Semi-Automated Measuring Capped Brood Areas of Honey Bee Colonies

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Abstract: The most important criteria on scientific studies at honeybee colonies are colony population development. A commonly used division is to estimate capped and uncapped brood areas. At this point of view, it is important to measure brood area in colony beside frame of bees. Brood area that contained eggs, larvae, and pupae on the combs in each bee colony has been measured as its size. Assessing a whole colony for strength provides a very good snapshot in time of colony size, brood production and food status. The estimation technique may take a bit of getting used to, but with experience it can be done quickly and accurately. To estimate the total area of capped worker brood cells in the colony can be used usually a 1 x 1 inch wire grid placed over the brood comb to estimate the total square inches of brood for each side of the comb. Another alternative method is digital photography. Measurements of worker brood area are determined by measuring sealed brood to the nearest cm^2 using *Adobe Photoshop® CS2 9.0.* This method based on estimating capped and uncapped brood. Colonies with new comb produced a greater area (cm^2) of brood, a greater area (cm^2) of sealed brood.

Key words: Honey bee, brood area, Adobe Photoshop® CS2 9.0

INTRODUCTION

In Langstroth hives each frame which is mainly brood (usually with some pollen and nectar or honey in the upper corners) is called a brood frame. This might be in square inches of sealed brood, square inches of total brood (eggs, larvae, and pupae).

To estimate the brood amount is measured using a wire grid frame to be placed against each comb containing brood and counting the number of wire squares containing open and capped brood. The total area of sealed brood in each colony is measured by placing a piece of clear Plexiglas ?with an inscribed 5x5 cm grid over each brood frame in the colony and counting the number of cm2 of sealed brood on both sides of the frames. The number of cells containing sealed brood was determined for a subset of 12 hygienic and 12 Star line colonies (three colonies of each type were randomly selected from each apiary) by counting square centimeters of brood using a wire grid sectioned into 5 by 5-cm squares[1]. In previous studies the size of the colonies the surface of sealed brood was measured by using one-sixth of a Dadant-Blatt frame (188 cm^2) as a unit of measure[2,3].

Step by step measure of brood area
Step 1: The digital camera is set up onto the stand so that it is firmly held by the mounting bolt and oriented directly towards the hive frame holder. The frame to assure the comb is supposed to be fully in the picture. The picture has been taken by focusing the camera. The frame holder is rotated so that the other side of the frame can be photographed; the hive frame is squared in the camera image area and takes the picture. When the first frame is done, that frame is removed, replaced it in the hive, and continued to the next frame show in Fig. 1.

Step 2: The image is analyzed from the digital camera using Adobe Photoshop CS2 9.0 on a PC platform. Selected image is cropped using cropping tool in the main menu bar (Fig. 2) so that only the comb (the area of interest is inside the wooden hive frame borders) remains in the image. Left mouse button is used and hold down while dragging the tool across the image to the opposite corner of the area to be crop the image. Once the cropping area is defined, enter button is used to see the cropped image. In case of any mistake, Control + z can use to back to the last step.

Step 3: First, to eliminate unwanted parts of the image (e.g., bees, honeycomb, pollen cells, holes, etc.) go to the main tool bar and into the Brush Tool. Before beginning the use of the brush tool, ensure that the paint colors to be used will be black. With the mouse, moves the cursor into the areas that need removing (e.g., overtop of a bee). Secondly, to paint capped brood area of the honeycomb go into the tool bar and select the Rectangular Marquee Tool that is the top left tool in the main tool bar. Select the paint packet tool, and using a

pure white (#FFFFFF) color draws selected Capped Brood (*Tip press and hold control + and control-to zoom in and out, also press and hold the spacebar to move image). With the marching ants area still selected, type the number 50 into the Tolerance window at the top of the Photoshop screen (just below the Select menu item). This value of 50 is an arbitrary number found to work in these image analyses

Step 4: The next step is to make black uncapped brood area in the image (Fig. 3). To do that, go to the Image > Adjust > Channel mixer function in the top menu of Photoshop. Check Monochrome and bring the Constant level down to -80% (or just enough so you can only visually see only your Capped Brood in white).

Step 5: The following step is to m ake the image black and white. To do this step, go to the Image > Adjust > Threshold function in the top menu of Photoshop (shown below in Fig. 4). The Threshold function leaves the image with only black and white pixels. I found that threshold setting 50 serves well but user can also determine threshold setting to get the best results.
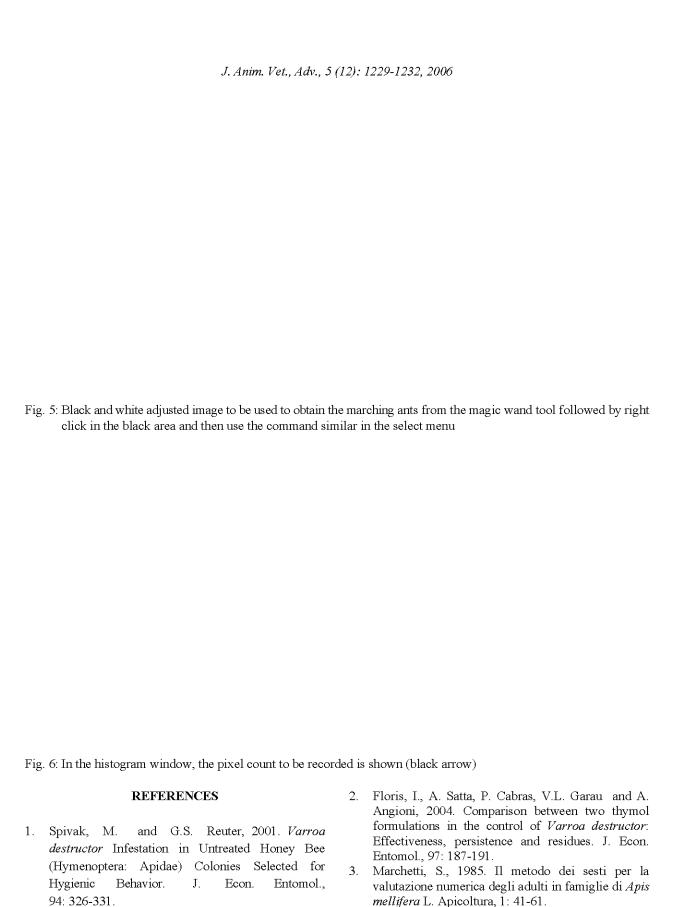
Step 6: The magic wand tool (shown below in Fig. 5) from the main tool bar is selected and with the left button of the mouse inside one of the black cells that are fully enclosed with white comb. The main goal is to have Photoshop® select all the black pixels without selecting any of the white ones. With the marching ants area is selected, type the number 135 into the Tolerance window at the top of the Photoshop screen. The Similar function with right click is applied anywhere on the black color. This function represents all uncapped cells.

Step 7: To calculate the number of pixels go to Window-Histogram Fig. 6. At the window of Histogram, Channel is activated to Luminosity. The number of pixels that represent capped brood (a) and (b) the number of pixels that are enclosed by the entire image (b). First pixel number is recorded after using magic wand tool and similar with right click (e.g., 132011). To record second pixel number, press Control+D. In this example pixel number is 311465. The amount of capped brood can be calculated as a percentage (c) of the entire hive frame (c = a/b x 100%), or the area of capped brood can be determined as a centimeter square, D (cm^2) (D = c x area of entire hive comb within wooden frame).

Step 8. Recorded two pixel numbers are calculated as mentioned above. For this example, 132011 pixels /311465 pixels gives us a value of 42.4% uncapped cells in this frame. The value of 57.6% is found as capped cells.

Fig. 4: The outline of the cells and capped brood should appear white, while the empty or uncapped brood and unanalyzed areas of the hive frame should appear black using threshold command and values

Fig. 5: Black and white adjusted image to be used to obtain the marching ants from the magic wand tool followed by right click in the black area and then use the command similar in the select menu

Fig. 6: In the histogram window, the pixel count to be recorded is shown (black arrow)

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