idea of these parts and relative forms than can be given in words will be found in fig. 21. The terminal part of the abdomen of the male (figs. 22, 23) shows, instead of extended ovipositors, a blunt, hood-shaped sclerite, turning up over that end of the body like the prow of a barge. The

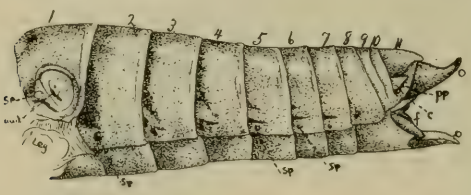

FIG. 21. (Original.) Side view of abdomen (female). *1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11*, segments; *Sp.* spiracles; *aud*, auditory organ; *o*, ovipositor; *pp*, podical plates; *c*, cerci; *f*, forked organ. Enlarged about three times.

FIG. 22. (Original.) Side view of male. *7, 8, 9, 10, 11*, segments; *c*, cerci. Enlarged about three times.

cerci are more prominent than in the female. The abdomen of the male, though consisting of the same number of segments, is generally shorter than the abdomen of the female.

INTERNAL ANATOMY. An idea of the internal workings of these grasshoppers will be of value, and will throw some light upon its habits and the effects of poisons upon it. This locust agrees with higher forms of life in having a circulatory, respiratory, digestive, reproductive and nervous system. It is believed that the subject can be best explained under such heads, with reference to figures illustrative of the same.

FIG. 23. (Original.) Dorsal view of caudal appendages of male. *6, 7, 8, 9, 10, 11*, segments; *c*, cerci. Enlarged about three times.

Digestive system.—The digestive system begins with the masticatory organs of the mouth, previously shown (figs. 12 to 16). The food is here masticated and mingled with the saliva secreted by

glands lying under the esophagus. From the esophagus it passes into the crop. The food then enters the gizzard-like proventriculus; the inner walls of this are lined with chitinized processes which, by a series of contractions, grind up the food and pass it on into the stomach proper. Lying alongside of this stomach, and connected to it, can be seen on each side three long tubes. These are called gastric pouches (ceca), because it is believed that they secrete a fluid which corresponds to the gastric juice, and this fluid enters the stomach to perform functions similar to that carried on by the gastric juice.

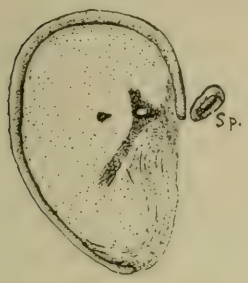

FIG. 24. (Original.) Exterior view of auditory organ; *Sp*, spiracle. Enlarged about fifteen times.

The food after leaving the stomach passes into the intestines, the upper part of which is called the ileum and the lower part the colon. At the forward end of the ileum can be seen a large number of tubes (malphigian tubes) running backward. These are believed to perform the same functions as the kidneys do in the higher animals. While the food is in the stomach, and as it passes through the ileum and colon, it is believed that the nutritive portions oozing through the walls of this digestive tube enter the circulation. The waste material is carried off through the colon.

Circulatory system.—In this locust there are no arteries and no veins. The circulatory system, as far as organs are concerned, is comprised of what we are wont to call the heart. This organ is a tube

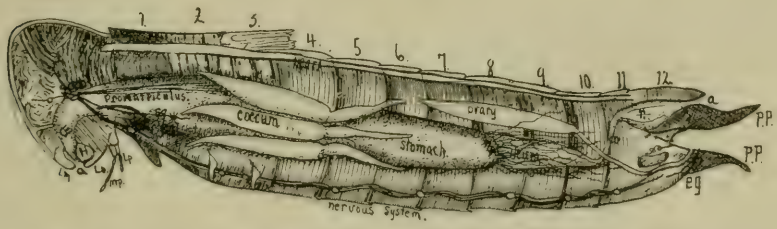

FIG. 25. (Original). Digestive, circulatory and nervous systems. *1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12*, segments; *a–a*, digestive tract; *H*, hypopharynx; *Lb*, labium; *Lm*, labrum; *Lp*, labial palpus; *mp*, maxillary palpus; *Œ*, esophagus; *pp*, ovipositors; *eg*, egg guide; *co*, colon; *r*, rectum. The heart is an open tube running along the back; it is so marked, but not easily shown. Enlarged three times.

extending from about the tenth segment of the abdomen up into the head. This tube has valves along its sides which admit of entrance of food and do not allow that which has entered to escape until it passes out of the main opening at the end of this organ in the head. This leads us to make a few remarks concerning the blood of insects.

The blood of insects differs from that of other animals in having no red corpuscles. It is a thin fluid and, being a mixture of blood and chyle, usually colorless, but sometimes yellowish or reddish. It is carried forward by this tube or heart to the front end, and then flows back, nourishing the organs as it passes, and likewise coming in contact with tracheæ, which are everywhere present in the body. When in contact with these tracheæ, action similar to that in the human lung takes place. More will be said upon this phase of the subject under the head of the "Respiratory system." It will be seen that the chief function of this heart is to conduct forward newly made blood and unused blood from the back end of the body, pour it out at the front end of the body, and allow it to flow back like a river in its course. This action of the heart can be seen with the naked eye in some caterpillars with light color and delicate skin, when held between the observer and the sun.

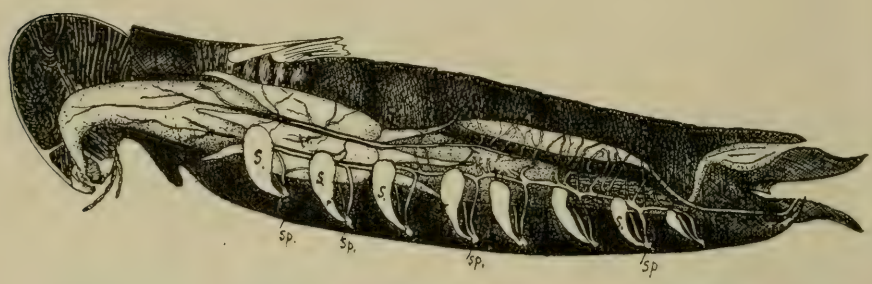

FIG. 26. (Original.) Respiratory system. *sp.*, spiracles, showing tracheæ permeating all parts of the body; *S*, air sacs. Enlarged three times.

Respiratory system.—This insect, instead of having one portion of the body set apart for the purification of the blood, similar to animals possessing lungs, may be said to have lungs all over its system; that is, there are tracheæ branched and branched until they cover every part of the system and extend to every organ in the system. These tracheæ do not depend upon the mouth for their supply of air, but are connected with the body wall direct, the outer portion of this connection being known as spiracles (figs. 21, 27). These spiracles have valves and openings which close and open at intervals, allowing free interchange of air. The tracheæ which run from these spiracles are membranous tubes, which do not collapse because they are kept open by continuous rings of cartilage similar, though on a much smaller scale, to the cartilage in the windpipe of those animals bearing lungs. In addition to carrying to all parts of the body, it would seem that this distribution of air within the body tends to make the insect lighter and more capable of flight. In addition to these tracheæ,

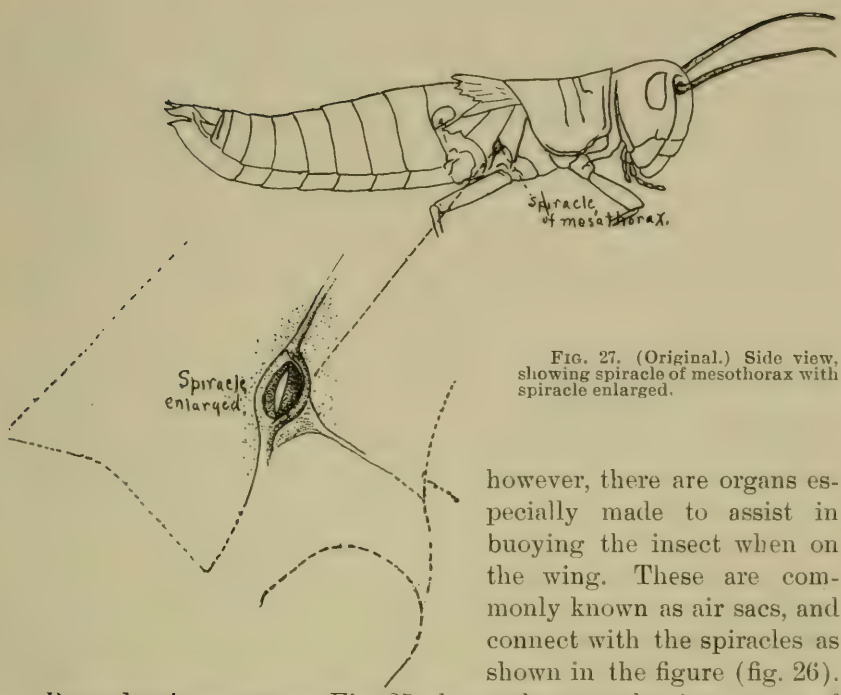

FIG. 27. (Original.) Side view, showing spiracle of mesothorax with spiracle enlarged.

however, there are organs especially made to assist in buoying the insect when on the wing. These are commonly known as air sacs, and connect with the spiracles as shown in the figure (fig. 26).

Reproductive system. – Fig. 25 shows the reproductive organs of the female, when not laden with eggs. It consists of an ovary, egg duct, and receptacle for the fertilizing fluid. Fig. 28 shows the ovary of the female just a few days previous to the time of oviposition. It

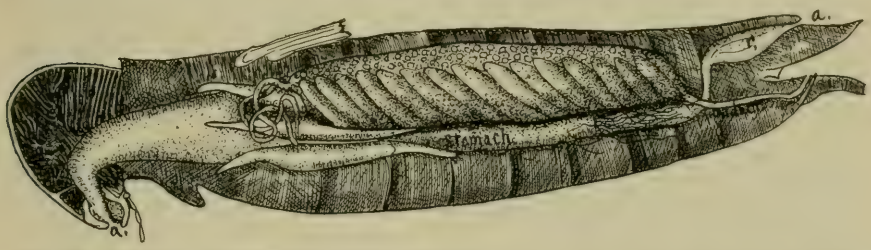

FIG. 28. (Original.) Reproductive system of female. Large egg sac lying above stomach; oviduct leading out above egg guide; *r*, rectum; *a-a*, digestive tract. Enlarged three times.

is believed that, in these insects, each egg is fertilized in passing from the ovary out through the egg duct. The number of eggs that the ovary of this insect will contain averages about 100.

Nervous system.—The nervous system is shown in Fig. 25. It consists of a series of ganglia, or collections of nervous matter, situated under the digestive canal. These ganglia are arranged along the body just next to the digestive tract. They are placed two together, and

these pairs, three pairs in the thorax and five pairs in the abdomen, are joined to each other and to the ones of the corresponding side by a cord of nerve tissue known as a commissure. This forms a double chain from the back part of the body up to the head, where a nerve band is formed around the esophagus; on the top of the esophagus are to be found the two largest ganglia in the body of the insect. These two ganglia found above the esophagus might be looked upon as the brain proper. From these there go out branches of nerves to the eyes, to the antennæ, to the maxillæ and mandibles, and other parts of the face.

MEASURES OF PREVENTION.

It is stated in sacred writ that there may come a time in the life of a man when the grasshopper shall be a burden. While this prophecy referred to the closing days of a man's life, it is evident that under certain conditions the grasshoppers might become a burden before man will have reached the time when the grinders cease because they are few. To avoid this burden, then, is a matter which will interest every one concerned, and to this subject we will now devote our attention, under the head of "Measures of Prevention"; and in this connection we will not discuss remedies in general, but those which we have actually tried in the localities interested, and which have proven most successful. We are glad to say that our experience has shown that in the cases under observation it is not by killing two birds with one stone, but rather three birds, instead of two, have been hit with the same missile.

As before stated, the conditions which favor the rapid multiplication of this species are, the soil undisturbed by cultivation, and food-plants which send forth nourishing vegetation early in the spring. These conditions are to be found in Kansas wherever alfalfa is sown and not cultivated thereafter, and where the small grain, such as barley and wheat, are sown without the ground being previously stirred. Wherever we have found these conditions we have found this species of grasshopper in burdensome numbers, together with other kinds of locusts in lesser numbers.

In the first place, I should like to call the attention of those interested to the subject of the value of cultivating wheat ground before sowing the seed. In making this suggestion, I am fully aware there is an opinion prevalent in the western part of this state that more wheat can be raised upon ground into which the seed has been placed without previous preparation than upon the same ground after having received some cultivation. While I am aware that this belief of the farmers is based upon observation covering several years, I believe that observations proving the contrary can be found.

In substantiating this statement, I refer to a tract of land near Goodland, Kan., the circumstances of which were related to me by Mr. Wm. Walker and Mr. G. L. Calvert, both of Goodland. This piece of land produced this year thirty-five bushels to the acre, and gave a quality of wheat that tested sixty-three pounds to the bushel. A number of pieces of wheat in the same locality were seeded by sowing in the stubble and gave only nominal yields. In this connection, it might be well also to mention the Campbell soil-culture method, which consists largely of thoroughly cultivating the upper layer of the soil and then thoroughly packing the same. Very favorable reports have been received concerning the results derived from this system of tilling the soil. And further, I am glad to make an extract here from a letter received from Hon. B. A. McAllaster, land commissioner of the Union Pacific railway. The extensive landed interests of Mr. McAllaster bring him in contact with many different soils, different climates, and different methods of culture. These facts make him speak advisedly when he says:

UNION PACIFIC RAILROAD COMPANY, LAND DEPARTMENT,
OMAHA, NEB., August 18, 1898.

DEAR SIR—I am particularly impressed with the statement made by you in the latter part of the paper, to the effect that the action of western farmers in not plowing their land except in periods of three to five years apart, is one of the principal causes for the increase of grasshoppers. It is and has been my opinion, very frequently expressed, that the crop failures in the western part of the state, which have been experienced during the past few years, are to a considerable extent due to this failure to properly plow and cultivate the land. It seems to me that a farm should be plowed every year in western Kansas, just the same as it is in other parts of the universe, and if, as alleged by the farmers as an excuse for their methods out there, the plowing of the ground allows the seed to be blown away by the high winds, that could be overcome by rolling the ground after plowing, or by using a subsurface packer. I believe that if I were a western farmer, I would prefer taking my chances of seed being blown away, rather than having the crop eaten up by the grasshoppers. Yours truly,

B. A. MCALLASTER, *Land Commissioner.*

The reader is also referred to the letters of Mr. C. J. Momyer, on page 15, and Mr. D. A. Long, on page 17, for opinions upon soil culture in western Kansas.

PLATE V. For Description, see Bottom of Opposite Page.

The subject of prevention, then, will be considered under two divisions, methods of cultivation and means of destruction.

ALFALFA CULTURE.

Since it has been shown in the previous pages of this publication that the conditions essential to the production of large numbers of these native grasshoppers are two in number: an undisturbed soil for the safe retention of the eggs, and an early food-plant for the nourishment of the young insect, every one who is familiar with an alfalfa field will readily see that in this field are two conditions which are highly adaptable to the production of these insects.

The problem which faced this department when attention was called to the subject two years ago was, how to disturb the solidity of the alfalfa field, destroy the eggs of the grasshoppers, and yet maintain the integrity and life of the plant. This is the problem which was not readily solved, and after a solution was presented it did not find ready acceptance.

The mode of procedure was as follows: It was already known that the alfalfa plant has a long tap-root, which extends many feet beneath the surface; and experiments showed that this root could be chopped and split at the top, and yet the life of the plant maintained with the same degree of vigor. The attention of the farmers had been called to this fact, and they were strongly urged to disturb the soil of their alfalfa fields with the disk harrow. Many were influenced to do this, but some were of the opinion that the fields would be injured by the process. A further discussion of the subject may be better set forth by giving a detailed account of the work carried on upon the land where the experiments of this department were conducted. Early in March, 1898, Mr. J. H. Smart, following instructions, caused disk harrows to be run over 160 acres of alfalfa ground belonging to the firm of Ball & Goddard, for whom he is superintendent. I have asked Superintendent Smart to give a brief statement of his work, manner of conducting the same, and his opinion upon the results. Believing that the same will be of great value to those interested, I have caused it to follow:

ALFALFA, IRRIGATION AND LAND COMPANY,
CATTLE BREEDERS AND DEALERS, KINSLEY, KAN.

The good effect of cultivation as applied to alfalfa has been very apparent this year on the land of the Alfalfa, Irrigation and Land Company, situated in Edwards and Ford counties, and operated by H. E. Ball, of Topeka, Kan. In

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DESCRIPTION OF PLATE V.—First crop of alfalfa; windrow in immediate foreground. This ground was thoroughly disked in March. For details, see Supt. J. H. Smart's letter, above. Land in Ford county. (Photographed by Hunter on July 23, 1898.)

March, 1898, we started two teams, disking 160 acres of alfalfa in Ford county. The harrow had twenty-inch disks and was set to cut about three and one-half inches deep, as an experiment. We afterward ran a light small-toothed harrow over the ground to level it after the disking. After this harrowing, the ground had the appearance of a wheat field that had been plowed very shallow. Almost immediately the good effect of the cultivation commenced to show, and so continued until the present time, not alone in the increased yield of alfalfa, but by destroying the native grasses which had not been entirely subdued when the seed was sown. I am of the opinion that the proper time to cultivate is early in the spring, while the ground is mellow, after the winter freezing, and the plant has not started to grow. The cutting up of the ground at this season of the year also exposes all the eggs of the insects to the action of the early frosts. This is very noticeable on this particular field, as there was not one-sixth as many 'hoppers as on an adjacent tract of an equal area, sown in the same season by the same party, and treated in every particular the same, with the exception of the disking given the former in the spring. The yield was one-third more and of a better quality than the land that received no cultivation. There was no bad effect on the plant to be noticed, such as cutting off the crown of the plant. It seemed to do it good. The yield of the second crop was a decided surprise. We will continue the disking of our alfalfa fields this winter and early spring. I will disk a part of the same quarter-section this spring that we did last spring, and note the effect. In addition to increase of yield and absence of grasshoppers, this field was very noticeable on account of being clear of weeds and free from native grasses. J. H. Smart, *Assistant Superintendent.*

My own observations upon this quarter-section I have endeavored to record, not only by means of words, but by photographs taken at the time, plates of which were made, and appear as plates I, V, and VI, with detailed descriptions given. The first crop averaged in height twenty-nine inches; stalks of extreme length were found thirty-three inches. This first crop was marked by an evenness in height of growth, and by the remarkable freedom from the presence of native grasses and noxious weeds. The second crop, however, appeared to me to show by far the more striking benefits derived from disking the ground, and, for an idea of it, I should like the reader to return to plate I, and note the height and luxuriance of the growth. This second crop averaged in height twenty-eight inches; stalks of thirty-two inches were found. I should like to say further, that the photographs were taken from different places in the field, and that one place in the field appeared to be equally as good as the other, with the exception of a low swale, where the ground was poor and non-productive. Concerning this second crop, it is not an exaggeration to say that, in thirteen counties traversed, I saw nowhere, *under any conditions*, a second crop of alfalfa which excelled the one upon this ground. It is of more striking interest to note that this crop was brought to maturity and harvested with no appreciable loss on account of grasshoppers, while two quarter-sections near by, of the same kind of soil, gave neither a first nor a second crop on account of the prevalence of

grasshoppers. Here it seems to the writer is an excellent example of the old expression, "killing two birds with one stone." The destructive influences of grasshoppers are removed, and at the same time and by the same work the yield is made more certain and of much greater quantity. Nothing was so convincing of this effect as a look over a quarter-section thus treated, and that this view might be given the reader, plates numbers I, V and VI are produced.

At the close of the season, I asked Superintendent Smart for an estimate of the yield of the alfalfa land under his care. His statement I will give verbatim: "In regard to the yield of alfalfa on our lands, I will say that the first crop raised on land that was disked was about one and one-fourth tons per acre, and the second crop, one ton per acre. We have harvested on our lands in Edwards and Ford counties, the past year, about 2500 acres, and the average yield for the first crop was three-fourths of a ton per acre, and the second crop, one-half ton."

Of further interest will be the wide experience of Superintendent Watson upon this subject; I have deemed it advisable to ask him to give his views, and these are as follows:

ALFALFA, IRRIGATION AND LAND COMPANY,
LAND DEPARTMENT.

I have been intimately connected with alfalfa culture in western Kansas for five years and have had charge of the seeding of 4000 acres. The advantages and profits arising from this crop are inestimable. No forage-plant is better adapted to the soil of the Arkansas valley than is alfalfa. I have observed, however, in recent years, a prevalence of native grasshoppers. The cause of their increase was not clear to me until my attention was called to their appearance in alfalfa fields, and that in territory away from alfalfa they were not so troublesome. For instance, I had a half-section of land on the high prairie in cultivation for eight years, and grasshoppers gave no trouble whatever. Four years ago I sowed twenty acres of alfalfa upon this tract. This year the grasshoppers caused damage to alfalfa seed crop and damaged forty acres of wheat joining. I am glad, however, to say that it has become evident that a better degree of cultivation will not only remove the grasshoppers, but also increase the quality and quantity of alfalfa produced. The alfalfa lands disked, upon our ranches, according to instructions, have shown remarkable freedom from grasshoppers, and very satisfactory increase in the alfalfa yield. If farmers will coöperate in cultivating their alfalfa fields in the early spring, and use the 'hopper catcher to capture any 'hoppers that may appear, it is very evident, since these are bred and die upon the same farm, that in a year or two there will be no further damage caused by them. GEO. W. WATSON, *Superintendent.*

PLATE VI. For Description, see Opposite Page.

THE HOPPER-DOZER.

See plates VII and VIII, figs. 29 and 30.

It has been shown that methods of soil culture which include the turning of the ground annually will destroy the locusts' eggs placed therein. It is evident, however, that some may escape and others hatch from undisturbed roadsides and pasture lands. To destroy these before the egg-laying time means not only a cessation of the damages caused by these, but also that every female killed causes a reduction of the number of young the following year to the amount of at least 100 individuals.

The simplest and most effectual machine, the one used by the department in its field-work this year, is commonly known as the hopper-dozer. The plan of construction, it is believed, can be best set forth by means of a sketch, giving dimensions of material used and showing positions in which each part is placed. Hon. Thos. H. Ford, of Syracuse, kindly sent me the plan of the one made under our direction and successfully used by him this season, and this is here shown. This machine cost Mr. Ford, in complete form ready for use, five dollars.

The pans are more readily constructed from two sheets of galvanized iron, and more easily handled. These pans should be two feet wide, four inches deep in front and eight inches at back. While it cannot be easily shown in the sketch, yet it must be understood that these pans are laid upon 1 x 4 boards previously nailed to runners. The height of the runners is not given, since that depends upon the height of crop to be protected. It is important that there be no timbers in front of pan, so that the front line of the pan may come in contact with the grain passed over. The insects then fall directly into the fluid.

When the machine is ready for use, place two buckets of water and one-half gallon of coal-oil in each pan, and then drive back and forth across the end of the field where the grasshoppers are entering until you have filled the pans, remove insects, replenish with oil and water, and continue until the field is rid of the pest.

There will be many grasshoppers strike the sheet-iron back, drop into the pans and immediately jump out again. Those farmers who watched the experiments this year were at first of the opinion that the locusts that jumped out had jumped away "to live another day." The writer asked those interested to watch the insects and note the actions

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DESCRIPTION OF PLATE VI.—Photograph of the disked alfalfa field in Ford county, showing the alfalfa yield: in swath in foreground, in windrow in background. Sand-hills in the distance. (Photographed by Hunter, July 23, 1898.)

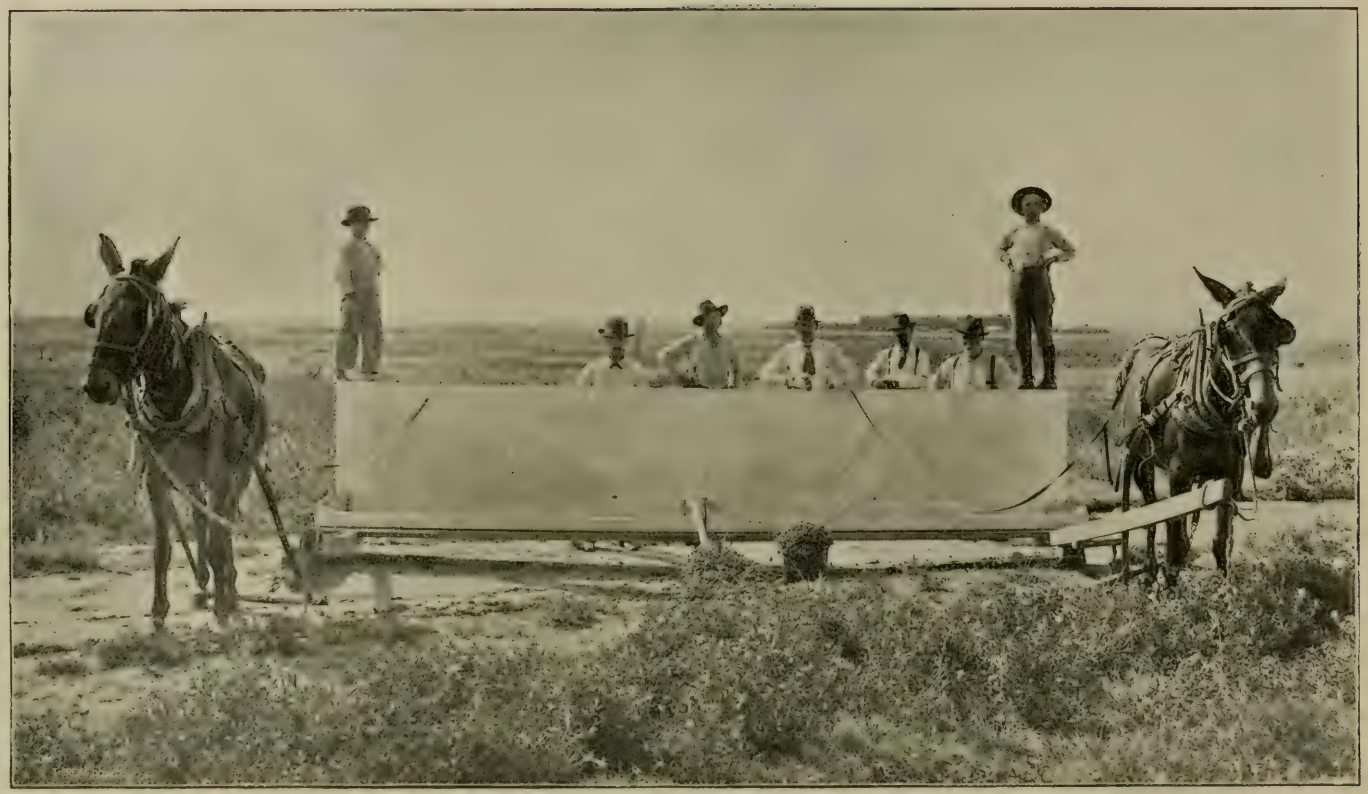

PLATE VII. For Description, see Opposite Page.

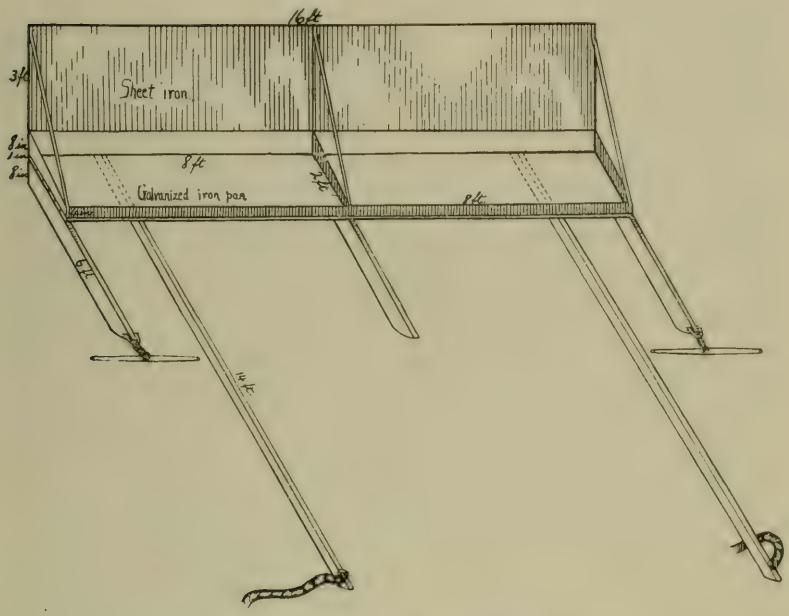

FIG. 29. (Original.) Plan for hopper-dozer.

of a grasshopper that had jumped out. In every case the report was that the insect "became sick and soon died." In fact, persons going over fields where a day or so before the hopper-dozer had been at work were impressed with the number of dead grasshoppers scattered about on the ground. An examination showed the presence of coal-oil upon the body.

This coal-oil and water is an external irritant, and my observations have been that the mixture is more effective than the pure oil alone.

The use of the machine may be best shown by examples. In Ford county this season a large tract of alfalfa was cut, and the locusts at once began moving into a large field of Kafir-corn which had been sown broadcast. The hopper-dozer was drawn back and forth across the end of the corn-field nearest the alfalfa land until a portion of the field about twenty rods deep had been gone over. Here it was apparent that there were very few grasshoppers; or, in other words, the advance line of the locusts' march only extended twenty rods into the

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DESCRIPTION OF PLATE VII.—Hopper-dozer at work on the ranch of Hon. Thos. H. Ford, Hamilton county. The photograph is taken in alfalfa field, which is being protected for seed crop. Quantity of grasshoppers just taken from pans can be seen in front of pans. This machine was made after instructions of this department, except the 2x4 fourteen-foot extending forward by the side of each mule. These were added by Mr. Ford, and are of great value in steadying the machine. (Photographed by Cass.)

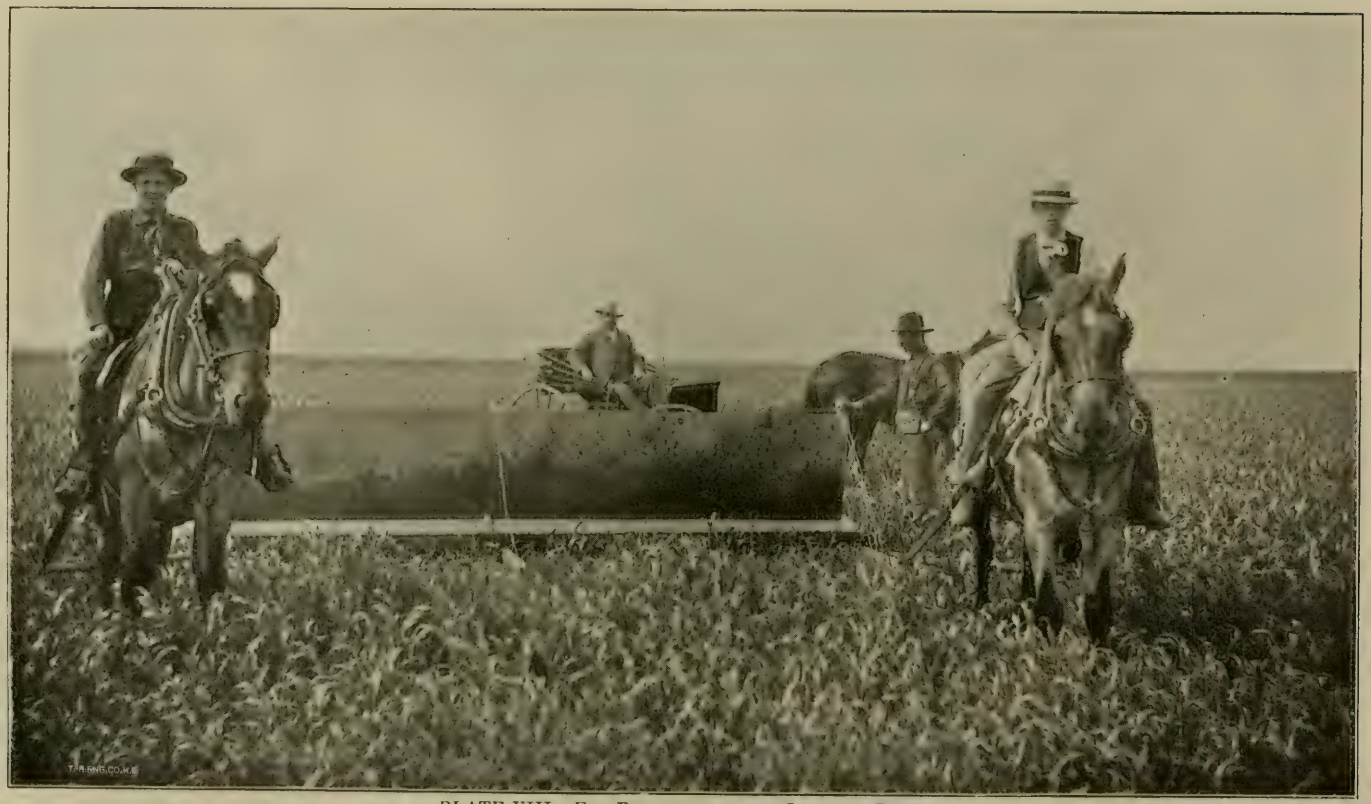

PLATE VIII. For Description, see Opposite Page.

FIG. 30. View in front of hopper-dozer, showing quantity of grasshoppers just taken from the pans.

field. Two days later the same amount of ground was covered, but not as many insects were taken. Grasshoppers no longer entered this corn and the hopper-dozer was no longer used at this point.

It has been my experience with this machine that after it has passed over vegetation it does not injure the plants, but in some way renders vegetation distasteful to the grasshoppers, so that they turn their course and seek food elsewhere.

I have observed that these native grasshoppers enter a field from one corner or side, and that they are not as a rule scattered over the whole field, but occur in great numbers in patches. This being the case, it is evident that with very little labor with this machine the products of a field can be given full opportunity to mature.

Mr. Ford, of Hamilton county, used this machine to protect the alfalfa seed crop. He did not stop, however, with guarding this field, but caught them wherever they were to be found. Some weeks after I left, Mr. Ford wrote me: "I am catching them whenever I get time, and I am now satisfied it is a solution of the grasshopper problem." The machine is much more efficient upon bright, warm days, when the insects are upon the vegetation and active, than upon cold, cloudy days, when the young locusts are resting sluggishly upon the ground.

DESCRIPTION OF PLATE VIII.—Hopper-dozer at work in Kafir-corn on north ranch of Ball & Goddard, Edwards county. J. H. Smart, superintendent; Wm. Weber, foreman. Native grasshoppers had entered this corn from newly mown alfalfa field on the left, outside of view in picture. (Photographed by Hunter, July 20, 1898.)

In 1891, in Minnesota, more than 200 of these machines were made and used. It was estimated that 5000 bushels of young grasshoppers were caught with these machines.

SPRAYING.

There is one crop which at the time of alfalfa harvest is too high for protection by means of the hopper-dozer; that is the growing corn. This can be readily protected by driving along the outside corn rows and spraying the corn thoroughly with Paris green, one pound to sixty gallons of water. The insects entering will feed upon the leaves and die. These rows should be sprayed about once a week until the grasshoppers have disappeared. Having neglected to place in my equipment a spraying pump, I was unable to conduct experiments and note results. I give this as a remedy without trial, and believe it will prove a sure destruction to all locusts entering the corn. The five or ten rows of corn thus sprayed had better be removed before the field is pastured. I see no reason, however, why the ears of corn when husked would be in any way dangerous.

SUMMARY.

Native grasshoppers require certain conditions for their increased multiplication. The grasshopper prevalent this year is frequently called the yellow locust, better known as the Differential Locust.

Large areas of undisturbed soil for deposition and protection of eggs, attended by early spring vegetation for nourishment of newly hatched young, are the essential conditions.

These native grasshoppers, especially the Differential Locust, show decided preference for cultivated ground and roads adjacent to places suitable for oviposition. This Differential Locust, contrary to supposition, does not require soil entirely free from grasses for oviposition, but will sometimes deposit its eggs among the roots of a bunch of buffalo-grass.

Wheat drilled in stubble or unplowed ground, alfalfa permitted to grow on the same undisturbed ground from year to year, furnish ideal surroundings for the welfare and productivity of native grasshoppers.

Wherever these conditions are found, in any state in the union, native locusts will appear in numbers directly proportionate to the area containing their required conditions.

Wheat, oats and barley were not disturbed this season in vicinities where large areas were devoted to alfalfa.

Differences of opinion exist concerning the best methods of soil culture for wheat. If grasshoppers damage crop, thorough tilling and packing of the soil previous to sowing seed should be the only method used. Unless this is done, harvesters may be produced on the same ground who will reap the rewards. Crop profits are figured from the granary.

In alfalfa culture, if the grasshopper proves an incentive to proper cultivation, the insect is a blessing in disguise.

Disking alfalfa fields in the early spring, after the frost has left the ground and before vegetation has well started, increases the yield of the first crop one-third; matures the second crop earlier, and brings from it an equally increased yield; destroys the native grasshopper eggs placed therein, and kills the native grasses which frequently threaten to reclaim the field.

The young grasshoppers that may hatch from undisturbed ground must be destroyed. They are raised upon the farm where found. The only way to go out of this kind of stock-raising is to kill all the stock. This can be readily done by means of the hopper dozer. The time to use this is as soon as the young insects begin to hop in the spring. Every female grasshopper killed means one hundred grasshoppers less the next year.

Contagious diseases and mortal enemies among the lower animals have thus far failed to keep these native locusts in check. It has been demonstrated that man can do it; upon him rests the responsibility. Proper cultivation and vigorous and intelligent use of the hopper-dozer will free any farm of this locust, and the labor expended will be the best investment of the year. The greatest good, the permanent reduction of this locust, can be brought about by the active, persistent coöperation of all concerned.

GRASSHOPPER LAW.

Below we print an extract from the General Statutes of Kansas relating to the destruction of grasshoppers, and found in volume 2 (1897 edition), on page 939.

CHAPTER 120, SESSION LAWS OF 1877.

SEC. 5. In any senatorial district in the state of Kansas where trouble is anticipated from the ravages of young grasshoppers in the year 1877, and any subsequent year thereafter, it shall be lawful for the counties in said senatorial district to coöperate together in the way and manner herein provided for the destruction of the same.

SEC. 6. The chairman of the board of county commissioners in the county having the largest number of inhabitants in a senatorial district, where two or more counties form said senatorial district, may notify the chairman of each of the boards of county commissioners of the remaining counties in said district of the time and place when the chairmen of the several boards of commissioners of the respective counties forming said senatorial district shall hold a joint meeting.

SEC. 7. At such meeting two of their number shall be chosen to act as chairman and secretary, and the proceedings of the meeting shall be published in all the newspapers printed in the senatorial district.

SEC. 8. Said meeting shall designate the manner of procedure by road overseers, and what day or days the young grasshoppers should be driven from the cultivated land onto the unburnt prairie or places of destruction, and shall also

designate on what day or days the grasshoppers shall be destroyed, by burning or otherwise, in said senatorial district, giving at least ten days' notice of the same by publishing in the newspapers of the said district.

SEC. 9. The board of commissioners of each county shall notify the road overseers of said county of the time fixed upon by the joint meeting for the driving and burning, or destroying by other means, of the grasshoppers in the district; said notice to be given to said road overseers as soon as practicable after the same shall have been determined by the joint meeting.

SEC. 10. Said road overseer shall immediately notify the residents of his road district of the time designated and the manner of procedure, in order to carry out the provisions of this act. He shall also specify what tools or implements will be required by each resident in performing the labor required by him: and such notice may be enforced the same as in the act authorizing road overseers to warn out the residents to perform road labor: and a refusal shall subject such persons refusing to the same penalties as are provided by law in such cases.

SEC. 11. The road overseer shall direct the manner of performing the labor, and have the supervision of the same, and shall keep a list of the names of those who shall perform labor, and shall certify to the number of days' work performed by each, and shall place such certified list in possession of the board of county commissioners of his county.

SEC. 12. It shall be lawful for two or more senatorial districts to coöperate together under the provisions of this act, on a basis of action which they may agree upon.

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TECHNICAL DESCRIPTION.*

The largest of our species of Melanopli, and heavy bodied: excepting the hind legs and the lateral lobes of the pronotum, the general color is a nearly uniform brownish testaceous, becoming paler testaceous in specimens from arid regions: in those from Nebraska, Kansas and Colorado it is sometimes a blackish green, while in those from Illinois and Indiana it is often of a dark brownish green. 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 expansion below, broadly and shallowly sulcate below (and including) the ocellus, punctate: eyes moderately prominent, short, not a great deal longer than broad: antennæ fulvo-testaceous, nearly twice as long (male) or fully half as long again (female) as the pronotum. Pronotum subequal, the metazona ex-

*S. H. Scudder, in Proc. Nat. Mus. Vol. XX, pp. 350–352.

panding somewhat, the disk of the prozona sometimes (but not always) very feebly tumid, the front margin feebly convex, the hind margin obtusely and roundly angulate, more obtusely in specimens from the Pacific coast than in others, the median carina distinct and sharp on the metazona, less prominent but distinct on the anterior half of the prozona, still less distinct (occasionally subobsolete) between the sulci; prozona subquadrate in both sexes, smooth, divided in the middle, and barely before the middle of the posterior half, by sulci, the principal sulcus bent forward in the middle by the posterior emargination of the prozona, the metazona plane finely subruguloso-punctate; lateral lobes nearly vertical, separated from the disl by a well-rounded angle nowhere forming distinct lateral carinæ, marked next the upper limit on the proxona by broken blackish patches, frequently reduced to a pair of short, oblique black dashes, one in either longitudinal half of the prozona, each in a clearer field, and also by the blackening of the sulci in this region. They are sometimes accompanied by slender, oblique, parallel black lines lower down, the hinder the lower: the pleural incisures are also heavily marked in black. Prosternal spine rather long, conical as seen from the side, bluntly cylindrical as seen from in 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 broad as the broadest subbasal portion; wings pellucid or (in darkest forms) very feebly infumated, feebly and narrowly opaque along the costal margin, the veins and cross-veins mostly brownish fuscous. 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 postmedian black patches, the genicular arc black on both inner and outer sides; hind tibiae yellow or fulvous (occasionally in California bright coral red), with a postbasal narrow black annulus (in dark specimens more or less infuscated beyond it), the spines black to their very base, ten to eleven, rarely twelve, in number in the outer series. Extremity of male abdomen heavily clavate, the supra-anal plate subclypeate, obtusely angulate at apex, the margins feebly and broadly elevated and the median portion correspondingly elevated and bearing on its summit a moderately shallow, longitudinal sulcus, tolerably broad and subequal on the basal half, narrowing and with falling walls apically; furcula completely absent or indicated only by a thickening of the last dorsal segment at their proper position; cerci very large and coarse, laminate, boot-shaped, the basal half subequal, punctate and straight, beyond expanding and at the same time feebly bifurcate, the upper fork as long and more than half as broad as the base, feebly invurved, strongly upcurved, apically tapering slightly and well rounded, the lower fork at right angles to it, forming only a rounded, downward and posteriorly projecting lobe, so that the apical margin of the whole is deeply and roundly emarginate below, the whole surpassing a little the supra-anal plate; infracercal plates wholly obscured; subgenital plate short and broad, scarcely so broad apically as long; the apical margin thickened, but hardly otherwise either elevated or prolonged, entire; upper valve of ovipositor abruptly upturned apically and sharp acuminate, the upper outer carina feebly serrate.

Length of body, male 39 mm., female 41 mm.; antennae, male 18 mm., female 16 mm.; tegmina, male 32 mm., female 34.5 mm.; hind femora, male 20 mm., female 23 mm. Some specimens, especially from the north (Illinois, *e. g.*), are hardly more than half this size.

Part II.

ALFALFA AND BEES.

W. D. FULTON, GARDEN CITY.
WM. MILLER, EMPORIA.

SOME KANSAS APIARIES.

DR. T. J. CONRY, FLORENCE.
J. H. WING, SYRACUSE.

INTRODUCTION.

IN industry, productivity, adaptability, and utility, the class Insecta produces none superior to the honey-bee. The head secretes a lactic fluid; the tongue collects nectar; the honey stomach begins the transformation of nectar into honey; the abdominal plates manufacture wax, and the posterior extremity is the seat of the defensive organ, the gland of which secretes formic acid. Every available bit of space is taxed to produce its required quota of valuable material.

In the economy of nature, the bee is depended upon to care for itself and its offspring. Should it be considered a source of profit, intelligent management must be added to secure margins; and it can be safely said the depth of these margins is directly proportionate to the amount of time, thought and attention invested. This supervision does not consist alone in the manipulation of the hive and its occupants, but includes, as well, provision for requisite pasturage from which ample supplies may be gathered.

It has been deemed expedient to place in this connection a treatise upon practical methods in the manipulation of bees. "A Year with the Bees" has been ably prepared by Mr. A. H. Duff, of Larned, Kan., who has devoted his attention almost exclusively to bees and beekeeping for the past thirty years. His early experience was gained in Ohio. This enables him to speak advisedly upon methods peculiarly adapted to Kansas. Mr. Duff, however, needs no introduction to the apiarists of Kansas, since he has conducted for years the apiary department of the *Kansas Farmer*, and is a regular correspondent upon apiculture for a number of other leading journals.

During the past summer the writer was placed in an excellent laboratory, the field, for observation and study of alfalfa as a honey plant, and the action of the bees thereon. Many apiaries in the alfalfa region were visited, observations made upon the conduct of bees toward alfalfa grown under varied conditions, and correspondence carried on with leading apiarists from all parts of the state. The qualities of alfalfa honey have also been chemically compared with the other leading varieties of honey, by Dr. E. C. Franklin, of the department of organic chemistry, a well-known authority upon sugar analysis. Doctor Franklin was assisted by Mr. J. C. Swayze, an advanced student of that department.

The pages following show that alfalfa, under Kansas conditions, produces a quality and flow of honey surpassed by no other plant. A few speak with great favor of Alsike clover, but the observations upon this clover have in each case been made upon small plats of ground. The plant is by no means generally cultivated in the state.

The greatest enthusiasm manifested upon apiculture is found in localities where large areas of alfalfa exist. The wives and daughters of many agriculturists and of some merchants, find pleasure and profit in caring for bees. Many keep bees simply for the table luxury derived.

The bees gather the nectar from the blossom, and at the same time insure the formation of seed where the blossom was. The results noted show that the seed crop of alfalfa upon which bees worked was 66⅔ per cent. greater than the crops taken from alfalfa dependent upon other insects for pollination.

Many flowers cease to secrete nectar after being pollinated. Alfalfa continues to secrete nectar until the blossom begins to wither. The only objection found with alfalfa is the not infrequent removal of the plant for hay during the blooming stage. It is no unusual thing, however, to find within range of the apiary several thousand acres of alfalfa. Here, the second crop is in bloom before the first is all in the swath, and this continual blossoming places the coveted nectar before the bee from the 15th of June until the middle of October.

This publication is sent forth with a desire that the resources of the alfalfa plant may receive the attention due them, and that those unacquainted with the honey-bee may become familiar with its good qualities, may appreciate the luxuries of the hive, and find in the bee not only a source of profit, but also a work of pleasure.

VARIETIES OF BEES.

The common name, bee, is applied to many forms of the order Hymenoptera. It is not within the province of this work, however, to enter into a discussion of the genera of bees within the order, but simply to confine the treatise to the species technically known as *Apis mellifica*, commonly spoken of as the honey-bee.

It is taken for granted that the name honey-bee is sufficiently familiar to require no further definition. Under this head, however, we find a number of kinds of bees; some speak of them as varieties, others as distinct species. It will suffice for our purpose, at present, to consider all as varieties of the one species, *Apis mellifica*, and to refer to each variety by the name popularly known.

The varieties of bees which have been brought to this country, for the honey-bee is originally a foreigner, are the brown or German bee,

the Italian, the Egyptian, the Cyprian, the Syrian, the Palestine, the Carniolan, and the Tunisian. Believing that the interest of the bee-keepers in Kansas will be centered around the German bees, the Italians, Carniolans, and Cyprians, I will speak in detail of these only.

GERMAN BEES.

The German or brown bee was the first bee brought into this country. In the early settlements of North America these bees, after introduction, went in advance of the settlers, notifying the Indians of the encroachments of civilization. Thomas Jefferson, in his history of Virginia, says that the natives called the honey-bee "the white man's fly": so the German bee not only established the first honey factories in the United States, but also the first institutions of civilization in many localities.

This bee is a native of middle and northern Europe. The species now among us is referred to as the black or brown bee. The characteristics of this bee may be summed up as follows: It has a highly irritable temper; by some it is termed cross, in that it not infrequently leaves the hive to attack a passer-by. This disposition varies somewhat with different strains. It is not a good neighbor, but frequently quarrels with others in the bee village. When long under manipulation it is liable to stampede, if such a term may be used, and the results of this turmoil may be, at least, disagreeable. It is not the best defender against robbers, it is slow to learn a new locality, rather slow in building up in the spring, easily discouraged. It is a good honey gatherer, flies early, ranks high as a comb builder. For those who market comb honey, this bee furnishes artistically white-capped comb. Its irritable disposition frequently overshadows its commendable qualities and loses it many friends among the apiarists.

CARNIOLAN BEES.

The Carniolans may be considered the other extreme in disposition. They are notably gentle. In color they resemble the German bee; in structure, however, they are larger and more robust. The rows of dense silvery white hairs on posterior portion of each of the abdominal segments mark these bees distinctively. This bee seems to obtain the good qualities of the German bee and none of the bad. It is a good comb builder—makes beautifully white-capped comb This bee uses little propolis, winters well, is long-lived. While it is a hard-working bee, a great accumulator of honey, it tends to swarm frequently. This objectionable feature, however, can be controlled by the intelligent apiarist.

PLATE II. (Original.) Enlarged twice.

CARNIOLAN QUEEN.

CARNIOLAN DRONE.

CARNIOLAN WORKER.

ITALIAN QUEEN.

ITALIAN DRONE.

ITALIAN WORKER.

ITALIAN BEES.

The United States department of agriculture in 1860 introduced these bees from Italy, and through the energy of this department they have been widely spread. For this reason they are well and favorably known.

The chief distinction in the appearance of this bee is the color. The hairs spoken of previously are present, but are yellow; the first three segments of the abdomen are for the most part tawny yellow. Leather or tan colored is a term sometimes used for this shade upon this bee. The first ring of the abdomen faces toward the front and the band upon this may be overlooked. The second segment is smooth yellow in front; this is hairless, because it passes beneath the segment in front of it when the body contracts. The central portion of this segment is covered with yellow hairs and the body at this point is yellow. The back portion of this segment is glossy black and covered with very fine hairs. The markings of the third ring are the same as the second. The fourth and fifth segments are black, but covered with yellowish hairs. The sixth segment is black, and bears very few hairs. The queens vary in color. The one shown on plate II (page 70) was a beautiful queen, abdomen yellow, with small brown spots upon upper median line of each segment of abdomen. The drones are smaller than the drones of the black bee and darker than the Italian workers.

These bees are usually gentle, bear manipulation, and remain firmly upon the comb when this is being handled. They fight hard, long and successfully for their homes; but this strength and this tenacity are sometimes turned in the wrong direction, and these same defenders become bold and persistent robbers of others' gains. They repel the moth with success. These bees are hard workers, at it early and late, excellent honey collectors, but care is required to avoid too great attention on the part of the bees in rearing young with the surplus stores.

CYPRIAN BEES.

A few colonies of Cyprians are to be found in this state, but not in representative numbers nor in numbers sufficient to draw conclusions upon them in this climate. Their temper is anything but cheerful when thoroughly aroused; their use of their weapon of defense is excelled by none of the varieties previously mentioned. This fault has prevented their general adoption. This variety has the largest honey record per hive for a single season. They winter well and are good defenders. Their comb is better for extracted than for comb honey. They fill the cups so full that cap and honey touch, giving the comb a watery appearance. They build comb well. They are

smaller than the German bee. Orange bands are apparent upon the first three abdominal segments. They are exceeding thrifty, and are said to thrive where others fail entirely.

A statement of the qualities of these bees has been given without an attempt to point out the one best adapted for this region. The Italians are justly popular. The black bee is still with us. The Carniolans and Cyprians are comparative strangers within our borders. If an opinion were asked, it would be that the Italians and Carniolans will merit every attention in this locality. Hybrids are being used to some extent, but a discussion of the various objects sought and qualities attained by this process will hardly apply here.

SOCIAL ECONOMY OF THE HIVE.

This communistic society contains three divisions, unequal in number but of equal importance in function. The colony is composed of a queen, the impregnated female, the drones or male element, and the workers or undeveloped females.

THE QUEEN. Before her true function was known she was termed the "king bee" on account of size. This, the most attractive personage in the hive, is more frequently ruled than ruler. She receives every attention that can be bestowed upon her by her attendants, the workers, and well they may caress her, for around her centers the existence of the hive. The difference between a queen and a worker is caused by the difference in the amount and the character of the food given each in the earlier stages of development. As Cheshire would say, the workers are weaned and the queen nurses during her lifetime.

Queens are developed in two ways, each under different circumstances. In the natural procedure the queen cell is made, the fertilized egg placed therein, and the young larva fed, instead of the bee-bread intended for bees, royal jelly, a substance resembling blanc-mange, a food given forth from an active gland in the head of the nurse bees. Should the colony be deprived of its queen, the workers hasten the appearance of a new queen by tearing down the partition walls between three surrounding cells, taking the contents away, and leaving one egg to be fed for the throne. The egg hatches in about three days after being laid. About six days are spent in the worm or larval state, then seven in the quiescent or pupal state. In some cases the workers choose a cell containing a larva for the production of an emergency queen. If the workers choose a worm as a princess, the time from formation of cell to emergence of queen will be shorter than the full sixteen days a number of days equal to the age of larva, including egg period. Cheshire has shown that emergency queens are not equal to queens produced in the natu-

ral way. He further states that it is highly improbable that the bees can develop a queen from worker larvæ which had begun to be fed bee-bread. The large queen cell extending out from the comb, frequently hanging down not unlike a peanut in shape, is easily recognized. Queen cells are illustrated in Mr. Duff's article, further on.

A few days after maturity the virgin queen leaves the hive on her marriage flight. She is met high in the air by a drone and fertilization takes place. She returns to her hive and there remains with the colony. The act of pairing takes place but once in the lifetime of a queen.

About two days after impregnation the queen begins laying. If a very fertile queen, she will deposit from two to three thousand eggs daily. While the worker exhausts itself and dies in a few weeks, or months at the most, the queen is of greatest service to her colony for two years, and while she will live longer it is not advisable to retain her beyond that time.

THE DRONE is developed from the unfertilized eggs placed in cells somewhat larger than worker cells. They develop in about twenty-four days, remaining three in the egg, six in the larval, fifteen in the pupal stage. These are reared in larger numbers during the swarming season. This is nature's provision for the marriage flight of the queen. Were the drones few in number, it would be very probable that many queens would fail to meet a mate in the air. As it is, many drones are in mid-air searching for mates and the fertilization of the queen is assured.

The fact that the drones are reared from unfertilized eggs, the unmixed blood of the queen, and that workers are short-lived, make the introduction of a queen into the hive a matter of much importance. For it will be readily seen that with the introduction of a new queen, new drones of her exact strain soon appear. If the queen has been tested, and found to be purely mated, then the queens reared from the eggs will be pure, and these will now mate with pure-bred drones and their progeny will be a pure strain. The workers of the queen introduced will be pure bred and will shortly replace the native workers, who will have lived out their existence.

This refers to a single colony. It must be noted in this connection, however, that in an apiary one colony of an inferior strain may contaminate many other colonies in a single season by sending forth drones to breed with the pure queens of the other hives in the apiary.

THE WORKER. This is the bee familiar to all of us: the one respected for its business air, as well as its powers for defense. The writer has realized the industry and activity of this marvelous little

honey gatherer when endeavoring to take its photograph while it was at work upon some of its favorite food plants.

The number of individuals in a good colony ranges from 20,000 to 80,000, according to the time of the year. The number can never exceed the laying powers of the queen for the season, and rarely, if ever, equals that number. Workers mature in about twenty-one days, spent in the following stages: Three days in the egg, five in the larvæ state, and thirteen as a pupa or chrysalis.

The division of labor among the workers is discussed in another portion of this work. A young bee is easily known by its pale color and lack of strength. In a few days it grows larger, develops strength and color, and is well covered with hair. The aged worker is known by its tattered wings and bald body. The average life of a bee in the working season is about five weeks.

BEE PRODUCTS.

The bee is capable of bringing to his hive four things: Bee-bread, propolis or bee-glue, royal jelly, and honey. In addition to these, the bee carries, to be used in case of defense, a gland filled with poison, consisting chiefly of formic acid. The larva has facilities for spinning silk.

Bee-bread is the pollen gathered from flowers, brought in upon the so-called pollen baskets of the hind legs, and placed, generally, in worker cells, packed down, then covered with honey and the cells sealed. This food is indispensable for the rearing of young brood. Huber demonstrated that young bees could not be reared without this pollen, though this without honey will not support mature bees.

Propolis, or bee-glue, is a resinous substance gathered from the buds and limbs of trees. The bees use it to seal over cavities or unnecessary openings in their hives. In the heat of summer this remains soft and is used by the bee-moth as a receptacle for eggs. Hives should therefore have as few cavities as possible, and a poor quality of lumber, or boards partly split, should be avoided in the choice of material for hives.

Royal jelly is a milk-like substance secreted in a gland within the head of the nurse bees. This is fed to all bees — workers, drones and queens alike. The workers and drones, however, are favored with this highly nitrogenous food during the first days of their larval existence, only until their stomachs become ready to digest the bee-bread. The embryo queens are more favored and this royal jelly is lavished upon them during their development. According to Cheshire it is the food of queens during their whole lifetime.

Silk.—The pupal cell is partially lined with silk. This is spun from glands in the head of the larvæ. These glands are not used after the bee reaches maturity.

Wax is a secretion which in the form of plates appears on the ventral surface of the second, third, fourth and fifth segments of the abdomen. The wax is primarily secreted from the blood-cells as a fluid, and becomes more firm when it is transuded upon the abdominal wax pockets shown in the accompanying figure 1. It was erroneously believed for a long time that wax was pollen digested and then regurgitated. It is what might be termed surplus energy, or a case quite parallel to the secretion of fat in animals. Young bees secrete wax well; old bees produce littlewax. The same may be said regarding fat-producing powers of young and old animals. The production of wax exhausts the strength of the bees, and is a heavy tax upon the stores of honey. The bees intending to produce wax gorge themselves with honey, and in about twenty-four hours afterward wax begins to transude and appear upon the wax plates of the abdomen. It requires from ten to sixteen pounds of honey to produce one pound of wax, according to Langstroth. Some authorities state greater weights and some less. When the amount of honey consumed is reckoned, the matter of comb foundation and subject of care of empty comb should receive careful attention.

FIG. 1. Secretion of wax scales. (Enlarged, from "Illustrierte Bienenzeitung.")

Honey.—The reward most coveted is expressed by this word. The word itself has a pleasing sound. It is the symbol of sweetness. The bee, bearer of this esteemed delicacy, collects nectar from the nectaries of flowers and sap from the trees—a little here, a little there. These fluids in their watery state are taken into the honey sac (pl. III), corresponding to the crop of other insects; instead of passing on into the stomach, the sweet fluid is retained here until the hive is reached. A reference to plate III at this point will make the subject of the honey sac, stomach mouth and stomach sufficiently clear for the purpose of this discussion. The watery nectar of flowers and sap of trees is reduced to the consistency of honey, either by secretion of the water from the bee's honey sac, or evaporation caused by heat and currents of air in the hive. These currents of air, forced by the fanning of bees' wings up through the hive and over the uncapped honey, do much toward ripening and removing unpleasant (probably volatile) flavors. Formic acid is found in honey; the exact form and amount have not been satisfactorily determined by chemists.

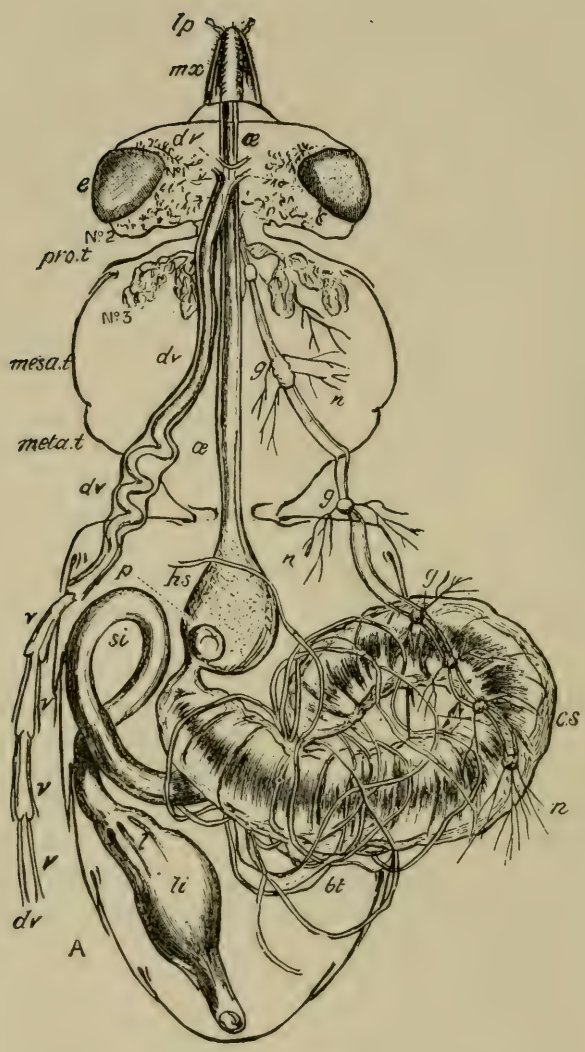

PLATE III.

Digestive system of bee, magnified ten times (after Cheshire). *A*, Horizontal section of body; *lp*, labial palpus; *mx*, maxilla; *e*, eye; *dv*, *dv*, dorsal vessel; *v*, ventricles of the same; *No. 1*, *No. 2*, *No. 3*, salivary gland systems, *1*, *2*, *3*; *œ*, œsophagus; *pro.t*, prothorax; *mesa.t*, mesathorax; *meta.t*, metathorax; *g*, *g*, ganglia of chief nerve chain; *n*, nerves; *hs*, honey sac; *p*, petaloid stopper of honey sac or stomach mouth, *c. s*, chyle stomach; *bt*, biliary or malpighian vessels; *si*, small intestine; *l*, lamellæ or gland plates of colon; *li*, large intestine.

While attending the National Beekeepers' Association, at Omaha, the writer was greatly impressed by the display of the varieties of honey. This publication being then in course of preparation, Commissioner Whitcomb and Superintendent Stilson, of the department of bee industries, very generously furnished five samples, from which the accompanying photograph and chemical analyses were made. The varieties sent and donors were: Basswood (*Tilia americana*), from the apiary of L. D. Stilson, York, Neb.; knotweed (*Polygonum pennsylvanicum*), E. Whitcomb, Friend, Neb.; white clover (*Trifolium repens*), L. M. Whitford, Arlington, Neb.; sweet clover (*Melilotus alba*), L. D. Stilson, York, Neb.; alfalfa and melon bloom, G. D. Swink, Rocky Ford, Colo. The alfalfa (*Medicago sativa*) honey was sent direct to the department through the kindness of Capt. J. H. Wing, of Syracuse, Kan.

The comparative lights and shades of these varieties of honey are shown in plate IV, and a careful analysis of the same has been made by Dr. E. C. Franklin and Mr. J. C. Swayze. Their results appear on page 79.

As may be inferred from the title of this treatise, the subject of alfalfa honey would come under consideration. I can conceive of no better method of procedure than that of comparison, and upon that plan I have here carried on the investigation. Cheshire's definition of ideal honey is, "An ideal sample would have a delicate but characteristic aroma, a rich flavor, leaving a distinct impression on the back of the palate, and would be of a straw or pale amber color. It should possess perfect clearness, and, as distinct from clearness, brightness due to a high refractive index, with density almost amounting to toughness, so that the air beneath the cork should rise very slowly through the mass upon the inversion of the bottle." Of the six samples submitted, a competent judge placed the alfalfa honey as the one most nearly approaching this standard. Especially was this so with regard to the color and toughness. The six were inverted in the tubes, and the other five were free from the air bubbles in a short time, as compared with the alfalfa sample. The color of pure alfalfa honey is certainly highly desirable. The six test-tubes on plate IV, while not showing the exact tints, illustrate the comparative degrees of light and shade. They might be said to range from very light straw (*6*) to dark amber (*2*). See next page.

The tastes and flavors, largely personal elements, are not susceptible to chemical tests or verbal descriptions; to be illustrated and appreciated they must be experienced.

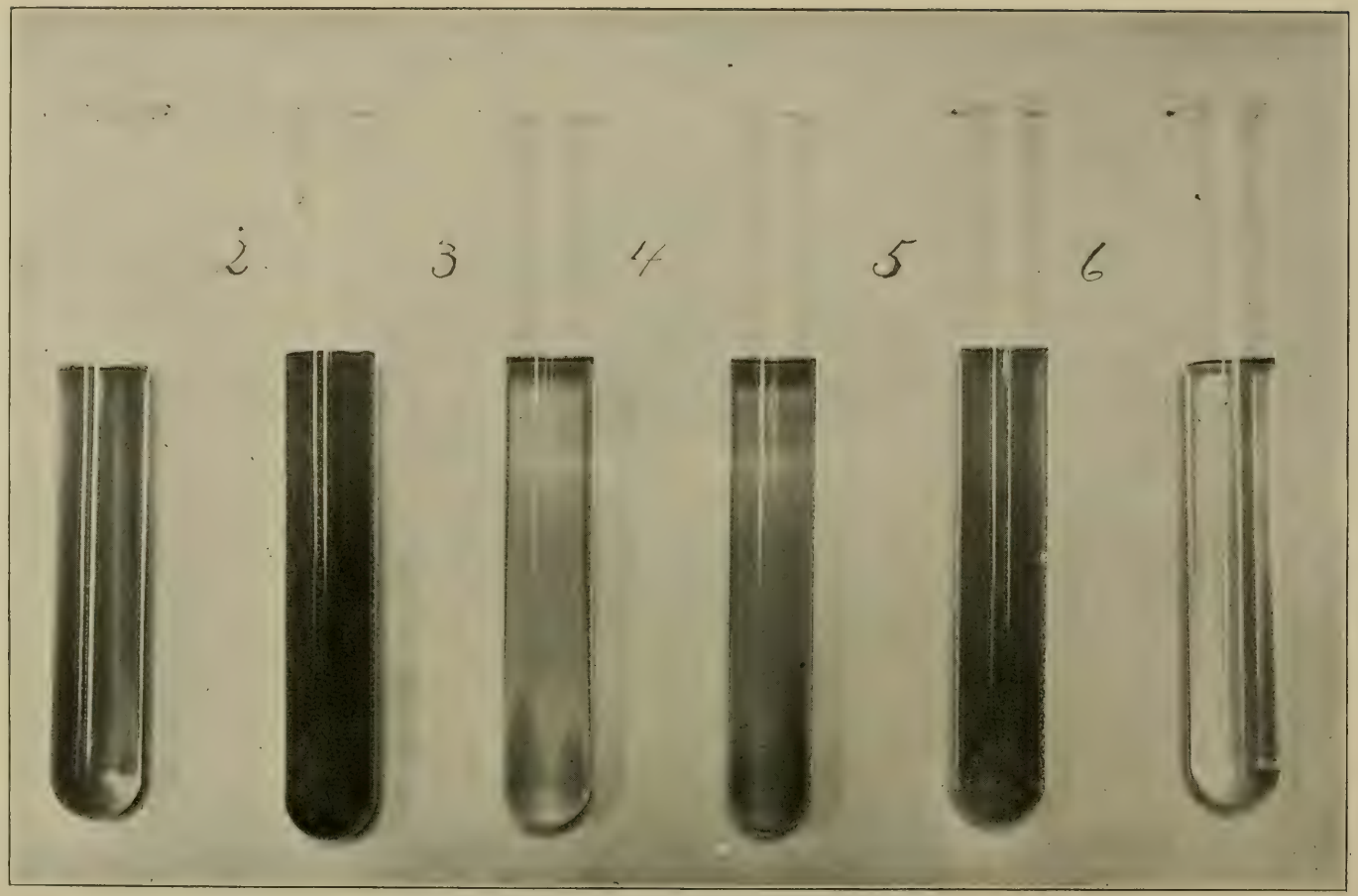

PLATE IV. For Description, see bottom of Opposite Page.

ANALYSES OF VARIOUS KINDS OF HONEY.

By Dr. E. C. Franklin and J. C. Swayze, Department Organic Chemistry, University of Kansas.

Sample.	Polarization.		Temp. C.	Sucrose.	Reducing sugars.	Water.	Ash.
	Direct.	Indirect.					
Basswood.....	-9.9	-14.9	23°	3.77 %	76.92 %	11.31 %	.39 %
Knotweed.....	-24.2	-29.	23°	3.62 %	75.19 %	11.41 %	.05 %
White clover.....	-10.3	-12.3	23°	1.54 %	76.34 %	7.98 %	.03 %
Alfalfa.....	-12.3	-18.1	23°	4.38 %	75.76 %	10.00 %	.05 %
Sweet clover.....	-16.	-21.	23°	3.77 %	78.13 %	7.97 %	.05 %

The above samples are all pure, as is shown by the different examinations. Pure honey consists of reducing sugars (d-glucose and d-fructose) and non-reducing sugar (sucrose.) Pure honey turns the plane of polarized light to the left, generally less than twenty divisions. An excess of this might indicate adulteration with invert sugar. This adulteration can be detected with certainty only when large quantities have been added. The sample of knotweed honey may have a slight excess of invert sugar.

Dextro rotation may signify either an adulteration of glucose or a normal amount of sucrose. By inverting the sucrose, the presence of glucose is proven, if it is still dextro rotatory. As none of the samples analyzed were dextro rotatory, there was no adulteration with glucose.

The sucrose found is in accordance with that of pure honey. It is determined by polarization before and after inverting. It is also determined by the Fehling method. The amount of reducing sugar is determined, the sucrose is then inverted, another titration is made, and the sucrose found by difference. We find that this method gives slightly lower results than the polariscope method.

The water and ash are normal. From the results, it would seem that a little dust had settled in the basswood honey and had increased the percentage of ash.

Comb Building. The architecture of the hive furnishes interesting study for the artisan as well as the apiarist. Contrary to supposition, however, comb is not constructed with geometric calculation. Cells are made of various sizes and shapes from the wax secreted. The store or honey cells are some what irregular and frequently deeper than

Description of Plate IV.—Shades in various kinds of honey: *1*, basswood; *2*, knotweed; *3*, white clover; *4*, alfalfa; *5*, sweet clover; *6*, alfalfa and melon bloom.

brood cells. The worker brood cells are the most regular, and average twenty-eight to thirty cells to the square inch. The drone cells are larger, and range about eighteen to the square inch. The structure of the queen cells has been described elsewhere.

THE STING. The accompanying figure illustrates the structure of sting and the gland attending it. This weapon is brought into use, not alone as protection against intruders, such as man, but is much used against the unwelcome visitors of its own tribe.

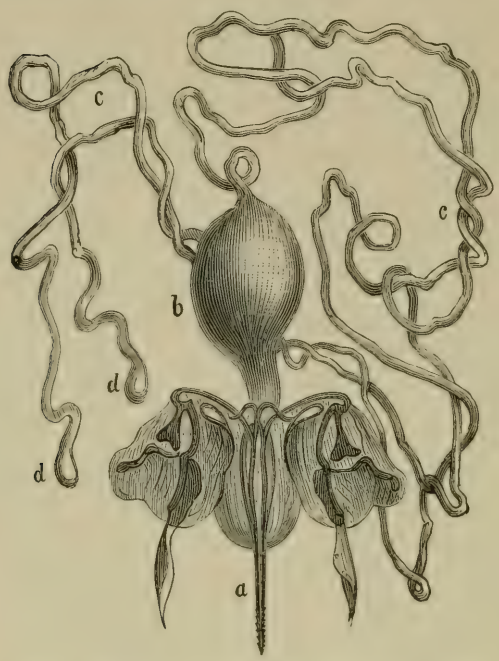

FIG. 2. The sting of the worker bee, and its appendages. (Enlarged, from Girard.) *a*, sting; *b*, poison-sac; *c c*, poison glands; *d d*, secreting bags.

The formic acid and the other toxic element probably present in the fluid injected from the gland into the body of the one attacked, while discomfiting to us, is quite deadly to bees. This poisonous fluid can be secreted from the blood-cells of the bees, but when it is injected into the tissues, by means of another's sting, death follows When the honey-bee stings the human flesh the sting generally remains, and the bee, if not killed before, dies on account of the wound caused by the tearing away of the organs connected with the sting.

"The third sting is composed of two spears of a polished, chestnut-colored, horny substance, which, supported by the sheath, makes a very sharp weapon. In the act of stinging, the spears emerge from the sheath about two-thirds of their length. Between them and on each of them is a small groove through which the liquid coming from the poison-sac is ejected into the wound.

"Each spear of the sting has about nine barbs, which are turned back like those of a fish-hook and prevent the sting from being easily withdrawn. When the insect is prepared to sting, one of these spears, having a little longer point than the other, first darts into the flesh, and being fixed by its foremost barb, the other strikes in also, and

they alternately penetrate deeper and deeper, till they acquire a firm hold of the flesh with their barbed hooks.

"The muscles, though invisible to the eye, are yet strong enough to force the sting to the depth of one-twelfth of an inch through the thick skin of a man's hand."*

Various remedies are recommended. It is important to scrape away with the finger nail the inserted sting; it should not be taken away by pinching it between the thumb and forefinger, for this act will force all the poison in the gland down into the wound. The place stung should not be rubbed, since this increases circulation and diffuses the poison over larger surface, consequently making the pain greater. This poison will mix freely with water, so that if the affected parts are placed in cold water the pain will be greatly allayed. Ammonia will neutralize the acid, and its use is recommended.

While attending the National Beekeepers' Association, at Omaha, the writer was much interested in the discussion upon the medicinal properties of the sting. It was strongly advocated by some that the sting of the bee, directed toward the seat of rheumatic pains, would give permanent relief. It was the observation of others, based upon experiments, that no permanent value could be attached to the medicinal properties of the sting. In each case the speakers spoke from experience, the speaker being the subject of the experimentation.

METHOD OF FERTILIZATION OF THE ALFALFA BLOSSOM.

The location of the coveted nectar at the base of the flower, the action of the tongue of the bee and the work of the hairs under the head and upon the breast in placing the pollen upon the stigma are shown in figure 3, and also in figure 4 at *b 4*. The flower gives material aid, by causing the stamens and pistils to spring up and strike the insect.

FIG. 3. (Original.) Pollination by bee.

A part of Müller's observations upon this point are: If in a young flower we cut through the claw of the carina, the column springs upward to some extent, carrying with it the carina and alæ. If in another unexploded flower, we carefully cut through one of the digitiform processes of the alæ, the parts remain motionless; but on cutting the processes of the other side, explosion at once follows. The pouched processes of the carina (fig. 4. *b 3* and *c 3*) are thus sufficient to hold the column down without

* Langstroth.

the aid of the processes of the alæ (*c 2*), nor are the latter sufficient after section of the carina. Explosion can therefore be effected equally well by separating the anterior pouches, by separating the digitiform processes, or, finally, by depressing the alæ and carina.

If an insect inserts its proboscis in the middle line between the anterior pouches and the digitiform processes, or if it stands upon the alæ and thrusts its head in the middle line under the vexillum, in either case explosion follows. The stigma (*c 5*) projects beyond the anthers, and, therefore, is the first to strike the under surface of the bee's body or proboscis; an instant later the anthers come in contact with an area close around the spot that the stigma touched, dusting it with fresh pollen. The first flower that the insect visits is, of course, not cross-fertilized, but as the bee withdraws from the flower, self-fertilization inevitably occurs. Self-fertilization is undoubtedly efficient, for Hildebrand has shown that flowers which wither unexploded when insects are excluded produce seed by self-fertilization. The same author finds two imperfections in the mechanism. One is the possibility of the insect securing the nectar without exploding the flower; the other is that the flower continues to secrete honey after it has been fertilized. This certainly is much in its favor as a honey plant, though somewhat against the visitation of other unfertilized flowers.

In the case of the alfalfa, however, it will be seen that the stigma of the ovary is higher than the pollen producing anthers, so that the grains of pollen may all drop to the base of the flower and the ovary go unfertilized; such being the case, no seed would be formed. Small forms resembling seed might be found within the ovary at maturity, but these, not being fertilized, would not germinate.

From the shape and size of the alfalfa blossom, it is not probable that cross-fertilization could be safely accomplished by means of currents of air.

It becomes evident, then, that outside agencies must be called upon, and the plant must provide for these agencies. The agents in this case we find to be insects, and the reward offered by the plant for favors rendered is a sweet drop of nectar; that is, the flower in an enticing way places a tempting sip of nectar in such a position that when the insect has favored the flower with a few grains of pollen unconsciously brought from an adjoining flower and just as unconsciously left, the coveted sip may be enjoyed. It is evident, however, that the first flower visited will not be cross-fertilized.

INFLUENCE OF BEES UPON THE SEED CROP.

It is well known to every stock-breeder that in-and-in breeding will soon cause the strain to deteriorate, and that infusions of new life are

FIG. 4. (Original.) *a*, cluster of alfalfa with bee feeding. *b*, bee thrusting proboscis into flower: *1*, vexillum; *2*, alæ; *3*, carina; *4*, reproductive organs (gametangia); *5*, calyx. *c*, alfalfa bloom with vexillum torn off: *2*, alæ; *3*, carina; *4*, reproductive organs (gametangia); *5*, stigma; *6*, anthers; *7*, calyx. *d*: *1*, filament; *2*, anther; *3*, style; *4*, stigma. *e*, pistil: *1*, ovary; *2*, style; *3*, stigma; *4*, ovules. *f*, cross-section of pistil: *1*, detached filament; *2*, filament sheath; *3*, ovary; *4*, ovule. *g*, highly magnified pollen grains.

required to keep the desired vigor within the breed. As is the case with animals so it is with plants. It was previously supposed that within each flower were the necessary organs and the means for assuring the formation of the embryo within the seed. Darwin, however, has clearly shown that many plants, instead of endeavoring to facilitate self-fertilization (the forming of seed in the ovary from pollen of same flower), are constructed in a manner to hinder or prevent it. Among this number may be classed the plant under consideration. A careful examination of the accompanying figure and explanations will reveal the fact that outside agencies are required to insure fertilization, especially cross-fertilization. The process of fertilization in a typical flower is not complex. The stamens have long filaments which bear the pollen-producing anthers high above the ovary; when the pollen is ripe it falls naturally upon the stigma of the ovary, and fertilization of the seed is soon accomplished.

The writer conducted a number of experiments upon the fertilization of the alfalfa bloom. The first work consisted in covering a large number of blossoms with fine cheese-cloth. It soon became evident that this would exclude all insects, and the good services of the bee would not be demonstrated, so that this line was discontinued and another taken up.

A large number of representative ripened pods were gathered from an alfalfa field less than one-half mile away from a large apiary, and a like number from another field of much the same soil and, practically, under like conditions as the first field, except that the second field was situated twenty-five miles away from a colony of bees. No bees were observed in the field, and the character of the surroundings, there being no timber or probable living places, was such as to preclude the possibility of wild bees in the vicinity. The pods from each locality were carefully opened and number of seeds in each counted. The results and comparison to be made therefrom are certainly of interest.

Seeds taken half mile from bees; 87 pods examined.			Seeds taken twenty-five miles from bees; 80 pods examined.		
No. of seeds in pod.	No. of pods bearing that number of seeds.	Total number of seeds.	No. of seeds in pod.	No. of pods bearing that number of seeds.	Total number of seeds.
0	0	0	0	2	0
1	1	1	1	8	8
2	5	10	2	18	36
3	8	24	3	20	60
4	14	56	4	15	60
5	18	90	5	7	35
6	11	66	6	5	30
7	15	105	7	3	21
8	9	72	8	1	8
9	2	18	9	0	0
10	4	40	10	1	10
Totals.....	87	482	Totals.....	80	268
Average number of seeds in a pod, 5.58+. Seeds plump; pods numerous in cluster; pods having several spirals.			Average number of seeds in a pod, 3.35. Seeds in at least one-third of the pods were small and shriveled; pods few in a cluster; short, with but few spirals.		

Per cent. of increase of the first field over the second, $66\frac{2}{3}$.

ALFALFA AS A HONEY PLANT.

My observations upon this subject during the past season have been that it will yield the greatest amount of nectar under circumstances which tend to give the plant the most vigorous growth; that is, proper amount of heat and moisture, upon suitable soil. If the plant is upon upland, dry weather will affect the secretion of nectar before it will be affected in the valley, such as the Arkansas valley,

where the roots of the plants extend to the water. In September the bees were busy in the alfalfa in the Arkansas valley; while, on the higher ground of one of the counties on the eastern border, I visited a beautiful piece of alfalfa near by an apiary, but no bees were found. They were at that time flying over the alfalfa to the knotweeds beyond. A strong point in favor of this plant, as shown by Müller, is that it continues to secrete nectar as long as the blossom flourishes. A greater part of the alfalfa produced in this state is cultivated for forage, and, since for this purpose it is cut while in full bloom, the honey crop is materially less than it would be if alfalfa were allowed to mature. During a dry period bees will fly over alfalfa fields in bloom to a field which has been irrigated a few days previously and has begun to bloom.

The relation existing between alfalfa and apiculture can well be obtained by a comparison of the tables following, the data for which Mr. F. D. Coburn, of the state board of agriculture, has kindly furnished. The attention of the reader is called to the yield of honey per hive in counties where larger acreages of alfalfa exist, as compared with the yield per hive where the crop is much less.

COMPARATIVE TABLE, showing alfalfa acreage, stands of bees, pounds of honey produced, and the value thereof, in Kansas, for the two years 1897 and 1898.

COUNTIES.	1897.				1898.			
	Acres of alfalfa.	Stands of bees.	Pounds of honey.	Value of honey.	Acres of alfalfa.	Stands of bees.	Pounds of honey.	Value of honey.
The State	171,334	44,345	534,925	$80,238 75	231,548	60,941	622,703	$93,405 45
Allen	91	526	4,295	$644 25	633	416	1,365	$204 75
Anderson	124	508	3,721	558 15	197	666	3,437	515 55
Atchison	315	546	4,546	681 90	171	1,391	12,579	1,886 85
Barber	1,453	11	.....	.....	1,026	4	50	7 50
Barton	1,565	1	.....	.....	1,678	.....	.....	.....
Bourbon	31	1,512	10,153	1,522 95	98	1,385	7,778	1,166 70
Brown	517	1,421	23,231	3,484 65	688	2,633	34,317	5,147 55
Butler	7,755	638	6,904	1,035 60	12,029	939	8,295	1,244 25
Chase	5,753	710	8,830	1,324 50	7,298	605	1,849	277 35
Chautauqua	3,481	299	3,691	553 65	3,998	501	929	139 35
Cherokee	6	2,046	23,058	3,458 70	37	1,476	6,286	942 90
Cheyenne	605	.....	.....	.....	682	6	100	15 00
Clark	775	.....	.....	.....	575	6	.....	.....
Clay	207	481	8,303	1,245 45	381	1,328	7,616	1,142 40
Cloud	4,696	689	8,763	1,314 45	5,729	744	10,614	1,596 60
Coffey	757	628	5,912	886 80	943	736	2,466	369 90
Comanche	7	.....	.....	.....	19	.....	.....	.....
Cowley	3,904	542	2,905	435 75	5,722	1,070	9,702	1,455 30
Crawford	19	1,509	19,234	2,885 10	6	1,922	10,566	1,584 90
Decatur	3,307	12	60	9 00	4,278	26	380	57 00
Dickinson	1,745	397	6,429	964 35	2,000	726	5,897	884 55
Doniphan	44	927	11,013	1,656 45	126	1,343	12,970	1,945 50
Douglas	396	1,258	15,112	2,266 80	604	1,605	20,714	3,107 10
Edwards	2,930	14	50	7 50	6,523	15	400	60 00
Elk	2,837	467	3,649	547 35	3,860	523	3,623	543 45
Ellis	185	.....	.....	.....	316	.....	.....	.....
Ellsworth	441	.....	.....	.....	644	5	80	12 00
Finney	11,726	533	13,665	2,049 75	11,795	722	50,535	7,580 25
Ford	4,277	5	10	1 50	4,508	39	2,020	303 00
Franklin	56	1,432	9,954	1,493 10	175	1,628	13,052	1,957 80
Geary	559	296	3,663	549 45	723	388	2,938	440 70
Gove	499	.....	.....	.....	1,019	.....	.....	.....
Graham	391	.....	.....	.....	707	.....	.....	.....
Grant	9	.....	.....	.....	.....	.....	.....	.....
Gray	1,918	8	40	6 00	2,250	29	867	130 05
Greeley	.....	.....	.....	.....	6	.....	.....	.....
Greenwood	5,359	596	2,831	424 65	9,518	623	2,231	334 65
Hamilton	2,422	106	.....	.....	2,779	3	200	30 00
Harper	527	10	.....	.....	321	2	.....	.....
Harvey	1,535	71	424	63 60	2,143	123	1,468	220 20
Haskell	.....	.....	.....	.....	.....	.....	.....	.....
Hodgeman	127	.....	.....	.....	131	.....	.....	.....
Jackson	575	915	10,189	1,528 35	865	1,836	21,839	3,275 85
Jefferson	239	1,207	15,031	2,254 65	325	1,255	14,313	2,146 95
Jewell	6,786	866	12,499	1,874 85	10,454	1,276	19,285	2,892 75
Johnson	129	932	13,215	1,982 25	129	1,164	15,486	2,322 90
Kearny	6,620	77	2,275	341 25	5,545	107	7,060	1,059 00
Kingman	407	.....	.....	.....	433	.....	.....	.....
Kiowa	109	.....	.....	.....	161	.....	.....	.....
Labette	156	1,196	8,367	1,255 05	170	1,503	2,662	399 30
Lane	430	.....	.....	.....	512	.....	.....	.....
Leavenworth	66	973	11,888	1,783 20	349	1,680	19,588	2,938 20
Lincoln	1,082	5	108	16 20	1,545	32	212	31 80
Linn	28	779	3,921	588 15	66	960	6,667	1,000 05
Logan	240	.....	.....	.....	159	.....	.....	.....
Lyon	5,143	1,154	12,658	1,898 70	9,129	1,145	3,458	518 70
Marion	4,913	476	4,310	646 50	7,518	502	416	62 40
Marshall	857	1,457	26,752	4,012 80	1,397	4 996	33,548	5,032 20
McPherson	3,354	97	1,151	172 65	4,546	178	2,223	333 45
Meade	1,286	5	.....	.....	2,323	5	15	2 25

COMPARATIVE TABLE—CONCLUDED.

COUNTIES.	1897.				1898.			
	Acres of alfalfa.	Stands of bees	Pounds of honey.	Value of honey.	Acres of alfalfa.	Stands of bees.	Pounds of honey.	Value of honey.
Miami	48	857	8,589	$1,288 35	152	1,006	12,073	$1,810 95
Mitchell	5,149	622	8,262	1,239 30	7,015	770	11,958	1,793 70
Montgomery	579	456	2,352	352 80	1,637	388	742	111 30
Morris	426	440	2,075	311 25	889	255	1,345	201 75
Morton	3	.....	.....	.....	2	.....	.....	.....
Nemaha	2,235	1,240	22,905	3,435 75	2,551	2,566	36,512	5,476 80
Neosho	136	711	6,615	992 25	252	733	1,023	153 45
Ness	121	.....	.....	.....	178	1	.....	.....
Norton	4,112	475	10,577	1,586 55	5,965	424	17,439	2,615 85
Osage	965	952	10,987	1,648 05	1,908	1,591	6,406	960 90
Osborne	3,924	19	60	9 00	4,076	19	356	53 40
Ottawa	2,725	390	3,102	465 30	3,308	447	3,900	585 00
Pawnee	365	24	500	75 00	597	21	1,620	243 00
Phillips	3,142	85	790	118 50	4,062	93	1,838	275 70
Pottawatomie	3,294	1,235	18,350	2,752 50	4,340	1,585	17,560	2,634 00
Pratt	76	.....	.....	.....	171	.....	.....	.....
Rawlins	2,401	8	40	6 00	998	10	720	108 00
Reno	3,574	10	22	3 30	4,385	13	64	9 60
Republic	2,667	614	9,890	1,483 50	4,012	1,220	17,696	2,654 40
Rice	1,830	29	205	30 75	2,871	36	1,160	174 00
Riley	1,927	1,376	22,118	3,317 70	2,806	1,558	14,723	2,208 45
Rooks	880	17	360	54 00	1,271	18	400	60 00
Rush	45	.....	.....	.....	70	.....	.....	.....
Russell	372	.....	.....	.....	407	.....	.....	.....
Saline	5,269	614	5,771	865 65	6,228	712	5,423	813 45
Scott	206	.....	.....	.....	248	.....	.....	.....
Sedgwick	4,389	468	3,510	526 50	6,530	769	6,969	1,045 35
Seward	17	.....	.....	.....	15	.....	.....	.....
Shawnee	1,115	872	8,106	1,215 90	1,740	1,192	6,739	1,010 85
Sheridan	2,096	2	.....	.....	3,334	3	.....	.....
Sherman	50	.....	.....	.....	18	.....	.....	.....
Smith	1,026	61	708	106 20	1,598	90	1,225	183 75
Stafford	352	.....	.....	.....	504	2	20	3 00
Stanton	.....	1	.....	.....	.....	.....	.....	.....
Stevens	.....	.....	.....	.....	.....	.....	.....	.....
Sumner	1,516	56	128	19 20	2,035	150	770	115 50
Thomas	227	.....	.....	.....	372	6	100	15 00
Trego	396	.....	.....	.....	677	.....	.....	.....
Wabaunsee	4,295	1,709	13,919	2,087 85	6,439	1,196	12,770	1,915 50
Wallace	570	.....	.....	.....	685	6	140	21 00
Washington	763	1,389	42,777	6,416 55	1,139	2,312	50,389	7,558 35
Wichita	148	.....	.....	.....	178	.....	.....	.....
Wilson	1,180	579	2,602	390 30	2,462	696	2,789	418 35
Woodson	843	380	3,720	558 00	1,325	312	1,170	175 50
Wyandotte	79	316	3,045	456 75	136	474	4,538	680 70

OBSERVATIONS GATHERED FROM KANSAS APIARISTS.

During the field-work this year it was the writer's privilege to meet a large number of the Kansas apiarists at work among their bees. In conversation, many thoughts concerning their observations upon bees and honey plants were expressed. Some of these, unknown to the speakers, were jotted down and appear here. An extensive correspondence with some 400 bee-keepers in this state furnishes much valuable reading for those interested. The substance of some of these letters is given here.

The number of personal discussions and opinions which appear here might be increased many times, but in so doing the same ideas would be repeated; want of space also forbids; so that the substance of the views of a few apiarists of Kansas upon the principal honey-producing plants of the state, together with a few other facts concerning apiculture, are herewith given.

J. F. Hughes, Marquette, McPherson county; thirty stands; Italians. "They are good workers, and it takes a very strong wind to keep them in their hives. In central Kansas we must depend almost entirely on alfalfa for a honey plant. White clover cannot be cultivated successfully here. Buckwheat can be raised in abundance, but can we afford to raise it for the honey alone? If season is favorable, Italian bees will gather 100 pounds per stand from alfalfa. Alfalfa will grow here entirely without irrigation."

Mrs. C. E. Anderson, Salina, Saline county; eighty colonies; Italians and hybrids. "Alfalfa is our main honey plant, and in a favorable season the honey is equal to the best white honey. Buckwheat makes a good yield sometimes, but the honey is dark and strong. In 1895 I had 1075 pounds fine comb honey from twelve colonies, and several hundred pounds more not in marketable shape."

Wm. Miller, Emporia, Lyon county; sixty-three stands. "I regard alfalfa superior as a honey plant to buckwheat or white clover, as I have known the latter in Ohio. I believe that a few stands of bees on the lands of every Kansas farmer would be a source of revenue, as well as adding quite a luxury to the living of himself and family, and that with less outlay of labor and money than anything else I know, unless it be the cow and hen. Bee-culture very naturally works in with all small fruits, truck patches, fowls of every description, and other kindred industries, as an individual can be working at the one, and yet have his apiary so located as to have an eye over it continually during the swarming season. The bee can be wintered in Kansas without any special preparation. Kansas is destined to become a great honey-producing state as the alfalfa gains more and more, as it is bound to do."

MRS. L. A. CAREY, Phillipsburg, Phillips county. "Began bee-keeping in 1895; have now twelve colonies. Five colonies this season produced 300 of pounds surplus honey and gave off two swarms. In order to prevent a second swarm, I changed position of old and new swarms in daytime. This causes all the bees in the field to fly to the young colony, builds it up, and weakens the old swarm, so that it does not have the desire for increase. We have to depend on alfalfa here for the main honey crop. It makes a beautiful white honey, like white clover. Alfalfa produces the most honey during the month of July."

H. M. HILL, Paola, Miami county; twenty stands; Italians. "I do not consider alfalfa a success as a honey plant, as we had a large pasture one-half mile from the bees and received no honey. I am a stock-raiser, and have no time for bees, so they receive but little care. We consider white clover the best of honey plants, and buckwheat good at times."

GEORGE YOXALL, Woodston, Rooks county; twenty stands; all Italians or hybrids. "Alfalfa is an excellent honey plant here, yielding the best white honey, from the 1st of June until the 1st of September, and sometimes as late as the 1st of October. Sweet clover may be superior in yield, in a more continuous flow of honey, as there is no check in mowing as there is in alfalfa, and alfalfa does not give the best results on account of taking off the crop just about the time the bees are commencing to work on it, and if there is no seed crop taken, there is not much benefit conferred."

J. G. BROOKS, Pleasanton, Linn county; forty stands. "Have spent fifty years with bees. I have had no experience with alfalfa. White clover, buckwheat, corn tassel and tree blossoms are good here. Bees should be cared for the same as other stock. Care will pay."

E. K. TERRY, Burlingame, Osage county; thirteen colonies. "Have had no experience with alfalfa as a honey plant. We have members in our town bee-keepers' association who have quantities of alfalfa on land watered by rains, who report favorably. Mr. Arnold has both alfalfa and alsike, and reports that alsike produces much better-flavored honey and more of it than the alfalfa. I consider the sweet clover one of the very best honey plants. It produces white and good-flavored honey. I would keep bees for the pleasure and honey enough to supply the family. I consider honey one of the greatest table luxuries that it is possible to have. I find that with cellar wintering I can bring out a strong colony in the spring on ten to twelve pounds of honey."

M. B. GUARD, Beloit, Mitchell county; eleven colonies; all Italians. "Alfalfa honey is better than white clover, because it is richer.

It is better than buckwheat, because it is as thick and rich and a great deal whiter."

Mrs. M. D. Hetzel, Kinsley, Edwards county; nine stands. "Our feed for bees here is mostly alfalfa, some wild flowers; no fruit-tree blossoms. The bees find considerable feed on the box-elder trees early in spring. Have a fifty-acre field of alfalfa joining the apiary, with plenty of water within a few rods. The bees have had continuous feed upon alfalfa blossoms from the 10th of May until frost, which this year did not hurt the blossoms until the 16th of October. Do not think white clover or buckwheat could be any improvement on

Fig. 5. (Original.) Honey-bee on alfalfa. From photograph.

alfalfa for honey, either in quality or quantity. Our best swarm this year produced forty pounds by July 3, and thirty-two more at the close of the season, making seventy-two pounds for the swarm. Five of the other swarms did nearly as well. Our honey this season was pronounced by all who tried it to be as fine, if not the finest, flavored they had ever eaten. I do not know yet as there is much profit in keeping bees, but it is light and pleasant work. My sixteen-year-

old daughter attends the bees almost entirely and enjoys it. She says it is easier than raising poultry, and has more money in it. I know it will pay any farmer's wife to keep a few stands of bees in order to have plenty of honey to use in the family."

J. C. BALCH, Bronson, Bourbon county; fifteen stands. "I prefer Italians; have found Cyprians cross and almost unmanageable. We have no honey-producing flora in this part of the state. Bees in Kansas are not a source of pecuniary income every year; but, taking one year with another, will average with other agricultural pursuits. I have been keeping bees in a small way since 1875, and have never been out of honey for our table but twice, for a few months each time, and I have sold hundreds of dollars' worth of honey."

D. B. JONES, Mound Ridge, McPherson county. "I have four stands of bees. My experience is that alfalfa is a good honey plant upon lands watered by rain. But I do not think there is any better plant to make fine-flavored honey than white clover. Yet our bees have been doing much better since there has been plenty of alfalfa raised here. I do not think bees have half the care they deserve."

H. H. MCGUGIN, Mayview, Jewell county; forty stands. "I prefer Italian, but like Carniolans almost as well. I think alfalfa and sweet clover are the best honey-producing plants we have."

P. C. GRESS, M. D., Atchison, Atchison county; fifty stands. "I have none but Italians, as I find them far superior in every way to other races. They are better workers, more gentle, less excitable, winter better, remain kindly upon the comb, while other races under like handling run and fall down and scatter, and are more annoying to the apiarist. One of my observations is of special interest to fruit-growers. In my estimation the honey-bee is one of the greatest necessities for the proper cross-fertilization of blooms. I have protected limbs of trees by screen cloth during blossoming season, and kept the insects from them, only to find a limb without fruit, where others, without protection, were well fruited. I have received good interest on every dollar invested, and mean to continue the industry, despite the loss and backset which I received last winter. 153 colonies stored for the winter being burned."

SOLON STEERE, Asherville, Mitchell county; thirty-five colonies; Italians. "I think that alfalfa is about the only plant here from which bees secure a surplus of honey, and that, of course, with natural moisture. Sweet clover I consider the very best honey plant we have, but there is not enough of it. It is not inclined to spread very fast. I have scattered quite a little of the seed at different times, but results have not been very encouraging. We seem to get the greatest benefit from alfalfa, when it is left for the seed crop. I do not make

any special effort to care for the bees, to make money from them. I have sold many colonies in the years gone by. We sell some honey, and have all we want for ourselves. There is no good reason why every family should not have a full supply of honey all the year round. All that is necessary is to get the start in bees; furnish them a home, and protect them. They seem to be willing to work for any one, and board themselves."

ROBERT DOUGLAS, Long Island, Phillips county. "I had six hives, grade Italians, last spring, and by natural swarming I saved thirteen, making nineteen swarms at present. From fourteen hives I have taken 800 pounds of section honey, which is worth at home ten cents per pound. My year's profit might be reckoned thus:

Dr.		*Cr.*	
6 hives bees, at $5	$30 00	800 pounds of honey, at 10c	$80 00
Supplies	25 00	19 hives bees, at $4	76 00
Labor	20 00		
To balance (profit)	81 00		
Total	$156 00	Total	$156 00

ED. HOFFMEISTER, Norton, Norton county. "My experience shows alfalfa to be a very good honey plant. Bee-keeping is quite profitable if a person tries to make it so. It is some expense to begin, but I have always made expenses and good interest on my money."

R. W. SMITH, Delphos, Ottawa county; twenty-two stands; Italians. "My bees gather their honey from alfalfa watered by rain, and have made forty pounds of honey to the stand. Alfalfa honey is superior to white clover or buckwheat honey. I lost several valuable swarms by wintering them in the cellar. Chaff hives are preferable. I use foundation comb for starting. Bees sometimes put comb in crosswise, and the starter prevents this. There is money, good health and honey in the bee business."

W. D. JONES, Neodesha, Wilson county. "I think alfalfa is equal to white clover or buckwheat."

M. A. BUTTS, Hiawatha, Brown county. "My honey has been mostly secured from white and alsike clover, basswood, buckwheat, and wild flowers. I consider alsike superior to white clover as a honey plant. My experience leads me to the conclusion that bees, with proper care and attention, will pay in this country. It is important to protect bees well in winter and have them strong in spring."

JACOB SWOYER, Winchester, Jefferson county; twenty stands; Italian. "Buckwheat, white clover and smartweed are the principal honey plants here. I have had no experience with alfalfa. Like white clover best when the season is not too wet. I do not allow my colonies to swarm much, about twice in three years. I prefer one strong colony to a dozen weak ones. In 1896 I had hives which made

110 pounds of honey and plenty for their own use. I would not do without my bees, as I think honey and pancakes good enough for anybody."

D. J. FRASER, Peabody, Marion county; fifty-four stands. "I use Italians crossed with the German bee. Alfalfa is best in a medium wet season. Bees seem to care nothing for it if season is very dry or very wet. Like all other stock in Kansas, bees require some intelligent care. If properly mismanaged they seem to swarm world without end."

FIG. 6. (Original.) Honey-bee on white clover. From photograph.

F. H. MILLER, Great Bend, Barton county. "I had thirteen stands in the spring, and have twenty-eight now. Have taken 1200 pounds of comb honey, all alfalfa. It is a good honey plant. There is but one clover that beats alfalfa, and that is alsike. I have a small patch which blooms eight or ten days earlier than alfalfa, and the bees are thick in it from morning till evening. Alfalfa is a good and delicious honey plant, and produces a fine-flavored honey, better than Colorado honey as there is no other flavor mixed with it. I sell my honey at fifteen cents per pound, while Colorado honey sells for ten and twelve cents. A person cannot expect something for nothing. Take care of your bees and they will pay as good profit as anything I know of. I am in the hardware and agricultural implement business, and have little time for bees myself. Mrs. Miller, however, thinks more of the bees than anything else, and enjoys taking care of them. I think if more wives and daughters would take it up it would be better for them. They would find it a very good and enjoyable business. If a bee stings sometimes, it is good for rheumatism, and there seems to be

plenty of that in this country. Alfalfa is far ahead of buckwheat or white clover."

R. L. SNODGRASS, Gordon, Butler county. "Have sixty hives and manage, in addition, forty for others. I have kept hybrids and Italians, and prefer the latter. Alfalfa has given me wonderful honey flows. My hives on scales this season and last ran as high as fifteen pounds per day. I have turned my whole attention to the bee business and have secured for this season's labor 5000 pounds comb and extracted honey from sixty hives. I secured this season 200 pounds from one hive. Alfalfa, in my experience, is far ahead of buckwheat as a honey plant. I winter my bees both in the cellar and in the open air with success."

W. D. FULTON, Garden City, Finney county; eighty-five stands. "Alfalfa as a honey plant is second to none for richness of nectar and flavor. It is a very common thing for a single colony to gather 200 pounds of comb honey in a season and sometimes more. I would prefer a dry climate for bees, provided there is plenty of water at command, but usually there is sufficient rainfall to make the business profitable here. I meet with very few difficulties in the care of my bees."

DR. T. J. CONRY, Florence, Marion county; 300 stands. "Alfalfa is our best and surest honey producer, although sweet clover would probably be better if raised in equal quantities."

C. A. D. BENNETT, Garden City, Finney county. "I have 220 stands of bees. Alfalfa is a splendid honey plant. There is no better in Kansas. We get three distinct flows from it each year. Each bloom gives a flow. The flow on irrigated land is more even than on land watered by rain, but is not so heavy. Alfalfa is superior in every way to white clover, sweet clover, or buckwheat. I do not attempt to build up weak colonies. I believe in the survival of the fittest. I give my bees the best care and attention. I leave plenty of honey in the fall for their winter's supply. Then if they dwindle I let them go, and pay attention to my other colonies. In this way I rear colonies disposd to be strong."

JOHN WEIR, Carbondale, Osage county. "I have at present fifty-five colonies. I prefer the pure Italian. They are good honey gatherers, hardy, gentle, and beautiful. I have had no experience with alfalfa as a honey plant. There is not much grown in my neighborhood. We have both the yellow and white sweet clover here on waste land. The yellow is of most value, as it blooms six weeks earlier than the white, and just at a time when the bees are much in need of something to do. When the honey flow begins, I place the comb-honey colonies in one brood chamber, and keep them well-shaded, put

on forty-eight sections, and prop the hive off the bottom board to give better ventilation. In this way I prevent swarming to a very large degree. I thus secure strong colonies, and in this lies the secret of profits in honey. I have one ton of surplus honey at my elbow taken from forty colonies, spring count—1500 pounds extracted, and 500 pounds comb, or an average of 50 pounds per colony."

LAURENS HAWN, Leavenworth, Leavenworth county. "I have had no experience with alfalfa. White clover is the main dependence for a flow of nectar in this vicinity, and as it is very uncertain, the bee business is consequently not very profitable. There seems to be a prevalent though erroneous idea among horticulturists and people in general who raise a little fruit that bees are destructive to the ripe fruit. On the contrary, they are very beneficial to fruit-growers, and this fact should be promulgated among the people. I have had considerable experience in this matter for several years, and know positively that without bees our fruit crops would be more often a failure. My apiary is in an orchard between two small vineyards; vines within twenty feet of the hives. I have suspended a bunch of ripe grapes in a hive during a time when the bees were working on decayed grapes in the vineyard, and not a grape was punctured. Of course, when grapes or other fruits are punctured or have rotten spots in them, and there is no nectar in the blooms, they will work on such fruit; hence arise the erroneous ideas concerning their destructive qualities. I have observed that if there is so much rain during the blooming period that bees cannot visit the fruit blossoms, there is always a failure of fruit crops. Many people spray their fruit-trees when they are in bloom, while they should never be sprayed until the bloom is falling. If people spray trees in full blossom they not only kill bees, but run the risk of poisoning the people who eat the honey made at that time. Another point is that in reference to the wholesomeness of honey as food: it can be used in all diseases when sugar and other sweets are prohibited, and if bought of reliable parties is free from all adulterations, which can hardly be said of sugar and other sweets. Bee-keeping in this locality, as a single occupation, is not profitable."

J. F. CROCKER, Garden City, Finney county. "Alfalfa is a splendid honey plant if it has plenty of moisure, either from rain or irrigation. During protracted dry weather it does not secrete nectar, and during excessive wet weather the bloom sloughs off, and we get no honey. If we were situated so we could irrigate the alfalfa fields immediately after each crop of hay was cut, and the fields were not all mowed at the same time, and none mowed until the seed-pods begin to form, we would have a continuous honey flow from June 15 to October 1."

FIG. 7. (Original.) Honey-bee on sweet clover. From photograph.

SAMUEL TEAFORD, Norton, Norton county. "Alfalfa clover is the best honey plant for this part of the state. It grows best on bottom lands, and produces most honey in seasons of moderate rainfall. The worst difficulty met with is the man who keeps bees and puts his honey on the market in a dirty, filthy condition, half capped, and no attention paid to grading; who, if he cannot find ready sale, will sell for anything offered him, to the great detriment of the man who is careful to place on the market only a choice article, nicely cleaned and graded. To the man who wants to keep bees, I would say, do not buy but one or two stands of bees to start with; get pure Italians, in standard hives, with combs built on full sheets of foundation and wired in frame; would use full sheets of foundation, if had to pay one dollar a pound for them. Then get a good text-book on bee-keeping, and pay no attention to the man who tells you that bees do not pay,

and that the drones build the combs, and that the wax is gathered from sunflowers. Every farmer who is located within two or three miles of alfalfa or clover fields should get a few stands of bees, and have nice honey for his family, instead of buying the filthy glucose jellies and other stuffs that are for sale in every store."

JOHN W. LABAR, Erie, Neosho county. "I have not been engaged in bee-culture except as a side issue and to furnish honey for our own table. We now have twenty-five colonies. We have taken 500 or 600 pounds of honey this fall, and the bottoms of hives seem to be full. There seems to be a good deal of white clover in this locality, and it is really the first honey flow we get that we can take off for table use, and is the finest flavor of any we get. This is a business that to be successful must be looked after in every little particular, and I believe it can be made to pay almost any year."

D. P. NOE, Burlington, Coffey county. "The difficulty here is the constant winds. Too many bees are lost as they come home laden with honey, and swarms are thus diminished in workers. Alfalfa is a good honey plant. Alsike clover is one of the best. I have visited several bee-keepers and asked them why they do not sow all kinds of clover and plant linden, locust and fruit-trees, raspberries and blackberries. The excuse was, bees do not pay. Neither would any kind of stock pay on a farm if it had to hunt its own living."

S. B. MCGREW, Kossuth, Linn county. "The study of the honey-bee in its home and ways has always been a fascinating employment for my leisure hours. I have completely failed to secure an alfalfa crop after several trials. Linn county farmers, so far as I have learned, have had no success in growing it. The worst and only difficulty that I have met with is the lack of honey-producing plants in sufficient quantities for large numbers of colonies. I have done fairly well with my bees and would like to learn if there are any better plans than I have known."

OLEY OLSTON, Cimarron, Gray county. "Alfalfa is considered a good honey plant in this section upon irrigated bottom river land."

J. P. EMERY, Cimarron, Gray county. "I purchased two stands of Italian bees in spring of 1897. That fall I had increased them to ten strong colonies. I took off about 500 pounds of honey. Alfalfa is the main honey plant in this section upon irrigated bottom lands."

E. DAVISON, Garden City, Finney county. "Alfalfa is the only honey-producing plant that we have in Finney county, with the exception of fruit bloom in spring."

P. H. BOLLINGER, Everest, Brown county: "I have forty stands of bees. Have found Italians to be best. Have never sowed anything but buckwheat."

D. F. Young, Long Island, Phillips county: "I find alfalfa a great honey producer where there is a medium amount of moisture in the ground. I believe alfalfa to be a great honey producer, equal to white clover or buckwheat. Winter in cellar, and think this requires less honey for the winter."

Wm. M. Bottom, Dexter, Cowley county: "Alfalfa is the best honey plant we have for all seasons; not so good as white clover or buckwheat, but the latter does not do well here. In my opinion, as soon as this southern and western country becomes settled up, and groves and orchards are planted and ponds built, rainfall will increase, and as the country grows older the raising of tame grasses will become successful, and with it profitable bee-culture."

Joseph Huffman, Garden City, Finney county: "Alfalfa under favorable conditions is considered a good honey plant. We have not had sufficient irrigation in this section to test its worth as a honey-producing plant. Alfalfa in this country is a better honey-producing plant than white clover, sweet clover or buckwheat is in the eastern states. Quality of alfalfa honey is the best."

A. L. Daniels, Allendale, Lyon county. "As to profit derived from bees, have not had enough to pay expenses and labor, but the pleasure of having pure honey of my own has kept me at work."

J. W. Sutton, Glasco, Cloud county. "I took 1400 pounds of honey from twenty-six stands. We have a large amount of alfalfa here. I do not think bees make much honey from alfalfa, as I have failed to find many at work on it. I find that my bees make more honey when the corn is in tassel, but the alfalfa is in bloom at the same time. I have seen more bees at work on corn than anything else. Have not given bees special attention, but am beginning to think it will pay to give them the care they require."

Capt. J. H. Wing, Syracuse, Hamilton county; 150 colonies. "Italians and hybrids. I have tried several stands of pure Cyprians and find their disposition quite objectionable. I find, however, that bees developed from these Cyprians crossed with Italians or Carniolans, give, all things considered, one of the most satisfactory strains of bees. Alfalfa furnishes our main honey flow. The quality of the honey is second to none."

SOME HIVE YIELDS.

Without any direct attempt at procuring the yields of the different apiaries within the state, or securing the highest yields, the reports here shown have come to the department giving amounts of honey produced. It is believed that these reports will be read with interest and will give a representative knowledge of what may be expected from bees.

It is regretted that the element of care and attention could not be expressed in figures alongside of the reports shown, for the old adage, "Keep your shop and your shop will keep you," is as true in apiculture as in any other line of business.

NAME.	ADDRESS.	Year.	No. stands.	Yield.
J. W. Sutton	Glasco.....	1897	26	1400 pounds.
D. S. Young.....	Long Island..	1898	3 new	64
			2 old	146
S. A. Lakin	Shaw.....	1898	1	1 gallon.
E. Davison.....	Garden City..	1896	5	50 pounds comb per stand.
		1897	.....	100 pounds comb per stand.
		1898	.....	40 pounds comb per stand.
J. P. Emery.....	Cimarron.....	1898	24	500 pounds.
H. H. Morten	Long Island..	.....	11	500 pounds (alfalfa honey).
Robert Ferguson....	Galesburg....	.....	.....	$3 to $7 per hive of twenty sections.
John W. LaBar.....	Erie	.....	25	500 to 600 pounds.
John Weir.....	Carbondale..	.....	40	2000 pounds (1500 extracted and 500 comb).
W. D. Fulton.....	Garden City..	.....	.....	Common to have one colony prod'ce 200 lbs.
R. L. Snodgrass.....	Gordon	.....	60	5000 pounds.
Mrs. C. E. Anderson,	Salina.....	1895	12	1075 pounds.
E. J. Johnson.....	Garden City..	1894	.....	Average per hive, 70 pounds comb.
		1895	.....	Average per hive, 52 pounds comb.
		1896	.....	Average per hive, 23 pounds comb.
		1897	.....	Average per hive, 70 pounds comb.
		1898	.....	Av. per hive, 39 lbs.; half comb, half ext.
F. H. Miller.....	Great Bend...	.....	28	1200 pounds.
R. W. Smith	Delphos.....	.....	22	40 pounds per stand (alfalfa honey).
Robert Douglas.....	Long Island..	.....	14	800 pounds, at 10 cents.
Mrs. M. D. Hetzel...	Kinsley	.....	1	72 pounds.
			5	Nearly as well.
Mrs. L. A. Carey.....	Phillipsburg,	1895	4	50 pounds.
		1896	5	300 pounds.
		1897	6	400 pounds.

I had the pleasure of meeting Mr. Frank Rauchfuss, secretary of the Colorado State Bee-keepers' Association, at the Omaha association, and gained from him the following data, which will be read with interest by Kansas apiarists:

RECORD OF COLONY No. 164, SEASON OF 1890.

By FRANK RAUCHFUSS, secretary Colorado State Bee-keepers' Association.

Date.	WEATHER.	Max. temp.	Min. temp.	Loss.	Gain.	Total weight.
June 8..	Clear and warm (*a*)	88°	47°	.....	.....	60½
" 9..	Clear and warm	93	57	½	.....	60
" 10..	Cloudy and warm	97	45	½	.....	59½
" 11..	Cloudy and windy (*b*)	97	48	½	.....	59
" 12..	Clear and hot (*c*)	99	50	.....	1½	60½
" 13..	Cloudy, and strong wind	87	46	.....	½	61
" 14..	Clear and warm	86	60	.....	3	64
" 15..	Clear, and strong wind after noon	87	45	.....	1	65
" 16..	Rain and wind part of day	86	55	.....	3	68
" 17..	Clear and hot	101	55	.....	10	78
" 18..	Clear and hot	98	55	.....	8	86
" 19..	Clear and hot (*d*)	99	53	.....	8	94
" 20..	Clear and hot	105	50	.....	8	102
" 21..	Clear and hot	101	55	.....	6	108
" 22..	Clear and hot, cloudy after noon	103	65	.....	6	114
" 23..	Clear and hot (*e*)	107	77	.....	5	146
" 24..	Clear and hot, wind, and cloudy after noon	109	78	.....	5	151
" 25..	.....	100	65	.....	5	156
" 26..	Clear and hot (*f*)	100	70	.....	8	164
" 27..	Clear and hot, cloudy and cooler after noon	105	65	.....	7	171
" 28..	Clear and cooler	99	83	.....	6	177
" 29..	Clear and warm	100	70	.....	3	180
" 30..	Cloudy and cooler	94	70	.....	2	182
July 1..	Clear and warm, small shower after noon	100	69	.....	2	184
" 2..	Clear and warm, storm after noon (*g*)	102	69	.....	¾	119
" 3..	Clear and warm	98	67	1	.....	118
" 4..	Clear and warm	105	72	.....	.....	118
" 5..	Clear and warm, cloudy after noon	106	73	.....	.....	118
" 6..	Clear and warm	106	74	.....	½	118½
" 7..	Clear and warm	102	71	½	.....	118
" 8..	Clear and warm	104	79	.....	½	118½
" 9..	Clear and warm, some wind, and cooler	108	76	.....	2½	121
" 10..	Clear and hot (*h*)	110	74	.....	1½	122½
" 11..	Clear and hot	105	71	.....	1½	124
" 12..	Clear and hot	107	65	.....	1½	125½
" 13..	Clear and hot, windy and cooler after noon	106	75	.....	4½	130
" 14..	Cloudy and cooler	104	72	.....	2½	132½
" 15..	Clear and warm, strong wind after noon	103	75	.....	5	137½
" 16..	Clear and warm, rain late in afternoon	103	69	.....	3½	141
" 17..	Clear and warm, cloudy and cooler after noon,	100	70	.....	3	144
" 18..	Clear and warm, severe hailst'm after noon (*i*),	101	60	.....	1	145
" 19..	Clear and warm, cloudy and cooler after noon.	106	84	.....	½	145½
" 20..	Clear and warm	103	75	.....	½	146
" 21..	Clear and warm, rain after noon	103	74	.....	2½	148½
" 22..	Clear and warm, rain after noon	92	67	.....	2	150½
" 23..	Clear and warm, cloudy after noon	90	72	.....	.....	150½
" 24..	Clear and warm, rain after noon (*j*)	94	72	.....	½	151
" 25..	Clear and warm	100	73	.....	1	152
" 26..	Clear and warm, cloudy and cooler after noon,	99	70	.....	2½	154½
" 27..	Clear and hot	111	73	.....	2½	157
" 28..	Clear and hot, windy and cooler after noon	109	80	.....	2	159
" 29..	Clear and hot, windy and cooler after noon	107	60	.....	2	161
" 30..	Clear and hot, windy and cooler after noon	98	76	.....	2	163
" 31..	Clear and hot	103	59	.....	3½	168½
Aug. 1..	Clear and hot, windy and cooler after noon	104	63	.....	2½	169
" 2..	Clear and hot	100	63	.....	3½	172½
" 3..	Cloudy and warm	100	55	.....	3	175½
" 4..	Cloudy and warm, windy and cooler after noon,	101	58	.....	1½	177
" 5..	Clear and warm (*k*)	105	55	.....	1½	114½
" 6..	Clear and warm	105	65	.....	1½	116
" 7..	Clear and warm, windy and cloudy (*l*)	103	60	.....	2½	118½
" 8..	Cloudy and cool	99	66	.....	1½	120
" 9..	Clear and warm	101	65	.....	4	124
" 10..	Clear and warm	104	57	.....	3½	127½
" 11..	Cloudy and cool, some rain after noon	103	56	.....	2½	130
" 12..	Cloudy and cool, some rain after noon	99	58	.....	2	132
" 13..	Cloudy and cool, some rain after noon	86	59	.....	1	133
" 14..	Cloudy and cool, some rain after noon	99	59	.....	½	133½
" 15..	Cloudy and cool	96	59	.....	.....	133½
" 16..	Rain	95	54	1	.....	132½
" 17..	Clear and warm	96	50	.....	3	135½
" 18..	Cloudy, cool, and wind	86	52	½	.....	135
" 19..	Rain	80	55	1	.....	134
" 20..	Fog, clear and warm after noon	87	50	.....	3	137
" 21..	Clear and warm	97	60	.....	1½	138½
" 22..	Clear and warm, some rain after noon	95	54	.....	1½	140
" 23..	Clear, cool, and wind	97	50	.....	.....	140

RECORD OF COLONY No. 164, SEASON OF 1890—CONCLUDED.

Date.	WEATHER.	Max. temp.	Min. temp.	Loss.	Gain.	Total weight.
Aug. 24..	Clear and warm	98	57	.....	2	142
" 25..	Clear and cool	97	57	.....	2	144
" 26..	Clear and warm	99	50	.....	3	147
" 27..	Clear and cool	97	52	.....	1	148
" 28..	Clear and cool	105	51	.....	1	149
" 29..	Clear and warm	98	53	.....	2½	151½
" 30..	Clear and warm	109	60	.....	3	154½
" 31..	Clear and warm, cloudy and cooler after noon,	98	59	.....	1½	156
Sept. 1..	Clear and warm	103	59	.....	2½	158½
" 2..	Cloudy and cool, some rain	90	50	.....	½	159
" 3..	Cloudy and cool	95	49	.....	.....	159
" 4..	Clear and warm	97	60	.....	2	161
" 5..	Clear, cool, and high wind	100	62	.....	.....	161
" 6..	Cloudy, cool, and some rain.	94	52	.....	½	161½
" 7..	Clear and warm	94	44	.....	1	162½
" 8..	Clear and warm	97	44	.....	1½	164
" 9..	Clear and warm	101	49	.....	3	167
" 10..	Clear and warm	96	54	.....	3½	170½
" 11..	Clear and warm	101	36	.....	2½	173
" 12..	Cloudy and cool	76	34	1	.....	172
" 13..	Clear and warm	97	38	.....	½	172½
" 14..	Clear and warm	94	39	.....	.....	172½
" 15..	Clear and warm	98	46	.....	½	173
" 16..	Cloudy and cool	98	58	½	.....	172½
" 17..	Clear and warm	96	51	.....	½	173
" 18..	Cloudy, high wind (*m*)	75	39	.....	.....	98

Total of honey secured, 182¾ pounds.

(*a*) Large double swarm, put in ten-frame hive, on full sheets of foundation, extracting super with ten combs given.

(*b*) Alfalfa in full bloom.

(*c*) Bees flying well until seven in the evening.

(*d*) Alfalfa suffering on account of lack of water.

(*e*) Another extracting super added; tare, twenty-seven pounds.

(*f*) Small shower late in the afternoon.

(*g*) Extracted 65¾ pounds of honey.

(*h*) Second crop of alfalfa in full bloom.

(*i*) Hailstorm destroyed most of the blossoms within two miles.

(*j*) Bees commencing to work on cleome.

(*k*) Extracted sixty-four pounds from scale hive.

(*l*) Cleome in full bloom.

(*m*) Extracted fifty-three pounds from scale hive.

ONE YEAR AMONG THE BEES.

By A. H. Duff, Larned, Kan.

PLAIN, SIMPLE, PRACTICAL AND ECONOMICAL METHODS OF HANDLING THEM FOR PROFIT, ESPECIALLY INTENDED FOR THE BEGINNER.

The first question may be asked, Who may keep bees, and where may they be kept? Any one permanently located may keep bees, whether he may be a farmer, lawyer, doctor, minister, or a member of any other vocation, who may have a few spare minutes occasionally to look after the wants of his bees. Bees may be kept successfully to some extent almost anywhere, either in the city or country, and will be found profitable if attention is given them in the right manner. Some localities are better than others for bees, but there is scarcely any locality that man can exist, that bees will not do likewise. A few hives of bees may be kept, and require but little attention, that will furnish all the honey necessary for family use, and at a very slight expense. Bees work for nothing, and board themselves at the same time, so that the principal requirement is a storehouse for them, properly arranged to suit their habits.

WHAT CONSTITUTES A COLONY OF BEES.

A fair working colony of bees consists of about 25,000 to 35,000 worker bees, a few hundred drones, and a queen. During springtime, and until after the honey season, they attain their greatest number, which may considerably exceed the above, after which time they gradually decrease until they reach their lowest number, during the winter months. This may fall far below the above number. Ordinarily, a colony of bees reaches its lowest number in March, and its highest number in June. Drones are bred only during the honey or swarming season after which they are killed off by the worker bees. The average life of the worker is about forty-five days, and the average life of the queen about two years.

There is but one queen in each colony and she is the only fully developed female in it. She is the mother of the entire colony, laying all the eggs that produce every bee in the hive. Two kinds of eggs are deposited by the queen, one kind being fertile and the other infertile. Three kinds of bees are hatched from these eggs, the fertile egg producing queens and worker bees, and the infertile egg, drones. The fertility of the queen remains the same throughout her life, never receiving fertilization but once; hence, produces the same stock during her existence. The queen has a sting, but seldom uses

it except in battle with other queens. Two queens cannot occupy the same domain; their presence is a signal to each other for battle, and their meeting, under any circumstances, is sure death to one or the other.

The drones are the male bees. They do no work whatever in the hive: nature did not intend they should. They are not provided with a weapon of defense, neither provided with a honey sac to carry honey, nor a tongue to reach the nectar in the flowers, nor pollen baskets to carry pollen, nor wax pockets to secrete wax. They are simply inveterate loafers in the hive. They come forth from the hive during the middle of the day, and at the same time virgin queens take their flight.

The worker bee is truly the "busy bee," and in sex is an undeveloped female, but is usually termed neuter. The busy bee does all the work: it gathers all the honey, the pollen, the propolis or bee-glue, carries water, secretes wax and builds comb, prepares food and nurses the young brood, defends the hive, cleans house and performs various other duties. If the workers ever take a rest, either night or day, from all the duties of the hive, no one has ever yet found it out.

The worker bees may be placed in three different classes, namely: The honey gatherers, the comb builders, and the nurse bees. They are thus classed as to age. The first work the young bee performs, after it is two or three days old, is to prepare food and feed the larva in the cells. The next duty, when ten or twelve days old, is to secrete wax and build comb. When about twenty days old they become field workers. This applies to a well-regulated colony that is in first-class condition in all respects.

In thus briefly going over the work of handling bees for one year, we will begin with spring management, follow with summer and autumn management, and close with winter management. As announced in starting out, our object principally was to help the beginner, the small bee-keeper, and farm bee-keeping generally; hence it will be necessary to go over considerable ground of the first principles of bee-keeping, which to the well-informed apiarist would seem, to some extent, stale reading; yet when we take into consideration that this work will go into the hands of hundreds uninformed on this subject to one informed, we hope that the expert will bear with us.

EARLY SPRING MANAGEMENT OF BEES.

The most critical period of the whole year with bees is in early spring, just about the time warm days begin to put in an appearance. With the long confinement of winter and the endurance of severe weather, bees are very tender and easily discouraged, and, if very weak, they will dwindle down and become less in numbers so rapidly

that the hatching brood at this time will not keep up the force of bees. This results from improper fall and winter management, of which I will have something to say later on. Colonies of bees should be of proper strength at all seasons of the year, and at no time are weak colonies desirable. We may not have this entirely under our control during the winter season, but largely so; for if we go into winter quarters with weak stocks we will surely come out with them much weaker in spring.

If colonies are reasonably strong in early spring, and have good fertile queens, with plenty of provisions in store, there is nothing to fear with regard to their coming through in good condition and proving profitable the following honey season. In making an examination of colonies at this time, ascertain, first, if the queen is present, and if she is depositing eggs, and if brood-rearing is progressing to some extent, and, also, as to amount of honey in the hive. If a colony is found without a queen now, and no queen at hand to supply it, it is absolutely useless to allow it to remain as a colony. The proper thing to do is to unite it with some other colony that has a queen. In such a case as this we can strengthen some weak colony that has a queen, by uniting with it. The process of uniting would be simply placing the queenless hive on top of the other hive, supposing of course that we use the common frame hive, when the bees will almost immediately go below to the queen. If any remain on the combs, they may be brushed off with a stiff feather and the upper hive removed.

It is a common practice to contract the space in the hives, and especially so in case of weak colonies, by division boards, which accompany almost all frame hives. This economizes the natural warmth of the bees, and enables them to rear more brood, and keeps them in more comfortable quarters. In handling the frames of comb at this season of the year we should be very particular when returning them to the hive to put them back in the same place and position they formerly occupied, so that the brood will be in a compact form and not separated or changed; for in case it should be thus separated and the cluster of bees were not able to cover it thoroughly, it would of course be lost.

In early spring bees should be inspected and handled only on warm days, when they are flying freely. In no case should hives be opened up and the bees disturbed at any other time. In every case after handling a colony the hive should be carefully and thoroughly closed, and during this period of springtime the entrances to all hives may be contracted to a small space with benefit to the bees.

STIMULATIVE FEEDING.

It is to be presumed that every colony has an abundance of reserve stores in the hive, and that reserve should consist of ten or fifteen pounds of sealed honey. If they are short of this amount, they should be fed. After warm weather predominates it is no trouble to feed bees, but until this occurs, but little if any feeding of syrup can safely be done. The term "stimulative feeding" applies to feeding for brood rearing, and is done at regular intervals during springtime, when the bees are unable to gather honey on account of either cool weather, or a shortage of nectar in the flowers so they cannot gather honey. Queens invariably stop laying eggs and brood-rearing ceases when the honey flow stops, and then again begin the rearing of brood when the bees begin gathering honey. Now in stimulative feeding we imitate a natural flow of honey, and if we feed thus at times when the bees are idle, the queens keep right on laying eggs to their utmost capacity, governed of course by the strength of the colony.

Food for bees should consist of the best grades of sugar; granulated sugar is the best, and perhaps the cheapest. To prepare syrup for this purpose, add water to sugar, equal parts of each by measure, and heat thoroughly, but do not boil it, but bring it nearly to the boiling-point. It may be fed warm, but not hot. For stimulative feeding, about half a pint to a strong colony is sufficient each and every day, given during such times as the bees are idle, from the time warm weather opens in spring, until the beginning of the natural honey flow of the season. Colonies thus brought up to the beginning of the honey harvest are fully twice as strong as those not so treated, and the result is that these colonies will store hundreds of pounds of honey while the others store tens.

Various kinds of feeders are used for feeding bees. The best and most simple, and a feeder that any boy can make, is made from a block of soft wood filled with holes one or two inches in diameter put nearly but not quite through the block, thus forming a trough, and the partitions between the holes are footholds for the bees, and prevent them from drowning in the syrup. This feeder may be made just the size to fit on top of the hive, covering the entire top of same, and a few holes in center of block put clear through for the bees to come up to get the feed and then pass down again. This feeder should be incased in an upper story added to the hive, with the lid on same to confine the bees inside and also prevent other bees getting in from the outside. The proper time to feed bees during the day is very late in the evening, and as late as we can see to do the work. Where many colonies are together it causes quite an uproar, and sometimes when fed during the day it produces robbing, but is always

done with safety thus in the evening, as the syrup is all stored away at night, and all is quiet in the morning.

The hives which are in general use, and which are here illustrated, have a capacity of about 2000 cubic inches. It is not presumable that the brood chamber alone of this dimension is large enough to contain extremely strong colonies at the beginning of the honey flow, or up to the time we would add surplus boxes. It would be a fatal mistake to try thus to confine such stocks of bees in a single story alone, and the result would be a severe case of swarming. The proper method to pursue would be to add another story the same in all respects as that of the brood chamber, with a set of frames of comb, or foundation comb, and use both stories for brood and honey combined, and at the beginning of the honey harvest put all brood frames below and add two tiers of section boxes to take the place of the upper story removed, if comb honey is the object; if to be run for extracted honey, retain the upper story, but put all brood frames below and bring up from below all frames of honey. No harm whatever comes of having some brood in the combs above, for the extractor will remove the honey without injuring the brood, if the extractor is properly handled.

It should be borne in mind at all times that strong colonies are the means which bring about large honey crops, and the ordinary method with the small bee-keeper, of letting his bees do as they please, and as they can, without his help, will not bring the immense profits obtained in many instances by those who get a proper understanding of their management and apply the same. I do not pretend to say that bees will not be of some value and give good returns frequently on the let-alone plan; but if a thing is worth doing at all, it is worth doing right, and this rule is not a failure in the management of bees by any means.

THE BEE VEIL AND SMOKER.

The apiarist equipped with bee veil and smoker considers himself master of the situation. The bee veil is but little used at present by the practical worker in the apiary; it has to a great extent been laid aside with the rubber gloves, which have also been used largely. But every one who keeps bees should have a bee veil in case of necessity, and not this alone, but he should always have a veil to accommodate visitors, and in every case of this kind bring it into use. A veil made of any veiling stuff will do, and one for rough and ready use may be made from common mosquito netting. A rubber band should be in the top to hold it firmly around the hat crown.

The principal defense lies in the smoker, being the apiarist's closest and best friend. No colony of bees will put up a fight against

FIG. 8. Bee veil and smoker.

smoke properly applied. Bees, when smoked, will become excited, and they seem to conclude that they are going to be robbed, and they readily give up and make a rush to the combs for as much honey as they can contain, and thus fill themselves full, and when in this condition they cannot, or at least do not, attempt to sting. Any one can master bees by simply learning how to use the smoker on them. The smoker should not be brought into use every time you are handling bees, for almost throughout the entire honey season they may be handled as well, or even better, without it. As for myself, I scarcely use it at all during this period.

THE HONEY SEASON.

All bee-keepers, as a rule, know just about the time the principal honey flow of the season begins in their locality. While the time may vary a little in different localities, yet it is a noticeable fact that the bulk of the surplus honey crop of the United States is obtained dur-

ing the month of June. There seems to be something about the balmy atmosphere of the month of June that not only deposits more nectar in the flowers, but of a better quality, and hence June honey, both in quantity and quality, excels all others.

If, at the beginning of the honey season, we decide that we do not want an increase in the number of our colonies, but that a crop of honey is the only thing in view, we must bend our energy in that direction, and work accordingly. To obtain the largest honey crop, it is necessary to prevent swarming to a great extent, if not exclusively. The idea is to put our entire force of bees down to storing honey, and no foolishness in the way of new swarms to start up housekeeping at the expense of the honey crop.

Swarming is prevented in more than one way, and the proper thing to do right at the beginning, and that time is when the colony becomes so strong that they are cramped for room in the lower story or brood chamber, is to add the upper story, even if a little in advance of the honey harvest. The first thing that puts bees in the notion of swarming is lack of room in the hive, and at all times throughout the entire season this must be carefully looked after, and abundance of storage room given at all times when bees are storing honey. This alone is the principal secret of large honey crops. It not only prevents swarming to a great extent, but the bees are never prevented from storing honey for want of space.

Space alone will not prevent swarming, but only to a certain extent. The principal method used to prevent swarms is the removal of all queen cells at the proper time from the combs. Bees will swarm in eight days after the construction of queen cells begins. These cells become very visible after they are five or six days old, and may easily be found and removed from the combs. The removal of these cells will prevent the swarm from issuing except in very rare cases—so rare, that it need not be taken into consideration. If these cells are allowed to remain, the young queens reach maturity in the larval state in eight days, at which time the cells are sealed over, and the swarm is due to come off. Hence, there will be seen the time when action must be taken for their removal to prevent the swarm from issuing. In most cases the bees will immediately again begin constructing more queen cells, to be followed by removal as before. It is only exceptional colonies that will thus torment us in trying to swarm, as the largest per cent. of them will be content to store honey without attempting to swarm, if they have plenty of storage room.

If in thus making an examination of the frames of comb and removing the queen cells we should happen to overlook a cell, we will surely be rewarded with a swarm, for one cell alone in the hive is

fully sufficient to bring out a swarm. In such cases we may return the swarm, but the cell must be hunted up and taken out or the swarm will come again. The most convenient time to secure this cell is when the swarm is out of the hive, as it can be more readily found, the bees being out of the way. When bees thus take the swarming fever they will not do as well at storing honey as they do otherwise, and in some cases of the most persistent swarmers I would advise hiving them in a new hive to themselves. And also in cases of extremely strong colonies, that seem to be so numerous that a two-story hive will scarcely contain them, if such colonies attempt to swarm I would hive them also, as such swarms will give better results separated.

HIVES AND APPLIANCES FOR HONEY PRODUCTION.

The illustration herewith (fig. 9) represents modern hives of the latest pattern now in general use in the production of honey. The hive proper is a modification of the old Langstroth hive, the frame being identical, or nearly so, to that of the former. The frame seen at

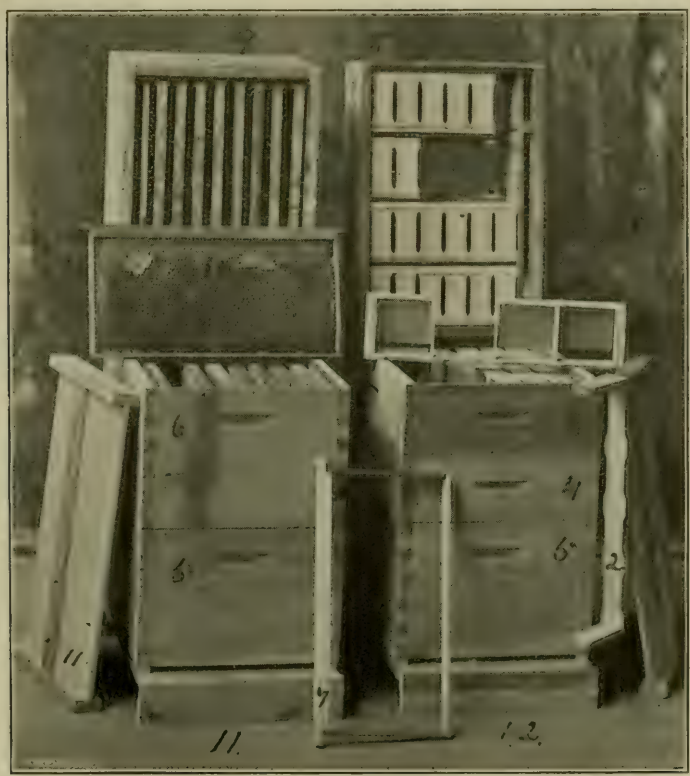

FIG. 9. Hives and appliances for honey production.

7, leaning against the front of the hives, in dimension is seventeen and five-eighths inches long, and nine and one-eighth inches deep. The body of hive is designed to hold eight of these frames and is a box without top or bottom, nine and a half inches deep, thirteen and seven-eighths inches wide, and twenty inches long, outside measure. The inside top edge of the end pieces are rabbeted out, thus letting the top bar of frame drop down one-fourth of an inch lower than the upper edge of hive. To facilitate handling, metal rabbets should be used for the frames to rest on, by cutting the rabbet one-fourth of an inch deeper than actual measurements, and then tacking in place a piece of folded tin to the required height. The entrances to these hives are made by nailing slats three-eighths of an inch thick to the bottom board, at the sides and at the back end, the front being left open.

In the illustration (fig. 9) *11* is a hive equipped for extracted honey, and *12* is one rigged out for comb honey. Having just arrived at the honey season, we will first take up the subject of comb-honey production. As previously stated, in order to reap a rich harvest of honey it is absolutely necessary to have colonies of bees in proper condition, by being strong in numbers, having a large amount of brood in the hive, and the queen laying eggs at the rate of from 1000 to 3000 a day.

To raise comb honey, and have it in good marketable shape, we must use the section box. And right here the question may arise, Will it pay the small bee-keeper or the beginner to go into all these little details and bring into use all these fixtures we have here brought out? In answer to this, I will say emphatically that it will, and it is only necessary to test the matter once to convince you fully. We have simply here shown a few articles, what we consider actually necessary for the small bee-keeper, and nothing more. The preserving qualities of comb honey lies in the section box exclusively, and in no other manner can it be retained any length of time in perfect condition. The section boxes in general use are made to hold one pound of comb honey. They are four and one-fourth inches square and one and seven-eighth inches wide. These section boxes, and crates holding the same on the hives, are shown at *12*; *5* is the brood chamber, or lower story of hive; *4*, just above it, is the first crate of sections, and *3* is the second crate of sections, and what we call a hive with two tiers of sections. Each crate holds twenty-four sections, and two tiers will make forty-eight one-pound boxes occupying the hive at one time. We do not use less than one tier of sections, and scarcely more than two tiers.

The amount of storage capacity used depends upon the strength of

the colony. The colony should be strong enough to occupy at once the boxes given, and it is only a very small per cent. of colonies that can take two tiers of boxes at the beginning, but, in most cases, one tier of sections is first placed on the hive, and when the bees are well at work in them, say half full or more, then add the second tier. This second tier is not usually placed on top of the first, but the first is raised up, and the empty one is placed under, as in this manner the bees being already in the upper one, must occupy both tiers at the same time, when otherwise they would be slow to go above into the empty boxes. In fig. 9, *8* shows a crate of boxes standing on end with a few boxes removed (and, by the way, we here show two kinds of crates, which we will explain further on, but will say the one represented as being on the hive is the "section holder" crate, and the one standing on end is the "T" crate or super); *2*, hanging on the corner of hive, is one of the section holders, and is again shown on the top of hive holding three sections, one being out of place. There are six of these, holding four sections each, in a crate. The sections as seen on the hive are furnished with foundation comb, and the manner of doing this work is seen in the following cut.

THE PARKER FOUNDATION FASTENER.

Figure 10 shows the "Parker" foundation fastener No. 4; *3* is a section rest and gauge to hold the section in place, so that the fastener may strike the section exactly in the center, and by pressure fasten the foundation in place; *1* is a section fully supplied with foundation, at least according to my notion. Some may differ a little with me in the use of so much foundation in a section, as many use

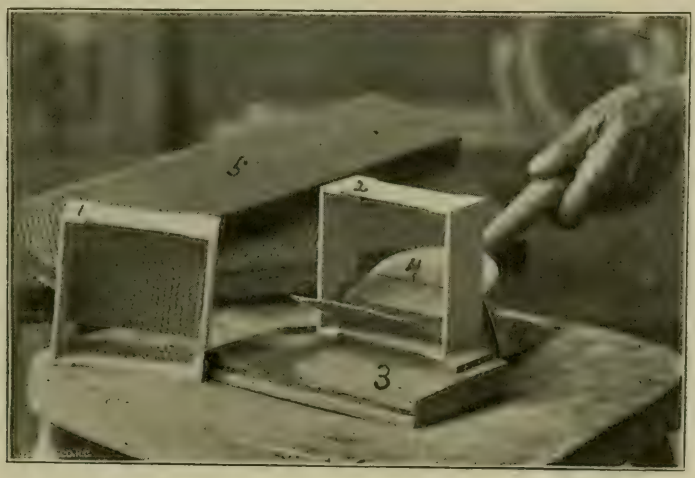

FIG. 10. Parker foundation fastener.

merely a starter of about half an inch at the top only, but perhaps all will agree with me that the double starter is the best. I fasten a three-eighths-inch piece on the bottom, and bring it to within one-half of an inch at the bottom, as is shown in cut, with the top starter. As the bees work it out, it will stretch until it will nearly, but not quite, meet, if the best thin foundation is used. It will thus make the best union, and a section thus furnished will make a good, smooth, solid section of honey, the difference being more noticeable when the flow of honey is rather moderate or uneven. At *5* is seen a pile of the raw foundation honeycomb.

Foundation comb is one of the most valuable inventions of modern bee-culture. For the benefit of those who are not well acquainted with it I will say, that it is made of pure beeswax, and molded out in very thin sheets, and then passed between rollers having dies of the exact size and shape of the base or the natural honeycomb, thus leaving the impression of the base of the cell on the sheet of wax. See figure 20, further on, and you will see comb *1* representing the raw foundation, and comb *2* one day's work by the bees. We will explain this more fully when we reach it.

No one who pretends to keep bees should be without this foundation comb. It has been said that bees consume twenty pounds of honey to produce one pound of wax, and more conservative writers figure it down to fifteen pounds; but just think of it, the price of foundation is on an average about forty-five cents per pound. Now, if one pound of this will save fifteen pounds of honey, is it not plain enough that it pays well to use it? Not only this, but by its use we can have frames of comb straight as a board, and every inch of it worker foundation besides, and we are not bothered with thousands of worthless drone bees in the hive; this it prevents, as you are doubtless aware of the fact that bees cannot rear drones in worker comb, but must have the large drone cells to rear them in.

SUPER FOR HOLDING THE SECTIONS.

The super here shown for holding the sections on the hive, similar to what is called the "T super," I consider one of the best. It holds the sections in place better than any other I have used. The super, when filled with honey, is more rigid, and less liable to become loose in handling, and the sections of honey are more easily removed from it. The illustration shows the bottom of crate, the section rests, and a few sections in place. The section rests are made of a piece of wood three-eighths of an inch thick and three-fourths of an inch deep, with a strip of tin one inch wide tacked on the narrow edge of the same, the tin being one-fourth of an inch shorter at the ends. These section rests are held in place by a wire staple driven in super as shown

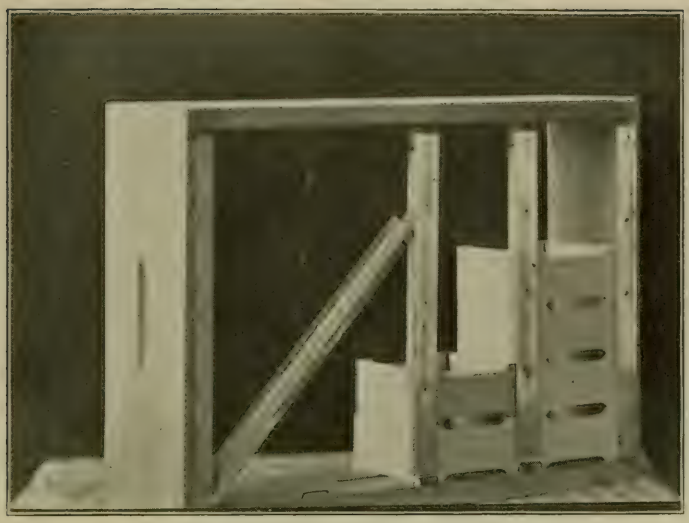

FIG. 11. Super for holding the sections.

in cut. The section rest out of place and leaning against the center one shows the extension of the tin strip on each side of the same. Tin is also supplied at the ends of super for the same purpose. When separators are used they may be dropped down between the sections, and rest on the section rests. A following board is used, and the sections are keyed up tightly in place in the usual manner.

THE SECTION-HOLDER SUPER.

This is a super largely used at present, and one that has many good features. The illustration shows the six holders, five of them in position in the crate, with the following board at the bottom and wedges under the same, one holder out of place and lying on top of crate. With this holder the sections are less liable to become soiled, as but one side of section is exposed. These holders filled with sections are held in the super by wedging up with the following board. This wedging keeps them nicely in place when empty, but when they become filled on the hives there is more or less shrinkage of the parts, and when you pick up the whole super to move it the outside shell usually comes, leaving the inside gearing on the hive. This can be removed by sections. This is of course easily removed, and this point is one of the good features of the section holder. Bees when storing surplus honey will usually fill the sections directly above the brood nest first, and thus the center sections are completed long before the ones on the outside rows. With the section holder those inside can be placed outside, and the empty sections are brought to the center,

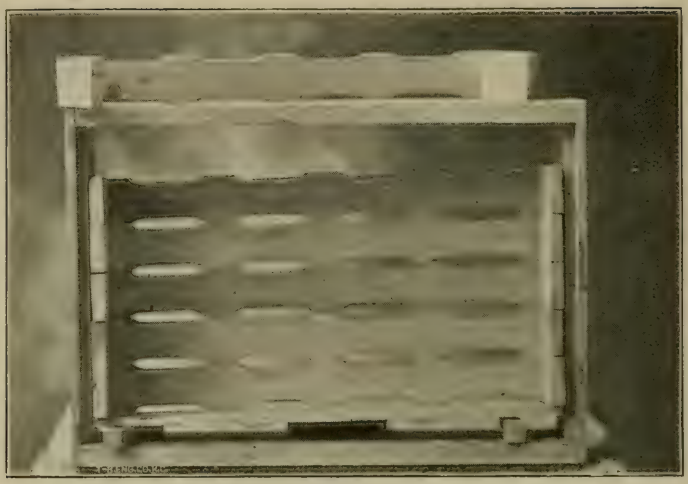

FIG. 12. The section-holder super.

by simply exchanging the position of holders. The supers of either of these crates are the same, and are the same dimensions as that of the hive proper, except they are just one-half the depth. Two of these empty supers make a hive, and are frequently used as such on a scarcity of hive. They have rabbets cut in them for the frames to rest in when thus used.

SECTION BOXES, SHIPPING CRATES, ETC.

In figure 13, *2* is a crate of 500 sections, as shipped from the manufacturers; *3* shows the section box, with the three saw cuts making the corners after being folded; *4* is a section partially folded, the dovetailed corners to be brought up and hammered together to complete it; *5* is a shipping case for sections of honey, and on top of same are three sections of honey.

HIVES COMPLETE.

In figure 14, *1* is a hive with two tiers of sections, being a complete two-story hive for comb honey. Each super holds twenty-four one-pound boxes, making forty-eight pounds surplus storage capacity. While as a general thing but two tiers of sections are used, yet more may be used, and thus for the time being several supers may be stored one above the other. This must not be considered ample storage capacity for the season by any means, for frequently colonies will store several times this capacity during the honey season. The proper method to pursue is to remove the honey just as soon as it is completed. As previously stated, begin with one tier of sections, and when the bees have these half full or more add another tier of boxes by raising the

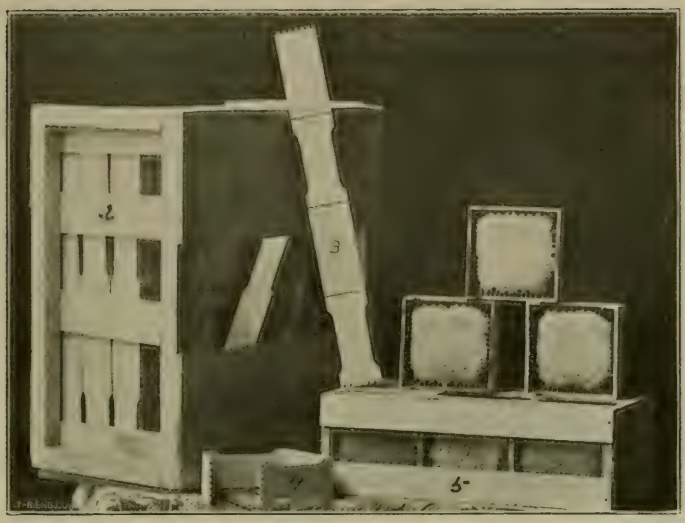

FIG. 13. Section boxes, shipping crates, etc.

first and placing the empty ones next to the bees. They will thus fill the upper tier first and have it all completed and capped over some time before the lower one is full; but perhaps about this time the lower tier is full enough to be raised up and an empty one added again. After removing supers and taking out the boxes, if any are not completed return them by using them to make up another super. These uncompleted sections are a good bait to induce the bees to take hold again; this they usually do more readily when uncompleted sec-

FIG. 14. Hives complete.

tions are present. It is not necessary to wait until the outside sections of the super are sealed over, for the bees oftentimes refuse to do this under any circumstances, and these can be put in the center of the next crate advantageously, as explained above.

If you have had some experience, you can judge pretty closely the time when the honey season will close, and if nearing the end you must think fast and work accordingly, or you will be left with quite a quantity of unfinished sections to carry over to another year. Now is the time to condense and get your sections nearest completed together as much as possible, and get them on your best comb-honey-building colonies. I say your best "comb-honey builders." Can there be a difference in colonies like this? you ask. Yes, and all closely observing apiarists well know this, and know the colonies that they prefer to put the finishing touches on comb honey. These colonies, like some people, never stop until their work is completed; they seal up their honey as soon as the combs are full and the honey is ripe, while others are slow to complete by sealing the combs, and especially when nearing the end of the honey season, they seem to almost stop business and let everything go wide open. But do not grieve over a lot of unfinished sections, for if we are out the cash they would have brought us at the present if finished, they are worth it all with good interest to carry over for the purpose of giving us a good early start with the next spring.

In figure 14, *2* is a two-story hive as arranged for extracting. This hive is better seen at *11*, in figure 9. A hive for extracting is simply two brood chambers. But we want the brood in the lower story, and frames of comb for the surplus honey in the upper story. In figure 9, *6* shows the upper story as arranged for the extractor, with eight frames of comb, one of the combs resting on top of hive. The hive standing on end at the back, and marked *9*, simply shows the bottom of a hive, and the manner the frames should hang thus evenly spaced to insure good manipulation of the combs.

THE EXTRACTOR.

The extractor (fig. 15) was invented about the year 1865, but is yet little known among the class of small bee-keepers. Scarcely any one who keeps but a few colonies of bees thinks of getting an extractor. This can also be set down safely as a mistake among the bee-keepers on a small scale. I will say that any one having as many as five colonies of bees will, with the use of an extractor, in one season get by its use enough additional honey to pay for it.

It has always been a query to many why extracted honey sells for less than comb honey. This question has already been answered in our discussion upon comb foundation. By the use of the extractor we

FIG. 15. The extractor with inside gearing raised up and exposed to view.

save all the comb, and the saving of a pound of comb is equal to the saving of fifteen pounds of honey. Wax is not gathered from flowers in any quantity that bees see fit to carry it in, but it is a production of their own, produced by the consumption of their food, honey. Wax is formed in the bee on the same principle that fat is formed in an animal, the difference being only in the locality in which it is deposited. Each worker bee has six wax pockets located between the rings on the under side of the body, three on each side of the dividing line in center of body. Wax forms in these little pockets in disks resembling small fish scales, and can plainly be seen during the comb-building season, protruding from these wax pockets. Now there are, perhaps, many who will read this, and who used to keep

bees, and may do so yet, and have hived swarms in old log-gums and square boxes, and the next morning in looking in, by tipping up the box, to see if the bees were there, discovered on the bottom board a large quantity of these scales, and wondered how they came there. When bees swarm they are, to their fullest extent, equipped with these tiny wax scales, stored up for future use, and when thus hived in an empty box, and on beginning to start their combs, they thus from some cause drop a large number of these scales.

It has been said, by good autuority, that we can double the number of pounds of honey by extracting that we would otherwise get in comb honey. If not altogether double the amount, we can certainly get considerable more; then why would it not be advisable for the small bee-keeper to thus increase the quantity of honey from his few hives of bees? Producing extracted honey is less complicated and more simple than producing comb honey.

EXTRACTING HONEY.

The illustration (fig. 16), shows the simple process of extracting honey from the combs. The operator on the right, with a long, thin-bladed knife, is shaving the cappings from a frame of comb that has partially been sealed over. He hands the frames of comb to the operator on the left; he, placing one in each comb basket, turns the crank and the reel inside revolves around a few times, thus forcing the honey from the outside of the comb by centrifugal force; when he reverses the comb baskets, thus turning the other side of comb outwards, extracting it also. The combs come out without being in any way injured, and are placed back in the hive to be refilled again by the bees.

FIG. 16. Extracting honey.

In removing the frames of honey from the hives of bees, we limit ourselves to the upper story, exclusively. We never extract honey from the brood chamber, but leave all that is stored there for the use of the bees. There has been considerable discussion with apiarists for some years past in regard to the proper time for extracting honey, with special reference to the condition of the same in the combs. Honey, when first gathered by the bees, is thin and unripe, and by letting it remain in the combs until the bees seal it or cap it over, it becomes thoroughly ripe. If taken from the comb soon after being deposited and before it is sealed over, it frequently is so thin that it will sour; but in most cases it will ripen into a fair quality of honey in time, if kept away from dampness. By extracting before the combs are sealed up, it saves considerable labor, not having to uncap the honey and the extracting being more easily done. It is now generally conceded that the proper time to extract is about the time of the sealing of the combs. Some extract when the bees begin sealing, and some just after the combs are well sealed.

The most extensively used packages for handling extracted honey are square tin cans holding sixty pounds each, and are shown on the left in figure 16. The most popular small package, for retailing, are Mason's glass fruit-jars, and also quart and half-gallon tin cans. For a small local trade, the common tin fruit-can, holding a quart, is the cheapest, and is in every way very convenient. Having a large opening, this can will admit of removing the honey in granulated form, and such cans may be filled and placed away until cold weather and the honey will be formed in a sugary mass resembling lard. All extracted honey will granulate during autumn and winter, and many prefer to use it in this form, but if not desired in this form, it may easily be brought back to liquid by placing the package containing it in hot water. It must not be boiled, but simply heated until it returns to liquid.

The large can shown on the right of the picture with the faucet, is very convenient for filling small packages, and also for retailing in small amounts. All extracted honey should be thoroughly strained, and no strainer made of wire will give as good satisfaction as a piece of thin muslin or cheese-cloth made in the form of a bag, about ten inches long, holding perhaps five pounds of honey, the weight of which forces it through the cloth.

HIVING SWARMS.

It has been the common practice, when the bees swarm and settle on trees—and they usually settle on fruit-trees—to cut off the branch containing the swarm. This is not only laborious, but it is a great damage to fruit-trees, and many valuable trees from this cause have

been permanently disfigured. Just procure a small box—one holding about a peck—and put several holes in it to give the swarm ventilation, and add a handle some eight to ten feet long to it, so that you may be able to reach up some distance with it. Push it against the cluster of bees and dislodge some of them at the same time, and they will readily go into your box. If they seem to be reluctant about it, give the branch a jolt with your box and dislodge most of the swarm, and then push the box up close to their clustering place. When the bees get well in the box, lower it and shake the remaining bees off the branch, and all will go into the box, when it may be taken to the hive ready to receive them. In hiving them, first brush a small quantity of them down near the entrance of hive, and these will usually go right in and will give the call to the others, when the whole army will move in this direction. When they get well started, shake them all from the swarming box, and they will go in the hive. When bees are thus swarming be very careful and handle them kindly. Do not kill a bee if you can well help it, as they have but one queen, and their whole welfare depends upon her; you might by rough handling kill her.

FIG. 17. Hiving swarms.

Bees cut up many very interesting pranks at swarming time. Swarms will come out frequently, and then return again to the parent hive. They may do this every day for a whole week perhaps, but not usually so often. When a swarm thus returns, the queen has not accompanied it, and I have had queens that absolutely refused to thus come with the swarm, and apparently nothing whatever to prevent

her. Queens, on account of bad wings, cannot fly with the swarm, and this occurs very often. They come out and crawl off on the ground, and sometimes are lost entirely. In this case, of course, the swarm returns also. When the queen comes out with the swarm and cannot fly, as in this case, the bees very frequently find her, as the odor of queens is very attractive to the bees, and if you are very careful to look all around in the vicinity where the swarm has been you may see a little handful of bees gathered up in a ball; then you can almost set it down as a certainty that the queen is inside the ball.

In case of swarms returning, they may be hived readily by removing the parent hive after the swarm has come out and putting an empty hive in its place, and the bees will walk right into the new one. But they must have a queen, and you can hunt out their own queen and put her in with them, providing she remained in the parent hive. The parent hive is then in the same condition as if the swarm came off with the queen, and it can be placed back at its old stand and the new one removed elsewhere.

In the above we speak of old queens only, and of first swarms, as the old queens always come with the first swarms; but second swarms containing young virgin queens are also guilty of the same tricks, and it is more like "tricks" with them, for they are active on the wing. More than one virgin queen may come with second swarms, as they emerge from the cells several in number at the time of the swarm's issuing; and right here is a nice little thing to make a note of. The young queens are kept imprisoned in their cells by the bees, and but one of them allowed at liberty in the hive, to prevent their killing each other; they thus keep them in their cells until the swarm is ready to come off, at which time they seem to allow them their liberty, or at least let a portion of them come out, and in this manner several of them may come out with the swarm, and thus come out, too, not being out of their cell perhaps five minutes. Or, in other words, we may say they swarmed with the bees, not being over five minutes old. But in this case the queens were kept imprisoned maybe twelve or twenty-four hours, or even longer, after they matured and were ready to come out. In all cases of second or after swarms thus having several queens issue from the hive with them, they settle down to business with but one queen, and the others will be found dead at the entrance of the hive a few hours later.

PUTTING HIVES TOGETHER.

The illustration (18) for putting hives together, and getting them perfectly square and exactly to the place before nailing them, explains itself. It is made of two-by-four stuff, well braced and spiked, and is readily made with ordinary tools, and can be made by any one. The

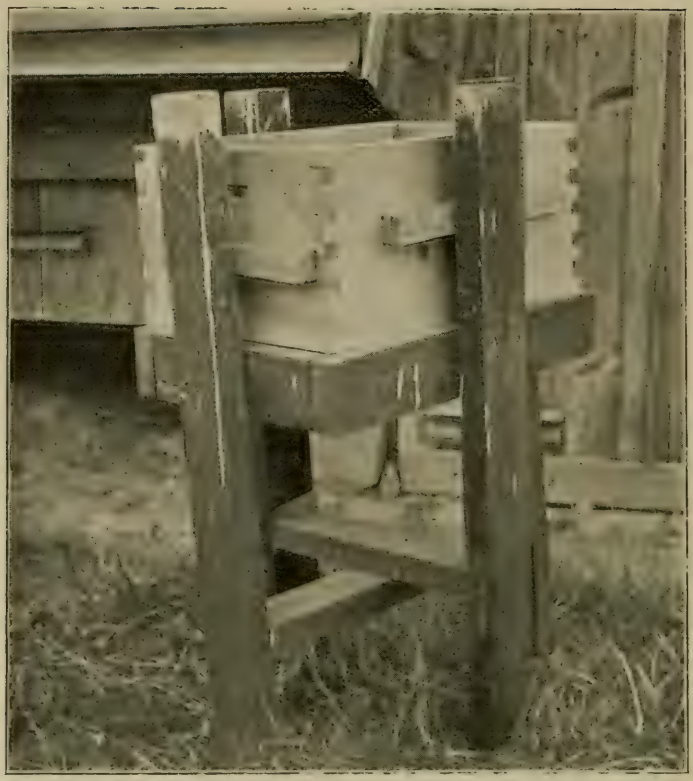

FIG. 18. Putting hives together.

hive is first put in place, and wedged up tightly to its proper shape, and when thus nailed it will take a hard knock to change it. Any style of hive, whether dovetailed or any other style of corner used, may thus be put up squarely and in proper shape.

QUEEN-CELLS AND QUEEN REARING.

Figure 19 is an ordinary frame of comb, and on it are seen queen-cells from the time they are commenced until they are completed. At *1* is a cell about four or five days old, *2* is six or seven days old, and at *3* we have one completed at eight or nine days old; and it thus remains until the queen hatches, at sixteen days. Two others still younger may be seen on the comb. This comb was used in what we call artificial queen rearing; that is, these cells were built here by the bees out of season, and not during swarming time, nor under the swarming impulse. They were built here as an absolute necessity by a queenless colony to produce a queen, as any colony will do at any season of the year if they have brood in the combs young enough to

produce a queen. Natural cells, as we call them, are produced only during the swarming season, and while the bees have the swarming fever. There is no difference in the cells, nor in the queens they produce, but usually there is a difference in the locality on the combs which these queen-cells occupy. In building queen-cells in natural swarming, the bees, having the entire work under their own management, select the edges at the ends and bottom of the combs, usually, to construct these cells, and also in uneven and broken places in the combs, and these cells are scarcely ever found on a smooth surface near the center of the combs, as in the illustration (fig. 19). I mention this fact, so that, if you are hunting the combs for queen-cells in swarming time, you will not be misled by the location of same.

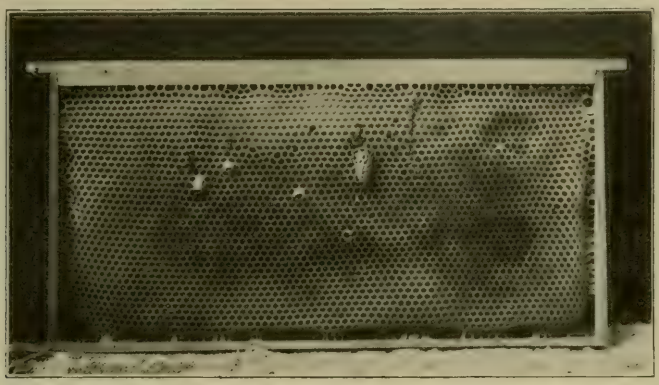

FIG. 19. Queen-cells and queen rearing.

There is no difference between an egg deposited by the queen to produce a worker bee and an egg deposited by her to produce a queen; they are one and the same. They are also the same after the egg hatches into larva; but at this point the change begins to occur: and if you give a queenless colony that has no young brood of its own a frame of comb containing worker-eggs or larvæ as usually found in a hive, they will at once begin to construct queen-cells around a few of these eggs, just as you see in figure 19, and in course of time produce as many young queens. This change is brought about by the bees changing the shape of the cell, and also administering a different kind of food and especial care to the larvæ. In extreme cases bees will take larvæ three or four days old and change them to queens, but such queens are not considered the best.

Now, on the above plan, you have our method of artificial queen rearing. Queens may thus be produced any time during the summer, spring and autumn included, or while warm weather continues. First

take a colony that does not have a queen, or you may remove the queen from any colony that has the proper brood in the combs, and this colony will proceed at once to thus build cells. When these cells are sealed up, and at any time before the first queen hatches out, they must be cut out of the comb and kept entirely separate, for immediately after the first young queen is out, she will hunt up these cells, and tear them open, sting the young queens yet in the cell, and thus destroy them. The proper time to separate the cells is about two days after they are sealed over, which occurs on the eighth or ninth day, which would make the cells ten or eleven days old. They will hatch out in sixteen days, providing the brood was not over three days old from the time the eggs were deposited, but if a day older, they will hatch that much sooner.

To care for these queen-cells we must form nucleus colonies; that is, we take one or two frames of bees and brood, and make a small colony, containing no queen of course, and engraft one of these cells in the comb, and thus accommodate each queen-cell with one of these nuclei. Full colonies must be drawn upon to form these nuclei, and one colony will make several of them. These cells hatch and the young queens will become fertile and begin laying eggs in ten or twelve days, when they may be removed and introduced into full colonies, or these nuclei containing them may be built up into full colonies. During swarming time is the best time to raise queens, as many hives now have a number of natural queen-cells in them, and we can utilize them and produce a large number thus. I have a preference for natural cells, but am not able to prove them any better than the others. One drawback to raising queens out of season is the supply of drones. We cannot raise queens without drones; that is, the queens will not become fertile, and of course are worthless; but usually there are drones enough retained to answer the purpose. We can produce drones at any time by feeding, but this is rather expensive; but one thing we can do, and that is retain them, by keeping colonies that have a large number of them queenless, for a queenless colony will not kill their drones.

FRAMES OF COMB FOUNDATION.

Figure 20 shows something that I think is of considerable value and importance to the bee-keeper. Here are two frames of comb foundation. Frame No. 1 shows a sheet of raw foundation just fastened into the frame, and the bees have not done any work on it. No. 2 shows a frame of foundation that the bees have worked on just ten hours. It was placed in a strong colony in the morning, and taken out in the evening. Examine it closely, and see how perfectly these cells have been drawn out. In these ten hours the cells were

lengthened out just one-eighth of an inch over the entire surface of comb and on both sides, thus making it a little over one-fourth of an inch thick. I am unable to understand why any bee-keeper can allow his bees to build their own comb, or use mere narrow strips of foundation as starters in the frames, and thus have crooked, unsightly combs, and oversupply of drone comb, which is always followed by an oversupply of drone bees.

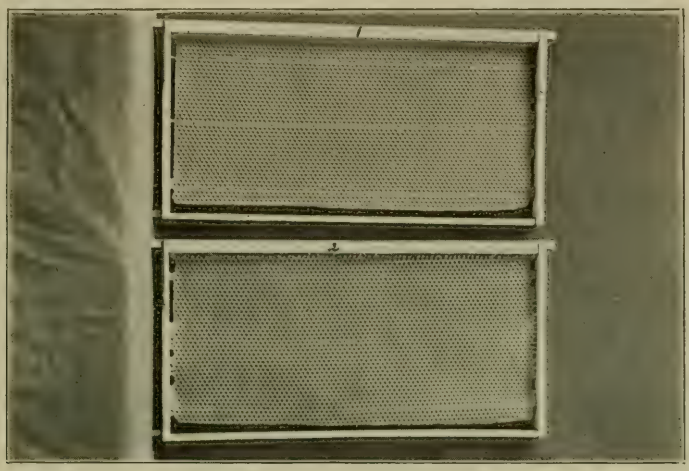

FIG. 20. Frames of comb foundation.

It will be noticed that these frames are wired. Three strands of fine wire are drawn through the frame, by piercing the end pieces in the center and passing the wire through and fastening the same at each end with a small tack. The wire must not be drawn up tight, so as to sound like a violin string when you touch it. It must be slack, scarcely drawn up straight, for if tight the comb will buckle, as it stretches as the bees work it out; so that the wire must be slack enough to stretch with the comb when the bees are working it. The top of the foundation is fastened to top bar of frame by pressure, the wax adhering to the wood when pressed against it. The sheet of foundation should not reach the bottom by half an inch, as it will stretch nearly this much in working it. In No. 2 a mere trace of the lower wire may be seen. The wire is imbedded in the comb by a wire imbedder made for the purpose.

FEEDING BEES.

Various kinds of feeders are used for feeding bees sugar syrup. I have tried almost everything that I have seen recommended, and the above simple arrangement suits me better than any other. It is a

two-inch soft white-pine plank filled with holes not quite through, thus forming a trough, and the partitions between the holes make a good foothold for the bees, so that none are lost by drowning. It may be made any size, but I prefer it just large enough to cover the entire top of hive neatly, and a few holes in the center put clear through for the bees to pass up and down. It is placed in an upper empty story, and with the lid on all is secure. In the illustration the side of the upper chamber is removed to show the feeder in place. This may be easily improved for a cool-weather feeder, by nailing a strip around the upper out edges, half an inch high, and dropping a cover down on this, which will give the bees good working room under it; and then fill the upper story with a chaff cushion or old clothes, and thus retain the natural warmth of the bees.

FIG. 21. Feeding bees.

HOUSE APIARIES.

The illustration (fig. 22) shows the location of hives of bees in a building. I should, perhaps, not say "house apiary," as house apiaries are generally known as very fine, expensive constructions, very peculiarly erected, and the more peculiar the better. But leaving out the peculiarity, and getting down to practical business, I use "any old house," and after having experience in handling bees in a

building, I could not be induced to again adopt outdoor apiaries. Figure 22 shows a section or corner of a room containing hives: *2* is a bottom board from which a hive has been removed. The hives sit two inches from the wall, and the bottom is arranged after the fashion of the chaff hive, and may be packed away in chaff during winter as a still better protection. *3*, shows sheets of legal-cap paper tacked to the wall, for the purpose of keeping a register of each colony. This is very important, and is a great help in the manipulation of colonies, to know exactly their condition by simply glancing at the register. This will frequently save a half hour's work spent in opening and examining them, and often furnish information that could not be found by an examination, such as time of swarming, number of pounds honey taken, age of queen, when young queens will hatch, quality of queen, tested or untested queen, queen purchased of whom, imported queen, selected breeders, etc., etc. *4*, shows nucleus hives containing one or two combs, and some bees for rearing queens, nailed up against the wall, and a small hole put through the siding for the bees to pass out and in. These I have previously explained under queen rearing. They may be used as well outdoors, in ordinary hives; and when one or two frames are thus used in a hive, an adjusting board to adjust the required space in the hive can be used.

I will name some of the advantages as I see them in keeping bees

FIG. 22. House apiaries.

in a house. The first and most important thing is, that you are almost entirely safe from bee stings. Bees will scarcely attempt to sting you in a building, and you will certainly get ten chances of being stung outdoors to one in a building, at the least estimate. You can handle bees in any kind of weather in the house, and as you are entirely out of the wind you can do your work much better. You are never bothered with robber bees poking in the hives when you have them open, and every apiarist knows how difficult it is to manipulate bees out of the honey season on account of robber bees. And for the same reason you can remove honey from the hives, change the section boxes of honey about, and handle the honey by putting it up in packages, and extract out of season; all this work is performed, and no robber bees to bother you. Occasionally we will have some bees inside when handling them; but place bee escapes on the windows, or in absence of this a few holes or cracks in the wall, or even a door open a minute, will cause them all to fly out. If the house is so that you can darken it to some extent by closing the doors and windows, the bees that are inside will in an instant hunt a hole to get out. You can thus clear the house of bees at once, and it would surprise you how quickly they will go. Wire screen should of course be on windows, doors, and all openings. By turning a key in the door your whole apiary and all implements are secure from thieves, and especially is this of great advantage when apiaries are kept away from home.

Another inexpensive way of keeping bees, and also a way in which to obtain nearly all the advantages of the house apiary, is to construct a small building ten feet long, six feet wide, and six feet high. This will accommodate eleven colonies of bees—five on each side and one at the end. On each side, where the hives sit, should be a floor of boards, and the center where you stand to operate should be ground floor. I have used two tiers of hives in such a building, thus having twenty-two colonies in it, but it is not convenient for handling the upper tier, and I would not recommend it. Houses like this will not cost any more than chaff hives enough for the eleven colonies, and is superior for winter use, as the entire building may be filled with chaff, or used in any quantity desired. House apiaries, as usually constructed, are very long buildings, and the result is, that the bees become lost as to their proper place of entering; the hives at the ends of building get the most of the stray bees thus, and these hives become very strong, while the hives in the center of building become weakened. This has always been a strong argument against house apiaries; but on the plan above given, not having more than a dozen hives facing one direction on the same line, obviates this difficulty

entirely, in my experience. Painting the entrances of the hives with different colors has been said to remedy this trouble to some extent, as the bees are attracted by the different colors.

OPENING HIVES AND HANDLING THE BEES.

Now, my friends, right here is where we must exercise a little nerve. The apiarist who is accustomed to doing this work does not need any toning up of his nerves, and neither will you if you have performed the job a few times. But one not accustomed to the work, and who undertakes it in an ordinary way, would be likely to get into serious trouble, and if you found out just the proper way of doing it by actual practice alone, it would be some time before you would make a complete success of it. While bees are frequently handled without smoke, yet the oldest apiarist has his smoker always at hand, and I would advise the beginner not to begin without first procuring a good bee smoker. If you are armed with a good smoker, and it is properly equipped for business, you can everlastingly whip any colony of bees into subjection on short order.

A great many people who do not take the trouble to post themselves on the subject of bees have very peculiar ideas about them. They will tell you that Mr. Soandso can handle bees and do anything he wishes with them, and the bees never sting him, but Mr. Somebody cannot go in sight of them without being stung, as bees have a special dislike for him, etc. Now, such ideas are handed down from one generation to another, and become instilled in the minds of people as actual facts, when the fact is, it is all a mistake. It is true that some people will receive more stings from bees than others, but the reason of this is altogether in the manner the person conducts himself when about them or working with them; so that if Mr. Somebody adopts Mr. Soandso's method of handling them he will receive no more stings than the latter. Bees do not know one person from another. I do not believe they know the apiarist that works with them every day for years from any one else, except that they get accustomed to his manner of handling, and if he is not an expert in this line a stranger that is an expert can take his bees and handle them at once with less stings than the owner. When a boy I was taught that only persons that were endowed with supernatural power could handle bees. Having inclinations in that direction myself, I was told by one of these "bee tamers" that I might be slightly endowed with this miraculous power, and I really thought, or at least hoped, I was. But after bringing my influence to bear rather heavily on a colony of bees soon after, I was nearly stung to death; hence this theory exploded with me early in life.

If we wish to handle bees successfully and without stings we must

FIG. 23. Opening hives and handling bees.

handle them carefully. First, open the hive, without jarring it, if possible. If the lid is glued fast—and it never will be if you keep a good, sound cloth under the lid and over all of the frames and top of the hive—but if it is, pry it up as easily as possible. After removing the lid, take one corner of quilt and draw it up; and, by the way, always take it up first at the side of hive farthest from you and draw it toward you, as seen in the illustration. Now, it is supposed you have your smoker in readiness, providing you need it, and if the bees come running up and boiling out between the frames on top, take your smoker and give them a few light puffs of smoke and send them back down again. If they seem to stay down pretty well you may go on with your work, but if they come back up as before, drive them down again with the smoke with a little more positiveness. Usually, by this time, you are master of the situation, and you may remove the quilt entirely and take out the frames, or any frame you desire. The frames are usually fastened with bee-glue, and when the weather is a little cool you will need something to pry the frames loose and, for this purpose, a screw-driver will answer nicely. When taking out the first frame, spread the frames on both sides of the one you wish to take out so that the frame will lift up clear, and not rub or be squeezed with the frames beside it, thus killing bees on removing it. Draw the frame up slowly and replace it in the same manner.

REVERSING THE COMB.

This illustration simply shows how you may turn the comb over without releasing your hold, for the purpose of examining the reverse side. Please notice the smoker in this figure; it is in proper position to hold fire. Fuel for smokers may consist of cotton rags. Old, thin, worn calico or muslin is good, but dry, rotten, spongy wood is still better. The fire-box of the smoker should be full of fuel before lighting it, and if the fire is well started, and the smoker set down in position as seen in the cut, it will hold fire several hours and be ready at any minute to furnish smoke. The smoker here illustrated is known as the "Clark's Cold Blast." It is one of the cheapest, costing only about half as much as many others, and I consider it one of the best.

FIG. 24. Reversing the comb.

CLOSE OF THE HONEY SEASON.

There will be found some important work to do immediately after the close of the principal honey season. The first thing on the program with bees, after the honey harvest, is to pry around to see if they can find a colony to rob. Just at this time they are not likely to be disappointed, for frequently there is such. Colonies that are in danger are those that have no queens, or very weak colonies; perhaps some of these nuclei in which we have been raising queens. Everything along this line must now be looked up, for we do not want them

to get a start of this kind, as they will everlastingly keep it up if they get a taste. To prevent it, we must furnish all colonies with good fertile queens, and make examination of every one to ascertain if they have laying queens. When bees become queenless they will not defend their stores, and robber bees soon find them out. We must not leave honey lying round carelessly or have it stored where the bees can reach it. All cracks and crevices about the hives except the entrance proper must be closed, and very weak colonies may have the entrances to their hives contracted, so they can better defend them. Queens now will cease laying to a great extent, and the hives that contain spring hatch of queens will be about the only ones that will continue to lay eggs and keep up their colonies in fairly good strength. Queens over two years old had better be removed, and also all others that failed to do good service during the honey season, and replaced with young, fertile queens of the present year's raising, if we can produce or procure them. We should be able to rear our own queens, so we can thus keep up our stock in the best of order without going to the expense of buying them. But we can if we wish purchase them in any quantity, as there are plenty of apiarists who make a business of rearing them for sale. At this particular season of the year they are usually sold at one dollar each, or ten dollars per dozen, for good, tested Italian queens.

FIG. 25. Outside view of house containing bees, showing the entrance to the hives.

Colonies that do not have stores enough to carry them through the winter, and honey not at hand to give them, should be fed during the month of September. They should be thus fed early, in order that they may be able to thoroughly seal up the stores given them while the weather is yet warm. Granulated sugar is the proper food for them, and in no case should they be fed cheap brown sugar on which to winter. The sugar should be well melted by adding water and allowing it to reach the boiling-point. The syrup may be made of about the consistency of thin molasses, and given them daily until twenty-five or thirty pounds are stored in the hive. The best time of day to feed bees is late in the evening: just as late as we can see to do the work. Feeding during the day is an incentive to robbing, and at night there is no danger, and by morning the work is all done and the bees all quiet.

CELLAR WINTERING.

Many winter their bees in a cellar. But this is generally practiced by specialists, and it usually takes the expert to make a success of it. A cellar for bees should be for them exclusively, and it would be very risky to undertake to winter bees in a cellar used for all purposes. A cellar may be so arranged by partitioning off a part of it for the bees

FIG. 26. Cellar wintering.

exclusively, but it must be well separated from the other part. The cellar where bees are kept must be kept in utter darkness at all times, except occasionally when we wish to make examination of the bees: then we may use lamplight.

The illustration, figure 26, shows the manner of placing the hives in a cellar. The foundation is made of two-by-four scantling, placed

fourteen inches apart, and the hives are set on these, leaving a space between them of about eight inches. The next tier of hives is placed directly over this space, and so on as high as wished. The bottom boards are not used on the hives, but left open thus for ventilation. In this manner the dead bees and all accumulations drop down and entirely out of the hive on the lid of the one below it, where it may be brushed off and thus kept clean. The hives thus arranged prevent the bees from getting together, as they will not venture from their combs far enough to thus get together. The proper temperature to keep a cellar for bees is about forty-five degrees. Bees should be placed in the cellar just on the beginning of severe winter, and put in place by very careful handling.

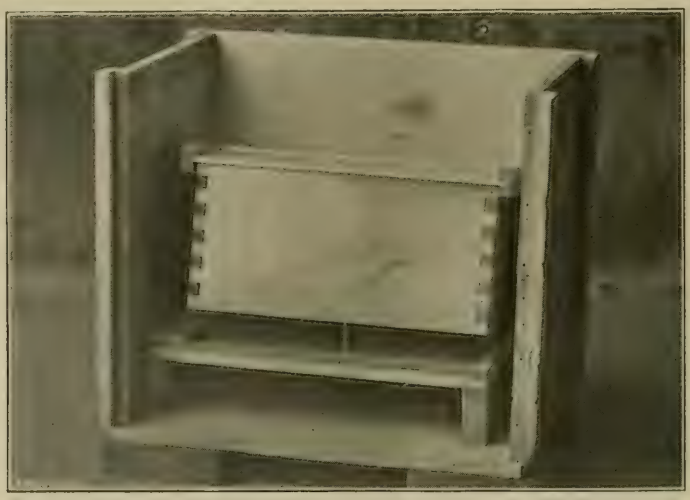

FIG. 27. Chaff hives and outdoor wintering.

CHAFF HIVES AND OUTDOOR WINTERING.

It will be observed throughout my articles here that I use considerable economy and advocate cheapness in many things, and I will frankly admit that I am not in the bee business for my health but for the actual profits that are in it. I have frequently, in my writings, advocated common dry-goods boxes for chaff hives. Figure 27 is one of them. I knocked the side out of it so you can see how to put your hive of bees in one of them. The hive is also tipped up a little sidewise to show you how the bottom board is fixed. It certainly needs no other explanation, only that the side is put back and the entire box, all around the hive, under and above, is filled with chaff and a good, water-tight cover put on the same. When completed it looks just like figure 28.

FIG. 28. Chaff hive, complete.

CHAFF HIVE, COMPLETE.

If you would tell a farmer that he must send off and buy chaff hives for all his bees, at a cost of perhaps two or three dollars each, I want to ask you how many of them will do it. But if you tell him to get dry-goods boxes at the store, and show him how cheaply and easily he can convert them into chaff hives, he will be pretty sure to get them, and his bees will be fixed up in first-class order, for there is no chaff hive made that will beat it for actual service. This is not only a winter hive, but a summer hive as well, and intended for an all-year-round hive. It is not only useful, but ornamental.

COLONY OF BEES READY FOR SHIPMENT.

Full colonies of bees may be safely shipped at any time from early spring until late autumn, but never in winter. Figure 29 represents

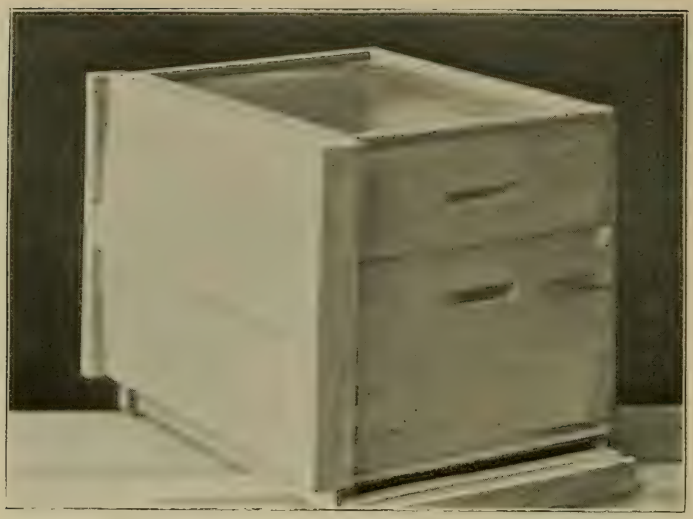

FIG. 29. Colony of bees ready for shipment.

a colony put up to ship any distance by express during the hottest days in summer. The half story added on top, covered with wire gauze, gives an empty chamber for the bees above the frames of comb, and the entrance to hive is also covered with wire cloth, so that they have all ventilation required. They may be thus safely confined several days, and shipped across the continent in perfect safety.

INTRODUCING QUEENS.

A colony of the worst type of the old black bees may be changed to the highest state of perfection by simply removing the black queen, and introducing an Italian queen in her place. If a queen is thus introduced in early spring, there will scarcely be a trace left of the old stock in midsummer. There is always some risk of losing the queen in introduction by the bees being dissatisfied with her and killing her. In almost all cases when the new queen is at once liberated among them immediately after the removal of the old one they will destroy her. It takes a prolonged method to induce them to accept her properly. It is necessary first to remove the queen, and be absolutely certain that the colony is queenless. Then with the new queen placed in a wire-screen cage, and placed in the hive near the brood nest, it is allowed to remain some thirty-six or forty-eight hours, after which time she may be released among the bees. In some instances the bees will not yet accept her, but will begin treating her very roughly and will attempt to sting her; but they do not sting her thus, but form in in a compact ball around her, and thus remain until they seemingly squeeze the life out of her. When they thus begin to ball around

her, the bees may be smoked away from her, and she may be placed back in the cage to remain perhaps another twenty-four hours, when the same process is repeated.

This is the general course taken in introducing queens, but at the present time queen breeders have what they call "introducing cages." These cages are so arranged that candy is placed in the entrance, and the bees in time, by eating out the candy, themselves liberate the queen, and chances are taken as to her safety. By introducing an Italian queen thus to a colony of bees, the whole stock becomes pure Italian, and as the queen never changes her stock the bees will be the same as long as she lives and is of service in the colony.

DIVIDING BEES FOR INCREASE.

There is not such a mania for dividing bees at the present time as in former years. After the introduction of the Italian bees into this country, the demand for them was immense, and those who bred them used every effort to increase their colonies, and dividing was principally practiced. Since the bees have become numerous and cheaper, apiarists have turned their attention to raising honey, and to increasing more moderately by the process of natural swarming.

Natural swarming will always give better results than dividing, but if you have some strong colonies that do not swarm, and you want more colonies, you can very easily divide them, and do it successfully too. You may divide one colony into several parts and build them all up to good, strong colonies; but at the same time, I would only cut it in two. This is done by simply lifting out half of the frames of comb containing both brood and honey, and placing them in a new hive. As there is but one queen, she will be in one or the other division, and if we have an extra queen to introduce to the queenless half, so much the better. If we have no queen, the combs containing brood of the proper age, the bees will rear one for themselves. A little more than half of the bees should go with the new colony, as many of the old bees will return to the parent hive, or former location, and the new hive thus will remain rather weak, and will not do much work for several days on this account.

WINTER CARE OF BEES.

Bees should be in winter quarters, if chaff hives are used, long before cold weather sets in, and early in autumn is the best time to prepare the hives for winter. When the cellar is used, they should not be placed there until just at the beginning of steady winter. When bees are thus placed in good winter quarters they need but little attention during the same. Bees must be kept perfectly quiet in cold weather, and at no time should the hives be opened or in any way

molested when the weather is so cold they cannot fly. On a warm day, when they are flying freely, the hives may be opened or any work done that is necessary, but only when necessary even on these occasions. Snow will do no harm to bees when drifted about the hives, not even if the hives were totally covered with it, but serves as a good protection in severe cold weather. Some people are so foolish as to get out with shovels and shovel away the snow, thus disturbing the bees and possibly doing them irreparable damage. A thorough examination of all colonies should be made during the first warm spell of weather in March, and if any need food or will soon need it, take a note of it and provide the same.

It has always been a question in my mind why it is that there are so many homes without bees. There is no diet more delicious or healthful than honey. The great Giver of all good has provided that the earth, with its annual offering of fruits and flowers, shall yield us a bountiful supply of the royal nectar, and has also furnished the little harvesters to gather it in. Only furnish them a home and a storehouse, and they will without money and without price supply you with the most delicious of all sweets.

DISEASES AND ENEMIES OF BEES.

FOUL-BROOD (*Bacillus alvei*) is a germ disease which may be found in all stages, from the egg to the adult bee. Owing to the fact that the bacilli, very minute organisms, multiply very rapidly, the disease spreads incredibly fast, and is therefore the most-dreaded malady of the hive.

Its presence among the larvæ may be very certainly detected by examining a comb of honey containing the growing larvæ. If these, instead of being plump and of a pearly whiteness, are yellowish or brown or shriveled, foul-brood may be suspected. The larva soon dies, and shrivels into a flattish black scale. If cells having sunken caps are opened and a dark brown, stringy, putrid mass is found, and if there is an odor similar to the oppressive odor given off from some varieties of liquid glue, foul-brood may be considered the cause of the unnatural condition.

In larvæ, the disease is very acute, embracing all parts of the body, probably on account of the thinness of the membrane. In the adult it may be more localized, and consequently will be longer in running its course. Bees which are nearly dead are almost bloodless, while the air sacs expand as the muscles decrease, and nearly fill the whole body. Workers, drones and queens are liable to attack. If the queen is inflicted with the disease, she will transmit it to the egg. Hence the very rapid destruction of the colonies when once attacked.

Remedial treatment, to be effective, must be heroic. Those who cannot for a time devote themselves entirely to the work of stamping out the disease had far better destroy the affected colonies. For others of their own apiary will soon be infected and the colonies of the neighborhood are endangered.

Culling out infected brood-comb, removing bees to new hive, dequeening in order to get rid of a probably diseased queen, adding a new queen, then starving the colony until some of the bees fall from exhaustion, is a method frequently effective. Many other methods are to be found in the various works upon apiculture. The Cheshire plan, however, has proven itself of great value, and is herewith given:

"To place the food, with added phenol, on the hive, will, however, do nothing in the greater number of cases. If honey be coming in, the bees will not touch it; but open the stocks, remove the brood-combs and pour the medicated syrup into those cells immediately around and over the brood, and the bees *will use* a curative quantity of phenol. In my experiments I inoculated a stock, and allowed it to

get into a bad state, then inserted a comb of store in the center of the brood-nest, and treated one side, from which the disease disappeared, but raged, although with abated fury, in the other half. Having, by these and many similar experiments, made the curability of *Bacillus alvei* a certitude, and having ascertained that $\frac{1}{400}$ of phenol could be given to the bees without limiting the queen in breeding, or touching her health, while $\frac{1}{500}$ dispatched the bacillus quickly when the honey was coming in, and $\frac{1}{750}$ when it was not, I, in the interest of apiculture, requested the British Bee-keepers' Association to provide me with a bad case, fully attested.

"It arrived late, June 21, 1884, with seven combs, about half a pint of bees, and a queen cell which I saw at once contained a dead larva only. Amidst crowds of bad cells, scarcely any living brood was visible. A casual counting of one of the best frames gave 371 dead larvæ on one side. The odor was pronounced. The case needed confidence: it was bad indeed. With me, queenlessness presents the worst of all obstacles. No grubs, no physic, no cure! I had stipulated that the stock should have a queen, and so the difficulty was greater than I had anticipated. Early next morning, seeing the utterly disheartened condition of the poor bees, I went to a nucleus, took out a very fine Italian mother, just proved as purely fecundated, and putting her under a dome cage on a card, placed the card over the frames. The bees came up and seemed to see in her a new hope. The cage was lifted and she was welcomed immediately. I waited three days, till she was regularly laying, giving syrup phenolated 1 in 500: and now, since I could not create bees, added two combs of brood. This step was made necessary by the fact that I required a strong hive by the time of the congress. The bees were now shut up by a division board; but the combs put behind it, waiting introduction as the bees multiplied, smelt so badly – the weather being hot – that I several times sprayed them with water 200, phenol 1. Now, I should compress the bees as much as possible, and spray the removed combs freely with water 50, phenol 1.

"Every evening the medicated syrup was given, by pouring around the brood-nest; but only so much as would be likely to be used, the object not being to fill the cells, but to get the food converted into bees. The smell vanished; the bees became active and earnest. The comb with 371 dead larvæ on one side was last added, and in six days I could only find five sunken caps in the whole of it. Now and again a grub took disease, but quickly perfect immunity was the issue. No cell was uncapped, no diseased grub removed, nor hive touched, except as described. The bees cleaned their floor and their combs: while, in four weeks and two or three days, every frame became filled with

brood in the brightest and best possible condition. Since this, worse cases have succumbed in the same fashion. Abundant corroboration has been given from those who have tried my method, and have succeeded, to their own delight, while some failed; but the testimony is general, that bees under phenol become more energetic than those that need no treatment.

"The quantities are easily managed: One ounce of phenol crystals (carbolic acid No. 1) will be sufficient for forty pounds of syrup, one-fourth ounce for ten pounds, or one-fourth ounce of liquid carbolic P. B., for nine pounds of syrup, or rather less than three quarts. The carbolic acid should be added to the syrup when the latter is cool, and mixed equally by careful stirring."

THE WAX-MOTH (*Galleria mellonella* Linn.) is an unwelcome guest among the bees and rarely gains admission to a strong colony. The weak colonies are chosen places for the deposition of its eggs. One of the highly commendable features of the Italian bee is that it ever and always repels the encroachments of this moth. This moth deposits its eggs in the comb, on propolis, or sometimes without the hive and the young worms are left to run the gauntlet at the entrance. The intelligent bee-keeper will keep his colonies strong, will permit no superfluous comb to remain in the hive, and none to lie carelessly exposed around the apiary for the reception of eggs. His trained eye will be ever on the alert for evidences of the presence of the moth in and about the hives. His constant care and supervision of his bees, together with their strength and activity, make the moth of little consequence in the well-kept apiary.

Ants, *wasps*, *spiders*, *toads*, *lizards* and *mice* prey upon the workers; the amount of loss is never great. The home of the offenders can generally be located near by and the occupants routed. Birds are not so destructive as was formerly supposed.

PRINCIPAL HONEY- AND POLLEN-PRODUCING PLANTS OF KANSAS.

*Willows, (*Salix*). March–May.

Red or Soft Maple, (*Acer rubrum*). March–April.

Redbud, (*Cercis canadensis*). March–April.

Elm, (*Ulmus*). March–April.

Alder, (*Alnus rugosa*). March–April.

Dog-tooth Violet, (*Erythronium albidum*). March–April.

**Apricot*, (*Prunus armeniaca*). April–May.

Juneberry, (*Amelanchier canadensis*). April–May.

*CRIMSON CLOVER, (*Trifolium incarnatum*). April–May.

Dandelion, (*Taraxacum officinale*). April–May.

Gooseberry and *Currant*, (*Ribes*). April–May.

Pear and *Apple*, (*Pyrus*). April–May.

Wild Crab-apple, (*Pyrus*). April–May.

Peach, *Cherry*, and *Plum*, (*Prunus*). April–May.

Rhododendron, (*Rhododendron*). April–May.

Pines, (*Pinus*). April–May.

*TULIP-TREE, (*Liriodendron tulipifera*). May.

American Holly, (*Ilex opaca*). May.

COMMON, BLACK OR YELLOW LOCUST, (*Robinia pseudacacia*). May

Black Gum, *Sour Gum*, *Tupelo*, or *Pepperidge*, (*Nyssa aquatica*) May.

RASPBERRY, (*Rubus*). May–June.

Persimmon, (*Diospyros virginiana*). May–June.

Grape-vines, (*Vitis*). May–June.

Alsike Clover, (*Trifolium hybridum*). May–June.

White Clover, (*Trifolium repens.*) May–June.

Strawberry, (*Fragaria*). May.

COW-PEA, (*Vigna sinensis*). May–August.

LINDEN, or "LINN," (*Tilia americana*). June.

Catalpas, or Indian Bean Trees, (*Catalpa*). June.

Chinquapin, (*Castanea pumila*). June.

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*The relative importance of the plants as honey and pollen producers is shown by the type used. Of least importance are those in plain body type; the italicized next, and the capitals, in accordance with size.

MAGNOLIA, or SWEET BAY, (*Magnolia glauca*). June.

Oxeye Daisy, or *Whiteweed*, (*Chrysanthemum leucanthemum*). June–July.

SOURWOOD, or SORREL *Tree*, (*Oxydendron arboreum*). June–July.

Milkweeds, (*Asclepias*). June–July.

ALFALFA, (*Medicago sativa*). June–September.

Teucrium canadense, (*American Germander, Wood Sage*). July.

Cucumber, Melon, Squash, Pumpkin, (*Cucumis*, *Citrullus*, and *Cucurbita*). July–August.

Indian Corn, (*Zea mays*). July–August.

MELILOT or SWEET CLOVER, (*Melilotus alba*). July–August.

Knotweeds, (*Polygonum*, especially *P. pennsylvanicum* and *P. persicaria*). July–September.

Monarda fistulosa, (*Wild Bergamot*). July–September.

Buckwheat, (*Fagopyrum fagopyrum*). August–September.

Goldenrods, (*Solidago*). August–October.

Bur-marigolds, (*Bidens*, especially Spanish Needles, *Bidens bipinnata*). August–October.

Thoroughwort, or Boneset, (*Eupatorium perfoliatum*). August–October.

Wild Aster, (*Aster*). August–October.

Cleomella augustifolia. August.

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Quinby's New Bee-Keeping; or The Mysteries of Bee-Keeping Explained. 1884. By L. C. Root.

The A B C of Bee-Culture: a Cyclopedia of Everything Pertaining to the Care of the Honey-Bee. By A. I. Root.

The Honey-Bee: a Manual of Instruction in Apiculture. By Frank Benton. Published by United States Department of Agriculture, Division of Entomology.

Advanced Bee-Culture; its Methods and Management. By W. Z. Hutchinson.

Bees and Bee-Keeping, Scientific and Practical. By Frank R. Cheshire. In two volumes: Vol. I, scientific; vol. II, practical. Published by L. Upcott Gill, London, England.

The Bee-Keeper's Guide; or Manual of the Apiary. By A. J. Cook.

A Modern Bee Farm and its Economic Management. By S. Simmins. Published in London, England.

The Blessed Bees. By John Allen.

Bee-Keeping for Profit. By Dr. G. L. Tinker.

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CORRIGENDA.

The foot-note bearing a † on page 11 should appear as a foot-note on page 12, and should refer to *Sarcophaga* sp., in line 7.

The line at the bottom of page 15 should be removed, and should appear as the third line from the bottom of page 16.

Under figure 14, page 41, end of second line, "menl" should be men-, and at end of third line "labia-" should be labial.

After each of the figures in Part II, from figure 8 to 29, inclusive, should appear the word "(Original.)"