MORPHOMETRICAL ANALYSIS AND TAXONOMETRICAL CLASSIFICATION OF HONEY BEES BY WING CHARACTERS

I. THE GENERAL DESCRIPTION

Description of the procedure

1. Wings are scanned.

2. XY co-ordinates of the following 19 points are measured on each wing of the complete wing set:

3. 30 wing characters are calculated on the basis of co-ordinates:

<table>
<thead>
<tr>
<th>ANGLE</th>
<th>points</th>
<th>ANGLE</th>
<th>points</th>
<th>LENGTH</th>
<th>points</th>
<th>INDEX</th>
<th>points</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>2;1;4</td>
<td>J10</td>
<td>6;9;10</td>
<td>Radial field</td>
<td>0;7</td>
<td>Cubital</td>
<td>2;4/1;2</td>
</tr>
<tr>
<td>A4</td>
<td>4;1;5</td>
<td>J16</td>
<td>8;9;18</td>
<td>A</td>
<td>2;4</td>
<td>Precubital</td>
<td>4;9/8;10</td>
</tr>
<tr>
<td>B3</td>
<td>1;4;3</td>
<td>K19</td>
<td>12;11;14</td>
<td>B</td>
<td>1;2</td>
<td>Dumb-bell</td>
<td>1;4/5;6</td>
</tr>
<tr>
<td>B4</td>
<td>1;4;5</td>
<td>L13</td>
<td>5;7;6</td>
<td>C</td>
<td>3;4</td>
<td>Radial</td>
<td>see p. 3</td>
</tr>
<tr>
<td>D7</td>
<td>4;3;13</td>
<td>M17</td>
<td>7;8;18</td>
<td>D</td>
<td>11;15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E9</td>
<td>6;5;10</td>
<td>N23</td>
<td>9;18;17</td>
<td>Inner length</td>
<td>1;14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G7</td>
<td>3;13;4</td>
<td>O26</td>
<td>15;14;16</td>
<td>Inner width</td>
<td>7;13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G18</td>
<td>12;13;14</td>
<td>Q21</td>
<td>11;16;17</td>
<td>Discoidal shift</td>
<td>see next picture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H12</td>
<td>11;10;12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Discoidal shift (in mm, or in degrees as angle)

Area6 (mm²) see p. 3
4. **DAWINO (Discriminant Analysis With Numerical Output)** results are computed on the basis of the above defined characters.

   The principle of the sample classification with the DAWINO method is that the computation compares the whole wings design with racial standards by including 30 wing characters.

   The computation runs similarly as by discriminant analysis. Centroids of each of races in standard is calculated from all 30 wing characters. Then the so called Mahalanobis distances are computed for tested sample between it and each race centroid. The sample is defined with greatest probability to that race which is most closed to, i.e. has shortest Mahalanobis distance to it and vice versa. Posterior Probabilities are computed on the basis of Mahalanobis Distances in the range 0 to 100 per cent. The sum of Posterior probabilities for all races in standard is 100.

   The **result of classification** is numeric data expressing the **similarity** (probability, in %) of the sample to a race in standard. High value for a race denotes that the sample belongs to that race, and vice versa. The probabilities of belonging to other races are summed and labeled "Other". (See protocol, first page below.)

**Pictures of 30 wing characters**

Notice: Abbreviations on the second lines are also used in tables in the protocol.
Angle L13 abbrev. L13
Angle M17 abbrev. M17
Angle N23 abbrev. N23

Angle O26 abbrev. O26
Angle Q21 abbrev. Q21
Radial field abbrev. Radial f.

Length A abbrev. Len. A
Length B abbrev. Len. B
Length C abbrev. Len. C

Length D abbrev. Len. D
Inner wing length abbrev. Inn. len.
Inner wing width abbrev. Inn. wid.

Discoidal shift abbrev. Disc. sh.
Cubital index abbrev. Ci
Precubital index abbrev. Pci

Dumb-bell index abbrev. Dbi
Radial index abbrev. Ri
Area of 6 fields abbrev. Area6
II. PREPARATION OF WING SAMPLES

Collecting bees:
1. In case of collecting samples in the season (preferably):
   Catch 30 young bees from a hive which are sure to originate from the colony (they have not flown yet), but no just after hatching from brood cells (their wings are still soft) and put them into a cage. Kill bees in a refrigerator. Then dry them.
2. In case of collecting samples in winter:
   Collect 30 dry, clear (!) and not injured dead bees from the hive bottom board or catch live bees in the winter cluster. Put dead bees into a cage or small box or kill live bees as in case Nr. 1.

Preparing samples:
Tear out right-sided forewing from each dead bee from the body by holding it between two fingers as they may not broken. Insert wings from one hive together into a small bag for they could not rumple, close the bag and label with a unique number, beekeepers’ name and/or address.

Sending samples:
Pack a few samples into envelope between two durable papers for the wings could not be deformed (important!) and send to:

*Bee Breeding Stn.,
P.O.Box 10,
CZ 756 54 ZUBRI 909,
Czech Republic

Contacts for other information:
Dipl. Ing. Kvetoslav Cermak PhD  Dr. Frantisek Kaspar
P.O.Box 10  Bee breeding Stn. Pekarov
CZ 756 54 ZUBRI  CZ 788 23 JINDRICHOV
Czech Republic  Czech Republic
E-mail: beestn.zubri@quick.cz  E-mail: beepk@iol.cz

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(Dipl. Ing. Dalibor Titera PhD)