

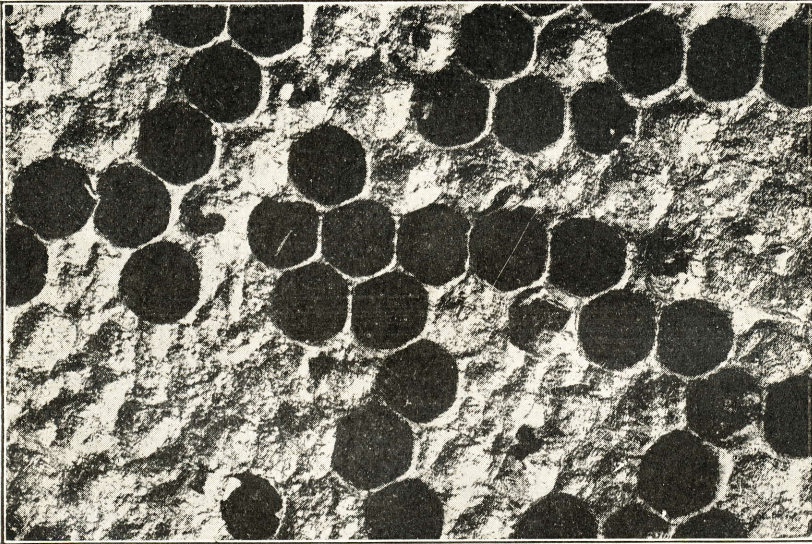
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DISEASES OF BEES IN MICHIGAN

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INTRODUCTION

Foul-brood is the name given to certain diseases which attack bees in the brood stage. Since it causes a yearly loss of many thousand colonies and the destruction of a great amount of apparatus, beekeepers consider foul-brood to be a very serious menace to the industry of honey production. Each succeeding year greater effort is made to control its spread, through education and legislation; and armed with the more perfect knowledge which thorough investigation has developed, the beekeeper is now better able to cope with the situation than heretofore.

The beekeeping profession owes much to Dr. G. F. White, whose thorough and exhaustive research work on bee diseases has given to the world a great deal of information concerning the foul-broods, and who from his work, has been able to offer invaluable suggestions as to methods of treatment.

Foul-brood is found practically wherever bees are kept both in America and in foreign countries. Certain areas in the United States are now disease free, however, probably because no infecting material has yet been introduced. The ease and rapidity with which foul-brood spreads from place to place is well-nigh disheartening, and it is only by constant vigilance and rigid adherence to precautionary measures that the fight against its ravages can be won. Under existing conditions of legislation and beekeeping practice it is folly to expect to continually remain free from disease. Each beekeeper must be forever watching for its appearance and prevent its spread by immediate and effectual treatment. It is for the purpose of supplying the beekeeper with the knowledge necessary for the control of foul-brood that this bulletin is written.

AMERICAN FOUL-BROOD

Of the three foul-brood diseases, American foul-brood is considered the worst. The disease is called American not because it is found more generally in America than elsewhere, but because an American scientist, Dr. G. F. White, Bureau of Entomology, Washington, D. C., was the first man to isolate the causal organism.

Due to the fact that colonies affected with American foul-brood must be deprived of their stores and combs and placed in a clean hive, a considerable loss is experienced by the beekeeper. The disease is infectious in nature and easily carried from hive to hive through the medium of honey. Whole yards may become diseased during a comparatively short period if not given close attention. Also as the method of treatment of American foul-brood is altogether different from the usual treatment of other foul-broods, it is essential that the beekeeper be familiar with the symptoms of the disease so that he may recognize it immediately and be able to distinguish it from other diseases.

Cause

The cause of American foul-brood is a bacillus called *Bacillus larvae* (White). This bacillus is very minute in size. It would take nearly 10,000 of the organisms placed end to end to cover an inch. The organism can be easily detected in dying or decayed larvae and scales by the use of the microscope, and in cases in which beekeepers are doubtful as to the correct diagnosis, a sample of the diseased material should always be submitted to a laboratory, where examination with a microscope can be made. Samples in which scales are predominant, and which lack the usual characteristic symptoms of either of the foul-broods, should always be examined with the microscope. One of the peculiar facts concerning American foul-brood is that when sample is examined microscopically it usually contains but one kind of bacteria, *Bacillus larvae*, whereas samples of European foul-brood may contain any one or all of several different bacteria.

American foul-brood invades the colony by attacking the young larvae during the time when they are being fed by the nurse bees. These infected larvae usually die just after the cells are capped, although larvae may be found dead of American foul-brood in rare cases still curled up in the end of the cells; on the other hand American foul-brood may kill larvae well advanced in the pupa stage. Adult bees are not affected.

Larvae of all three classes, i. e., worker, drone, and queen, may become infected, although the worker larvae are found diseased most frequently. In fact queen and drone larvae are seldom attacked. The experience of beekeepers has shown that no race of bees is particularly immune to the ravages of American foul-brood.

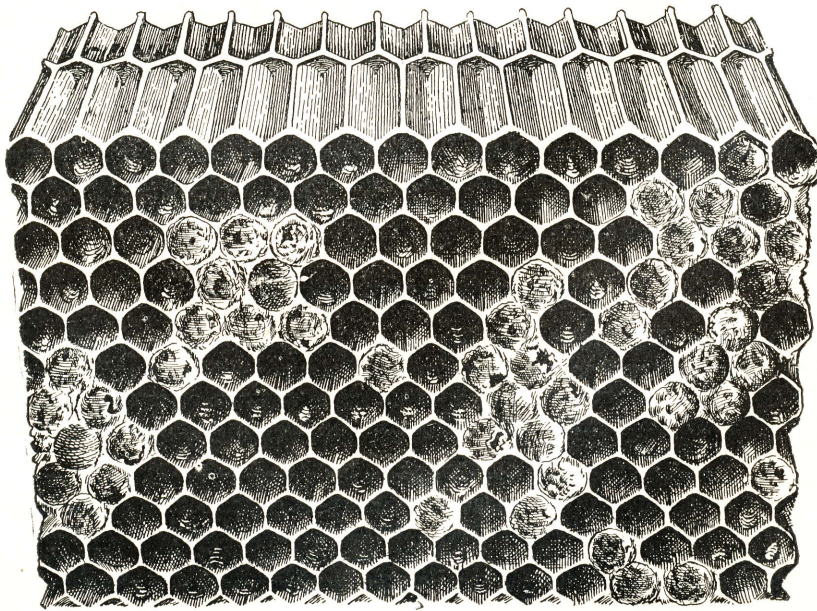


Fig. 1. American foul-brood comb, showing irregular patches of sunken cappings and scales. The position of the comb indicates the best way to view the scales. From Farmers' Bulletin 442, U. S. Department of Agr., Bureau of Entomology.

Since the larvae affected with capped, American foul-brood before the beekeeper recognizes brood-nest is usually that of purple color of the diseased cells. It is frequently so pronounced that affected larvae die at a time when

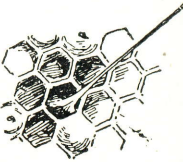


Fig. 2. The ropiness of American foul-brood. From Farmers' Bulletin 442, U. S. Department of Agr., Bureau of Entomology.

they are found lying lengthwise. Healthy larvae at this stage are glistening, and the skins are quite firm. In the case of American foul-brood the skin also becomes tender and changes to a more distinct brownish-brown shade. As the change progresses the larvae becomes more easily crushed and assumes a stickiness or ropiness characteristic of American foul-brood. The material remains for several weeks after the death of the larvae to the point where the remains of this ropiness is very characteristic. The remains at this time it is several inches long. This cannot be compared with European foul-brood, and is a strong odor which has been frequently mentioned. This is so pronounced that in a hive is first opened. Pupae die sticking to the top of the cell. This is characteristic of American foul-brood.

There are, then, three chief characteristics of American foul-brood, namely, the ropiness, the scales, and the irregularity of the diseased material.

After the decayed material is removed a thin layer known as the scale is left. However, there are occasional exceptions. One sample of foul-brood which was examined contained scales which were not attached to the comb. Another irregularity is

Symptoms

Since the larvae affected with the disease usually die after the cells are capped, American foul-brood is frequently well established in the apiary before the beekeeper recognizes it. The first indication of a disorder in the brood-nest is usually that of punctured and sunken cappings and a darkened color of the diseased cells. In well advanced cases the "glue pot" odor is frequently so pronounced that it can be easily recognized. Since the affected larvae die at a time when they are beginning to transform into pupae

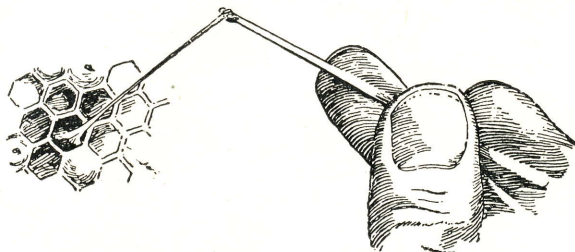


Fig. 2. The ropiness of American foul-brood. From Farmers' Bulletin 442, U. S. Department of Agr., Bureau of Entomology.

they are found lying lengthwise on the floor of the cell with the back down. Healthy larvae at this stage are white or slightly bluish in color,—appear to glisten, and the skins are quite tough. Diseased larvae first change color from the bluish-white of the healthy larvae to a light brown color. The skin also becomes tender and is easily broken. As decay goes on, the color changes to a more distinct brown, finally assuming a coffee color or chocolate-brown shade. As the change in color of the larvae progresses the skin of the larvae becomes more easily broken and the decaying material gradually assumes a stickiness or ropiness which is one of the chief characteristics of American foul-brood. The matter does not become distinctly ropy until several weeks after the death of the larvae, but when decay has progressed to the point where the remains commence to dry down into a thin "scale" this ropiness is very characteristic. When a match or toothpick is applied to the remains at this time it can be drawn out into threads from one to six inches long. This cannot be done with the remains of larvae attacked by European foul-brood, and is a distinguishing characteristic. As the decay of the larvae progresses, another symptom to be noted is the presence of a strong odor which has been frequently described as the odor of the glue-pot. This is so pronounced that in advanced cases it can be detected when the hive is first opened. Pupae dead of the disease, frequently have the tongue sticking to the top of the cell. This is rarely if ever found in cases of European foul-brood.

There are, then, three chief distinguishing features of larvae affected with American foul-brood, namely, coffee color, ropiness, and the glue-pot odor of the diseased material.

After the decayed material has dried down on the bottom of the cell into a thin layer known as the scale, it is not easily moved from the cell. However, there are occasional exceptions which may mislead the beekeeper. One sample of foul-brood which microscopical diagnosis proved to be American contained scales which were so loose that they were shaken from the comb. Another irregularity sometimes noted is that larvae are affected by

American foul-brood while still curled up in the bottom of the cell. Combs containing larvae which had died curled up in the bottom of the cell, but which had the coffee color, ropiness and glue-pot odor of American foul-brood have proved upon microscopical examination to be American foul-brood.

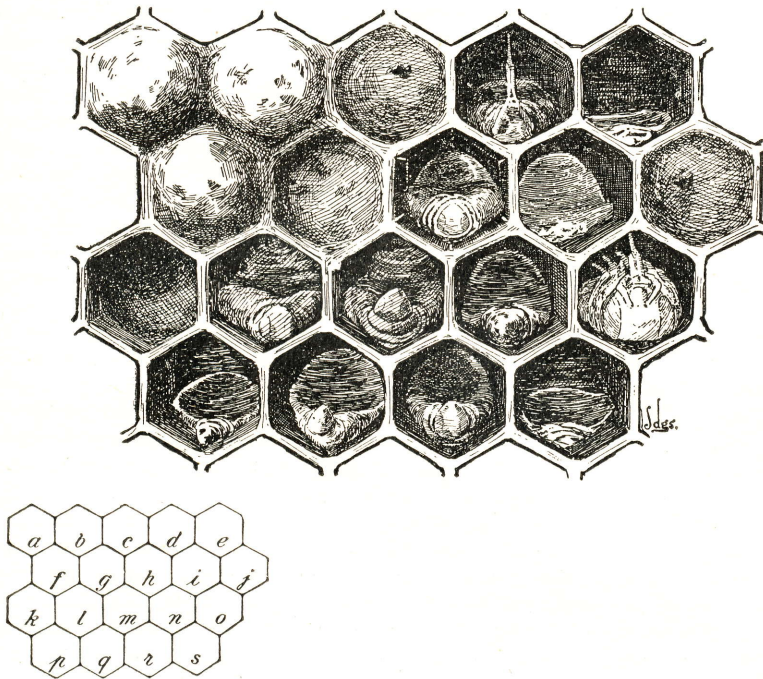


Fig. 3. American foul-brood; a, b, f, normal sealed cells; c, j, sunken cappings, showing perforations; g, sunken cappings not perforated; h, l, m, n, g, r, larvae affected by disease; e, i, p, s, scales formed from dried-down larvae; d, o, pupae affected by disease. Three times natural size. From Farmers' Bulletin 442, U. S. Dept. of Agr., Bureau of Entomology.

No doubt the gross examination of larvae dead in this unusual stage of American foul-brood has led to an incorrect diagnosis of European foul-brood in some cases, and has possibly added to the confusion which has existed between the two diseases.

The scales of American foul-brood are usually uniform in thickness on the bottom of their cells, and as they are removed by the bees with great difficulty, it is very seldom that combs containing scales of American foul-brood are cleaned by bees. In all cases which have been brought to the attention of this office where bees have cleaned combs containing scales of American foul-brood, the disease has returned later.

Methods of Spread of the Disease

The ordinary medium through which American foul-brood is spread is contaminated honey. *Bacillus larvae*, the causal organism of the disease, produces spores which are very resistant to all of the common means of control of bacterial diseases, and these spores will live in honey and diseased combs for a period of years. The robbing of diseased colonies by healthy colonies or of empty hives that have contained diseased colonies is the method

by which most American foul-brood diseased colonies which are the "Equalization of Brood," the disease shock swarming and other such disease throughout the apiary. It has begun to appear in one or two colonies of the shape of diseased honey-pot colonies and not yet actually fed. In these cases the beekeeper is not to his colonies until a few weeks later. Various colonies manipulated. A questionable practice. Frequently contained disease, and the rinsing a dilution of honey and spores to one colony to another by the bees. This means of spread is not so common. Bee-trees in the woods should be occupied by the occupants of the tree frequently out during the winter and the bees within flying distance. No doubt the non-traceable causes of interchanging of supers, combs, and in extracted honey production and should be carefully guarded. Combs, supers and super-covers of the same apparatus on the same honey passing through the comb. Frequently apiaries are located near and leaky shipments of honey from bees from one state to another without the consent and inspection against. It is probable that it is over practically the entire United States.

Bacillus larvae is very resistant to disinfectants. It has been known for 9 years. It is this resistance to diseases that makes the treatment for American foul-brood. The treatment consists of the replacing of clean hive and full sheets of fresh clean combs. This treatment prevents robbing or else performed during. When a number of colonies perform the operation during the time the bees are in the field. When the treatment should be given in the field are to be treated all should be done. The danger of robbing is increased. The treatment needed for the operation should be a smoker, hive tool, complete c

by which most American foul-brood is spread. The feeding of honey from diseased colonies which are thought to be healthy, the practice known as "Equalization of Brood," the dividing of brood among weak colonies after shook swarming and other such practices, are often the means of scattering disease throughout the apiary. Frequently in such cases the disease has only begun to appear in one or two cells in the brood nest or else is present in the shape of diseased honey previously robbed from some other diseased colony and not yet actually fed to larvae to produce disease. In many of these cases the beekeeper is not aware that he has spread disease through his colonies until a few weeks later when he discovers the symptoms in the various colonies manipulated. The use of secondhand cans is another questionable practice. Frequently the honey which was shipped in the can contained disease, and the rinsing of the cans previous to use usually exposes a dilution of honey and spores to the bees. Disease is also transmitted from one colony to another by the beekeepers' hands and hive tool. However, this means of spread is not so much to be feared as the others mentioned. Bee-trees in the woods should be promptly attended to by the owner as the occupants of the tree frequently become infected with foul-brood, are killed out during the winter and then remain a source of infection for all bees within flying distance. No doubt this source of infection explains many of the non-traceable causes of infection which beekeepers meet with. The interchanging of supers, combs and other apparatus frequently practiced in extracted honey production is a prolific method of spreading foul-brood and should be carefully guarded against. Each hive, together with all combs, supers and super-covers, should be numbered, thus insuring the use of the same apparatus on the same hive every time. Leaky shipments of honey passing through the country are another means of spreading disease. Frequently apiaries are located within flying distance of railroad switches and leaky shipments of honey are robbed. The indiscriminate shipping of bees from one state to another or from one section of the state to another without the consent and inspection of a bee inspector is to be guarded against. It is probable that in this way the disease has spread so rapidly over practically the entire United States.

Treatment

Bacillus larvae is very resistant to heat, drying, sunlight, chemicals and disinfectants. It has been known to live in the scales of a diseased comb for 9 years. It is this resistance to the ordinary means of control of bacterial diseases that makes the treatment of American foul-brood difficult. The treatment for American foul-brood known as the McEvoy or Shaking treatment consists of the replacing of the diseased hive, combs and honey with a clean hive and full sheets of foundation, thus forcing the bees to build new clean combs. This treatment should be given during the honey flow to prevent robbing or else performed under a tent of wire cloth or mosquito netting. When a number of colonies are to be treated, beekeepers prefer to perform the operation during the middle of the day when the majority of the bees are in the field. When only a few colonies have to be treated, the treatment should be given in the evening. If a large number of colonies are to be treated all should be shaken at the same time. Otherwise the danger of robbing is increased. Before treating the colony all equipment needed for the operation should be in readiness. A queen guard, lighted smoker, hive tool, complete clean hive with full sheets of foundation, a

tightly closed hive body in which to put the diseased combs and a bee brush of some sort will be needed.

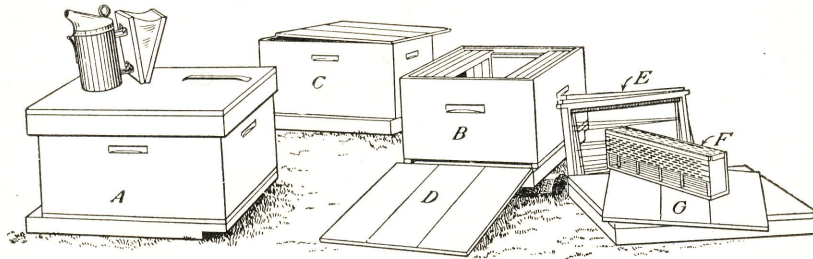


Fig. 4. Apparatus for shaking treatment: A, hive containing diseased colony (formerly in position of B); B, clean hive; C, empty hives to receive combs after shaking; D, hive cover used as runway; E, frames removed from B to give room for shaking; F, queen and drone trap; G, cover for clean hive B. From Farmers' Bulletin 442, U. S. Dept. of Agr., Bureau of Entomology.

The diseased colony is lifted to one side, within working distance of the clean hive placed on the old stand. Three or four frames are then removed from the center of the clean hive. The diseased combs with bees are removed from the diseased colony one at a time and the bees are lightly brushed into the middle of the clean hive. The diseased combs are then placed in the tightly closed hive body. This operation is repeated until all of the bees have been removed from the diseased combs. The remaining bees in the diseased hive may be shaken into the clean hive. Use every precaution to prevent spilling of diseased honey, and burn the brush used. A queen guard is then placed over the entrance to prevent the colony from absconding. The whole operation should be performed as quickly as possible to lessen the possibility of robbing. Experienced beekeepers who treat several diseased colonies at the same time prefer to save the healthy brood remaining after the treatment. This is done by piling the hive bodies containing brood from several diseased colonies over a queen excluder on a weak diseased colony whose entrance is contracted to prevent the possibility of robbing. About two weeks later this colony is also treated. Commercial beekeepers find it very convenient to use a hospital yard for diseased colonies to which all colonies are removed immediately upon finding signs of disease.

If the beekeeper has no wax-press or means of removing the wax from the diseased combs, these combs and frames should be placed in a hole in the ground and burned and the ashes buried. If the combs are to be rendered, extreme precaution must be taken to place the diseased combs in some container which is absolutely bee tight and which is stored in a building to which bees do not have access. Otherwise the treatment of diseased colonies is time, labor and equipment wasted. Comb foundation made from wax rendered from diseased combs does not transmit disease.

A diseased hive body may be cleaned by first scraping with a hive tool the inside of the walls, the grooves containing the rabbets and all parts covered with propolis. The inside of the hive body should be then scorched to a light brown with a blow-torch or flame of any sort. Frames which have contained diseased combs may be saved by first carefully removing all possible wax and propolis with a hive tool and later boiling in lye water made of one pint of concentrated lye to a boiler full of water. One boiler full of lye water will not treat satisfactorily more than two hundred frames. The lye water should first be brought to a boiling point. Then with the fire

remaining under the boiler to are placed in the boiler at a water from two to five minutes dissolved from the frames. hive-bodies to dry. By this and thoroughly at a real saving.

If there is much diseased ing. As it is very difficult to during the extracting or before at all times to keep the honey. Diseased honey is suitable for until after being diluted one-minute. As the boiling can be fed to bees for winter food in closed containers for comm

There are modifications of recommended for beginners. with the principle involved diseased so late in the fall the winter may be shaken on solid cells for storage of diseased honey. Weak colonies should be destroyed wintered in the cellar if possible healthy colony in early spring.

The use of drugs in the treatment of foul-broods is a waste of time. disease can be successfully eradicated is certain that commercial beekeepers to follow the course of procedure.

EUROPEAN

European foul-brood is a disease of bees only. The term European foul-brood for the American foul-brood for the first to perform laboratory studies practically all over the United States, probably due to the lack of information found at present. European foul-brood is American, and is considered by the beekeeper who keeps his stock which has proved resistant to disease is infectious, and can be transmitted to other colonies. European foul-brood brood-nest of the colony at a result that the colony infected before the beekeeper is aware of

remaining under the boiler to keep up the temperature, eight to ten frames are placed in the boiler at a time, submerged and allowed to remain in the water from two to five minutes until all of the propolis and wax have been dissolved from the frames. They are then removed and placed in empty hive-bodies to dry. By this method frames can be cleaned very quickly and thoroughly at a real saving for the beekeeper.

If there is much diseased honey on the colony it can be saved by extracting. As it is very difficult to prevent robbing of this diseased honey either during the extracting or before or after, the greatest of care must be taken at all times to keep the honey in bee-tight containers in a bee-tight building. Diseased honey is suitable for eating purposes but cannot be fed to bees until after being diluted one-half and boiled in a closed vessel for twenty minutes. As the boiling caramelizes some of the sugar, boiled honey cannot be fed to bees for winter food. It is unlawful to sell diseased honey except in closed containers for commercial purposes.

There are modifications of the treatment given above but they are not recommended for beginners. Experienced beekeepers who are familiar with the principle involved use them successfully. Colonies found to be diseased so late in the fall that it is impossible for the bees to build up for winter may be shaken on solid combs of honey in which there are no empty cells for storage of diseased honey. Only strong colonies should be so handled. Weak colonies should be destroyed or united. Diseased colonies should be wintered in the cellar if possible to remove the possibility of robbing by any healthy colony in early spring or in warm days during the winter.

Drugs

The use of drugs in the treatment of American foul-brood or of the other foul-broods is a waste of time and material. It is extremely doubtful whether disease can be successfully eradicated by the use of any known drug, and it is certain that commercial beekeepers do not have sufficient time to spare to follow the course of procedure necessary if drugs are to be used.

EUROPEAN FOUL-BROOD

European foul-brood is an infectious disease which attacks developing bees only. The term European is given this disorder to distinguish it from American foul-brood for the reason that European investigators were the first to perform laboratory studies of the disease. This disease is found practically all over the United States except in certain areas where, probably due to the lack of introduction of diseased material, no disease is found at present. European foul-brood is not as serious in its nature as American, and is considered by the best authorities to be of little danger to the beekeeper who keeps his colonies strong and requeens annually, using stock which has proved resistant to disease. Like American foul-brood the disease is infectious, and can be easily transmitted from diseased to healthy colonies. European foul-brood spreads through the apiary and through the brood-nest of the colony at a much faster rate than American, with the result that the colony infected can become practically rotten with disease before the beekeeper is aware of it.

Cause

The cause of European foul-brood has been practically determined to be *Bacillus pluton* (White). Although this organism refuses to grow on artificial media, by process of elimination it has been proved that the other organisms found in larvae infected with European foul-brood are not the exciting cause of the disease. It therefore appears that *Bacillus pluton* is the exciting cause. *Bacillus pluton* is smaller than the causal organism of American foul-brood and has a different shape. This difference in size and shape aids the bacteriologist in determining microscopically the kind of foul-brood being examined. There are present in diseased larvae any one or all of several bacteria other than *Bacillus pluton*. This fact has caused some confusion among investigators.

European foul-brood attacks the larvae at a much earlier age than does American, usually at two days of age or older. As the period of sickness has been determined to be two days or more, larvae are at least four days old when they die. In fact it is at this age that larvae are most often found dead of European. However, as larvae dead of the disease are sometimes found in capped cells it is evident that older larvae are also occasionally attacked. All three classes of larvae are infected, and unlike American, European foul-brood frequently attacks drone and queen larvae.

Experience has proved that black bees are more susceptible to the disease than are Italian. Furthermore it is possible to develop strains of Italian bees by selection which are more nearly immune to the disease than others. For that reason beekeepers in European foul-brood districts should endeavor to raise their own queens from colonies which show resistance. The disease is most prevalent in the spring time. The coming of the honey flow will often remove all traces of the disease in the colony, while cessation or lack of a honey flow seems to assist in the destruction of the colony.

Symptoms

It has been shown that there are three stages of development at which larvae are attacked by European foul-brood. The early stage at which they are attacked is when they are at least four days old and lie in the bottom of the cell in a C shape, not entirely filling the end of the cell. It is at this stage that European usually attacks larvae. They are also attacked at a slightly later stage of development, at which time they occupy the whole of the end of the cell and have begun to stretch out into the base of the cell. Larvae are frequently found dead of European at this stage. European foul-brood also attacks larvae after they have been capped in the cell, and it is from brood found dead at this stage that much of the confusion in differential diagnosis between European and American is experienced. Healthy larvae in the various stages mentioned are perfectly white in color, sometimes with a slightly bluish tinge, plump and rigid, and appearing firm. The position occupied in the cell will depend, of course, on the stage of development. Those in the first stage are still curled up in the end of the cell, while those in the last stage will be stretched out the entire length of the cell and capped over.

When attacked by the disease the larvae turn color from a healthy white to a yellowish tinge, sometimes more distinct than at others, later turning to a brownish color as decay goes on, and finally becoming a dark brown in the final stage of decay. The brood-nest has the appearance of a pepper box,

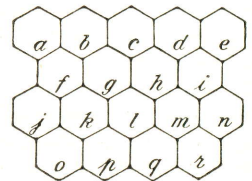
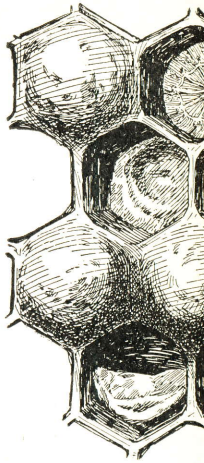


Fig. 5. European foul-brood: a, j, k, n, normal larva at age attacked by disease; r, normal larva at age attacked by natural size. From Farmers' Bulletin 442.

after the disease has progressed ease among the cells of healthy dead of the disease in capped cells cappings present. However, the capped over as a general rule, sunken cappings are found as very little odor present. Except ever, and it is probable that pupae are present in the larval remains has examined microscopically several larvae containing the causal organism of foul-brood. Such dead larvae have a meat, others, the odor of rotting, tions, emphasize the advisability of gross diagnosis, especially of the regular symptoms.

In the process of decay the shell is broken, much the same as in American of the decayed material that is the decayed matter dries down stringy and more or less granular qualities of American foul-brood tent of the body is watery in color frequently stand out as white lines characteristic may remain after the s

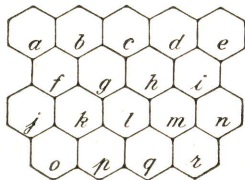
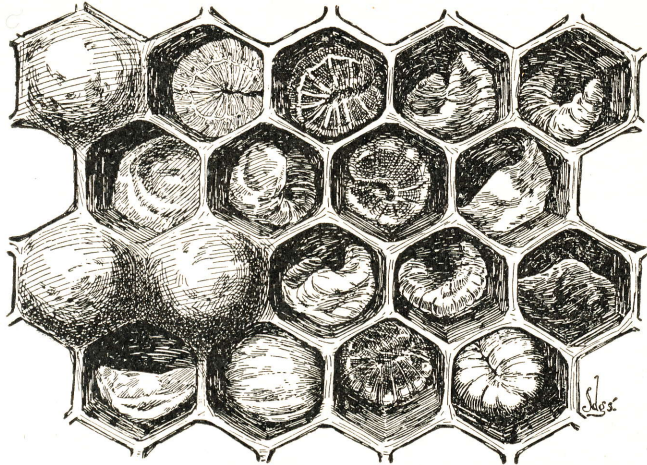


Fig. 5. European foul-brood: a, j, k, normal sealed cells; b, c, d, e, g, i, l, m, n, p, q, larvae affected by disease; r, normal larva at age attacked by disease; f, h, n, o, dried down larvae or scales. Three times natural size. From Farmers' Bulletin 442, U. S. Dept. of Agr., Bureau of Entomology.

after the disease has progressed somewhat, due to the scattered cells of disease among the cells of healthy brood. Occasionally a larva will be found dead of the disease in capped cells, and then there will be punctured and sunken cappings present. However, the disease attacks the larvae before they are capped over as a general rule, and therefore not as many punctured and sunken cappings are found as in American foul-brood. Usually there is very little odor present. Exceptions to this rule have been reported, however, and it is probable that putrefactive organisms such as *B. alvei*, which are present in the larval remains, are the cause of these odors. The writer has examined microscopically several samples of foul-brood in which were larvae containing the causal organisms of both American and European foul-brood. Such dead larvae have unusual odors; some that of decaying meat, others, the odor of rotting vegetables. These cases, although exceptions, emphasize the advisability of microscopic examination as a check to gross diagnosis, especially of those samples which do not have all of the regular symptoms.

In the process of decay the skin of the larvae becomes tender and easily broken, much the same as in American, but at no time is there the ropiness of the decayed material that is found in American foul-brood. Just before the decayed matter dries down into the scale the material is sometimes stringy and more or less granular, but does not possess any of the elastic qualities of American foul-brood. During the first stages of decay the content of the body is watery in consistency. The tracheae of the larvae frequently stand out as white lines resembling spokes in a wheel. This characteristic may remain after the scale is formed and is one of the ways of dis-

tinguishing European foul-brood. Larvae which are older than four days commence to stretch out in the cell as room for growth is required, and when attacked at this period will be found dead in a sort of a cork screw position. Sometimes the larvae are attacked after they have stretched out in the bases of the cells, but this is not the general rule. The scales are not adhesive to the walls of the cell as are the scales of American foul-brood, and can be removed by the adult bees. Furthermore, diseased larvae which have not dried down in the scale are sometimes removed by the adult bees in piecemeal.

Methods of Spread of the Disease

European foul-brood is spread from diseased to healthy colonies by means of the transmission of infected honey or other diseased material. The robbing of diseased colonies by healthy ones is probably the most frequent method of spread. The interchanging of combs of brood from diseased to healthy colonies also transmits the disease. It is possible that nurse bees from the diseased colony many carry the virus on their mouth parts and body, thus infecting healthy larvae in feeding them. It is also probable that occasional nurse bees from diseased colonies return to healthy colonies after play flights, carrying diseased material. This has not been definitely proved. As the virus lives in honey about 7 months there is slight danger of infection from feeding honey which has been carried over winter. Dry extracting combs which have contained honey from a European foul-brood colony would probably transmit the disease to brood reared in those combs. However, as the virus lives for a shorter period of time in the scales and honey than the virus of American foul-brood, the European is more easily controlled.

Treatment

The method of treatment of European foul-brood will depend upon the progress the disease has made in the colony, the race of bees, the strength of the colony and the honey flow. It is known that Italian bees resist European foul-brood better than other races, probably due to their superior ability as house cleaners. It is also known that European foul-brood is a disease of weak colonies principally and will usually disappear in the colony with the arrival of a good honey flow. If the disease has not made considerable progress in the brood-nest by the time the treatment is given it is advisable to allow the bees to clean up the diseased combs. If on the other hand a very large percentage of the brood nest is diseased it is questionable whether it is best to force the bees to clean up the diseased combs or whether the colony should be shaken on to full sheets of foundation and given a young laying queen of resistant Italian stock. If the bees are to be forced to clean up the disease the following method is followed: First, make sure that you will have a young laying Italian queen available two weeks from the time the treatment is given. Kill the queen in the diseased colony, and if the diseased colony is weak in bees double enough diseased colonies together to make strong colonies. Allow these colonies to remain queenless for from ten days to two weeks, then introduce the young laying queen of resistant Italian stock. If the attack is mild and the colonies are already of pure Italian stock it may be desirable to cage the queen for ten days instead of killing her. Dr. Miller used this method successfully. If the queen is old, and especially if she is not Italian, it is always best to kill her. The period of time that the colony remains queenless will depend upon the length of time

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It is extremely desirable to flow, as the incoming nectar a flow stimulates the young bees material and greatly assists in sary to have the colonies as s and full of young bees. It i which have contained Europea Combs which are so foul that i should be treated as American

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necessary for the bees to make the combs free from scales. However, it is not necessary to wait until the diseased combs are completely clean as the introduction of a young laying queen sometimes stimulates the bees to greater activity in cleaning house, and although a few cells of disease may appear after the queen has been introduced it will soon disappear completely.

It is extremely desirable to treat at the beginning of or during a honey flow, as the incoming nectar and the hive activity associated with a honey flow stimulates the young bees to greater activity in the removal of diseased material and greatly assists in the success of the treatment. It is very necessary to have the colonies as strong as possible during the queenless period and full of young bees. It is not considered necessary to disinfect hives which have contained European foul-brood before using for healthy colonies. Combs which are so foul that it is not advisable to compel bees to clean them should be treated as American foul-brood combs.

SAC-BROOD

Sac-brood is an infectious disease of bees in the brood stage, the cause of which has been proved to be a filterable virus. Its effect upon the colony is usually not serious. Due to the fact that larvae die of sac-brood at approximately the same time as those attacked by American foul-brood a careless observer might, at first glance, mistake sac-brood for American. However, the position of the scale in the cell, well compared to the shape of a Chinaman's shoe, together with the looseness of the scale in the cell makes differentiation simple.

The method of spread of the virus is not well known, nor is the relation of the race of bees to resistance to the disease of value. In ordinary beekeeping practice, a treatment for sac-brood is rarely necessary. Requeening a colony which has a severe attack, with a vigorous young laying queen usually cleans up the disease. The virus is not present in the scales, and a hive which has contained a colony suffering from sac-brood should be all right for use with a healthy colony without treatment.

NOSEMA DISEASE

Nosema disease is a disease of adult bees caused by the protozoan *Nosema apis*. It is probable that the disorder caused by *Nosema apis* is recognized by other names in different countries and in different sections of the United States. It is not known that there is any relation between Nosema disease and Isle of Wight disease, and there probably is not. The disease attacks the adult bees through the alimentary tract. Usually the first symptoms of nosema disease is weakness of the colony. As the affected bees behave similar to healthy ones, a slight attack on the colony would never be noticed. The disease does not affect the brood, and work in the colony goes on naturally. The method of spread of the disease is not well known. The spores of the disease pass out of the affected bee in the excrement. Should this excrement fall in the water supply of the bees it would furnish one means of spread. The bodies of bees dead from nosema disease in the water supply would probably transmit the disease. The infection may or may not kill the colony. It does, however, weaken the colony to such an extent that in many cases little or no surplus honey is stored. As diseased colonies become weak it is probable that robbing is one means of spread of the disease. The disease is not considered of great importance in Michigan at present.

DYSENTERY

Dysentery is not a disease, but is the result of prolonged retention of the feces by the bees during the winter months. This results in the production of an irritation in the intestines of the adult bee with the result that the feces which can no longer be held are voided within the hive. Evidence of dysentery is found in the spotting of the frames and interior of the hive and entrance. Colonies suffering from dysentery usually begin brood-rearing earlier than normal in the spring, and as a result lessen instead of improve the chance of recovery. Dysentery is very likely to produce the disorder referred to as spring dwindling.

SPRING DWINDLING

Spring Dwindling has doubtless been used to indicate various disorders. The term as it is commonly used by beekeepers refers to the condition of a colony in the spring in which the number of bees very rapidly diminishes. This is usually the result of the death of those bees which have worn themselves out in the process of maintaining the cluster temperature during the winter. Colonies without sufficient packing during the winter, and especially colonies composed of a majority of old bees the fall before, are especially likely to appear in this condition. This disorder is not a disease but a condition of the colony which can largely be prevented by the beekeepers who take proper precautions in the preparation of the colony for winter.

PARALYSIS

The disorder referred to by beekeepers as paralysis or Disappearing Disease or Palsy is little understood. The disease may suddenly attack every colony in an apiary. Affected bees will be observed on the grass in front of the hive and throughout the apiary in distorted positions, some crawling upon a blade of grass and attempting to fly; others fanning feebly. Still others will rear themselves on their fore legs and mandibles, fanning, while others will be found crawling on the grass with abdomen pulsating rapidly, which has given rise to the term Palsy. The disease may appear throughout the apiary one day and be gone completely the next, or it may remain in the apiary several days or longer. In some apiaries a few colonies are affected throughout the season, whereas all others appear to be healthy. The disease may reappear after it has once left the apiary. The irregularity of its behavior has given rise to the term "Disappearing Disease." It is probable that more than one disorder is indicated by the term Paralysis, but actual proof of this is lacking. The cause of the disease is not known, and no known treatment is satisfactory. The most serious effect of the disease is to so weaken the colonies affected as to prevent the storing of surplus. Apparatus from colonies which have been killed by the disease can apparently be used for healthy colonies without reinfection.

ISLE OF WIGHT DISEASE

Isle of Wight Disease is a disease of adult bees which causes serious losses in England and neighboring territory. Usually the symptoms are similar to those of nosema disease, although it is very likely that the two diseases are different. Recent investigators have demonstrated the possibility that

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the disorder is caused by a mite which occupies the tracheae or breathing tubes of the bee, thereby shutting off air circulation. The disease is not considered serious in Michigan.

NECESSARY PRECAUTIONS

“An ounce of prevention is worth a pound of cure.” The beekeeper can often save himself much trouble and expense by preventing disease from getting a foot-hold in his apiary.

Never feed honey—unless you are absolutely sure it is not infected—without diluting one-half and boiling in a closed vessel for twenty minutes.

Never purchase bees from anyone without inspection by a competent person or else with inspector's certificate attached.

Never allow a weak or dead colony to be robbed out. It may be diseased. Contract the entrance of weak colonies to one bee-way in robbing season.

If you attempt to winter diseased colonies, if at all possible winter them in the cellar where they can not be robbed out in early spring if they die in winter.

If you winter outdoors see to it that all colonies not defending their entrance in early spring are closed to prevent robbing.

The use of old combs and second hand apparatus of all kinds is dangerous. Never expose sweets of any kind during the robbing season. If robbing is once started your bees may visit diseased colonies in the neighborhood.

Be on the watch continually for symptoms of disease in your apiary.

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