Overwintering of Russian honey bees in northeastern Iowa

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Summary

Colony survival, levels of tracheal mite infestation, worker population size and weight loss of colonies from Russian test lines were evaluated during three winters (2001, 2002 and 2003) in Cresco, Iowa. Overall, 90% of the colonies survived the period from November to April with all lines showing good survival. The percentage of bees infested with tracheal mites in most Russian colonies in August, November and April was below the economic threshold of 20%. Surviving Russian colonies had good populations at the end of each winter [cluster volumes at *ca.* 50ºF(10°C) averaging at least 750 cubic in (12 *liters*)]. Colony weight loss from November to April was on average less than 20 lbs. (9 kg). The use of a screened bottom board increased weight loss by 20% compared to a standard wooden bottom board while additional top insulation had no effect. Russian bees provide a viable alternative for beekeepers needing to overwinter colonies in northern states.

Keywords: *Apis mellifera, Acarapis woodi*, honey bees, survival, tracheal mites

Introduction

Tracheal mites have made overwintering of honey bee colonies more difficult in the United States and Canada. Until the middle of the 1980s, high colony survival (about 90%) was possible for colonies which were disease-free, had large populations of workers, had a productive queen, had adequate honey stores and were physically protected from rapid heat loss due to wind or extreme cold (Furgala and McCutcheon 1992). In those days, colony losses were generally caused by small populations of workers or by inadequate honey stores (e.g. Johansson and Johansson 1971). Since the arrival of tracheal mites, increased winter mortality has been associated with high levels of tracheal mite infestation in the autumn (Furgala *et al.* 1989, Otis and Scott-Dupree 1992, De Guzman *et al.* 2006).

Tracheal mite resistant stocks prevent mites from reaching harmful levels. Colonies resistant to tracheal mites have a much greater chance of successfully overwintering, especially if they have other characteristics such as frugal food consumption and good clustering ability. Honey bees imported from the territory of Primorsky in far-eastern Russia are highly resistant to tracheal mites (De Guzman *et al.* 2002) and have shown good overwintering attributes (De Guzman *et al.* 2006). Beekeepers in Primorsky report good survival of colonies through winter, especially when colonies are held in wintering barns. We report on the overwintering performance in northeastern Iowa during 2001, 2002 and 2003 of colonies from queen lines being tested in the USDA, ARS breeding program of Russian bees. The main aims of this program are to select for resistance to varroa mites and honey production. However, the program also selects between and within queen lines to maintain resistance to tracheal mites and overwintering ability. The objectives of these tests were:

1) To confirm that Russian bees can overwinter successfully without treatment for tracheal mites in climates where beekeepers tend to have large problems with tracheal mites.

2) To evaluate possible differences between Russian queen lines in their overwintering performance prior to their inclusion in the breeding program.

Materials and Methods

Test Queens – Queens in colonies placed into overwintering tests were produced in the spring of each of three years. Queens produced in 2001, 2002 and 2003 were from lines in blocks C, A, and B of the breeding program, respectively (Rinderer *et al.* 2000). Queens were mated each year with drones from groups A and B, B and C, and A and C, respectively. Additionally, queens from a standard Russian queen line ("White-Yellow/Blue" from block A) were used each year.

Colony Conditions – Colonies chosen for the wintering experiments met several criteria, as follows: (1) the presence of the original queen introduced in the spring had been verified in August or September, (2) they were treated in August with Apistan® to eliminate possible confounding effects of varied rates of varroa mite infestation, (3) they had worker bee populations which were adequate for successful overwintering in that area (bees occupying at least the equivalent of 6 standard Langstroth sized frames), (4) they were housed in two standard Langstroth boxes and had been fed high fructose corn syrup (three to five gallons, 11 to 19 *liters*) so that most of the top box was filled with feed and honey and the total hive weight was above 90 lbs.

Data Collection – Colonies were overwintered in the same one or two apiaries near Cresco, Howard County, Iowa. Samples of workers for dissection of tracheal mites were taken in August of two of the three years (2002 and 2003). Colony weight, cluster dimensions (length, width and depth) at 45 to 55°F(*ca* 7 to 13°C), and worker samples were taken in November of 2001, 2002 and 2003. Colonies were placed on a metal platform attached to a load cell (SP4-100, HBM Inc., Marlboro, MA) connected to electronic digital displays for monitoring of weights. Colonies were then fitted with three sheets of insulation board (R-10, Dow-Corning) over the inner cover, and covered with corrugated cardboard wraps (WT-150, Mann Lake Ltd., Hackensack, MN). The same cluster measurements and samples were taken in each colony in April after removing the winter wraps. Summary weather data from a station 20 mi SSE (KDEH, Decorah, Iowa) were used to assess the severity of the winter periods.

Winter 2001-2002 – In the fall of 2001, 49 colonies representing nine test lines, and the Russian standard line (W-Y/B) were set up in two apiaries. In this test, the possible value of screened bottom boards and additional top insulation [25 lbs. (11.3 kg) of dry oats in a screened box] also were evaluated. Beekeepers in the area had used this technique decades ago because of possible value for humidity control and insulation. Cluster dimensions of colonies were used to produce size classes to which random assignments were made of four treatments (combining either a standard bottom board or a screened bottom board with a standard cover or a screened rim with oats).

Winters 2002-2003 and 2003-2004 – In 2002 and 2003, fewer colonies with original queens were available after evaluations in the autumn. The emphasis of the tests changed to comparing possible differences between Russian queen lines. A few colonies with queens of Italian origin were also included these two years (two and three colonies, respectively). In 2002, 21 Russian colonies from six test lines and a standard line (W-Y/B) were established in one apiary with screened bottom boards. In 2003, four test lines, plus colonies from the standard line were replicated for a total of 16 colonies in one apiary. Due to smaller bee clusters in 2003, this experiment was conducted with standard bottom boards.

Statistical Analyses - The weight loss and final cluster volume of colonies surviving the winter of 2001-2002 were compared between treatments by analysis of covariance of a randomized block design with a factorial treatment arrangement of bottom board (screen vs. solid) and top insulation (addition of a layer of dry oats vs. the standard 3 layers of R-10 insulation board). Initial colony cluster volume was added as a covariate, and apiary was considered a random effect. Weight losses and final cluster volume in April for the two other winters (2002-2003 and 2003-2004) were analyzed as a completely randomized design with queen line as a fixed effect and initial cluster dimensions as a covariate.

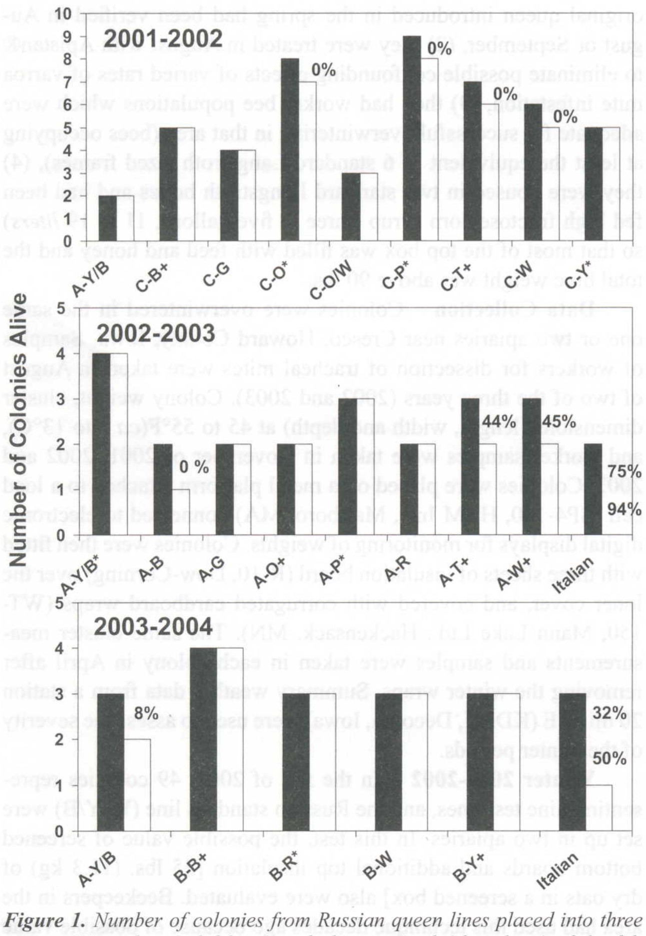

Figure 1. Number of colonies from Russian queen lines placed into three tests in November (solid bars) and alive in April (clear bars) of the following year. Eight out of 86 colonies of Russian origin died through the winter, while four out of five Italian origin hives died. Percentage of workers infested with tracheal mites in November is indicated in the position corresponding to death of a colony recorded in April. Russian queen lines are indicated by group and color code within group. Queen lines followed by an asterisk were maintained in the breeding program. Queen lines followed by a cross were removed from the breeding program.

Results and Discussion

Colony Survival and Tracheal Mite Infestation

The survival of Russian colonies ranged from 86 to 94% (Fig. 1) during three typical winters for the area. These survival rates were comparable to the 71 to 94% survival observed the previous two winters with Russian bees in the same apiaries (De Guzman *et al.* 2006). The survival of these Russian colonies matched the levels recorded in Minnesota for bees from different sources in the U.S. prior to the arrival of tracheal mites (Haydak 1958, Sugden and Furgala 1982, Duff and Furgala 1986, Sugden *et al.* 1988).

Most Russian colonies maintained negligible or very low levels of tracheal mites during the winter (Fig. 2). Colony mortality the first year was clearly associated with smaller colony sizes and not due to tracheal mites. The four Russian colonies that died had the smallest cluster volumes in November, and no detectable tracheal mites (Fig. 1). In contrast, the death of both Italian and Russian colonies during 2002 and 2003 were clearly associated with high tracheal mite loads in November: two of four Russian colonies that died those two winters and all four Italian colonies had more than 30 % of the bees infested prior to the wintering period (Fig. 1). Dead workers could be recovered from four of these six colonies at the end of the winter evaluation. From 90 to 100% of the recovered workers in each colony were infested with tracheal mites. Similar associations of high mite infestation with mortality had been found in Russian and Italian colonies in the same apiaries (DeGuzman *et al.* 2006).

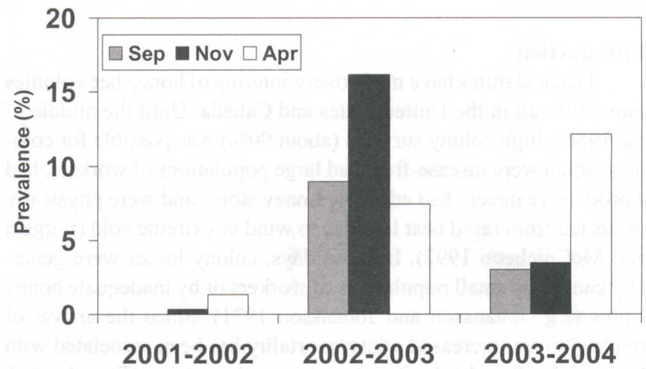

Figure 2. Average colony tracheal mite prevalence (percentage of bees infested in a colony) in Russian colonies during three overwintering seasons. No data was collected in August of 2001. Data in April include infestation of dead workers recovered from the eight colonies which died between November and April.

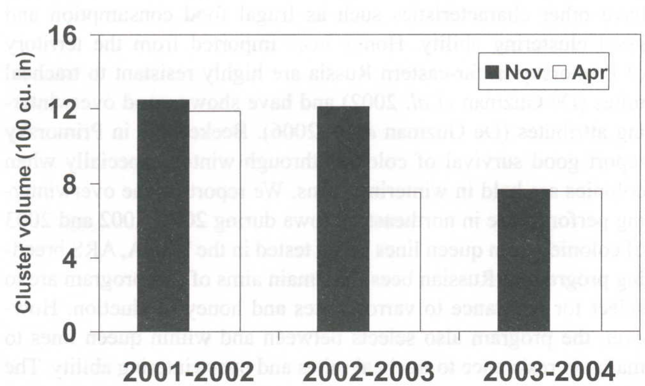

Figure 3. Average volume of the cluster (cubic inches) estimated in each Russian colony at temperatures from 45 to 55°F in November and April. Analysis of covariance for each year showed no differences between lines.

Colony Populations

Colonies which started the winter with low levels of tracheal mites and adequate populations, survived the most critical part of winter with good populations of bees (Fig. 3). Predictably, there were effects of the initial cluster volume in November on the final cluster volume in April (P=0.276, 0.007, 0.014 for 2002, 2003 and 2004 respectively). No significant differences between queen lines were found in the estimated final cluster volume in April (P= 0.66, 0.13, 0.46 for 2002, 2003 and 2004, respectively) when the initial volume in November was used as a covariate. Although Russian lines vary in other characteristics, they have similar good abilities to survive winter.

Colony Weight Loss

Weight loss per colony during the period from November to April averaged less than 20 lbs., 9 kg. (Fig. 4). De Guzman *et al.* (2006) found weight losses of Russian colonies in these same apiaries during the winter of 1999-2000 to be very low (about 9 lbs., 4 kg.), and found significantly higher weight losses in larger colonies of Italian origin (about 15 lbs. 7 kg.). Colony weight loss did not differ between Russian queen lines any of the three years (P=0.12, 0.97, 0.80 for weight loss through April 2002, 2003 and 2004, respectively), when initial colony volume was taken into account. Not surprisingly, a larger colony volume in November tended to increase weight loss (P=0.0013, 0.79, and 0.08 for 2002, 2003 and 2004, respectively). While we had no simultaneous comparisons with typical U.S. colonies of Italian origin, we have observed that Russian colonies tend to maintain lower populations during the winter. This attribute may prevent early starvation during the period of intense buildup in April and May, where honey stores and possible incoming resources are consumed at a very high rate (Furgala and McCutcheon, 1992).

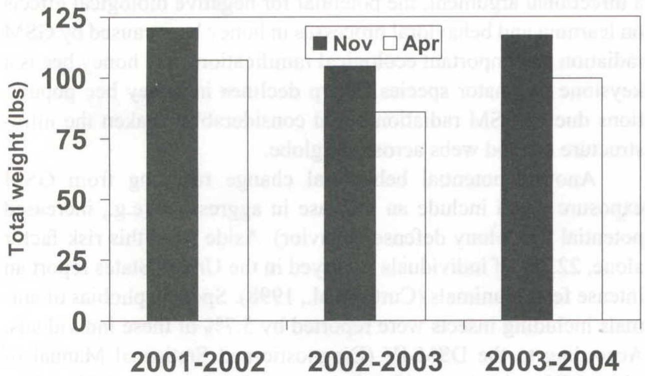

Figure 4. Average weights of Russian colonies (lbs) in November and April during three overwintering periods. Analysis of covariance showed no significant differences between lines in the weight losses each year.

Effect of Screened Bottom Boards and Additional Insulation

The test evaluating the benefits of extra top insulation [a layer of 25 lbs. (11.3 kg.) of dry oats above the hive] and of screened bottom boards did not show any clear colony survival advantage. The test did demonstrate that the screened bottom produced an increase in food consumption of about 20% (P=0.04, Fig. 5), but that the additional insulation from the layer of oats did not significantly decrease food consumption (P=0.37). There was no significant effect of the type of bottom board or of the extra insulation on the final cluster volume of bees in April (Fig. 5).

Conclusions and Recommendations

Russian colonies can survive well through the winter and are a valuable genetic resource for North America. Russian colonies tend to maintain tracheal mite levels below critical levels even through harsh winters, and this gives them an advantage in surviving winter periods with good populations for the spring buildup period. Additionally, Russian colonies use honey stores frugally during the overwintering period, decreasing the need for feeding in the spring.

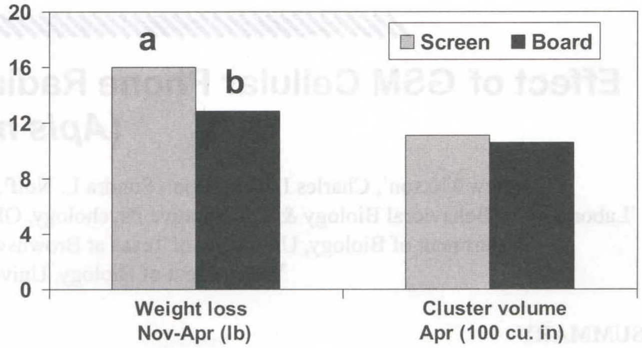

Figure 5. Weight loss and final cluster volume in April of 49 colonies overwintered in 2001-2002. Colonies were assigned either a screened bottom board or a regular bottom board, combined with either standard insulation from three sheets of insulation board (R10) or a screened box holding 25 lbs of dry oats below the standard insulation boards. Analysis of covariance indicated no effect of the extra insulation, so the data are summarized for the effects of screened vs. solid bottom boards only. Different letters above the bar indicate significantly different means (P<0.05).

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