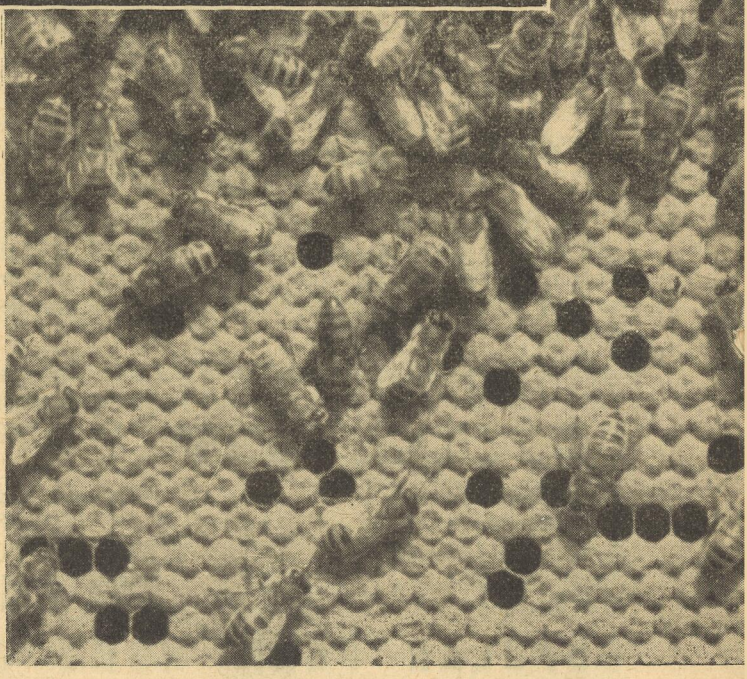
BEE DISEASES



— By —

T. S. WINTER,

Senior Apiary Instructor,

Wellington

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BEE DISEASES

By T. S. WINTER,
Senior Apiary Instructor, Wellington.

BEES, like all other living creatures, are subject to diseases, but fortunately those affecting bees do not affect humans or animals. They do, however, create a serious problem for the beekeeper. Diseases of bees with which the beekeeper has to contend may be divided into two classes—those which attack the brood and those which affect the adult bee.

THE most serious diseases of the brood which occur in various countries throughout the world are American foul-brood (*Bacillus larvae*), European foul-brood (*Bacillus pluton*), and sac brood, which is caused by a filterable virus; while those of the adult bee are Acarine disease (*Acarapis woodi*), Nosema disease (*Nosema apis*), dysentery, and paralysis.

In New Zealand diseases of the brood and of bee-combs are far more serious than diseases of adult bees. Fortunately Acarine disease—the most devastating of all adult bee diseases—does not occur in this country.

AMERICAN FOUL-BROOD (*Bacillus larvae*).

American foul-brood is one of the major problems of bee-keeping the world over. The causative organism is *Bacillus larvae*, a spore-forming bacillus taken in with the larval food. In the digestive tract the bacillus changes to a vegetable form, multiplies rapidly, and attacks the walls of the alimentary canal (Phillips). Thus the disease attacks the young larvae during the time when they are being fed by nurse bees. The infected larvae usually die just after the cells are capped over. *Bacillus larvae* is a bacterium which may be described as a form of life very low in the order of the vegetable kingdom, and is discernible only by the aid of a microscope. Certain symptoms associated with the disease, however, enable the beekeeper to detect its presence in a hive shortly after the first larva has been attacked.

To become expert in the detection of brood diseases the beekeeper must first become familiar with the condition of healthy brood in all stages of development. Keen observation and frequent examination of healthy brood under the guidance of an experienced beekeeper will soon enable the beginner to distinguish between normal and unhealthy brood.

Healthy larvae during the feeding period, before the cells are capped over by the bees, present a moist, glistening white appearance (Fig. 1), while a pupa in a capped cell is pearly white in colour until the final stages of development are reached, when it gradually takes on the more natural colourings of a fully-developed young bee. The large compound eyes of a healthy pupa first change from white to pink, darkening to brown, and finally black; while the legs and body parts gradually change from white to natural adult bee colourings. These developments are normal, and may be observed by removing the cappings from brood in various stages of development.

The cappings of healthy brood may vary in colour from light straw to a dark brown, according to seasonal and general conditions in the hive, and also materials available to the colony;

but in all cases the cappings are built over the cells more or less in convex form and are easily removed.

Fig. 2 shows a patch of healthy brood. In the centre hatching bees may be observed, while nurse bees may be seen busy feeding young larvae and cleaning out empty cells. The whole picture is one of normal activity and healthy conditions within the brood nest.

Symptoms

In the early stages of the disease a larva assumes an unnatural position, and then gradually flattens out fully extended on the bottom side of the cell, with the tail turned slightly up and the head lying flat. The consistency of the dead matter is at first slightly viscid; it later becomes ropy, and finally reduces down to a scale which sticks hard to the bottom of the cell. During the final stages of decomposition the dead matter has a strong, objectionable smell somewhat resembling hot glue.

The pupa decays in the same manner. The tongue of the pupa appears like a fine thread pointed towards the top side of the cell. This characteristic occurs only in American foulbrood. (Fig. 3 illustrates stages of decomposition in each case.)

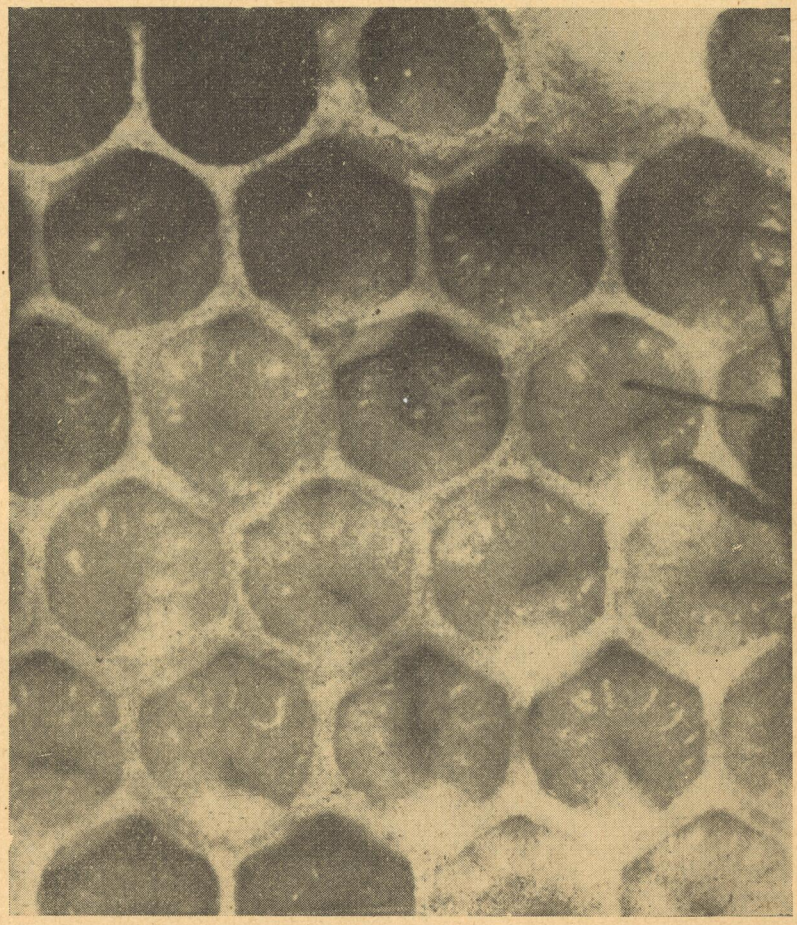

Fig. 1.—Healthy larvae.

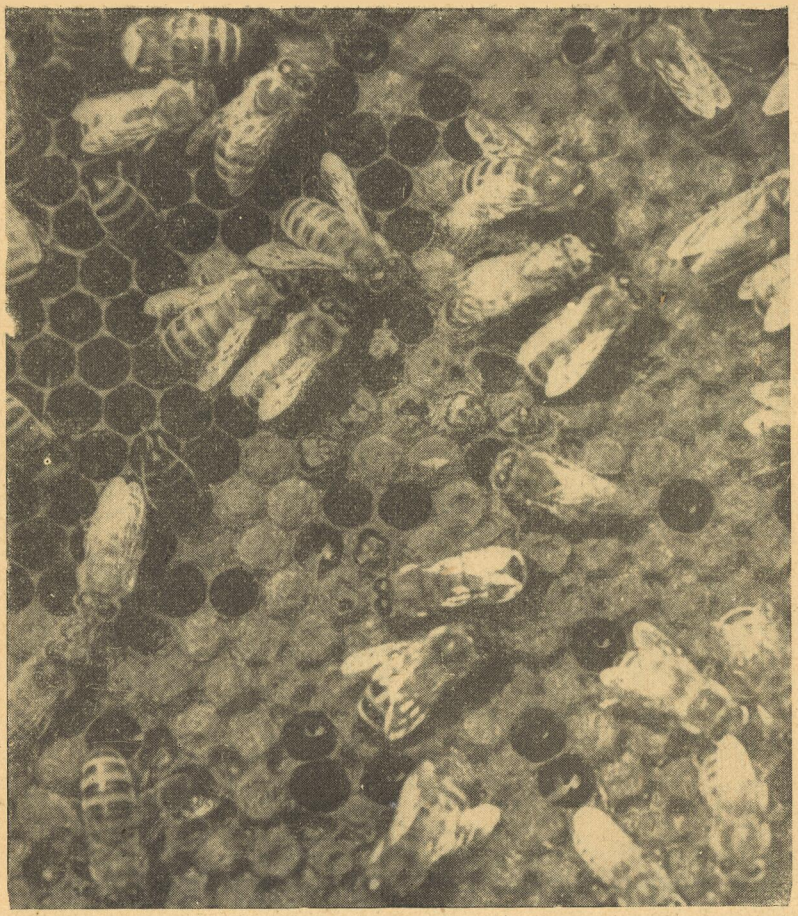

Fig. 2.—Patch of healthy brood.

The death of the larva rarely occurs during the coiled stage, but usually during the late larval and early pupal period, when the cells are capped; consequently the beekeeper is best able to detect the presence of this disease when the brood is capped over. In the early stages of the trouble a capped brood cell here and there appears somewhat different from the surrounding healthy brood; it is dark in colour, greasy in appearance, sunken, and in some instances slightly perforated (Fig. 4). By the time the dead matter beneath the cappings has partially dried down the most typical characteristic of this disease manifests itself.

Simple Test

A simple test for American foulbrood is to remove the cap from a diseased cell and probe the dead matter with a thin splinter of wood or a match stick, which should be given a slight twist and then slowly withdrawn. If part of the contents of the cell adheres to the stick and ropes out some distance, usually ½in. to 2in. (Fig. 5), it is considered conclusive evidence of the disease.

Where there is a variation of the symptoms described, and there is any doubt as to the cause of dead brood, beekeepers should immediately for-

ward specimens to the Apiary Instructor for the district for examination.

American foul-brood is highly infectious, and may be spread in many ways, including:—

1. **The acquisition of infected swarms, hives, and apiary appliances.**
2. **Exposure of diseased bee-combs or honey to robber bees.**
3. **The use of honey taken from diseased colonies for bee-feeding purposes.**
4. **Interchange of diseased combs and appliances in the apiary.**
5. **Drifting worker bees from diseased to healthy colonies in the apiary.**
6. **The purchase of queens and bees from diseased apiaries**

When a diseased colony becomes too weak to defend its stores it is liable to be robbed out by bees from other colonies; and as honey is the chief agency by which the spores of American foul-brood are transmitted, whole apiaries may become infected in this way.

Eradication

The first essential in the successful eradication of this trouble from an apiary is to find the disease in an early stage of its development and immediately to eliminate or treat all material and hive equipment which might spread it.

While a strong colony of bees may be successfully treated under certain circumstances, the safest plan is to destroy completely by fire all diseased bees and bee-combs, including any honey present in the hive, especially where the infected hive is situated in the middle of an otherwise clean

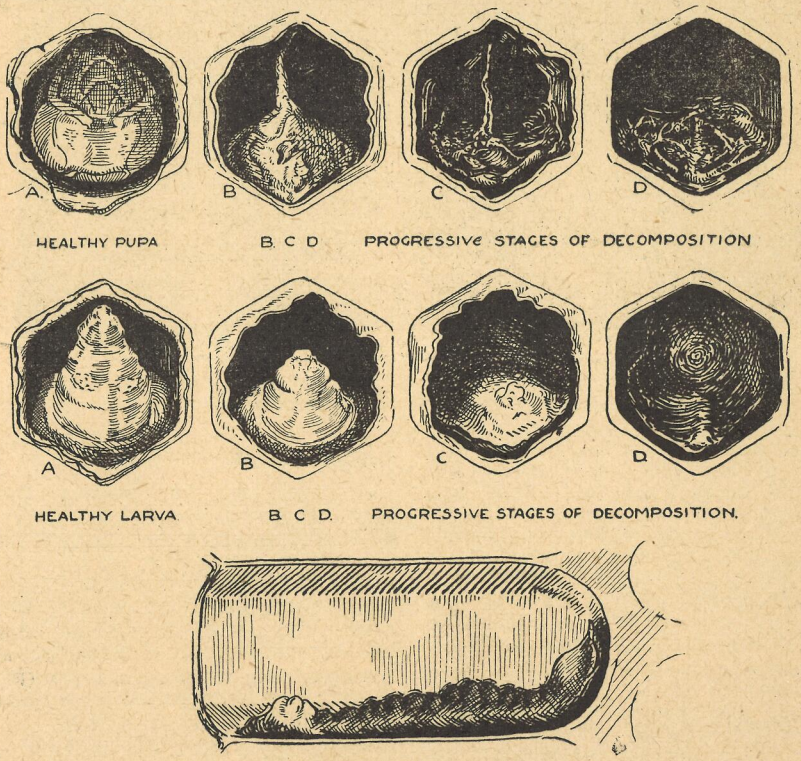

Fig. 3.

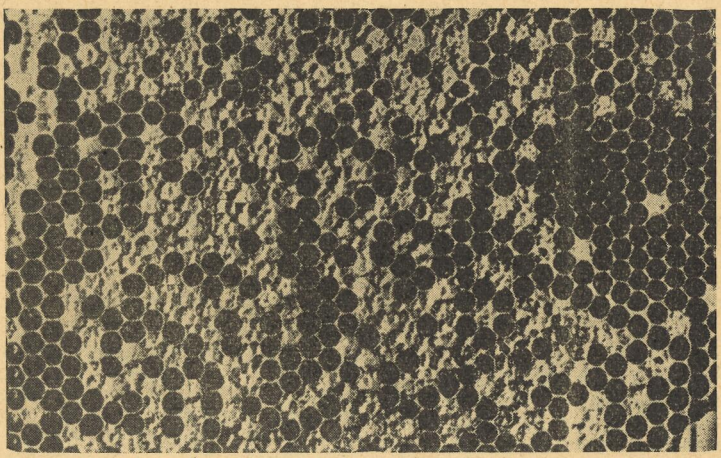

Fig. 4.—Portion of comb infected with foul-brood.

apiary, or close to other clean colonies.

To carry out this work first dig a suitable sized hole about 3ft. square or more, according to the amount of material to be dealt with, and 6in. to 9in. deep, well away from other hives. Get a good fire going in the centre of the hole, then gas the bees at a time when no bees are flying. One desert-spoonful of calcium cyanide (powder) spread on a stiff piece of paper and pushed in the hive entrance is sufficient to kill all the bees instantly. When all the bees are dead carefully remove the whole hive and its contents (including the floor-board) to the fire and burn all bee-combs, hive mat, dead bees, and any refuse collected on the floor-board. If the hive boxes, lid, and floor-board are of standard make and are in good condition, these may be saved; otherwise all hive equipment should be burned. Stand the first few combs on end and others in a more or less upright position on the fire, a few at a time, to keep the burning material well ventilated; otherwise the melting honey and wax will clog and may put the fire out. When all is burned the ashes should be completely covered with earth as a further precaution.

Any appliances worth saving should be either boiled for 15 minutes in a strong caustic solution (1lb. of caustic to 10 gallons of water), or immediately scorched inside with a painter's blow-lamp to remove all sources of infection.

Once American foul-brood appears in a colony every bit of comb, hive equipment, and honey on the hive should be treated as suspect, even though only a few brood cells appear to be affected. The removal of diseased brood alone does not necessarily indicate removal of all infectious material from the hive. Even when the complete brood nest is removed there may remain within the hive unused honey which is capable of infecting brood reared later. Thus the disease may remain inactive for indefinite periods, during which time it may be spread to other colonies in the district.

Progress of Brood-rearing

A normal healthy colony builds up rapidly during the season. The queen usually continues to lay eggs from July or August to April, according to the location in New Zealand, and at the height of the brood-rearing period (about December in this country) a good queen may lay from 1,000 to 2,000 eggs per day. A strong colony may have upwards of 30,000 cells of brood at one time, each with a young bee which will reach the stage of adult life in 21 days. The life of worker bees depends chiefly on the amount of individual activity. During the height of the honey-storing season six to eight weeks is their

normal span of life. Thus it becomes essential for each colony to maintain a high rate of hatching brood daily to keep up the population of the hive. Where the hatching rate of brood is gradually reduced by disease the affected colony dies out, and if American foul-brood were allowed to run its course this disease would very quickly wipe out the beekeeping industry of any country.

Treatment of American Foul-brood

The value of a diseased colony depends on its strength of bees, the number of hives kept, and the position the hive occupies in the apiary; also how early in the season the trouble is detected. When disease is discovered late in the season the bees as well as the contents of the hive should be destroyed immediately. This also applies to all medium and weak colonies as soon as they are located at any time during the season, and also where a diseased colony is situated in a group of clean hives or in a position where there is a danger of drifting bees causing a further spread of the trouble.

Apiary Instructors of the Depa ment of Agriculture have power unc the Apiaries Act, 1927, to destroy fire any diseased colonies locat where the bees have been neglect or where they are likely to become source of infection to other hives.

Every beekeeper should inspect bees thoroughly at regular interv during the season and deal promp with any disease found.

Shaking Treatment

The treatment of American fo brood consists essentially in the moval of all infected material fr the colony, and in compelling the b to make a fresh start by building n combs and gathering fresh sto (Phillips). This is accomplished what is known as the McEvoy or sha ing treatment, which should be appl only during a honey flow, and pref ably at the beginning of the ma flow. At this time the hives a light in stores, there is little danger robbing, and the bees have a reas able chance of re-establishing the selves under favorable conditions field work and brood-rearing.

Procedure: Prepare a set of fran (9 or 10), five of which should be fitt

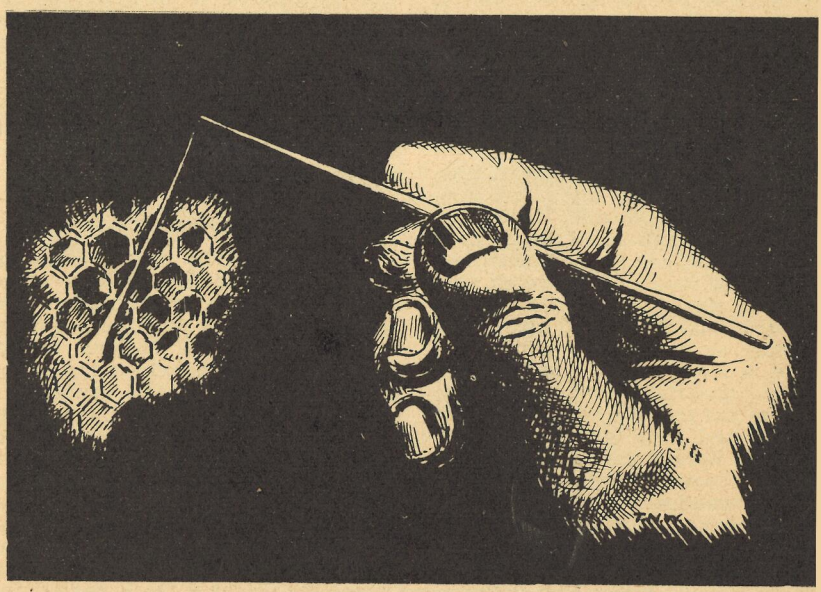

Fig. 5.—Simple test for American foul-brood.

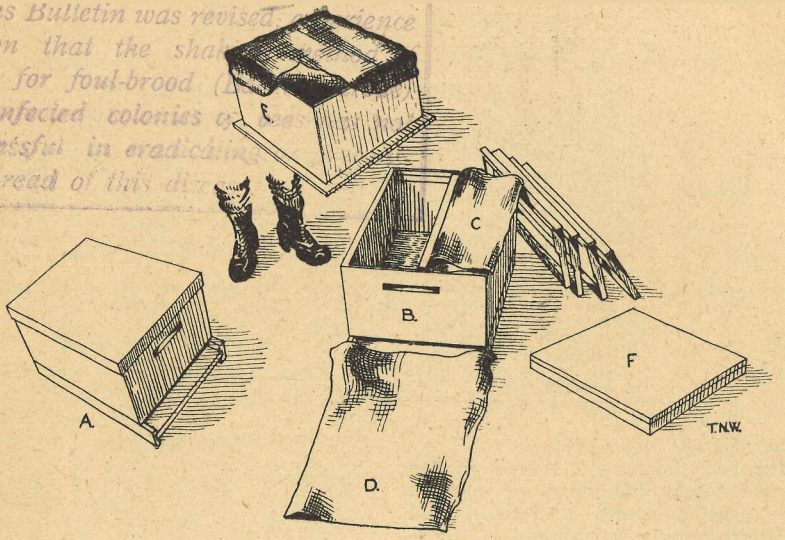

Fig. 6.—Set-up for carrying out shaking treatment for American foul-brood.

with a ½-in. strip of comb foundation wax (called a starter) in each. Move the infected hive (complete with floor-board) to a convenient position about 3ft. to one side (Fig. 6, A). Place a clean hive body containing the five prepared frames (pushed over to the far side of the box) on a clean bottom board, on the old stand (B), with a good mat (C) placed half way over the hive body directly on top of the frames. Provide a runway of sacking or paper (D) in front of the hive on which to shake or brush any bees not removed from the combs direct into the new hive. This will not only act as a suitable runway for the bees, but also collects any fresh honey shaken out of the combs. (The material used for a runway and any droppings of honey should all be carefully burnt immediately the job is completed.)

Smoke the diseased colony just enough to keep the bees reasonably quiet, then proceed to take out the frames (combs) one by one and shake the bees off them into the open half of the empty body box (B). The diseased combs should be immediately placed in an empty box (E) as the work proceeds, and completely covered to keep all flying bees away from them.

When all the bees are shaken into the newly-prepared hive fill in the empty space with the balance of the prepared frames, draw the mat completely across the top, and close the hive with a good-fitting flat lid. To prevent the bees swarming away, which they will sometimes attempt to do under such drastic treatment, place a piece of zinc queen excluder across the hive entrance to keep the queen at home.

Leave the colony three full days. Late in the afternoon of the third day replace the floorboard, remove the lid and mat (burn this mat later), then gently but quickly shake the bees off the frames down into the hive, beginning with the frames which contained the starters. When a little more than half way through place two or three new frames fitted with full sheets of comb foundation (fully wired) on the outside wall of the empty space, and cover these with a new mat. The shaken bees will usually move over into the darkened side of the box on to the comb foundations. When all frames have been shaken free of bees fill the remaining empty space with frames fitted with full sheets of new comb foundation, draw the new mat completely across, and close the hive.

IDENTIFICATION OF BROOD DISEASES.

Causative Organism.	American Foul-brood *(Bacillus larvae)*	European Foul-brood *(Bacillus pluton)*	Sac Brood Filterable Virus
Odour	Usually strong and glue-like	Not offensive	None
Amount of brood affected	Usually much	Usually much	Usually little
Cappings	Often sunken and perforated	Affected brood, mostly unsealed	Sunken caps less prominent than American foul-brood
Age of larvae	Usually die after capping	Usually die before capping	Usually die after capping
Colour	Become dark brown	Yellow, grey, brown	Become dark brown
Consistency	Sticky, "roping out"	Soft, breakable, sometimes slimy	Watery, granular
Position in Cell	Usually lengthwise, soon become shapeless	Usually curled at bottom	Lengthwise, become mummified
Pupae	Sometimes affected, tongue sticks up	Not affected	Not affected
Scales	Dark brown, stuck to floor of cell	Yellow to brown, free at bottom of cell	Blackish, free lengthwise along floor

Immediately the bees have been shaken and the hive is closed all the diseased combs, including the mat, on each occasion should be burned, and any hive parts saved should be thoroughly sterilised as previously described.

Although the shaking method is considered reliable in the hands of the expert beekeeper who understands all the risks involved, the safest plan for the beginner is to burn all diseased bees and combs to prevent the possible spread of the disease and to make a fresh start with clean colonies.

The success of disease control in any apiary depends largely on the methods used. Where American foul-brood tends to recur this may be attributed to the careless handling of bees and appliances removed from infected hives, or by treatment carried out at the wrong period of the season.

EUROPEAN FOUL-BROOD.

While no positive evidence has been found to show that European foul-brood (*Bacillus pluton*) is present in New Zealand, the accompanying identification table (Webster) will assist beekeepers to identify any brood troubles which may occur in their apiaries.

Where there is any doubt as to the actual cause of dead brood beekeepers should communicate at once with the Apiary Instructor for the district and forward samples packed in a suitable small tin for examination.

SAC BROOD.

Sac brood is caused by a filterable virus, and is a mildly infectious disease of the brood which usually occurs during the spring months.

Infected larvae usually die about the time the cells are capped over. They first turn a yellowish colour, deepening to brown, while the tip of the head is generally black, and if larvae are left in the cells undisturbed they pass through a gradual degeneration until finally only a dried scale-like mass is left, which is easily removed by the bees. The dead larvae have a slightly swollen, stretched-out, collapsed, sack-like appearance, with the larval skin, which does not adhere to the cell wall, intact and clearly visible, hence the name sac brood.

With care an infected larva can be lifted completely out of the cell, and when broken or probed the dead matter is watery and will not rope out similar to American foul-brood. Dr. Kenneth M. Smith, Cambridge University, states that it is not yet known how the virus is carried over from one season to another, as only recently-dead larvae are infectious, and that no virus can be recovered from larvae which has been dead for more than one month. Similarly, the virus remains virulent in honey or in pollen for one month; after this time it is non-infectious.

No definite treatment is recommended, but where the disease has persisted to such an extent that the colony has become weakened, it is advisable to re-queen the hive with a

young, vigorous queen, and replace any badly-infected brood comb with fresh comb to save the bees the trouble and loss of time in clearing out so much dead brood. Otherwise the trouble usually clears up as the season advances and the colonies gain strength. Beekeepers should study closely the symptoms described above to avoid confusing this disease with other much more serious brood diseases.

CHILLED, OVER-HEATED AND STARVED BROOD.

Many different external factors may cause healthy brood to die. Chilling of the brood may occur at any time during the spring when there is a sudden cold snap which drives the bees into a close cluster away from the outer edges of the brood nest. Under these conditions all brood not covered by bees becomes chilled and dies. The remains of chilled brood dry down very slowly with little change in colour to dark grey, and are usually cleaned out quickly by the bees with a return to normal conditions. Weak colonies, however, may move upwards or to the side of the combs away from any dead patch of sealed chilled brood, rather than attempt a clean-up, which may be beyond their strength. Where there is any quantity of dead brood it is best to melt up the combs.

Over-heated brood may be caused by insufficient suitable ventilation of strong hives during the hottest summer weather, or in over-crowded hives when shifting during the brood-rearing season. Over-heated capped brood has a sunken, moist, darkened appearance, while larvae in open cells will often squirm forward and hang partly out of the cells before dying.

The dead brood will quickly decay and smell strongly if left in the hives. All such combs should be removed as soon as possible and destroyed, or rendered down for the wax they contain if there is sufficient of them. To avoid this trouble see that all hives have suitable ventilation, and when moving bees never leave closed hives standing in the direct rays of the sun for any length of time.

Starved brood results from neglect by the beekeeper to supply his bees

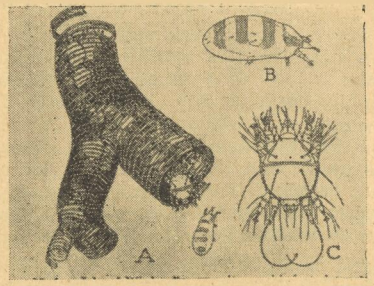

Fig. 7.—Isle of Wight disease and infested trachea. A. Piece of prothoracic trachea containing mites. B. Immature mite. C. Adult mite.

with adequate food supplies ahead of immediate colony requirements during the breeding season, when no nectar is available to the bees from natural sources, and where all reservse of honey have been used up. Under these conditions the dead brood retains its natural colour and is quickly removed by the bees when food is made available to them and they have sufficient strength to carry out the work.

DYSENTERY AND BEE PARALYSIS.

Scientific investigators (Milum and Burks) state that dysentery is a physiological disturbance not involving pathogenic organisms, and that the name paralysis has been applied to quite a vague condition of sickness of adult bees. Fermented or poor-quality stores, excessive moisture in the hives, or insufficient protection, which tends to cause the consumption of more food than is necessary for normal wintering, may cause dysentery. Where bees are subjected to these conditions, and are kept inside the hive by bad weather for long periods, they become diseased owing to undue retention of accumulated fecal material.

Affected bees void their feces, which are dark and muddy in appearance, within or near the hives. This trouble weakens the affected colonies considerably. It can be avoided by providing the bees with clean, dry conditions and adequate stores of good-quality capped honey.

BEE PARALYSIS.

There is no general agreement as to the cause of this trouble, which may occur in odd colonies at any time during the honey season. Fortunately this trouble is not serious in New Zealand apiaries, but when a colony is affected the adult bees are in no condition for field work. The lighter strains of Italian bees appear more susceptible to this trouble than the darker strains.

The main symptoms are loss of ability to fly, spasmodic trembling, distended abdomen, and dark-coloured, shining body. Bees in this condition usually crawl out of the hive and die, while many may be found inside the hive moving up to the light along the top bars of the frames when the mat is removed. They are very conspicuous by their trembling and intermittent movements of the legs and outspread wings.

There is no evidence of transmission to nearby colonies, and the disorder usually disappears if the affected colony is promptly re-queened with a queen raised from a good strain of Italian bees. When this is not done an infected colony seldom recovers sufficiently to store a crop of honey, and the trouble will persist so long as the old queen remains in the hive.

SPRING DWINDLING.

While dysentery and, to a much lesser degree, bee paralysis cause trouble and losses under certain conditions, so far as is known at present strong winds are the chief cause of serious spring dwindling at the most critical period of colony development in many New Zealand apiaries. Where field bees are unable to take cover along depressions in gently rolling or hilly country during flight they are liable to be forced down by strong, cold winds and die of exposure in numbers sufficient to reduce colony strength far below seasonal requirements. Dwindling troubles may be intensified, however, by Nosema disease (*Nosema apis*), which occurs in most countries of Europe, England, Canada, U.S.A., and Australia. Where serious spring and early summer dwindling occurs for no apparent reason, especially where the brood is normal and the colonies have sufficient stores, beekeepers should forward to the Department of Agriculture live worker bees from those colonies for examination. So far Nosema disease has not been reported in New Zealand.

Nosema apis attacks the stomach of the adult bee, but does not affect the brood.

ACARINE DISEASE (*Acarapis woodi*).

The mite *Acarapis woodi*, which causes Acarine disease, is prevalent in the British Isles, and has also been located in parts of Europe. In 1919 a band of workers, including Drs. Rennie and White and Elsie J. Harvey, of Great Britain, were able to give the first correct explanation of the cause of this trouble, first known as Isle of Wight disease. The name *Tarsonemas woodi* was given by Rennie. Subsequently Stanley Hirst, an English scientist, placed the parasite in a new genus, Acarapis, and scientists now generally accept his findings.

The mite enters the respiratory system of the bee through the air spiracles (Fig. 7) and lives internally in the breathing tubes or tracheae of adult bees, causing irritation and partial paralysis with crawling and eventual death.

As the disease advances the bees become listless, drag their swollen abdomens along the ground, and are quite unable to take normal cleansing flights or return to their hives. In a short time every bee in the hive becomes involved and the disease quickly spreads throughout an apiary with disastrous results. New Zealand has so far been fortunate in escaping this disease.

THE BEE-LOUSE (*Braula coeca*).

According to competent observers the bee-louse is not a true parasite, and apparently does little harm except to be a constant annoyance to the bee. In the adult stages it simply sucks its food from the outstretched mouth parts of the worker bee, upon which it is found in small numbers during the brood-rearing season. At other times they may be found on the body of the queen, and here lies the danger of this pest reaching New Zealand with imported bees.

Braula coeca is a blind, spider-like parasite in appearance, about one-

sixteenth of an inch long, and is a well-known pest of the honey-bee in some European countries. Its presence was first announced in America about 1923. It has reached Tasmania, but so far as is known has not been introduced into this Dominion. Similar to other known bee diseases, its importation is guarded against by Government regulations on the importation of bees from foreign countries.

Dr. Phillips describes the development of *Braula coeca* as follows:—"The female deposits her eggs on the brood combs in the hive, and they hatch out into typical muscia larvae, which make their way into cells containing young bee larvae. The larvae feed on food supplied to the brood by nurse bees, and, beyond robbing the bee larvae of a little of their food, do no harm. The larvae pupate inside the cells beside the bee pupae; they emerge before the bees do, and make their way at once on to the bodies of their hosts."

WAX MOTHS.

The principal insect enemies of bees in New Zealand are wax moths, of which there are two species, the greater wax moth (*Galleria mellonella*) and the lesser moth (*Achroia grissella*). If allowed access to stored honey-combs, they become very destructive. They will also attack any unprotected combs of weak colonies standing in the apiary. These moths are of Oriental origin, and are now found in almost every country of the world. The greater moth (*Galleria mellonella*) is by far the more destructive, and was first reported in New Zeaand in 1904 in the Taranaki

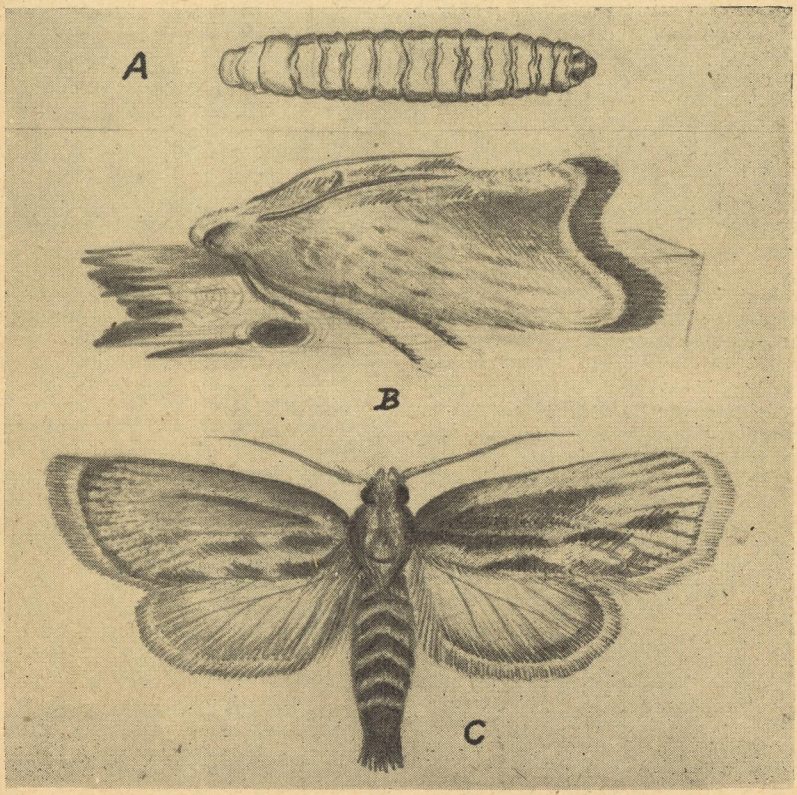

Fig. 8.—Greater wax moth. A. Larva. B. Adult moth resting in natural position. C. Adult female.

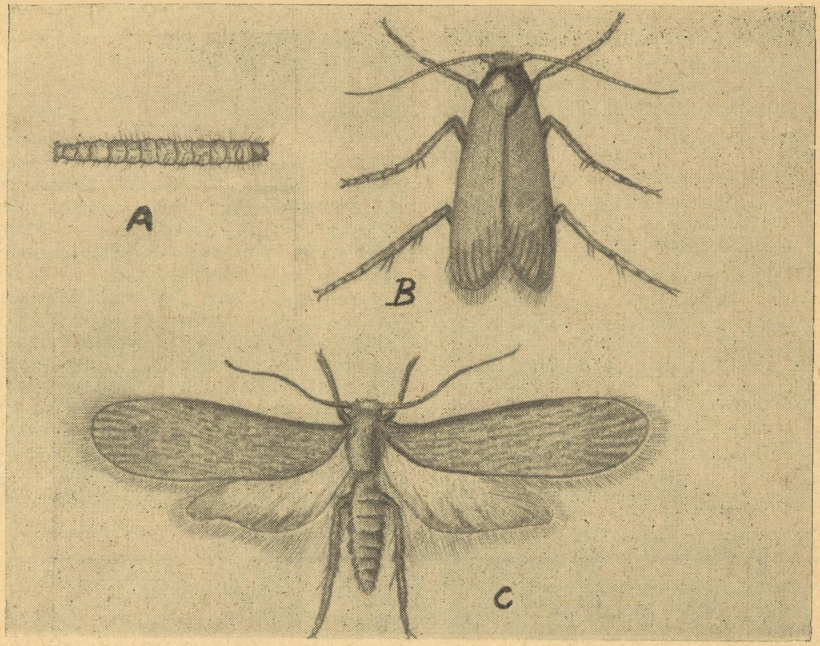

Fig. 9.—Lesser wax moth. A. Larva. B. Natural position. C. Female.

district. These moths gradually spread over the North Island of New Zealand, thriving particularly well in northern areas, where climatic conditions are warmer. Some locations, however, particularly districts in the South Island of New Zealand, are still free from them. Centres of infection are very often the result of careless bee-keeping methods and the storage of unprotected bee-combs during the period they are not required on the hives. These conditions provide easily accessible feeding grounds for wax moths, and enable them to prosper and multiply until they become a positive pest and danger to beekeepers if they are not drastically dealt with when found.

Figure 8 (A) illustrates the larva of the greater wax moth; B shows the adult moth resting in a natural position and C is an adult female with wings extended. Normal female adults are approximately five-eighths of an inch in length, with a wing expanse of approximately 1¼in., while the lesser moth is less than half that size.

Both species lay their eggs and fly at night. They avoid the daylight, resting during the daytime, and are not attracted by artificial light at night; consequently the use of chemicals has proved most satisfactory in their control. The female of the greater moth lays her eggs in any small cracks and crevices of the hive parts, where later the tiny larvae will have easy access to the bee-combs within.

Kunike and other scientific investigators have observed that wax moth larvae are able to digest beeswax, but they require a mixed diet. They definitely do not thrive and grow to normal size on bee-combs which are free from pollen and the remains of brood-rearing, while comb foundation or block beeswax remains almost untouched by them.

Soon after hatching the larvae start building individual tunnels of silk, in which they live, eating their way forward. When feeding ceases the tunnels are extended beyond the food mass and at the point of pupation a tight case is constructed and fixed on to

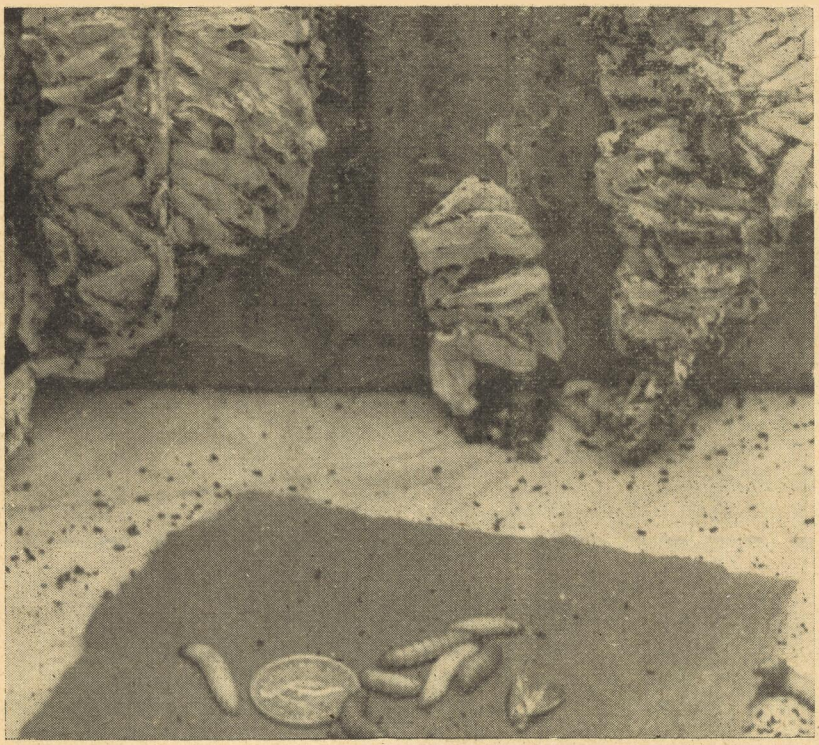

Fig. 10.

the wooden frames and sides of the supers, as illustrated in Fig. 10. The coin used to illustrate the size of the grubs is a sixpenny piece.

The lesser moth larvae tend to have their own individual tunnels, while the greater wax moth larvae congregate.

It is during the feeding period of the larvae that so much damage is done to the bee-combs. To prevent this both the moth and grubs must be destroyed.

Control Methods

The beekeeper's most valuable asset, apart from his bees, is a plentiful supply of good bee-combs, and special care must be taken to protect them from rats and mice, mould, and particularly wax moths at all times when they are not in use on the hives.

To protect bee-combs from rodents when they are stored in supers in open sheds place a queen excluder top and bottom of each stack, also at intervals of three or four boxes to seal the tiers in sections against these destructive pests. To prevent mould store the combs loosely in each super and keep them dry by allowing a free circulation of air around the supers. Owing to the feeding habits of wax moths, it is a distinct advantage to sort and store bee-combs where possible in three classes—

1. Clean new combs free from pollen and remains of brood-rearing.

2. Empty discoloured combs previously used for brood-rearing and honey storing.

3. All dark heavy combs and those containing stored pollen.

The combs should be equally spaced as wide apart as possible, eight to each 10-frame standard super.

In areas where the large wax moths are prevalent the only sure method of complete control is to keep the flying moths away from the supers and stored combs. To do this it is necessary to have a moth-proof room which could be completely closed for fumigation purposes, if necessary, and provided with shutters over wire screen windows, which could be opened at frequent intervals to allow a free and complete circulation of fresh air to keep the combs in a dry, fresh condition. It is not always possible to provide a room large enough for this purpose, especially where many thousands of combs are required to be stored. Many commercial beekeepers, therefore, must resort to a more liberal use of chemicals.

Chemicals Used

Of all chemicals so far tested for wax moth control, calcium cyanide and carbon bi-sulphide have proved the most effective for all purposes, without injury to the combs sufficient to cause contamination of honey subsequently stored in them, if properly used; and paradichlorobenzene (P.D.B.), a comparatively new chemical, is also used for this purpose under certain conditions.

Calcium Cyanide: Calcium cyanide may be obtained in coarse crystal or powder form in New Zealand. Where combs are stored in large numbers in open sheds, the supers holding them may be stacked ceiling high in rows on floor-boards, with the entrances closed and the top of each stack covered by a tight-fitting hive lid.

If floor-boards are not available, or where they take up too much floor space, anything which will fit tightly and allow access to the bottom super whenever necessary will do. A level tablespoonful of calcium cyanide placed on paper under each stack of

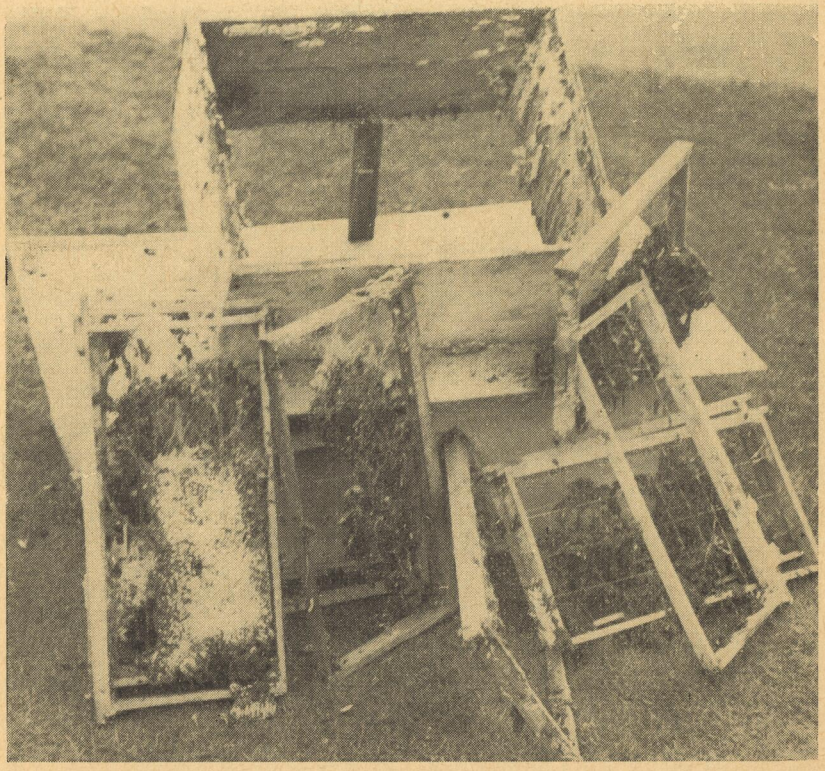

Fig. 11.—Bee-combs completely destroyed by larger wax moth.

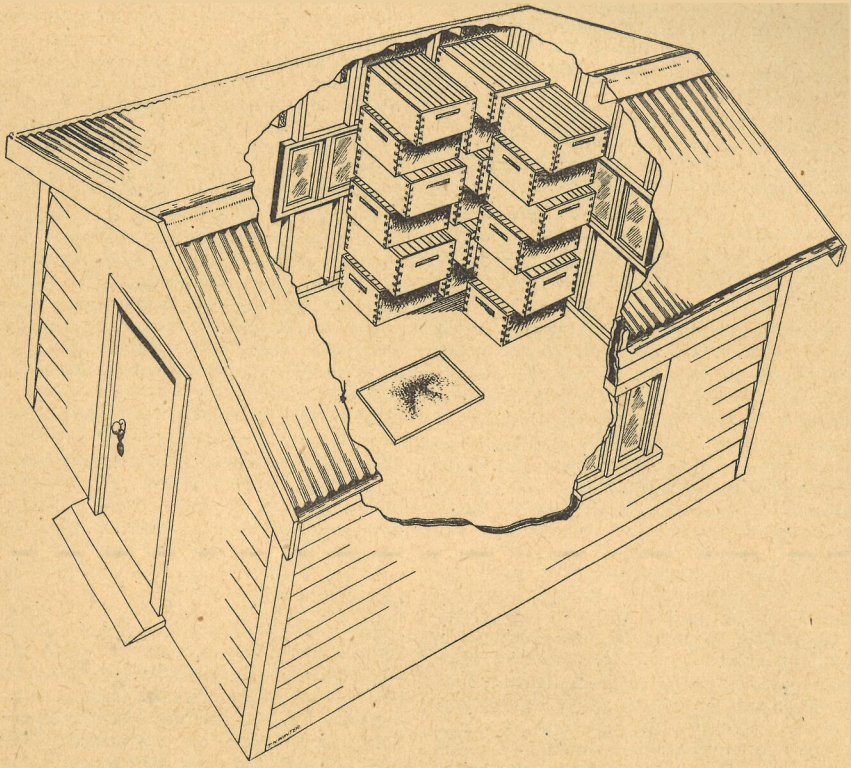

Fig. 12.

supers at intervals of three or four weeks during the storage period will keep the combs free of intruders.

Where it is desired to fumigate a large batch of infected combs which are worth saving the supers containing the combs may be placed criss-cross in tiers in a moth-proof outbuilding, as shown in Fig. 12, and a quantity of calcium cyanide (approximately 3lb. to every 1,000 cub. ft. of space) placed about the room on shallow trays or on sheets of paper. Calcium cyanide is non-inflammable and non-explosive, but the gas is extremely poisonous to humans and all animal life. Therefore the operator should leave the building as soon as possible and then close all doors and windows tightly for at least 24 hours, after which a free circulation of air during daylight hours should be allowed before again entering the building. Treatment of infected combs in this way should be repeated in about three weeks' time, as the gas is not effective against eggs of the wax moth. Calcium cyanide is most effective during warm, damp weather conditions.

Carbon Bi-sulphide: This chemical is sold commercially in liquid form, and when exposed to the atmosphere develops a strong, evil-smelling gas. To secure the highest efficiency in fumigating combs already slightly infected with wax moth a sponge or cloth may be saturated with at least two tablespoonfuls to every five supers of combs, and placed in a saucer or other shallow receptacle on top of each stack under a close-fitting hive lid. A light pad of newspaper placed beneath each stack will help to confine the gas, which is heavier than air, and which gradually filters down through the bee-combs, killing any grubs or moths present.

Carbon bi-sulphide should be handled with the greatest care, as the gas is poisonous to humans and is highly inflammable and explosive.

When combs have been treated in this way in a closed outbuilding all windows and doors should be opened a few hours before re-entry and, if the work is done out of doors, which is the safest place, strips of gummed paper should be placed over the cracks between the supers for the best results.

Paradichlorobenzene (P.D.B.): This is a white crystalline substance which evaporates slowly in air, and is a very convenient substance to use for the control of wax moths. The vapour is heavier than air, not unpleasant to smell, and is non-injurious to humans. Provided the crystals are not taken internally, this chemical may be used with safety.

"P.D.B." is most effective at temperatures above 70° F., and vapourises more rapidly as the temperature rises. One pound of crystals made into convenient cakes is sufficient under normal conditions to provide fumigation of 40 supers of empty (dry) extracting combs during the storage period. Where this substance is used in crystal form, as sold commercially, the rate of evaporation during warm weather is usually more rapid than is required for this purpose.

The melting point of the commercial product is approximately 133° F. and the boiling point 343.4° F. To avoid loss and any possible danger of fire it is advisable to heat the substance carefully in a deep container floated in a cut-down kerosene tin containing boiling water. A small flame could be applied to the larger container to prevent the water cooling too rapidly. Immediately melting occurs the substance should be run into moulds to cool and solidify, after which the cakes are ready for use, or may be stored in airtight jars until required. Bakers' patty tins make suitable moulds. The cakes should be approximately three-eighths of an inch thick and the size of a round wine biscuit. This method of melting is slower than direct heating in a single container, but is more economical and safer. Where heating is continued much above the melting point, there is considerable loss by evaporation. For prolonged light fumigation sufficient to kill any wax moths, also all larvae as they hatch out from any eggs present, the supers containing the combs should be stacked in tiers as tightly as possible with a sheet of newspaper placed on top of every third or fourth box and a cake of "P.D.B." as described placed on a piece of tin or cardboard on the top bars of the top super in each division.

Sections containing comb honey should not be fumigated with this chemical, as it is liable to taint the honey and impair its natural delicate flavour. The flavour of extracted honey may also be impaired if the combs used are not thoroughly dry and free of all traces of honey when stored under fumigation.

The combs should also be thoroughly aired before use on the hives. Careless handling or excessive use of this chemical in the treatment of bee-combs for the control of wax moth may cause serious contamination of honey subsequently stored in them. Where this happens the natural flavour of the honey is destroyed,

WAX MOTH CONTROL.
CONDENSED TABLE OF INFORMATION.

Conditions Suitable to Wax Moths	Remedies (Bee-combs in storage)
Closely packed food mass	Well-spaced combs, eight to each standard 10-frame super when in storage
Warmth and darkness	Plenty of light, ventilation and low temperatures
Old brood combs and combs containing pollen	Sort combs into suitable grades before storage: (1) new white combs, (2) little-used discoloured combs, (3) dark, heavy combs, and those containing pollen
Eggs are not affected by fumigation	Repeat fumigation at intervals of three weeks, or light constant fumigation in warm climates where moths are prevalent
Weak colonies	Keep good strain of Italian bees
Unprotected combs	Remove all combs not in use by the bees
Heaps of old broken combs and hive refuse	Render all broken combs before wax moth locates them. Keep hive bottom boards clean of all refuse.

making it quite unpalatable for table use.

SUMMARY OF THE APIARIES ACT.

The Apiaries Act, 1927, and the regulations thereunder are administered by the Department of Agriculture, and were designed to enable the maximum of protection and service to be applied to the beekeeping industry for the economic production of honey and beeswax.

It has long been recognised that the diseases of bees, besides being a serious matter to beekeepers, cause much loss to other members of the farming community. The honey-bee is perhaps the insect which accomplishes more than any other—the successful pollination of flowers so necessary for the proper production of fruit and seeds. It is an indispensable ally of the orchardist, gardener and farmer. The beekeeper who gives his bees proper attention is a benefactor to his neighbours, since he fills gardens, orchards and fields with willing workers; but, as he has no control over the flight of his bees, he must run the risk of their contracting infectious disease unless all the other beekeepers in the neighbourhood co-operate. Without efficient organisation and a widespread knowledge of the destructive nature of the diseases affecting bees, it is difficult for even an efficient beekeeper to carry on successfully over a long period. He cannot take precautions against his neighbours' carelessness. His is a losing battle unless the State gives him legal protection.

The Apiaries Act, as its name suggests, aims at consolidating and amending the law relating to the industry in New Zealand. In addition to the machinery clauses, the Act provides for the compulsory registration of apiaries, forbids the keeping of bees in box hives, and compels the cure or destruction of all diseased bees and their hives. It also prohibits the removal of bees and appliances without a permit, treats the exposure of honey, wax, and materials from diseased hives as an offence, and requires beekeepers to notify the inspector of the presence of disease within seven days after its discovery.

Section 5 of the Act deals with the registration of apiaries, and requires that no person shall keep bees except in an apiary registered under the Act. In addition, it makes any person keeping unregistered hives, or allowing them to be kept on his land, liable to a fine of £20. This compulsory registration provides the inspector with a complete list of the beekeepers in his district—an immense help in carrying out inspectional work.

The provision that the keeping of bees in box hives is a breach of the law proclaims itself a wise measure. Only by providing the bees with movable combs can the beekeeper hope to keep a check on the condition of his colonies. Movable frames allow him to examine his hives easily, and to note at a glance the condition of brood, queen, and food-supply. No one can judge of these matters by merely looking at the entrances. Subclause (3) of this section is an important one, and should be known to every householder, as it provides for a penalty of £20 for allowing bees that may have become established in any other than a frame hive to remain after notice to remove them has been issued by an inspector. Bees that have taken up their abode in houses, sheds, or other irregular shelters must be removed or destroyed.

Another important section of the Act deals with the moving of bees and appliances from one location to another. No colonies may be removed without the written consent of an inspector. This precaution is taken for the purpose of preventing the transfer of diseased bees to the neighbourhood of clean apiaries. Much harm has been done in the past by practices of this nature. Any beekeeper who moves colonies more than 10 chains without a permit, or fails to observe the conditions imposed by an inspector, renders himself liable to a fine of £25 on conviction of such an offence. The allowance of a range of 10 chains is mainly for the purpose of facilitating merely local readjustments of apiary-sites.

Section 8 of the Act requires the beekeeper in whose apiary disease appears to take proper steps to cure it and to prevent it spreading. He is also required to notify the inspector in his district of its presence within seven days of the date on which he

becomes aware of it. This latter regulation is also a wise precaution, inasmuch as it enables an inspector to take steps to locate the source of infection if possible, and to control the disease, thus preventing its spread to neighbouring apiaries.

Section 9 deals with bees, honey or appliances found to be diseased, and gives the inspector authority to issue instructions as to their cure or destruction. The inspector is also authorised to destroy any infected bees, honey, and appliances without notice if circumstances demand such action.

A further clause in the Act has reference to persons dealing in diseased bees and materials, or who expose honey, wax, combs, or appliances taken from infected hives or used in connection therewith, in such a manner that bees may gain access to such material. Until these materials have been thoroughly sterilised by approved methods they must be kept secure from the bees. Neglect of this precaution **renders the offender liable to a fine of £50.** No fine could be too heavy for this class of offender, for he may put a neighbouring beekeeper to endless trouble and expense through his negligence.

The foregoing are the main clauses of the Act which concern the beekeeper, and, while they make provision for inspection of bees by duly appointed inspectors and compel treatment or destruction where disease is present, the work can be greatly assisted by every beekeeper becoming an inspector of his own bees. It is not sufficient to rely upon periodic visits from a Government inspector to ensure that all is well with the bees.

The aim of the Department of Agriculture is to make every beekeeper competent to handle the everyday problems with which he is confronted. This it hopes to do, not by force, but by spreading useful knowledge wherever it is most needed. The Act provides the authority for dealing with the many important matters, and enables the Government to employ experienced officers to undertake any necessary enforcement. It is obvious, however, that the administration cannot hope to cope successfully with the immense amount of work involved without the reasonable co-operation of all owners of bees.