SECTION I
General Information

1. Project Number, Grant Number: LNE96-66(USDA-COOP-1-2700)
   Funding Period: 1 August-31 December
2. PROJECT TITLE: Evaluating a Heat-Therapeutic Control of the Honeybee Mite Varroa Jacobsoni
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4. Type of Report: Final
5. Date of Report: 31 December 1997
6. Reporting Period 1 August 1996 TO 30 December 1997

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9. Project Status: This 16 month project was new in 1996.

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SECTION II

1. OBJECTIVES

1.)Efficiency studies will determine the percentage of mites which bee-safe temperatures and treatment times remove for sample sizes ranging up to the entire adult bee population of an established colony.

2.) The project will identify and attempt improvements to the heat-therapy apparatus and procedure as regards effectiveness and ease of handling bees during treatment.

3.) The project will assess winter survival of Varroa infested nucleus colonies heat-treated during the preceding fall.

4.) The project will assess the influence of spring and fall/spring heat-treatments on the health and honey production of Varroa infested nucleus colonies during the following first summer of establishment.

5.) The project will measure the influence of heat therapy on the population levels of the endoparasite Acarapis woodi .

2. ABSTRACT

Varroa jacobsoni is an exoparasitic mite the size of a pinhead which evolved on a species of honeybee, Apis cerana, in Java but appeared on agricultural honeybees, Apis mellifera, in North America in 1987. Varroa mites have since spread throughout the continent with the result that now virtually all commercially productive honeybee colonies in the US must be treated to control Varroa mite infestations or they will die within three years. Varroatosis affects larvael, pupal and adult stages of honeybees with a wide range of symptoms some of which are associated with known honeybee viruses (parasitic mite syndrome or PMS). Currently only one approved miticide, fluvalinate, is available to an estimated 140,000-211,600 (Caron'95) US beekeepers for controlling varroa. It is generally agreed that the effectiveness of this miticide is unsustainable, and some populations of Varroa already exhibit resistance to fluvalinate (Tabor '94, Griffes '96).

"Evaluating a Heat-Therapeutic Control of the Honeybee Mite Varroa Jacobsoni" was a 16 month project which evaluated and developed a method of managing varroa mite infestations with heat alone. The heat-treatment involves temporarily removing the bees from a hive and exposing them to 46-48°C (114.8-118.4°F) for several minutes until most of the mites have been detached but before the bees can be injured by the heat. A simple cabinet-type heating apparatus, similar to that used by beekeepers in Uzbekistan where varroa mites have been an apicultural pest for decades, was constructed, tested and improved. This project deals exclusively with *extro*hive thermotherapy of honeybees which should not be confused with a patented device costing several hundred dollars that heats bees and the entire contents of the hive.

Preliminary heat-treatments enabled the project participants to develop bee-safe handling and heating proceedures while determining factors which limit the number of bees per treatment. An efficiency study showed that heat-treatments removed between 82 and 98% of the varroa mites from treated colonies which rivals the efficiency of experimental organic acid treatments and miticides such as fluvalinate (Imdorf, et al 96).

The principle research study closely monitored 32 colonies over the course of a year to observe the health and productivity of heat-treated colonies relative to a control group.The project was conducted in areas of mixed woodland and small-scale agriculture in hilly areas of Southeastern Vermont and Southwestern New Hampshire on sites where varroa infestation pressure from other honeybee colonies was reduced by a 2 mile or wider buffer radius. Participants seeded 32 nucleus colonies (8 frame size) of hybrid "Hardy Northern Stock" (Webster'93) with Varroa mites from donor colonies which had been infested for two years and exhibited symptoms of PMS. In October 1996 the 32 colonies were randomly assigned to 8 sites paired according to expected more or less favorable environmental factors so as to mitigate the effects of site on project outcomes. After normal wintering 16 colonies at 4 sites were heat-treated during a naturally broodless period in March -April 1997 and the other 16 colonies at the other 4 sites were maintained as a control group.

During the entire project an experienced apiculturist regularly inspected all colonies and recorded the following: symptoms of disease; brood levels; varroa mite counts, using both sticky boards and adult bee sampling methods; and honey production. When treated colonies were compared with control colonies according to these outcome measures, the treated colonies showed markedly lower varroa populations through the entire summer and fall following treatment.

The extro-hive thermotherapy was shown to be inexpensive in regards to materials, but, as expected, heat-treating is labor intensive. Interested beekeepers will need to learn the techniques involved which are not difficult although extreme operator inexperience or inattention can result in unnecessary loss of livestock. Findings include labor conserving techniques such as preparing colonies for treatments and efficiency improving techniques such as performing treatments nocturnally

3. SPECIFIC PROJECT RESULTS

A. Findings and Accomplishments

Description of the heat-treatment apparatus and bee handling procedure The apparatus used in this project was, as proposed, built similarly to a design of a home-made Russian apparatus documented by the project coordinator in use in Uzbekistan in 1994. It consists of a portable wooden cabinet which accommodates a standard 1500 watt "milk house" type heater that stands on the floor of the cabinet and a wire mesh cylinder or "cage" for suspending the bees in the upper portion of the cabinet. Plexiglass windows were fitted into the top and sides of the cabinet for ventilation and observation. Bees are shaken, brushed and/or blown from the hives frames into the heat-treatment cage via a large funnel and thus transferred into the cabinet for heating. The actual heating can take less than 15 minutes per hive while the handling of the bees can take twice as long.

The first trials with the heat-treatment apparatus, in August 1996, preliminary to the first efficiency study, showed that an accurate and practical indicator of effective temperatures is the falling of mites from the caged bees. By observing the thermometer and mites falling onto a paper lined cookie sheet, the operator was easily able to obtain effective mite-fall temperatures within the cabinet. Then by turning the heater off or on and opening or closing either of two sliding Plexiglass windows he was able to maintain mite-fall temperatures or begin cooling All of the treatments performed during the course of this project followed this same basic procedure.

i. Objective One: Efficiency Study (see table 1)

Efficiency study heat-treatments were performed, as were all subsequent treatments, in the following fashion. The bees were loaded into the treatment cage, the cage inserted into the cabinet which had been pre-heated to between 25-30°C and the electrical circuit to the heater closed. When an accurate full-immersion type glass thermometer positioned in front of and near the top exterior of the cage showed 47 degrees Celsius (116.6 ° F),Varroa mites began to fall from the caged bees. Other thermometers and thermocouples positioned inside and below the cage sometimes showed a differential of 10 degrees or more, but as long as the reading at the primary thermometer stayed above 47-48 degrees, depending slightly on ambient temperature, mites fell at a more or less steady rate for 2-6 minutes, never as long as 10 minutes. A cookie sheet lined with white paper was positioned on a screen shelf below the cage where it was easily visible through a Plexiglass window. When mite fall was observed to cease and a little agitation of the cage failed to produce more mites, the heat was turned off and ventilation provided for cooling.

For the purposes of this efficiency study 4 colonies ranging in size from 456 to 1133 grams (1 - 2.5 pounds) were heat-treated and the bees returned to their hives over a " sticky board" so that additional mite fall and bee mortality could be measured. The hives to which the bees were returned where brood free and the comb reasonably clear of mites. Egress or ingress of bees was prevented by covering the hive entrances with wire mesh. Two plastic strips coated with 10% fluvalinate (commercial name: Apistan) were inserted and mite fall counted over the next 9 - 14 days. This control treatment of known very high efficiency, administered to single-chamber brood-free hives was expected to remove virtually all the remaining varroa mites. Efficiency of the heat-treatments was calculated by dividing the number of mites detached during heat-treatment by total mites and ranged from 81.9 to 94 .6.%

The efficiency of mite removal with two additional colonies was similarly measured except that instead of a control treatment with Apistan the bees were sacrificed and all remaining varroa mites counted using a 30 minute agitated alcohol bath and straining (DeJong et al "82). The efficiencies of these two treatments were 90.6 and 97.9% for colonies weighing 1420 and 1498 grams (3.13 and 3.30 Lbs).

Contrary to expectations that treatment temperatures and durations would need to be carefully adjusted to maintain efficiency in treatment of different sample sizes, the 47-50 degree temperature range for no more than ten minutes worked well for all sample sizes below 1588 grams (3.5 pounds) as long as the cage was not over filled and other operating procedures

During heat-treatment trials, preliminary to the efficiency study, it became apparent that certain factors grossly affected the efficiency of treatments. For example if the mixed adult bee population of a large varroa infested colony was treated in successive batches it became obvious that while a cage filled with bees so as to allow ample space for air circulation produced an impressive mite fall, a cage overfilled with bees was slow to heat, detached very few mites and was more likely to result in and damage or death to bees. If the treatment cage was oversized for the cabinet, mite fall was also grossly reduced. For the purposes of the efficiency study and subsequent treatments performed as part of this project an 11 inch diameter X 16 inch long cage was used.

If over-heating occurs, with the primary thermometer readings above 49-50 degrees, some bees began to regurgitate a clear liquid, became excessively lethargic, and more likely to clump together in collective helplessness made worse by the cohesive effects of the regurgitated liquid. If the cage was overfilled or the bees in the cage were in other ways allowed to clump together during heating far fewer mites fell than with the treatment of loosely distributed bees from the same colony. So whether clumping is allowed at the beginning of critical heating or results from over heating, in both cases bees are undesirably stressed and the efficiency noticeably reduced

A more detailed description of bee "clumping", cage size and capacity follows under findings for "Objective two: Improvements".

ii. Objective Two: Improvements to the Heat-treatment Apparatus and Procedure

Experience with heat-treating bees enabled the project participants to effect improvements to the heat-treatment apparatus. It was discovered that bee handling and heat-treating was greatly facilitated through preparatory manipulation/inspections and choice of when to treat.

(a) Cages and Cage Size Three cages of cylindrical mesh (mesh size: 8 x 8 openings per inch) were built to the following dimensions: 8 inches diameter x 16 inches long, 11 x 16 and 14 x 19. Samples ranged from 170 grams (6 oz) up to 3.63 kg (8 pounds) of bees per cage. If the cage was filled beyond its capacity excessive clumping occurred as the surface area of the inside of the cage was insufficient to allow a grasp for a large number of bees who ended up falling to the bottom of the cage in a clump. The greater the number of bees in a treatment the greater the probability of treatment and post treatment clumping

Guidelines for determining appropriate cage sizes should take into account bee distribution on the mesh; the surface area of the cage should be equal to or a little more than that which the bees can cover evenly. A few trials with samples not exceeding 1360 grams (3 pounds) in the 11 inch cage proved effective, but above 1587.6 grams (3.5 pounds) clumping was more difficult to prevent. So maximum number of caged bees per square inch is as follows: 1360 gr bees ÷ .121 grams per bee (average spring bee weights) = 11240 bees, 11240 bees ÷ 743 square inches per 11 inch x 16 inch cage = 15 bees per square inch. This 15 bees per square inch density was greater than expected; subsequent observation suggested the high number of bees which can manage to hold on to a square inch of wire mesh actually involves the remarkable ability of the bees to interlock with each other and the cage while continuing to move about the surface.

In early spring the average weight of the project colonies was approx. 680 gr.(1.5 lbs). It was found that with a second 11 inch cage it was possible to fill one cage from one colony while still treating the first one or to treat as large as a 2720 gr.(6 lb) colony by filling each cage with 1360 gr (3 lbs) of bees and heating each cage in turn.

(b) cage construction materials A cage frame built entirely of metal will work very well but requires welding. The 11 x 16 inch cages built in the course of this project did not require access to welding skills or equipment but instead were built using 1/4 inch threaded rod and 1/2 inch plywood. Experience with different meshes showed that a common type of galvanized 8 x 8 mesh seemed more thermo-transparent than a heavier gage 8 x 8 steel mesh .

(c) Clumping of bees Since in most cases--assuming the cages are not overfilled with bees--clumping can be easily prevented by manipulating the cage with its axis rods which protrude

from the cabinet, it was not attempted to quantify the reduced efficiency caused by clumping. However two causes for clumping-induced inefficiency can be supposed and are included in this report as follows.

Firstly excessive clumping of bees in the cage seems to prevent even heating from both convective and radiant sources. Some bees seem overheated while others are shielded and under heated. Secondly, it seems reasonable to suppose that if mites are heated and dislodged despite clumping together of bees in the treatment cage, fewer detached mites can fall free of the clump especially if the clump is sticky. The mites may survive to reattach to another host as the bees and mites are cooled. This is supported by the observation during all of the 24 heat-treatments performed during this project that some mites falling from the treatment cage during heating remained obviously alive and animated. Even after contact with the catchment pan, which reaches temperatures above 50 degrees, some mites survived the treatment if removed promptly and would readily re-attach to any prospective host bee introduced into their container.

(d) Avoiding post treatment clumping, cooling techniques By trial and error it became apparent that clumping after the treatment presented as much of a threat to treatment success as clumping of bees during treatment. Upon reintroducing a colony to the hive it was a challenge to distribute helplessly lethargic bees without damaging many of them especially if they were sticky. An improperly re-introduced cluster can bake itself especially if the hive is closed up before the cluster has a chance to eliminate excess heat. This happened with a preliminary treatment colony which, during a postmortem 24 hours later, gave off a smell of baked bees and was still unusually warm to the touch. The first step to avoiding this problem while the bees were still in the cabinet was to stop heating the bees immediately after the mite fall ceased. Next it was found that removing one or two frames and spacing the remaining frames made it easier to coax the reintroduced bees down in between the frames where clustering was limited by the combs.

These techniques helped reduce or even eliminate post treatment bee mortality and were employed during every treatment performed during the principle research study. Consistent with the Russian-Uzbek method the caged, treated bees were usually allowed to eliminate excess heat while still inside the cabinet with the vents open and the heater off. Later it was also found that in many cases, depending on ambient temperatures, additional pre-cooling of caged bees outside the cabinet was helpful.

(e) Transferring Bees from the Hive to the Treatment Cage It is the handling of bees from the hive into the treatment cage that of all the steps takes the most time and effort. Two types of funnel were employed for this purpose. The first funnel was only large enough to accommodate in its mouth a frame covered with bees and conduct them down into the treatment cage. The bees were dislodged by shaking, brushing, and sometimes blowing with the exhaust of a shop vacuum. Handling techniques of this sort are routinely employed by beekeepers when harvesting honey supers and making-up packages of bees.and can be done with little damage to bees. In cold weather a blower should not be used as it can excessively chill the bees.

The single frame funnel design used in this project had to be modified from the Russian-Uzbek model whose dimensions accommodate a single frame 30 % larger than the American or Langstroth type frame. The multi storied Langstroth type of hive used in the US with its ten frames per story or "chamber" differs from the Russian type in both size of frame and size and configuration of chamber. The Russian hive is a single chamber which is used with 18 or more large frames These differences between American and Russian hives not only require a 30% smaller single frame funnel but additional modifications.

Because of differing hive configurations the winter cluster of bees might occupy only a few frames in the Russian hive but portions of as many as 12 frames in the Langstroth hive. This means that the heat therapist of a Langstroth hive must find a way to handle all those extra frames. In this project a second funnel type was built large enough to support an entire brood chamber. A screen was fitted over the top of the chamber and a blower employed to move the bees off the frames down the funnel into the treatment cage without the necessity of handling frames individually.

(f) Preparation of Colonies for Heat-treatments

(i)Consolidation of Bees onto a Minimum of Frames in Advance of Treatment

Another way to facilitate handling of frames of bees is to prevent them from occupying more than a maximum of 8-9 frames. Consolidation of bees onto selected frames for the purpose of heat-treatment greatly facilitated heat-treatments conducted during the course of this project. A typical triangle type bee escape board was inserted between the upper and lower chambers of the hive a day or two in advance of the scheduled heat-treatment. A great advantage to advance consolidation of the cluster in this way is that the beekeeper can select mostly empty frames for the consolidation area thus easing the shaking and brushing process which can be complicated by the weight of honey comb and the spilling of loose nectar or honey onto the bees prior to treatment. Care was taken to make sure at least one frame of honey and pollen was available to the consolidated cluster for their consumption during the 24-48 hours leading up to the treatment.

(ii) Queens It is a practice among some of the Central Asia practitioners of Heat therapy, and it seems a sensible one, to protect the queen from potential damage due to handling or heat by removing her to a pocket sized holding cage for safe keeping until the heat-treatment is finished. In this project the queen was caged within the hive at the same time as colony was consolidated. At the time of treatment she was kept in a warm pocket.

Preparation of colonies presented an opportunity to combine several seasonal management tasks into one or two detailed inspections. A frame to frame search for the queen familiarized the beekeeper with the quantity and quality of honey and pollen stores necessary for wintering or spring survival. Disease detection can also be performed. As the colony is undergoing treatment its hive can be cleaned of dead bees and debris, the chambers configured with selected frames taking into account the colony's winter need for sufficient honey, pollen stores and clustering space.

(g) Choosing When to Treat

(i) Broodless Periods Common in Fall and Winter Varroa mites reproduce in the brood cells on pupating bees where they are protected from most mite control methods. Therefore it is desirable to treat colonies for varroa during those few, geographically variable, periods when brood is not present in the hives. A Univ. of Guelph Study showed November broodless periods among 28 wintered colonies(Szabo '93). During the heat-treatment study we found significant cold weather periods of near or total broodlessness (in fall, winter and spring of 1996-97) among the 32 colonies in this study.

(ii) Cold Weather Handling Some experimental chemotherapies for varroatosis lose effectiveness during the cold weather when broodless periods would otherwise make treatment desirable. By contrast, this study found multiple advantages to heat-treating colonies during cold broodless periods. Most beekeepers do not need to disturb colonies during cold weather and prudently avoid doing so under the assumption that colony health will suffer. During the course of this study it was occasionally necessary to inspect colonies and handle bees in air temperatures below freezing. In the absence of brood, the colonies showed no obvious long term effects of exposure to freezing air temperatures for the roughly 5-30 minutes it took to inspect a colony or prepare it for heat-treatment: with care, hives were opened and the bees emptied into cages for successful treatment without causing significant bee mortality.

If sufficiently disturbed while being handled for heat-treatment many bees would fly and escape heating thus reducing the efficiency of heat therapy. It was preferable to prevent bees from flying during the pre-treatment handling. Cold weather handling was an advantage since the bees in this study would fly only reluctantly in temperatures much below 50-55°F (10-13°C). However, wind, rough handling or the accumulation of alarm pheromone on the beekeeper and equipment could induce bees to fly regardless of low air temperatures resulting in undesirably high bee mortality.

(iii) Nocturnal Treatments The fact that bees do not fly after dark provided a solution to the problem of some bees flying before they could be placed in a treatment cage. All treatments recorded during this project were conducted at dusk or in the dark . The field researchers wore head-lamps and a low wattage lamp was attached to the treatment cabinet.

(h) Periodic Cleaning of Apparatus The cages should bee cleaned with a brush, soap and hot water between sessions or apiaries in order to keep the cage free of debris that might decrease thermo-transparency, remove accumulated alarm pheromones and other smells that may unduly disturb the bees, and limit the potential transmission of disease from apiary to apiary. Heating of the empty cage and box above 50°C for 24 hours or more will kill Nosema spores (Sammataro and Avitable 1986) and possibly other disease organisms. Such procedures were practiced during the course of this project and are recommended for all bee thermo-therapists.

....iii. Objective Three: Winter survival after fall treatments

It was originally planned to obtain the livestock for this project already infested with Varroa mites and in the interest of moderating costs as much as possible perform the first set of treatments in September 1996 so as to generate winter survival data early in 1997. Contrary to the bee supplier's original stated intentions he treated all his stock for varroa using Apistan. It was too late to find other sources of untreated colonies so the fall treatment was cancelled; the senior investigator and entomological advisor modified the project design so that 1/2 instead of 1/4 of the 32 colonies would be treated in spring. The result was a simplified experiment with increased repetitions.

After acquisition in September 1996, all 32 colonies were collected into a holding yard where they were weighed, fed sugar syrup. The colonies were seeded with brood and bees from some of the coordinator's colonies which were heavily infested with varroa. Special care was taken to seed equally and randomly assign colonies to sites (see table 5).

iv. Objective Four Summer, fall assessments of treated and control colonies

With the forced cancellation of the fall 1996 treatments the objective was to compare progress of spring 1997 treated colonies and control colonies over the summer of 1997 through November. Both groups originally included 16 colonies; the treated group lost 1 robust colony to late winter starvation and the control group lost two colonies which exhibited mite associated symptoms over winter-spring. Such losses are within the normal 10% experienced by healthy colonies.

Between 28 March and 5 April 1997 the fourteen surviving colonies randomly assigned to the treatment group were heat-treated *in situ*. All colonies were managed in conventional fashion over the following spring and summer except that detailed inspections quantified cluster size, brood, honey, pollen on a regular basis.

The first outcome measure to distinguish treated from control colonies were the sticky board counts begun in July and August. The sticky boards consisted of oil coated paper, separated from the bees by 1/8 inch mesh, placed on the floors of the colonies to show the number of varroa mites naturally falling in each colony (see table 3). These counts were conducted over four 10 day to two week periods July - November 1997.As is typical with varroa infestations the mite populations began to boom in August. Analysis of sticky board data showed that the control group produced 7.2 times more mean mites per day than the treated group.

In second or third year infestations, untreated colonies of honeybees often crash dramatically and die after the annual varroa populations boom. This study was not funded for the two -three years necessary to compare control and heat-treated colonies over the full two to three year course of varroa disease. Advanced stages of varroatosis include an aggregate of little understood symptoms associated with viruses which is called parasitic mite syndrome (PMS). These symptoms appeared in several colonies but did not occur in one group more than the other. Honey production by the control colonies was higher than the treated colonies, but beekeeper experience with varroa infestations suggests that honey production is often an unreliable indicator of varroa infestation , and in this study honey production was measured as an indicator of general colony vitality and forage opportunities Other factors probably affecting honey production were bear damage to three of the treated colonies and the very poor forage opportunities at a treated site that had been expected to provide good forage (see table 2).

v. Objective Five Tracheal mites (Acarapis woodi)
In March 1997 a total of fifty bees from each site were collected from the inner covers of the colonies and examined for tracheal mites to establish base line data prior to heat-treatments. The bees were dissected and examined under 40x dissecting scopes according to established procedure for tracheal mite detection. On average each yard showed one bee in 50 had tracheal mites at a time of the year when tracheal mite infestations are expected to be concentrated. With such low counts a specialist indicated we should perform these examinations every month. The projected labor allotment for this new work was so great as to be impossible within the financial scope of this project, and no further investigation of the effects of heat therapy on tracheal mites was attempted.

3.B. Dissemination of Findings

In an attempt to further measure treatment efficiency, data for this project was still being generated as late as December 1997 which was the final month of the project. and the time when the bulk of this report was written. Therefore the majority of dissemination will take place in 1998.

In 1997 two beekeeping workshops were presented by the coordinator which included descriptions/demonstrations of extrohive thermotherapy. The workshops took place on 24 August and 5 October 1997 involving 12 beekeepers.

During the third week in September and first week in November 1997 a Vermont Public Television crew (Andrea Melville producer) taped the coordinator and field researcher describing and demonstrating sustainable beekeeping methods and conducting heat-treatments. Special attention was paid to documenting and describing the heat-treatment research conducted by this SARE project. The results of these taping sessions are scheduled to be broadcast in 12 October 1988 as part of VPT's new series "Rural Free Delivery" with an estimated audience of 3000 television viewers throughout the VPT viewing area of VT, NH, NY, Quebec.

In 1998 the first scheduled dissemination event will be a guest speaker presentation of this project's findings by the coordinator to the Biannual meeting of the VT Beekeepers Association in Montpelier 27 January 1998.

Publication of the project findings in scientific journals are planned for 1998-99. The first publication is planned for the American Bee Journal in 1999.

More workshops are currently being planned for spring, summer of 1998.

In addition to the dissemination activities achieved with this project, significantly more beekeepers could make use of this treatment if an instructional booklet or video was compiled and published with USDA support.

3.C. Site Information (see Table 2)

The project was conducted in areas of Southeastern Vermont and Southwestern New Hampshire on either side of the Connecticut River Valley in areas not associated with the best agricultural land.

In October 1996 after bringing together the 32 colonies in a transition yard for mite seeding, weighing and feeding the 32 colonies were randomly assigned to 8 sites paired according to expected more or less favorable environmental factors so as to mitigate the effects of site on project outcomes. These sites can be characterized as being on hilly areas of mixed woodland and small-scale agriculture. Altitude ranged from 132 to 486 meters. Many Vermont and New Hampshire locations such as those sites chosen for this project are currently considered of only marginal economic importance to apiculture as contrasted with the traditionally more productive sites in the agricultural valleys (e.g. Connecticut River Valley, Champlain Valley).

In order to reduce varroa infestation pressure from other honeybee colonies all eight project sites where buffered by at least 2 miles of woodland. Immediately adjacent to the apiaries were a minimum of 10 and as much as 75 acres of cleared land in use for dairy production, sheep grazing, certified organic vegetables, hay, human recreation. All land was privately owned; some land adjacent to apiary sites was under Vermont Land Trust.

3.D. Economic Analysis

Cost comparison of varroa control with fluvalinate and heat therapy

When using chemotherapy, colonies are treated through the insertion of fluvalinate coated plastic strips between the brood frames at 3 to 6 dollars per year in materials plus the labor to open and close each colony 2 or 4 times. The plastic strips, now in use internationally are then discarded. The cost might be higher when we consider the likely appearance in the US of mite resistance to fluvalinate, a problem already observed in Europe (Aug. 1995 Am. Bee Jrnl. p.533). Although perhaps labor-saving, the actual cost of using fluvalinate can compare unfavorably with the more labor intensive heat method over the course of several years.The coordinator calculates that in the Northeast it costs between 433 and 933 dollars in materials and labor to treat 100 colonies with fluvalinate, not including transportation.

If a beekeeper supplied himself with heating cabinet, heat source, thermometers, etc. for a one time (10 year) cost of 200 dollars, and he took 45 minutes (labor costs= 7 and 10 dollars/hour) with each colony it would cost him between 545 and 770 dollars each year with the initial equipment cost spread out over ten years. (See Figure 1 apparatus dimensions) An additional argument for using heat therapy arises if one takes into account the likely increase in the cost of fluvalinate and the likely increased income from the sale of uncontaminated, premium priced honey produced using heat therapy.

With organic honey standards in place in Vermont and other states, the number of specialty and certified organic producers is likely to increase dramatically in the next several years. Most standards do not allow use of fluvalinate in colonies used for the production of honey labeled certified organic and likely all organic honey standards will similarly exclude or strongly limit the use of other pesticides.

Sample Costs of Building a Heat-treatment Apparatus:
Cabinet, Cages, Electrical Components
(One Time or 5-10 Year Investment)

Dollars	MATERIALS
12.81	1/4 inch x 4' x 8' plywood sheet
3.38	Two lengths of 2" x 3" x 8' Pine
11.45	4' x 8' sheet of 1/2" Plywood
24.82	threaded rod, fasteners, hardware
6.99	switched outlet strip
24.99	"milk house heater"
7.5	Plexiglass (cabinet windows)
19.14	6' of 8 x 8 mesh (1/8 inch openings)
111.08	**Total Materials**

LABOR IN HOURS

(All labor can be performed by any beekeeper with basic woodworking skills and tools)

4 - 8	cabinet carcass
4 - 6	vents, windows, door, mesh shelf
5 - 9	2 cylindrical cages
13 to 23 hrs	**Total Construction Time**

When considering whether to attempt a program of varroa mite control using extrohive thermotherapy, the beekeeper may consider several economic factors.

--Are his or her bee yards accessible with a 120 volts AC electrical current or can colonies be SARE brought to a treatment site accessible to electrical current on an annual basis? For this project both household current and an electrical generator on a trailer were used when performing heat-treatments at five rural sites. Or can bee yards be advantageously relocated with access to electrical current.

--This is a labor intensive, materials cheap varroa control method. A beekeeper can perform the colony preparations and treatments alone or with an assistant. Depending on size of bee yards and skill of workers, colony preparations can take between 10 and 25 minutes per hive. The treatments can take between 15 and 45 minutes each depending on number of colonies per session, set up time and skill of workers.

--Does the beekeeper intend to incorporate sustainable methods into all aspects of colony management and processing either with the intention of following his or her own sustainable philosophy or achieving organic certification? If so, extrohive thermotherapy would be compatible with most any sustainable apiculture program. An advantage of extrohive thermotherapy over chemical miticides not yet approved for use in the US is that the beekeeper can choose to begin heat-treating immediately, without having to wait for government or corporate decisions necessary determine the availability of commercial miticides to the beekeeper.

The additional labor required for extrohive thermotherapy can be weighed against the premium price customers are willing to pay for wax, honey and pollen from certified organic or colonies otherwise managed using sustainable methods.

4.Potential Contributions and Practical Applications

A. Potential Impacts

Potential impacts of this project include providing a safe, sustainable alternative to decreasingly effective chemotherapies such as fluvalinate. Current apicultural practices which involve extensive handling of adult bees, such as the formation of nuclei and package bees, colonies could be adapted with relative ease so as to incorporate heat-treatments .

Prospects for the production of certified organic honey and other bee products will likely improve with the availability of non-chemotherapeutic varroa control measures such as heat therapy. Organic honey production in the continental US is currently very low as a direct result of the lack of sustainable alternatives to chemotherapy for the control of varroa infestations.

4.B Pesticides whose use could be significantly reduced by the adoption of extrohive thermotherapy to control varroa mites on honeybees

Fluvalinate is a miticide sold in the US under the trade name Apistan and the only pesticide currently used by the majority of US beekeepers to control varroa mites in honeybee colonies.

Although Apistan is a class lll pesticide, there exists concern about documented fluvalinate residues persisting in beeswax comb. The EPA has approved only this one miticide for the control of varroa mites on honeybees. Thermotherapy is one of the very few effective alternatives available and as such offers an important tool to the beekeepers who are concerned about chemical residues in their hives.

Extrohive thermotherapy could provide a biotechnical alternative to the use of Fluvalinate in some apiaries. Application of fluvalinate is as follows: 2 strips/hive body x 2 bodies avg. per colony = 4 strips per application. Thermotherapy can reduce application of fluvalinate per hive by 100 percent.

As fluvalinate becomes less effective, some chemotherapies currently in use outside the US are likely to be approved for use by beekeepers in the US. When this happens, the use of thermotherapy as an alternative could reduce dependence on these pesticides. Among the proven chemotherapies currently in use against varroa mites outside the US are Folbex VA neu (bromopropylate), Perizin (coumaphos), Bayvarol (flumethrin), and the organic acid (oxalic, formic, lactic). Some plant oils and plant oil derivatives and biotechnical controls of limited efficiency are also described in the literature.

4.C. New Hypotheses

Heat therapy mode of action

Immediate reheating of caged bees did not seem to result in significant additional mite fall . In contrast another heat-treatment on another day did produce additional varroa mites,but at greatly reduced numbers, when performed on a few occasions with the same broodless colonies suggesting a mode of action involving behavior of bees and/or mites as they are brought from normal temperatures to the critical 45-50 degree Celsius range. Addressing this hypothesis could be the subject of another study.

By observation of more than two dozen heat-treatments performed in the course of this project it is clear that perhaps 5-20 percent of mites falling from the heat-treated bees and landing on the 50 degree plus catchment pan can be observed crawling around. Furthermore, heated mites salvaged by the coordinator and kept in a lidded plastic tub easily survived for more than 24 hours at room temperature. These mites immediately attached to new host bees introduced to the container of mites. To really determine the mode of action in this type of thermotherapy some questions might be posed as follows. What percentage of mites fall dead from the heated cluster of bees and in what condition are they? What exactly do bees do as they are heated? It seems they might react in such a way that the mites are involuntarily detached by the bees. This is in contrast to another hypothesis that the mites voluntarily abandon their stressed hosts.

5.Farmer Adoption and Direct Impact

A. Changes in Practice & C. Farmer Evaluations

At the time of this report, December 1998, this project has only just recently concluded. The beekeepers in the northeast who might alter their practices by adopting thermotherapy have not yet had a chance to implement heat therapy in their disease management program.

B. Operational Recommendations

It can be suggested based on the findings of this project that beekeepers who think they have sufficient labor to enable them to heat-treat, begin using this method as part of an IPM approach to honey bee mite control. Heat therapy would likely prove compatible with bee breeding for mite tolerance; sale of nucleus colonies and package bees; organic honey and wax production,

Now that varroa control requires avoiding post treatment re-infestation from other apiaries it is important for beekeepers to cooperate among themselves to treat at the same time or establish sufficient buffer distances between apiaries. For these same reasons part-timers and hobbyists who make up the majority of beekeepers need to find favorable sites and establish buffers or coordinate closely with neighboring beekeepers. Commercial beekeepers have always sought out favorable areas on which to locate their apiaries and it would behove some hobbyists and part-timers to do so. With these and other pressures on the beekeeper to find isolated sites he may do well to consider "economically marginal" areas which through trial an error may prove worthwhile.

Effectiveness of most methods of controlling Varroa can be improved by treating during broodless periods. In the course of this project more broodless periods were discovered than literature or anecdotal information had indicated.

6.Producer Involvement

Twelve beekeepers from VT and NH attended 2 workshops given by the coordinator at Patch Farm, Westminster West, VT during the summer of 1997. These workshops included a description of the heat-treatment apparatus and procedure with hands-on use of the apparatus. The coordinator will also give a presentation to members of the VT Beekeepers Association in Barre, VT on 27 January 1998. These beekeepers participated in a talk and discussion of the SARE project:, "Evaluating a heat-therapeutic control of the honeybee mite Varroa jacobsoni". This presentation involved a detailed description of the heat-treatment process and apparatus using a slide show and the actual heat-treatment apparatus.

7.Areas Needing Additional Study

Hypotheses described in section 4.C. might be appropriate to address in future projects(e.g. If heat-treated bees respond in such a way as to eject varroa, what other stimuli substances might cause this desirable bee behavior or physiological reaction?)

Current economic, agricultural and biological concerns of beekeepers are significantly altered from the WWII era when beekeeping in the US approached its peak and practices and mind-sets where widely established. Since the onset of the Varroa mite epidemic in the US in the late 1980's the following areas of apiculture regularly present a challenge to beekeepers' apiary management choices in the Northeastern US due to a need for more information and research.

Concerning heat therapy: what are the negative and positive effects of heat-treatment on disease transfer and fertility of queen bees. Do apiaries treated exclusively by heat for several years differ from other apiaries in terms of colony susceptibility to Acarapis woodi and minor parasites, American and European Foul Broods, nosema and viruses associated with Varroa infestations? What are the effects of humidity on effectiveness of heat therapy.

In what ways do mites spread from colony to colony and what is a minimum buffer distance between colonies for t he purpose of lessening the spread of varroa mites from untreated to treated colonies?

Pesticides sprayed on earth and leaves are not generally considered to affect honeybees significantly (e.g. Rotenone, Atrazine, Metolachlor). However bees have been observed collecting dew from a variety of surfaces other than flowers; many of these surfaces can easily be tainted with pesticides. It would be helpful to determine, for example, if herbicides sprayed on soil tilled for corn present a risk to bees that justifies placing colonies at a distance from pre-emergent herbicide applications.

APPENDIX B: GLOSSARY

Apiary- The yard or site where honeybee colonies are kept. Also used in a more general sense to connote a business or other activity dealing with honey production.

Brood- The area of *comb* where bees *cluster* and maintain conditions of humidity and temperature for raising young bees from eggs laid in the *cells* by the queen.

Cluster- bees move close together to form a mass, or *cluster*, on brood *comb*. This *clustering* behavior is crucial for incubating and tending *brood*. The *cluster* becomes more compact in cold weather.

Colony- a complex collectivity of honey bees, including one egg laying queen, workers and usually some males, called drones, and naturally ranging in population from about 8,000 to 80,000 individuals.

Comb- Bees secrete wax for use in the construction of hexagonal cells. The resulting vertically suspended *comb* consists of cells on both sides. *Comb* is used by the bees to store pollen, cure nectar and store honey. When the queen lays eggs in the cells the bees use that area to raise young bees and we call it *brood comb*.

Dearth- absence of wild or cultivated nectar and/or pollen *forage*, usually seasonal and differing from one agricultural region or ecosystem to another as well as according to fluctuating weather conditions.

Forage, Foraging Range- bee *forage* consists of a huge assortment of flowering plants including vegetable and fruit crops, trees and bushes which bees visit for *nectar* and/or *pollen*. Innate efficiency requires bees first fail to find sufficient food near the hive before travelling farther. Bees normally forage within a radius of about 2 miles but will range as far as 10 miles from the hive if required by scarcity of *forage*.

Frames- the movable wooden constructions made to fit 10 to each hive *body* and *super*, which act as moveable horizontal attachments to support the comb.

Hive Body or Brood Chamber- usually the tallest box(es), positioned beneath the *supers* in a *hive* and where most of the *brood* is likely to be found.

Hive- a structure of wood and metal parts, consisting of *hive bodies, supers, frames,* covers, etc. Sometimes refers to the structure complete with a *colony* of bees.

Nectar Flow (sometimes called honey flow)- *Nectar* is the sweet fluid produced in flowers to attract pollinating creatures such as bees. The *flow* refers to the time periods when the combined flowering of plants produces annual abundances of *nectar* and usually *pollen*. Nectar flows create, often dramatic, increases in hive activity as brood rearing is stimulated and food stores accumulated. The first nectar flows after long periods of *dearth* are crucial for building up *strength*. Subsequent nectar flows might allow *colonies* to produce a surplus of honey for human use.

Pollen- Pollen is a primary component of the food bees give to their larval young. Its availability stimulates brood production and as such constitutes an important aspect of early *nectar flows*. Different species and cultivars of plants provide bees with varying proportions of pollen to nectar(e.g. bees collect nectar but little pollen from alfalfa and exclusively pollen but not nectar from wind pollinated plants like corn and conifers).

Strength- determined by a *colony's cluster* size or population and its health and vigor.

Super(s)- the boxes which the apiculturist adds to the top of the *hive* as bees collect nectar during a *flow* and which naturally or with the use of a queen excluder does not contain brood.

APPENDIX C: LITERATURE

Caron, Dewey M. "Changes on the Farm." Am. Bee Jrnl. 135(June'95):384-385. A rare discussion of the future of organic beekeeping including US demographics.

Eischen, Frank. "Pesticide Resistant Biology." Am. Bee Jrnl. 136(Feb.'96):111 Describes the mechanisms of Varroa resistance to fluvalinate.

Eischen, Frank. "Varroa Hunting." Am. Bee Jrnl. 135(Oct.'95):682-684. Methods of counting and estimating mite populations in colonies of bees.

Fries, Ingemar and Henrik Hansen. "Biotechnical Control of Varroa Mites in Cold Climates." Am. Bee Jrnl. 133 (June 1993): 435-438. The study performed by the authors took advantage of the Varroa mite's preference for drone brood to trap Varroa and reduce mite populations in test colonies.This article refers to another study (Wallner 1992) which showed that fat soluble pesticides, such as fluvalinate, leave residues in wax which can contaminate honey.

Griffes, Jack. "Honey-bee Improvement Program" Am. Bee Jrnl.. 136(March'96): 203-205. Breeding for mite tolerance and fluvalinate resistance in Italy.

Harbo, John R. "Effect of Heat on Tracheal and Varroa Mites." Bee Science 3 (1994). In this article the researcher states that "heat is an important aspect of mite control".

Harbo, John R. "Evaluating Bees for Resistance to Varroa Mites" Am. Bee Jrnl. 133 (Dec.1993): 865. This study is significant to the proposed project in that 300 g bee samples were heated to 40 degrees Celsius for 48 hrs which removed all Varroa mites. This has implications for heat therapy as well as provides a method of counting Varroa in bee samples.

Harbo, John R. "Field and laboratory tests that associate heat with mortality of tracheal mites." Journal of Apicultural Research 32(3/4) (1993): 159-165. This study shows that hive temperature as determined by hive color and weather conditions can reduce tracheal mite populations but also reduced colony productivity..

Hoopingarner, Roger. "The time of Fall Treatment with Apistan and Winter Survival of Honey Bee Colonies." Am. Bee Jrnl..135(Aug.'95):535-536. Recommends treating for Varroa during broodless periods Mentions (research) that one mite on a bee in the summer will shorten the bee's life by 30%.

Hung, Akey C.F. "Bee Parasitic Mite Syndrome (II): the role of Varroa Mite and Viruses." Am. Bee Jrnl..135(Oct.'95):702-704. Crawling bees, queen supersedure, and other symptoms that seem a combination of EFB, AFB and sacbrood describe PMS syndrome. This article confirms the presence of several viruses in association with mites and infested bees.

Komissarov, A.D.. "Unit for Thermal Treatment of Varroasis [sic]." Pchelovodstvo No. 6 (1978): 5-8. Russian language article describing the technical aspects of an inexpensive cabinet type apparatus using hot plates to heat bees for 15 minutes @ 45-48°C., includes discussion of optional wiring and components.

Kulinncevic, J.M., Tommazin,F. "Thermo-Chemical Control of Varroa Jacobsoni with Minimal Application of Amitraz" European Research on Varroatosis Control: proceedings of a meeting of EC experts group/Bad Homburg Pub. A.A. Balkema, Rotterdam, Brookfield, 1988. This article refers to a 1982 study by Kommisarov called "Efficiency of Thermal Bee Treatment"which it reports determined a treatment of 45-48 ° C to be 50.2 -76% efficient.

McGregor, S.E.. Insect Pollination of Cultivated Crop Plants. Washington, DC:Agricultural, Research Service of the USDA, 1976. In addition to looking at the pollination needs of individual crops this noted apiculturist considers the benefits of bees and beekeeping to ecosystems and looks at pesticides in relation to beekeeping and pollination..

Rademacher, Eva. "How Varroa Mites Spread." Am. Bee Jrnl.. 131(Dec.'91):763-765. Explains that Varroa spreads easily between colonies in the same yard and between apiaries 2 kilometers apart; 15% of bees drift; recommends discouraging robbing.

Sammataro, Diana and Alphonse Avitable. The Beekeepers Handbook 2nd ed.. New York/London: Macmillan/Collier Macmillan Pub. 1986. Describes basic beekeeping practices including drift and robbing prevention.

Szabo, Tibor I.. "Brood Rearing in Outdoor Wintered Colonies." Am. Bee Jrnl. 133 (Aug.1993): 579-580. This study collected data on the number of bee brood cells occupied by pupae through the winter season and is useful in estimating the best time to heat treat.

Taber, Steve. "The Development of Resistance to Pests and Diseases in Bees." Am. Bee Jrnl. 134 (July 1994): 461-462. In this article a noted apiculturist and researcher identifies a need for breeding mite resistant bees and speculates that a control method which leaves a "residual population of mites for the bees to work with" could allow the bees to "develop some resistance to the mite".

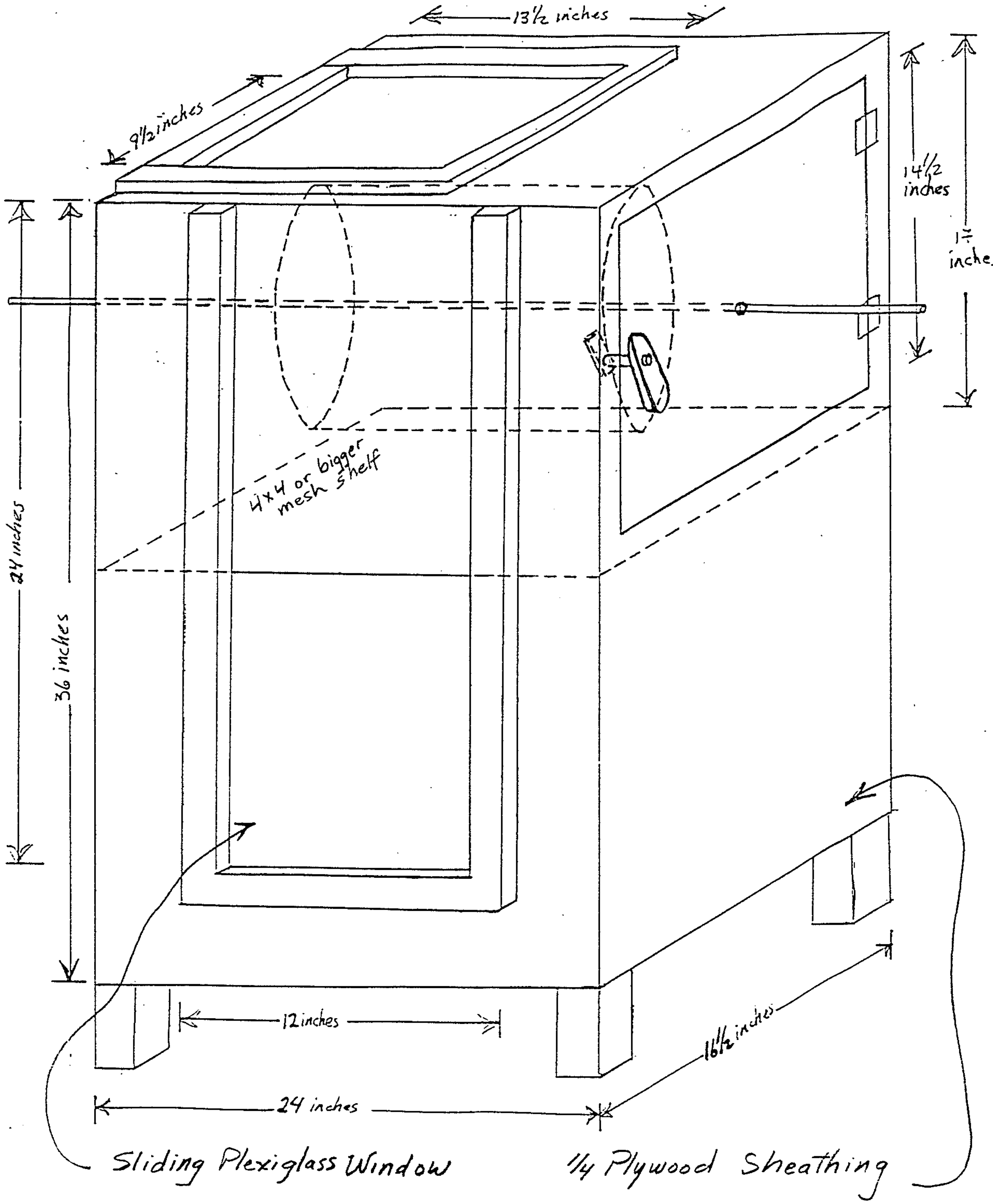
USDA. "Natural Products Show Promise for Controlling Tracheal and Varroa Mites." Am. Bee Jrnl. 135 (Aug.1995): 533-534. This article describes the possibilities for using natural plant extracts in the control of Varroa mites

USDA. "Diagnosis of Honeybee Diseases". Recommends a 70% isopropyl agitation bath to remove mites from a sample of bees. Alludes to DeJong et al 1982 where 1 minute shaking removes 90% and 30 minutes removes 100% of the mites in a sample of bees.

Wallner, Klaus. "The Use of and Their Influences on Quality of Bee Products." Am. Bee Jrnl. 135(Dec.'95):817-821. This article describes maximum allowable quantities of residue in wax, how residues are tracked around hive surfaces by bees, how bees relocate resources within the hive.

Webster, Kirk. "More thoughts on Mites, Queen Rearing and Stock Selection in the North East" Am. Bee Jrnl.. 133 (Jan. 1993): 55-56. This article recommends breeding for resistance and exploring all reasonable avenues of controlling mites.

Figure 1
Heat Treatment Apparatus: Dimensions of Cabinet with Cage in Place.



Project Report, December 1997, SARE number LNE96-66

TABLE 1 — 1996 HEAT TREATMENT EFFICIENCY STUDY

COLONY	Colony Size in Grams	lbs	Varroa Removed by Heat Treatment	Sticky Board Counts After One to Three Days	Dead Bees After One to Three Days	Varroa Removed by Control Treatment w/ Apistan	Total Varroa Mites Removed	Efficiency of Heat Treatments
I	906	1.99	2789	75	150	209	3073	90.76%
II	1133	2.49	1895	7	70	101	2003	94.61%
III	456	1.00	760	39	413	129	928	81.90%
IV	864	1.90	235	9	600	12	256	91.80%

1997 HEAT TREATMENT EFFICIENCY STUDY

COLONY	Colony Size in Grams	lbs	Varroa Removed by Heat Treatment	Sticky Board Counts After One to Three Days	Dead Bees After One to Three Days	Varroa Removed by Agitated Alcohol Bath*	Total Varroa Mites Removed	Efficiency of Heat Treatments
V	1420	3.13	234	2	2080	3	239	97.91%
VI	1498	3.30	346	5	1690	31	382	90.58%

*In the 1997 Efficiency Study the colonies were sacrificed and all remaining varroa removed and counted using a 70% Isopropyl bath agitated vigourously for 30 minutes (DeJong et al. 1982a as alluded to in USDA pub. Diagnosis of Honey Bee Diseases).

SARE project report December 1997, LNE96-66							
TABLE 2 SITE ENVIRONMENTS							
Sites Rated According to Four Criteria							
		Altitude	Progress of	Spring Brood	Average Spring	Actual Rating	Expected
Better		in Meters	Spring Thaw	Levels (frames)	Bee Weights in gr.	(Treated/Control)	Rating
	1	132 East	East	2.062 Hunt	.1364 Hunt	East (cntrl)	Hunt (cntrl)
	2	186 Hunt	Hunt	1.387 East	.1359 Wils	Hunt (cntrl)	East (cntrl)
	3	250 Wils	Wils	1.253 Marl	.1303 Litt	Wils (trtd)	Wils (trtd)
	4	342 litt	Litt	1.183 Maca	.1274 East	Litt (cntrl)	Hamm (trtd)
	5	360 Cool	Cool	1.1311 Wils	.1268 Hamm	Cool (trtd)	Cool (trtd)
	6	464 Maca	Maca	.761 Hamm	.1135 Cool	Marl (cntrl)	Marl (cntrl)
	7	480 Marl	Marl	.249 Cool	.0984 Marl	Maca (trtd)	Maca (trtd)
	8	486 Hamm	Hamm	.1700 Litt	.0928 Maca	Hamm (trtd)	Litt (cntrl)

TABLE 3 Sticky Board Varroa Mite Counts

SARE project LNE96-66, December 1997, final report

Yard Colony Name ID	Mites per Day	Mites per Day	Mites per Day	Mites per Day
	31July-12Aug.	13-23Aug.	24Aug.-10Sep	8-16Nov.
Hamm 8†	-	-	-	-
14	0.3846	1.1818	2.6111	0.8750
21	0.2308	1.1818	0.5000	0.2500
32	7.9231	6.5455	11.8889	0.7500
		13-23Aug.	24Aug.-14Sep	8-18Nov.
Wils 4†	-	-	-	-
12	0.2308	1.0000	2.3182	0.6364
16	0.1538	0.1818	1.9091	0.4545
30	0.7692	0.8182	6.4545	4.0000
	3-14Aug.	15-26Aug.	27Aug-8Sept	8-21Nov.
Maca 9	0.4167	0.0833	0.5385	0.1538
13	0.8333	0.5000	1.9231	0.6154
17†	-	-	-	-
31	0.0833	0.5000	2.0000	0.4615
	8-17Aug.	18-28Aug.	29Aug-12Sept	8-15Nov.
Cool 3	0.8000	1.6364	0.2000	0.3750
23	0.2000	0.0909	0.4667	0.8750
25	0.2000	0.9091	0.4667	1.5000
26	0.2000	0.7273	2.8000	0.6250
Treated Group	0.9558	1.1812	2.6213	0.8901
Control Group	12.2727	10.6932	15.3135	2.4303
	6-17Aug.	18-28Aug.	29Aug-9Sept	8-15Nov.
East 6	8.3333	34.6000	12.9167	1.0000
11	3.0000	11.9000	11.6667	1.5000
22	0.7500	2.3000	4.2500	0.3750
27	0.4167	1.5000	1.5833	0.5000
	3-14Aug.	15-28Aug	29Aug-8Sept	9-17Nov
Marl 2†	-	-	-	-
15	8.7500	14.3077	5.9091	1.6250
18	93.7500	45.2308	39.3636	4.1250
29†	-	-	-	-
Hunt 1	4.2727	6.1333	29.3636	9.0909
7	5.0000	2.0000	12.0909	1.4545
19	30.2727	10.8667	49.5455	8.9091
24	2.1818	2.8667	10.5455	2.0000
Litt 5	0.0909	0.0769	0.6154	0.2222
10	3.0909	1.9231	4.6923	0.7778
20	11.0000	11.6154	21.7692	2.1111
28	0.9091	4.3846	10.0769	0.3333

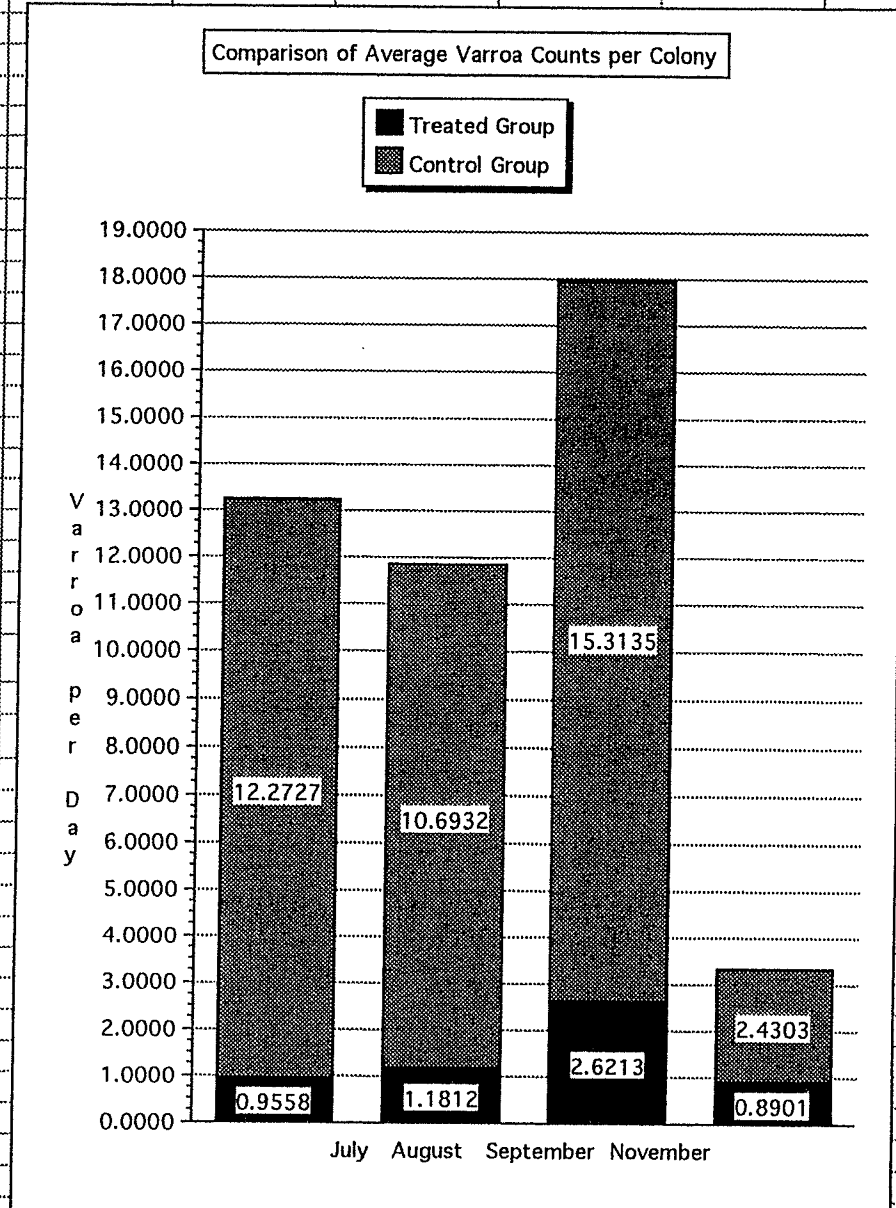


TABLE 4

Comparison of Honey Production** SARE Project Report December 1997, LNE96-66

Yard Name	Colony ID	Honey Production in Pounds *	Totals for Yards	Average Honey per Hive by Yard	Average Honey per Hive Treated Group	Average Honey per Hive Control Group
Heat Treated Group:						
Hamm	8†	-	130	43.33	58.54	77.5
	14	45				
	21	20				
	32	65				
Wils	4†	-	76	76.00		
(b.damage)	12	75				
	16	76				
(b.damage)	30	65				
Maca	9	5	140	46.67		
	13	60				
	17†	-				
	31	75				
Cool	3	90	240	80.00		
	23	55				
(b.damage)	25	35				
	26	95				
Control Group:						
East	6	105	395	98.75		
	11	110				
	22	80				
	27	100				
Marl	2†	-	130	65.00		
	15	55				
	18	75				
	29†	-				
Hunt	1	90	350	87.50		
	7	40				
	19	60				
	24	160				
Litt	5	30	210	52.50		
	10	75				
	20	50				
	28	55				

*harvested honey plus capped honey remaining in hive in October before feeding.

** Bear damaged hives probably produced less than they would without the damage; all bear damaged colonies were in the treated group.

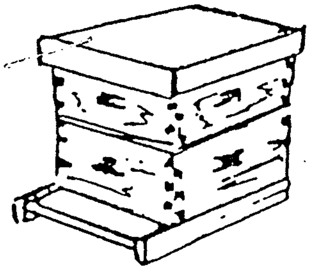
b. damage= bear damaged

SARE project final report, December 1997, LNE96-66

TABLE 5 HEAT TREATMENTwith VARROA COUNTS and VARROA SEEDING METHODS

Yard Name	Colony ID	Treatment Date 1997	Dead Bees in Hive after One Day	Ambient Temperature in Farenheit	No. of Bees in colony @ 121 grams ea.	No. of Varroa Removed	Varroa per 100 Bees	Sticky Board Total Mites Divided by Total Days	Varroa per 100 Bees by Alcohol/ Detergent Method by Yard* Pre-treatment (Sample Size)	Post Treatment (Sample Size)	Varroa Seeding Method Used** Autumn 1996
Hame	8†	-	-	40-43 F	-	-	-	-	.5319 (564)	0 (465)	ad + br
	14	5 April	250		6479	59	0.91	1.4400			br
	21	5 April	300		8562	151	1.76	0.5400			ad
	32	5 April	Normal		7289	38	0.52	7.9000			ad
Wils	4†	30 March	Normal	38-46 F	5074	222	4.38	-	1.7021 (235)	0 (456)	br
	12	30 March	Normal		6645	36	0.54	1.3585			ad + br
	16	30 March	Normal		5041	37	0.73	0.9623			ad
	30	30 March	Normal		3372	39	1.16	3.8679			ad
Maca	9	7 April	1000	35-41 F	7371	43	0.58	0.3000	2.0408 (245)	.2320 (431)	ad + br
	13	7 April	Normal		6239	7	0.11	0.9800			br
	17†	-	-		-	-	-	-			ad
	31	7 April	Normal		4562	49	1.07	0.7800			ad
Cool	3	28 March	Normal	42-50 F	5041	16	0.32	0.7273	.2202 (454)	0 (405)	br
	23	28 March	Normal		5174	12	0.23	0.3864			ad
	25	28 March	Normal		7537	35	0.46	0.7045			ad + br
	26	28 March	Normal		3868	44	1.14	1.2955			ad
East	6	Control	Control	Control	Control	Control	Control	14.5000	-	1.6330 (612)	ad + br
	11	Control	Control	Control	Control	Control	Control	7.3095			br
	22	Control	Control	Control	Control	Control	Control	2.0476			ad
	27	Control	Control	Control	Control	Control	Control	1.0238			ad
Marl	2†	-	-	-	-	-	-	-	-	0 (569)	br
	15	Control	Control	Control	Control	Control	Control	8.2000			ad
	18	Control	Control	Control	Control	Control	Control	48.4222			ad + br
	29†	-	-	-	-	-	-	-			ad
Hunt	1	Control	Control	Control	Control	Control	Control	11.7083	-	0 (630)	ad + br
	7	Control	Control	Control	Control	Control	Control	4.8750			br
	19	Control	Control	Control	Control	Control	Control	23.7292			ad
	24	Control	Control	Control	Control	Control	Control	4.2708			ad
Litt	5	Control	Control	Control	Control	Control	Control	0.2609	-	1.0183 (491)	ad + br
	10	Control	Control	Control	Control	Control	Control	2.7609			br
	20	Control	Control	Control	Control	Control	Control	12.4783			ad
	28	Control	Control	Control	Control	Control	Control	4.3696			ad

*Alch./ Detergent Varroa mite detection technique from DeJong, et al 1982 in USDA's "Diagnosis of Honey Bee Diseases" and Collison, et al's "equating Ether Roll Samples...". ** ad=adult bees; br=sealed brood comb with PMS symptoms



VERMONT BEEKEEPER'S ASSOCIATION
SPRING 1998 NEWSLETTER

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The Vermont Beekeeper's Association held its Winter Meeting on January 27, 1998 in Barre. Attendance was good this year with 50 or so people attending. Jeff Cunningham gave a very informative talk about using heat to control varroa mites. As usual, there was plenty of delicious food for all.

Listed below are the results of the 1998 Honey, and Honey Products Contest held at the Farm Show. Entries were up this year in the Honey category (28), and down in the Honey Products category (16), compared to last year. There were 5 rejections in the Honey contest due to non-glass jars, crystals and lint.

HONEY WINNERS

Class A - Comb Honey	George Babcock - Morrisville
Class B - Light Honey	Burton Knopp - Orwell
Class C - Amber Honey	Russell Devino - Richmond
Class D - Dark Honey	(No Entry)
Class E - Chunk Honey	(No Entry)
Class F - Creamed Honey	Russell Devino - Richmond

Best of Show - George Babcock

* * *