The equation of the egg oval

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Abstract

Bird eggs can be found in a lot of different forms in nature, but the intuitive idea of the egg oval is more narrow. Here, a simple and flexible formula, which to a high degree agrees with both the natural shape of an egg oval and an abstract idea of the egg shape, is presented.

1   The formula

Several equations for the egg shape have been proposed, many with astounding complexity (Narushin et al., 2021; Shi et al., 2022). A very simple formula for the egg oval is here presented in a two-dimensional version. It constitutes a three-dimensional egg when it is rotated around the y-axis (for parameter definitions, see also figure 1):

$$y = \frac{p \cdot b}{p - b} \left(\left(\frac{p}{b} \right)^{\pm \left(1 - \left(\frac{\pm 2x}{w} \right)^{\frac{1}{s}} \right)^{s}} - 1 \right) \ .$$

where

- w is the greatest width of the egg,

- b is the length of the blunt part of the egg,

- p is the length of the pointed part of the egg, and

- s is a measure of how sharp or rounded the egg is (with $s = \frac{1}{2}$ denoting elliptic form and $s > \frac{1}{2}$ meaning a more sharp form).

Unfortunately, this model does not fit eggs with the most prominent "polar asymmetry" (Biggins et al., 2018), e.g. guillemot eggs, and, therefore, further elaboration is required before the a modified version hopefully can reach general applicability.

For ellipsoidal forms of eggs, where $s = \frac{1}{2}$, the formula simplifies to

$$y = \frac{p \cdot b}{p - b} \left(\left(\frac{p}{b} \right)^{\pm \sqrt{1 - \left(\frac{2x}{w} \right)^2}} - 1 \right) \ .$$
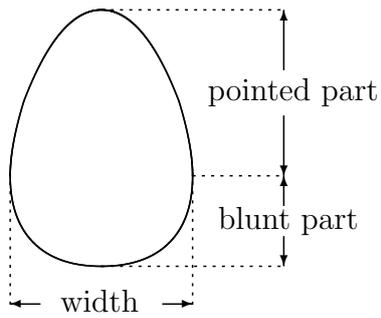
Figure 1: Basic parameters of the egg

References

Biggins, J. D., Thompson, J. E., & Birkhead, T. R. (2018). Accurately quantifying the shape of birds eggs. *Ecology and Evolution*, 8, 9728–9738.

Narushin, V. G., Romanov, M. N., & Griffin, D. K. (2021). Egg and math: introducing a universal formula for egg shape. *Annals of the New York Academy of Sciences*, 150 5, 169–177.

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