Revision of the sporograph method of E. J. H. Corner

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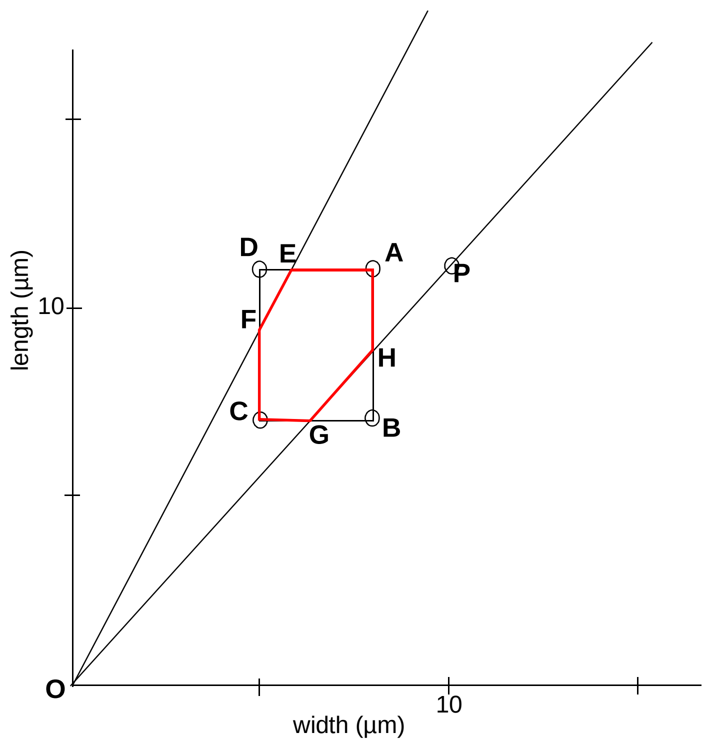
The fundamental idea is to provide a simultaneous graphical representation of spore size and shape ranges. For this purpose, six data are required: the fifth percentile (5%-ile) and 95^{th} percentile (95%-ile) of length, the 5%-ile and 95%-ile of width, and the 5%-ile and 95%-ile of Q.

Length and width are only measured for spores appearing in lateral view (i.e., only when both ends of a spore are in focus simulataneously and the apiculus is also clearly and distinctly observable, not significantly rotated up or down from the focal plane). Q is a computed value; for each spore measured, Q is the length:width ratio of the spore. Q is always greater than 1.0.

In the most common case, a sporograph for a given species is a hexagon bounded by six clearly defined lines. The places where these six lines intersect and the vertices of the hexagon. In developing an algorithm for automatically drawing this hexagon, we will use only simple elements of Algebra and Geometry. We will plot the hexagon in the first quadrant of a graph with y- and x-axes intersecting at the point (0,0). The y-axis will represent length (µm) and the x-axis will represent width (µm). The two Q values of interest will be represented by two lines the slope (m) of the first will be the 5%-ile value of Q; the second, the 95%-ile value of Q.

First let's see how we would place this data on a first quadrant graph, shown at right. Remember that we need six values; we give them names as follows:



x_1 = the 5%-ile value of spore width from our data

x_2 = the 95%-ile value of spore width from our data

y_1 = the 5%-ile value of spore length from our data

y_2 = the 95%-ile value of spore length from our data

m_1 = the 5%-ile value of Q from our data

m_2 = the 95%-ile value of Q from our data

In our example, we will use imaginary values as follows: x_1 = 5 µm; x_2 = 8 µm; y_1 = 7 µm; y_2 = 11 µm; m_1 = 1.14; m_2 = 1.90. [The range of Q is very unrealistic for a species of *Amanita*.]. The first thing to notice is that if the diagram were not further limited by the values of Q, we could end up with a rectangle with vertices A, B, C, and D in the figure above. Because each pair of points determines a unique line, the four sides of the rectangle are segments of the lines, AB, BC, CD, and DA.

To draw the two remaining lines is not difficult. First of all, both will pass through the origin (0,0). In such a case, the slope of a line is the value such that for every point on that line the y coordinate value for that point divided by the x coordinate value for the point is equal to that number. [Note: The lowest possible value for a slope is 1.0, which is the slope of a line that forms a 45 degree angle with the x-axis in the first quadrant of the plan—the geometric location of our figure.] That information and the knowledge of the slopes of the lines allows them to be drawn. For example, by definition of slope, the line with slope m_1 is the unique line passing through (0,0) and (10, m_1×1.14) or (10,11.4). Call the origin O and this line OP. In a similar manner, we can draw the line with slope of 1.90; it will pass through O and the point (10,19), which is outside are figure; however, it will also pass through the point (5,9.5), which we'll call F in our diagram—in fact, the line with slope 1.90 passes through any point with coordinates of the form (x,1.90×x). Now we have our hexagon: AHGCFE, which is traced in red in the figure. And that's how you can draw a sporograph by hand or a computer drafting tool

When you draw the figure by hand, you can just draw the lines; and if they "miss" the original rectangle, then you won't get a hexagon, and that's that.

But if you're using a graphic tool that asks you to specify all the vertices of the figure you want drawn, how will you know if there are four, five, or six vertices? Moreover, what are their coordinates. This is not a big problem; in fact, we've already touched on the answer.

What could go wrong with the production of a final hexagon? The answer is that one or both of the lines determined by values of Q could "miss" the original rectangle altogether—the value of Q might not be a contributing factor in terms of the polygon that we are constructing. But we can define this situation very clearly in terms of computing coordinates for the final polygon. Consider the two vertices of our original rectangle that are <u>not</u> vertices of the final figure that we just drew—points B and D. When will either of them become part of the final polygon? Recall that the coordinates for B in the general case are (x_2,y_1). Note that the line passing through this point has the slope y_1/x_2. The point B will be in the final diagram if and only if m_1 is less than or equal to y_1/x_2. Otherwise, the above construction is used.

In the case of point D, it will be a vertex of the final figure if and only if m_2 is greater than or equal to y_2/x_1.

So now we know the precise conditions under which B and/or D will be vertices of the final figure.

At this point we know the coordinates of A, B, C, and D—namely, (x_2,y_2), (x_2,y_1), (x_1, y_1), and (x_1,y_2).

We also have some clues about the coordinates of E, F, G, and H. We know one coordinate for each. Let's write what we know in the following way (p,y_2), (q,x_1), (r,y_1), and (x_2,s).

Then we apply what we know about points that lie on the lines determined by m_1 and m_2:Point E is on the line with slope m_2, and its y-coordinate is y_2. Then $m_2 = y_2/p$, and $p = y_2/m_2$. In a similar manner, we can compute the values of q, r, and s.

In summary no matter which points may be chosen in the end, the formulae for coordinates of those points are as provided in the following table:

vertex	formula
A	(x_2,y_2)
B	(x_2,y_1)
C	(x_1, y_1)
D	(x_1,y_2).
E	(y_2/m_2,y_2)
F	(x_1,$m_2 \times x_1$)
G	(y_1/m_1,y_1)
H	(x_2,$m_1 \times x_2$)