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Drifting of Honeybees

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Drifting of Honeybees

BY
C. L. CORKINS

INTRODUCTION

The term "drifting," as applied to honeybees, means the change of residence of bees from one hive to another. Honeybees may not only drift from their parental home into another colony, but may move from their new home into some other hive.

Nature has provided, however, that this changing of the domicile of the honeybees may not go too far, else the balance of the colonies might suffer by complete freedom of emigration. It is recognized that each colony has its distinctive hive odor which is distinguishable by the bees. Likewise, each bee from a given hive, or the offspring of a given queen, has its peculiar individual odor. Guards are usually stationed at the entrance of each hive so that strangers in odor cannot readily gain admittance. In spite of this arrangement young bees often do enter the wrong colony. Furthermore, field bees carrying a load of provisions are thought to be welcome in any colony, should they by chance miss the location of their own hive.

REVIEW OF LITERATURE

The phenomenon of drifting of honeybees has long been recognized by apiculturists. Langstroth (1),* who has been termed the "father of modern commercial beekeeping" and who was one of the pioneers in North American beekeeping, says, "When several colonies are brought close together for shelter, there is danger of the bees drifting, i. e., the bees of the weaker colonies are attracted by the noise of the stronger ones, and, as their location has been changed, many of them are apt to go into the stronger colonies, thus weakening the already weaker ones." Of particular importance in this statement is the possibility of the flow of drift being greater from the weak colonies to the stronger colonies than vice versa, especially following a change of location.

*The numbers in parenthesis refer to citations at the end of this bulletin.
A. I. Root (2), who followed Langstroth as one of the great American authorities on beekeeping, writes, "Young bees in their play-flights, not thoroughly having learned the location of their homes, will drift to a hive or hives where many bees are flying strongest, and go in just as if it were their regular home. Even old bees, when all the hives are set out of the cellar, will frequently drift into the wrong hive. The colonies that are making the biggest hubbub in front of the entrance will attract flying bees from their weaker neighbors."

Phillips (3) discusses the prevention of drifting of bees during the spring, especially when they are taken out of cellar winter-quarters. He makes no reference to any possibility of serious drifting during any other season of the year, except when there is a change of location.

Kelty (4) calls attention to the fact of wind and its effect upon drifting. "Drifting is more prevalent during stiff winds in early spring and the bees always drift in the direction from which the wind is blowing, probably because they approach their hive headed into the wind."

King (5) carried on experiments to determine the percentage of drift, particularly, in order to determine its bearing upon the value of production records. His method was to mark newly emerged worker bees, introduce them to a given colony designated number 1, and determine the number of bees drifting into six other colonies in the row which had the entrances over four feet apart. He found that, "On the basis of 108 bees as the total of those which drifted, the percentage of drift from colony number 1 into colonies numbers 2 to 7 amounted to the following: 33.33%, 32.41%, 21.30%, 18.5%, 9.25%, and 1.85%, respectively." He, therefore, concludes that, "In practical apiary management the carefully kept production records of individual colonies apparently may be discounted because of conditions of which the beekeeper is unaware. The selection of choice breeding stock may be difficult or inaccurate for the same reason."
THE IMPORTANCE OF DRIFTING

Beekeepers, rather generally, have recognized the importance of drifting when the location of the colonies was changed. Drifting from such a cause has largely been prevented by moving the bees during the evening or night, in order that they might become accustomed to their new location gradually as they start the morning flight. Entrances are sometimes reduced or obstacles placed in front or over them to prevent the bees from coming out hurriedly without recognition of a change of location. Apiary sites are sometimes located with particular reference to an uneven terrain or variety in the landscape, which is thought to be helpful to the bees in finding their own hives.

On the other hand, little attention has been given to the possibilities of drifting once a yard of bees has been located for the season. The amount and characteristics of this seasonal drift within an apiary is highly important to three different classes of apiculturists.

First, the research worker may be greatly interested in the drifting of honeybees, particularly if his method includes records of production of individual colonies. If the percentage of drift is large and is unevenly distributed among the colonies in the apiary, the results are thereby vitiated. This type of an experiment has been conducted by this experiment station (6) in a comparative study of the Caucasian with the Italian race of honeybees. A knowledge of the drifting factor is desirable in any experiment having to do with individual colonies unless they are sufficiently isolated to eliminate the possibility of drifting.

Second, commercial queen breeders should base their selection of breeding queens primarily upon the honey production records of individual colonies. Perhaps other factors, such as color, size, and temperament, have been given undue consideration in selective breeding. At the present time, which is characterized by a low-priced honey market, the commercial beekeeper is largely interested in securing queens which will be, first of all, the mothers of superior bees in honey production. The alert commercial queen breeders are cognizant of this fact, and, consequently, are paying more at-
attention to individual production records as a basis of selective breeding. The reliability of these records is, therefore, of extreme importance.

Third, some commercial beekeepers, particularly of the northern states, are interested in the reliability of the honey production records of individual colonies. It seems very likely that the cost of honey production can be lowered more by systematic selective breeding and requeening by the commercial beekeeper than by any other one means. This practice has been gravely neglected by the majority of beekeepers. It has been the purpose of this experiment station to encourage this practice and make it more general. In so doing honey production records of individual colonies have been held to be the primary consideration. Unless seasonal drifting of honeybees in the apiary does make such records unreliable, the practice of selective breeding by the commercial honey producer should be further encouraged.

Because of the questions which have arisen upon seasonal drifting and its effect upon beekeeping practices, an intensive statistical study of this problem was begun in the spring of 1932. Unfortunately, due to circumstances outside the experiments, the study could be conducted for only 10 weeks. However, sufficient data are at hand to warrant their presentation at this time.

METHODS OF EXPERIMENTATION

In order to determine if bees have drifted into the wrong hive, there are two general methods of experimentation which may be used. The one is the marking of the bees and the counting of those which have drifted to the other colonies in the apiary, the counting being done without killing the bees in the hives. This method is open to certain objections. In the first place, it is uncertain just what effect the removal of bees, their marking and return to a given hive may have upon their sense of location. Secondly, it is difficult to locate and count all of the bees by examination of the colonies, unless all the bees of the hive are killed outright when they are all in their quarters. Thirdly, unless a given number of bees from each colony in the yard are marked and returned to their original home, there is no measure of the uniformity of the
flow of drift between all the colonies in the apiary. This point is important, for even if the amount of drift was large, its ill-effect upon the reliability of colony production records might be largely offset by a similar amount of drift between all the colonies of the apiary. Fourthly, it would be a stupendous task to obtain sufficient data by this method to permit of statistical analysis of their reliability.

The other method is the use of two different races of bees of distinctly different colors. In this experiment, Caucasians and Italians were used. The Caucasians were of the Rauchfuss strain and were uniformly dark gray in color. Each colony was headed by a select tested queen, which had been chosen for the uniformity of the color of the offspring. The Italians were of the Burleson strain and varied in color from three yellow bands to almost golden. With the exception of five packages which were received just prior to the beginning of the experiment, the Italian colonies were chosen out of the general apiary, with respect to the uniformity of the color of the bees. Of the six packages, two were later found to be hybridized.

**SAMPLING**

The method chosen to determine the drift between the two races of bees was that of taking a random sample and counting. In order that a statistical analysis might be made, 1,500 bees were taken in each sample. The samples were taken once weekly, except when sampling unduly weakened the colonies. In these samples, a total of 237,000 bees were taken and counted during the season.

In taking a sample the queen was located and temporarily removed from the hive. From four to six frames of bees, selected at random from the hive, were then shaken into a container. The samples were then removed by a dipper and placed in a cyanide jar. Two dipperfuls assured a sample containing at least 1,500 bees.

Such a weekly disruption of the colonies might add to the confusion and increase drifting. However, it was little if any more serious than the usual manipulation in a commercial apiary.
Perhaps the most serious objection to this method is the fact that the total drift cannot be accurately determined. For example, bees from a Caucasian colony theoretically are just as apt to enter another Caucasian colony as an Italian colony. This phase of the problem is discussed later.

Samples were taken in the morning, usually at 8 o'clock and never later than 9 o'clock. During the first half of the season, little flight activity had started before the samples were secured.

The total number of colonies entered in the experiment was 22. They were distributed in three different yards under three different sets of conditions.

The University Yard

The University yard was established on the campus of the University of Wyoming May 20, 1932. The apiary was located in an open area, where the wind had free sweep through the yard (figure 1). Five 2-pound Caucasian packages and five 2-pound Italian packages were used in making up the colonies. For two days prior to the establishment of this yard, the Italian packages
were in an apiary containing 21 colonies of Caucasians, which had been started from packages the previous week. In the University yard, these 10 colonies were sufficiently isolated so that there was no danger of drift from any other bees.

The 10 colonies were located in two rows of five each. In these rows, the Caucasians were alternated with the Italians. There were two feet between hives in the rows, and the two rows were three feet apart. The colonies in the two rows were staggered so that those in the front row were not in front of those in the rear.

The Caucasian colonies in this apiary were numbered U 1 to U 5, inclusive, and the Italian colonies were numbered U 6 to U 10, inclusive.

The Bosler Yard

The Bosler yard was established May 23, 1932, near Bosler, Wyoming. The location was on flat, open ground, protected only by low-growing brush (see figure 2). At the same time 60 other colonies of bees were placed in this small enclosure, divided equally as to Caucasians and Italians, with the Caucasians on the

Fig. 2. Bosler Apiary.
north and the Italians on the south of the row of colonies on the drifting experiment. The six colonies on the experiment, alternating with Caucasians and Italians, were placed in a row through the center of the yard, with fronts to backs of the hives, separated by three feet. With such a concentration of colonies in a small yard without a windbreak, it was thought that ideal conditions for maximum drift had been provided.

The colonies used for the drifting experiment in this yard were selected from the general University apiary. These colonies had been wintered in this apiary and were about equally divided as to the two races. Hence, they had been subjected to drifting in their original location prior to their removal to the Bosler yard.

The Caucasian colonies in this apiary were numbered B 1 to B 3, inclusive, and the Italian colonies were numbered B 4 to B 6, inclusive.

The Pahlow Yard

The Pahlow yard was established May 23, 1932, 11 miles southwest of the campus. Six colonies placed in a row side by
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side, three feet apart, were the only bees in this yard (see figure 3). The colonies were alternated with respect to the two races of bees. They were placed in front of a good windbreak which protected them from the prevailing winds. The conditions for drifting were less favorable in this yard than in either of the other two apiaries.

The origin of the colonies in this yard was the same as that of those in the Bosler yard. The Caucasian colonies were numbered P 1 to P 3, inclusive, and the Italian colonies were numbered P 4 to P 6, inclusive.

**Duration of the Experiment**

Sampling was started the week of May 23 and continued for 10 consecutive weeks, carrying the experiment until August 1. This gave an opportunity to study drifting during the various typical environmental conditions of the summer season. The dandelion honey flow, which was late, had just started at the beginning of the experiment. It lasted until the middle of June. During the third week in June there was a general dearth of nectar and the bees were robbing seriously. Although robbing ceased shortly thereafter, there was no great amount of nectar until the week of July 4. At that time yellow sweet clover came into bloom and the main honey flow had started. By the middle of July white sweet clover began to bloom. Thus, the experiment was continued into about three weeks of the best honey flow of the season.

**METHODS OF ANALYSIS OF THE DATA**

For the purpose of statistical analysis of the data, each sample of 1,500 bees was broken into 50 sub-samples of 30 bees each, and the percentage determined by counting. This method was used in order to obtain statistical measures of dispersion and reliability. From the data thus obtained, the mean percentage of drifting with its probable error and the standard deviation were computed from a frequency table. Thus, the possibilities of errors in sampling could be determined.

The size and number of sub-samples was as small as possible, consistent with permitting the application of the methods of
the statistics of large numbers to their analysis. Larger samples could not have been taken as frequently as once weekly without weakening the colonies too greatly.

The consolidation of the data for each week and for the season was made in the same manner as for each individual colony.

Comparison of Drift by Races

In order to determine if there was any significant difference in the drift of the Caucasian as compared to the Italian race of honeybees, the data for each of these races was analyzed separately. Comparisons were made by yards by weeks, and by all colonies in all yards by weeks.

The significant difference in the percentage of drift of these two races was computed as follows: The probable error of the difference of the two means was determined by the formula:

\[ P.E.\text{ diff.} = \sqrt{(P.E.\cdot m_1)^2 + (P.E.\cdot m_2)^2} \]

This P.E. difference then was multiplied by 4. This result was subtracted from the difference in \( M_1 \) and \( M_2 \). The remainder constituted the significant percentage of difference in drift between the two races.

This same procedure was used in comparing the difference in drift between the stronger and the weaker colonies.

The Relation of Intradrift to Interdrift

Two types of drift must be distinguished in the interpretation of the data. Drift from a colony of one race of bees to a colony of a different race of bees is termed “interdrift.” It is this interdrift which is determined from the samples. Drift from a colony of one race of bees to a colony of the same race of bees is termed “intradrift.” Intradrift cannot be determined from the samples by the method of experimentation here used. Theoretically, on the whole, it should be less than the amount of interdrift.

Seasonal History of the Colonies in Each Yard

A few of the original colonies in each group were removed, for one reason or another, and new colonies inserted in their places. The following notes indicate such changes. Colonies not mentioned remained in the experiment throughout the season.
University Yard

Colony U 6 became queenless May 23, and an overwintered colony from the general apiary was substituted in its place June 10. Colony U 2 became abnormally weak and was removed the week of July 4. Colony U 10 superseded its queen and was removed the week of July 4. Replacements were not made for these two colonies.

Bosler Yard

Colony B 5 was found to have American foulbrood on June 8. It was immediately replaced by an overwintered colony from the general apiary.

Pahlow Yard

On May 27, the first date of sampling, Colony P 4 was found to be badly hybridized. It was immediately replaced by an overwintered colony from the general apiary.

FLIGHT CONDITIONS AT TIME OF SAMPLING

For the most part, samples were taken when the bees were not flying generally. Samples were usually taken at 8 a.m. and never later than 9 a.m. During the first part of the season the nights were so cool or the weather so cloudy that up to and including the third week of June, there was little or no flight by the time the samples were secured. After that time, flight was general at the time of sampling in the various yards as follows:

University: June 28 and July 6, 18, and 26.
Bosler: June 22 and 29, and July 7, 13, 19, and 27.
Pahlow: July 1, 14, and 20.
SEASONAL WEATHER CONDITIONS

No attempt was made to study drifting in relation to weather. Temperature and wind conditions during the experiment are given in Table I in order to show the type of weather conditions under which the project was conducted. In general, the weather is cool and fairly windy in this territory.

TABLE I.
TEMPERATURE AND WIND CONDITIONS DURING EXPERIMENT
MONTHLY MEANS

<table>
<thead>
<tr>
<th>MONTH</th>
<th>TEMPERATURE °F</th>
<th>WIND</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Min.</td>
<td>Mean Max.</td>
</tr>
<tr>
<td>May</td>
<td>36.5</td>
<td>61.0</td>
</tr>
<tr>
<td>June</td>
<td>43.5</td>
<td>68.8</td>
</tr>
<tr>
<td>July</td>
<td>78.8</td>
<td>53.1</td>
</tr>
</tbody>
</table>

PRESENTATION OF DATA

Data from Individual Colonies

The complete record of every large sample taken of every colony is given in Table II. Blank spaces indicate that the colony was too weak for sampling, or, in a few cases, was dropped from the experiment.

The only colonies with a consistently high percentage of drift are U 8 and U 9. It was discovered that these bees were hybridized. This was not noted until after they had been in the yard so long that it seemed undesirable to remove and replace them with overwintered colonies. This hybridization was of Italian queens and resulted in the rearing of a certain amount of black bees in a colony which should have raised only yellow bees. These, of course, could not be differentiated from the Caucasian bees which drifted into these two colonies, and were counted as drifted bees.

For the most part, it is rather remarkable how little change there is in the percentage of drift in an individual colony from
### TABLE II.

**MEAN PERCENTAGE OF DRIFT FOR INDIVIDUAL COLONIES WITH PROBABILE ERROR OF MEAN BY WEEKS FROM THE FOURTH WEEK OF MAY TO THE LAST WEEK OF JULY**

<table>
<thead>
<tr>
<th>Colony No.</th>
<th>1st Week</th>
<th>2nd Week</th>
<th>3rd Week</th>
<th>4th Week</th>
<th>5th Week</th>
<th>6th Week</th>
<th>7th Week</th>
<th>8th Week</th>
<th>9th Week</th>
<th>10th Week</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>U 1</td>
<td>2.67±.23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.33±.24</td>
<td></td>
<td></td>
<td>1.53±.21</td>
<td>0.67±.16</td>
</tr>
<tr>
<td>U 2</td>
<td>2.67±.29</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.53±.26</td>
<td></td>
<td>6.13±.37</td>
<td>1.53±.16</td>
<td>1.00</td>
</tr>
<tr>
<td>U 3</td>
<td>2.27±.25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.53±.26</td>
<td></td>
<td>6.13±.37</td>
<td>1.53±.16</td>
</tr>
<tr>
<td>U 4</td>
<td>1.33±.21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.00</td>
</tr>
<tr>
<td>U 5</td>
<td>0.67±.13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.53</td>
</tr>
<tr>
<td>U 6</td>
<td>2.47±.24</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.40±.34</td>
<td></td>
<td></td>
<td>4.90</td>
</tr>
<tr>
<td>U 7</td>
<td>1.20±.15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.27</td>
</tr>
<tr>
<td>U 8</td>
<td>6.13±.44</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.80</td>
</tr>
<tr>
<td>U 9</td>
<td>3.40±.34</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6.33</td>
</tr>
<tr>
<td>U 10</td>
<td>5.09±.33</td>
<td>3.13±.29</td>
<td>2.00±.24</td>
<td>2.33±.26</td>
<td>2.53±.15</td>
<td>0.93±.16</td>
<td>0.20±.08</td>
<td>0.60±.14</td>
<td>1.00±.16</td>
<td>0.20±.08</td>
<td>3.06</td>
</tr>
<tr>
<td>B 1</td>
<td>0.07±.04</td>
<td>3.13±.29</td>
<td>2.00±.24</td>
<td>2.33±.26</td>
<td>2.53±.15</td>
<td>0.93±.16</td>
<td>0.20±.08</td>
<td>0.60±.14</td>
<td>1.00±.16</td>
<td>0.20±.08</td>
<td>3.13</td>
</tr>
<tr>
<td>B 2</td>
<td>0.80±.15</td>
<td>1.47±.19</td>
<td>2.20±.26</td>
<td>3.13±.27</td>
<td>2.87±.25</td>
<td>2.33±.26</td>
<td>0.53±.13</td>
<td>0.93±.16</td>
<td>0.67±.13</td>
<td>0.00±.00</td>
<td>3.13</td>
</tr>
<tr>
<td>B 3</td>
<td>8.32±.46</td>
<td>8.32±.46</td>
<td>8.32±.46</td>
<td>8.32±.46</td>
<td>8.32±.46</td>
<td>8.32±.46</td>
<td>8.32±.46</td>
<td>8.32±.46</td>
<td>8.32±.46</td>
<td>8.32±.46</td>
<td>9.33</td>
</tr>
<tr>
<td>B 4</td>
<td>0.80±.18</td>
<td>1.07±.18</td>
<td>0.67±.13</td>
<td>0.47±.11</td>
<td>1.27±.16</td>
<td>0.40±.13</td>
<td>0.53±.12</td>
<td>0.27±.09</td>
<td>0.60±.15</td>
<td>0.00±.00</td>
<td>1.27</td>
</tr>
<tr>
<td>B 5</td>
<td>8.73±.51</td>
<td>8.73±.51</td>
<td>8.73±.51</td>
<td>8.73±.51</td>
<td>8.73±.51</td>
<td>8.73±.51</td>
<td>8.73±.51</td>
<td>8.73±.51</td>
<td>8.73±.51</td>
<td>8.73±.51</td>
<td>8.00</td>
</tr>
<tr>
<td>B 6</td>
<td>0.20±.08</td>
<td>0.60±.14</td>
<td>0.67±.13</td>
<td>0.40±.12</td>
<td>1.07±.17</td>
<td>0.33±.10</td>
<td>0.27±.09</td>
<td>0.07±.04</td>
<td>0.73±.13</td>
<td>1.00</td>
<td></td>
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<tr>
<td>P 1</td>
<td>4.47±.33</td>
<td>2.53±.23</td>
<td>5.00±.31</td>
<td>3.87±.32</td>
<td>0.73±.15</td>
<td>0.47±.13</td>
<td>0.00±.00</td>
<td>0.20±.08</td>
<td>0.07±.04</td>
<td>0.53±.12</td>
<td>5.47</td>
</tr>
<tr>
<td>P 2</td>
<td>5.47±.28</td>
<td>5.47±.28</td>
<td>5.47±.28</td>
<td>5.47±.28</td>
<td>5.47±.28</td>
<td>5.47±.28</td>
<td>5.47±.28</td>
<td>5.47±.28</td>
<td>5.47±.28</td>
<td>5.47±.28</td>
<td>5.47</td>
</tr>
<tr>
<td>P 3</td>
<td>1.13±.16</td>
<td>0.13±.06</td>
<td>0.67±.14</td>
<td>0.80±.15</td>
<td>0.73±.15</td>
<td>0.07±.04</td>
<td>0.47±.11</td>
<td>0.73±.13</td>
<td>0.07±.04</td>
<td>0.29±.08</td>
<td>1.06</td>
</tr>
<tr>
<td>P 4</td>
<td>0.00±.00</td>
<td>0.20±.08</td>
<td>0.53±.12</td>
<td>0.40±.10</td>
<td>0.13±.06</td>
<td>0.00±.00</td>
<td>0.20±.08</td>
<td>0.13±.06</td>
<td>0.07±.04</td>
<td>0.09±.00</td>
<td>0.53</td>
</tr>
<tr>
<td>P 5</td>
<td>1.60±.21</td>
<td>2.07±.25</td>
<td>3.60±.28</td>
<td>2.73±.29</td>
<td>2.67±.24</td>
<td>0.40±.10</td>
<td>0.33±.09</td>
<td>0.50±.16</td>
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<td>1.53±.16</td>
<td>3.00</td>
</tr>
<tr>
<td>P 6</td>
<td>7.00±.43</td>
<td>5.40±.43</td>
<td>6.00±.44</td>
<td>1.27±.26</td>
<td>3.93±.18</td>
<td>2.93±.34</td>
<td>3.53±.29</td>
<td>1.80±.31</td>
<td>5.73</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
week to week. Some inconsistencies appear, but few of them are sufficiently larger than the probable error of their difference to be particularly significant. This indicates that the samples were large enough to give a true picture of the amount of drift.

**Composite Data**

The composite data of each yard and of all yards combined is presented in Table III. Perhaps the most striking feature of these data is the similarity of the amount of drift in the Bosler and the Pahlow apiaries. The yard at Bosler was crowded, with 66 colonies in a small space, and the colonies on the drifting experiment were in the center of the apiary. It was thought that this condition would make for the maximum opportunity for drifting. The reverse condition obtained in the Pahlow apiary. The mean seasonal drift in the Bosler yard was $1.78 \pm 0.04$ per cent. In the Pahlow yard it was $1.58 \pm 0.04$ per cent. The difference in these means is only 0.20 per cent, while 4 times the probable error of their difference is 0.22 per cent. In other words, there was no significant difference in the amount of drift for the entire season in these two apiaries.

The figures for the University yard are generally high, due largely to the two hybridized colonies.* It is likely that if these colonies had not been present there would not have been a significant difference in the amount of drift in any of the three apiaries.

In the Bosler and Pahlow yards there is a slight tendency towards less drifting during the last three or four weeks of the season. It is possible that the opening of the major honey flow in July affected this. However, insufficient data are available to establish this point.

The mean percentage of interdrift for all colonies in all yards during the entire season was $2.21 \pm 0.03$. This mean was derived from a frequency table of the percentage of drift in each small sample of 30 bees. There were 7,900 such samples counted during the season.

A little clearer idea of the problem of drifting is obtained from the mean of the weekly means of each colony. In determin-
<table>
<thead>
<tr>
<th>Yard</th>
<th>Measure</th>
<th>1st Week</th>
<th>2nd Week</th>
<th>3rd Week</th>
<th>4th Week</th>
<th>5th Week</th>
<th>6th Week</th>
<th>7th Week</th>
<th>8th Week</th>
<th>9th Week</th>
<th>10th Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>University</td>
<td>Mean with P.E.</td>
<td>2.87 ± .10</td>
<td></td>
<td></td>
<td></td>
<td>3.37 ± .15</td>
<td>2.92 ± .14</td>
<td>3.60 ± .16</td>
<td></td>
<td>3.97 ± .16</td>
<td>3.53 ± .16</td>
</tr>
<tr>
<td></td>
<td>Standard Deviation</td>
<td>3.31</td>
<td></td>
<td></td>
<td></td>
<td>4.43</td>
<td>4.28</td>
<td>4.64</td>
<td></td>
<td>4.70</td>
<td>4.63</td>
</tr>
<tr>
<td>Bosler</td>
<td>Mean with P.E.</td>
<td>2.61 ± .18</td>
<td>1.57 ± .11</td>
<td>2.28 ± .14</td>
<td>3.49 ± .17</td>
<td>3.24 ± .14</td>
<td>1.22 ± .08</td>
<td>0.69 ± .06</td>
<td>1.17 ± .09</td>
<td>1.00 ± .08</td>
<td>0.48 ± .06</td>
</tr>
<tr>
<td></td>
<td>Standard Deviation</td>
<td>4.50</td>
<td>2.38</td>
<td>3.16</td>
<td>4.36</td>
<td>3.68</td>
<td>2.09</td>
<td>1.60</td>
<td>2.32</td>
<td>2.17</td>
<td>1.53</td>
</tr>
<tr>
<td>Pahlow</td>
<td>Mean with P.E.</td>
<td>3.93 ± .16</td>
<td>1.18 ± .10</td>
<td>3.02 ± .14</td>
<td>2.64 ± .13</td>
<td>1.16 ± .08</td>
<td>2.20 ± .28</td>
<td></td>
<td>0.66 ± .07</td>
<td>0.66 ± .07</td>
<td>0.56 ± .06</td>
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<tr>
<td></td>
<td>Standard Deviation</td>
<td>3.85</td>
<td>2.11</td>
<td>3.51</td>
<td>3.27</td>
<td>1.96</td>
<td>2.95</td>
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<td>1.92</td>
<td>1.84</td>
<td>1.58</td>
</tr>
<tr>
<td>All Yards</td>
<td>Mean with P.E.</td>
<td>3.26 ± .08</td>
<td>1.37 ± .08</td>
<td>2.95 ± .09</td>
<td>3.07 ± .11</td>
<td>2.65 ± .08</td>
<td>1.73 ± .07</td>
<td>2.34 ± .10</td>
<td>0.91 ± .06</td>
<td>2.09 ± .08</td>
<td>1.72 ± .07</td>
</tr>
<tr>
<td></td>
<td>Standard Deviation</td>
<td>3.81</td>
<td>2.25</td>
<td>3.14</td>
<td>4.00</td>
<td>3.81</td>
<td>3.24</td>
<td>3.94</td>
<td>2.17</td>
<td>3.69</td>
<td>3.50</td>
</tr>
</tbody>
</table>
ing this mean, the means of the two hybridized colonies were excluded. This mean of means was $1.77 \pm 0.06$ per cent. The standard deviation was $1.01$ per cent. Thus, 94.5 per cent of all cases fall within a dispersion of $4.05$ per cent around a mean of $1.77 \pm 0.06$ per cent.

So, in addition to the fact that the percentage of drifting is very low, it is further reduced in its significance in the records of an apiary by the fact that such a small amount of dispersion of the differences of drift occurs among the various colonies.

*Comparative Drift of Caucasians with Italians*

A summary of the comparative drift between the Caucasian and the Italian colonies in the experiment is presented in Table I. Where the significant difference is followed by a — C or — I, it indicates a greater drift of the Caucasians or of the Italians, respectively.

In the University apiary, only, is any particularly significant difference in the drift of these two races of bees apparent. Here, again, the data are slightly distorted by the presence of the two hybridized colonies, as these would tend to increase the percentage of drift attributed to the Caucasian colonies. On the whole, it may be said that there is a very slight tendency shown by the Caucasians to drift more than the Italians.

Perhaps the most important fact shown by these data is the small amount of difference in the percentage of drifting in two different groups of colonies. It will be noted in the difference shown by all yards, when samples were not taken in the University apiary, that the two groups of colonies are remarkably similar. This, again, shows the degree of equality of drifting.

*Comparative Drift of Strong and Weak Colonies*

It seems to be the opinion of many writers that if the colonies in a yard are of unequal strength, the tendency is for the bees from the weaker colonies to drift more into the stronger colonies than *vice versa*. In order to determine the validity of this point, a comparative analysis of the data on drift of the weak and strong colonies in each yard was made.
<table>
<thead>
<tr>
<th>Yard</th>
<th>Measure</th>
<th>1st Week</th>
<th>2nd Week</th>
<th>3rd Week</th>
<th>4th Week</th>
<th>5th Week</th>
<th>6th Week</th>
<th>7th Week</th>
<th>8th Week</th>
<th>9th Week</th>
<th>10th Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>University</td>
<td>% Caucasian Drift or M₁</td>
<td>3.65 ± 0.16</td>
<td></td>
<td></td>
<td></td>
<td>5.17 ± 0.25</td>
<td>5.00 ± 0.24</td>
<td>5.67 ± 0.38</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>% Italian Drift or M₂</td>
<td>2.12 ± 0.11</td>
<td></td>
<td></td>
<td></td>
<td>1.58 ± 0.10</td>
<td>0.83 ± 0.09</td>
<td>1.42 ± 0.11</td>
<td></td>
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<td></td>
<td>Difference in M₁ and M₂</td>
<td>1.53</td>
<td></td>
<td></td>
<td></td>
<td>3.58</td>
<td>4.17</td>
<td>4.25</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>4 x P.E. Diff.</td>
<td>0.76</td>
<td></td>
<td></td>
<td></td>
<td>1.09</td>
<td>1.01</td>
<td>1.57</td>
<td></td>
<td></td>
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<tr>
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<td>Diff. M₁ and M₂−4 P.E. Diff.</td>
<td>0.77-C</td>
<td></td>
<td></td>
<td></td>
<td>2.49-C</td>
<td>3.16-C</td>
<td>2.68-C</td>
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<td></td>
</tr>
<tr>
<td>Bosler</td>
<td>% Caucasian Drift or M₁</td>
<td>3.36 ± 0.28</td>
<td>1.33 ± 0.09</td>
<td>0.67 ± 0.13</td>
<td>2.04 ± 0.14</td>
<td>3.13 ± 0.24</td>
<td>1.11 ± 0.11</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>% Italian Drift or M₂</td>
<td>2.00 ± 0.20</td>
<td>2.30 ± 0.18</td>
<td>3.36 ± 0.19</td>
<td>5.16 ± 0.28</td>
<td>3.29 ± 0.16</td>
<td>1.71 ± 0.13</td>
<td>0.27 ± 0.05</td>
<td>0.67 ± 0.08</td>
<td>0.60 ± 0.07</td>
<td>0.07 ± 0.03</td>
</tr>
<tr>
<td></td>
<td>Difference in M₁ and M₂</td>
<td>1.55</td>
<td>0.97</td>
<td>2.69</td>
<td>3.11</td>
<td>0.16</td>
<td>0.98</td>
<td>0.84</td>
<td>1.00</td>
<td>0.80</td>
<td>0.82</td>
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<td></td>
<td>4 x P.E. Diff.</td>
<td>1.36</td>
<td>0.82</td>
<td>0.50</td>
<td>1.24</td>
<td>1.16</td>
<td>0.65</td>
<td>0.49</td>
<td>0.71</td>
<td>0.67</td>
<td>0.46</td>
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<tr>
<td></td>
<td>Diff. M₁ and M₂−4 P.E. Diff.</td>
<td>0.19-C</td>
<td>0.15-I</td>
<td>2.19-I</td>
<td>1.87-I</td>
<td>0</td>
<td>0.33-I</td>
<td>0.35-C</td>
<td>0.29-C</td>
<td>0.13-C</td>
<td>0.36-C</td>
</tr>
<tr>
<td>Pahlow</td>
<td>% Caucasian Drift or M₁</td>
<td>4.30 ± 0.30</td>
<td>1.33 ± 0.14</td>
<td>3.07 ± 0.21</td>
<td>3.07 ± 0.22</td>
<td>1.67 ± 0.12</td>
<td>0.91 ± 0.11</td>
<td></td>
<td></td>
<td>0.16 ± 0.04</td>
<td>0.09 ± 0.03</td>
</tr>
<tr>
<td></td>
<td>% Italian Drift or M₂</td>
<td>3.69 ± 0.18</td>
<td>1.00 ± 0.14</td>
<td>2.98 ± 0.18</td>
<td>2.50 ± 0.15</td>
<td>0.64 ± 0.08</td>
<td>0.40 ± 0.06</td>
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<tr>
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<td>Difference in M₁ and M₂</td>
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<td>0.30</td>
<td>0.09</td>
<td>0.57</td>
<td>1.02</td>
<td>0.51</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>4 x P.E. Diff.</td>
<td>1.40</td>
<td>0.80</td>
<td>1.09</td>
<td>1.07</td>
<td>0.58</td>
<td>0.52</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diff. M₁ and M₂−4 P.E. Diff.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.44-C</td>
<td>0</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>All Yards</td>
<td>% Caucasian Drift or M₁</td>
<td>3.70 ± 0.13</td>
<td>1.08 ± 0.09</td>
<td>2.11 ± 0.14</td>
<td>2.22 ± 0.16</td>
<td>3.51 ± 0.14</td>
<td>2.49 ± 12</td>
<td>3.70 ± 18</td>
<td>1.41 ± 11</td>
<td>3.05 ± 13</td>
<td>2.77 ± 13</td>
</tr>
<tr>
<td></td>
<td>% Italian Drift or M₂</td>
<td>2.45 ± 0.09</td>
<td>1.67 ± 0.12</td>
<td>3.17 ± 0.13</td>
<td>3.58 ± 0.16</td>
<td>1.81 ± 0.07</td>
<td>0.97 ± 0.06</td>
<td>0.92 ± 0.07</td>
<td>0.41 ± 0.05</td>
<td>1.12 ± 0.07</td>
<td>0.62 ± 0.05</td>
</tr>
<tr>
<td></td>
<td>Difference in M₁ and M₂</td>
<td>1.24</td>
<td>0.58</td>
<td>1.06</td>
<td>1.36</td>
<td>1.69</td>
<td>1.53</td>
<td>2.77</td>
<td>1.00</td>
<td>1.93</td>
<td>2.15</td>
</tr>
<tr>
<td></td>
<td>4 x P.E. Diff.</td>
<td>.64</td>
<td>0.60</td>
<td>0.76</td>
<td>0.90</td>
<td>0.62</td>
<td>0.54</td>
<td>0.76</td>
<td>0.44</td>
<td>0.61</td>
<td>0.57</td>
</tr>
<tr>
<td></td>
<td>Diff. M₁ and M₂−4 P.E. Diff.</td>
<td>.60-C</td>
<td>0</td>
<td>0.30-I</td>
<td>0.46-I</td>
<td>1.07-C</td>
<td>0.99-C</td>
<td>2.02-C</td>
<td>0.56-C</td>
<td>1.33-C</td>
<td>1.61-C</td>
</tr>
</tbody>
</table>
University Yard

This yard was established with two-pound packages. Italian colony U 6 became queenless after the first week and was replaced by an overwintered colony which contained about three times as many bees as the packages. So the drift into this strong colony was compared with the drift into the four Caucasian colonies which were studied throughout the season. The Caucasian colonies were chosen for comparison because of the hybridization of two of the queens in the Italian packages.

The mean percentage of drift in the strong colony derived from the three samples taken over a seven weeks' period was 0.91±.10. The mean percentage of drift in the four Caucasian package colonies calculated from four samplings over an eight week's period was 1.53±.05. Four times P.E. diff.=0.45%. The significant difference in $M_1$ and $M_2$, therefore, was 0.16 per cent greater drift of the strong into the weak colonies.

Bosler Yard

In the Bosler yard the two strongest colonies were compared with the two weakest colonies. One Caucasian and one Italian colony was in each pair. The data from nine samplings over nine weeks were used. The mean percentage of drift into the two strongest colonies was 2.95±.06, and into the two weakest colonies it was 1.84±.08. The significant difference in drift was 0.70 per cent, being from the weak into the strong.

Pahlow Yard

This comparison in the Pahlow yard was made identically the same as that in the Bosler yard, except that two Italian colonies comprised the strong pair. The mean percentage of drift into the two weakest colonies was 3.07±.11, and into the two strongest colonies it was 1.14±.06. The significant difference in drift was 1.45 per cent, being from the strong into the weak.
Effect of Strength on Percentage

The comparative strength in bees of the colonies is not taken into consideration in this analysis. Bees going from a weak colony into a strong colony lose in percentage value, while bees going from a strong into a weak colony gain in percentage value of the whole. Thus the comparison here made is not entirely valid. However, in spite of this, the evidence does not support the opinion that the tendency of drift in an apiary is from the weak into the strong colonies.

SUMMARY AND CONCLUSIONS

1. The problem of drifting is important to research apiculturists, commercial queen breeders, and commercial beekeepers where records, particularly of production, of individual colonies are desired.

2. Little research work on the problem of drifting has been done. One worker, however, concludes that drifting vitiates honey production records of individual colonies.

3. The work here reported shows the percentage of inter-drift of 20 colonies of bees weekly by counting samples of 1,500 bees per colony. There were 237,000 bees counted over a period of 10 weeks. Interdrift, only, was determined by the use of two races of bees of different colors.

4. The mean percentage of drift of all colonies for the entire season was 2.21 ± 0.03. The mean of the means of each colony each week, excluding the data of the two hybridized colonies, was 1.77 ± 0.06%, with a standard deviation of only 1.01 per cent.

5. There was a slight tendency of the Caucasian race of bees to drift more than the Italian race of bees.

6. There was no indication of any significant difference in the tendency of weak colonies to drift more than strong colonies.

7. The crowding of a large number of colonies into a small yard did not tend to increase drifting.
8. The dispersion of the percentage drift of different colonies in the yard is small.

9. These data indicate that drifting does not vitiate the records of individual colonies in a yard. This is of particular importance in the reliability of individual colony honey production records.

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(4) Kelty, Russell H.

(5) King, George E.

(6) Corkins, C. L., and Gilbert, C. H.
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