

Ecological Archives E088-196-A1

Christophe Bonenfant, Jean-Michel Gaillard, Stéphane Dray, Anne Loison, Manuela Royer, and Daniel Chessel. 2007. Testing sexual segregation and aggregation: Old ways are best. *Ecology* 88:3202–3208.

Appendix A. Link between the sexual segregation and aggregation statistic (SSAS) and the segregation coefficient (SC).

APPENDIX A

LINK BETWEEN SSAS AND SC

The data consist of N individuals (X males and Y females) distributed in k groups. There are N_i individuals in the i -th group: X_i males and Y_i females. Data are organised in a 2 by k contingency table. The traditional χ^2 statistic computed on this contingency table is given by:

$$\mathbf{X}^2 = \sum_{i=1}^k \left(\frac{(X_i - X N_i/N)^2}{X N_i/N} + \frac{(Y_i - Y N_i/N)^2}{Y N_i/N} \right)$$

We can then develop this equation as follows:

$$\begin{aligned} \mathbf{X}^2 &= \sum_{i=1}^k \left(\frac{X_i^2 - 2X_i X N_i/N + X^2 N_i^2/N^2}{X N_i/N} + \frac{Y_i^2 - 2Y_i Y N_i/N + Y^2 N_i^2/N^2}{Y N_i/N} \right) \\ &= \sum_{i=1}^k \left(\frac{X_i^2}{X N_i/N} - 2X_i + X N_i/N + \frac{Y_i^2}{Y N_i/N} - 2Y_i + Y N_i/N \right) \end{aligned}$$

Using that $N = X + Y$, $X = \sum_{i=1}^k X_i$ and $Y = \sum_{i=1}^k Y_i$, we get :

$$\begin{aligned} \mathbf{X}^2 &= \sum_{i=1}^k \left(\frac{X_i^2}{X N_i/N} + \frac{Y_i^2}{Y N_i/N} \right) - N \\ &= N \left[\sum_{i=1}^k \left(\frac{Y X_i N_i + X Y_i N_i - N Y_i X_i}{X Y N_i} \right) - 1 \right] \\ &= N \left[\sum_{i=1}^k \left(\frac{X_i}{X} \right) + \sum_{i=1}^k \left(\frac{Y_i}{Y} \right) - \frac{N}{XY} \sum_{i=1}^k \left(\frac{X_i Y_i}{N_i} \right) - 1 \right] \\ &= N \left[1 - \frac{N}{XY} \sum_{i=1}^k \frac{Y_i X_i}{N_i} \right] \end{aligned}$$

Consequently, $SSAS = \frac{\mathbf{X}^2}{N}$. The original formula of the segregation coefficient being

$SC = 1 - \frac{N}{XY} \sum_{i=1}^k \frac{X_i Y_i}{N_i - 1}$, is intimately linked to the \mathbf{X}^2/N statistic.