Using EMM_MACRO

EMM_MACRO calculates geometric section properties given biplanar external and cortical breadths using an eccentric ellipse model described in detail by Milgrom et al. (1989), Biknevicius and Ruff (1992), and Ohman (1993). These routines are modified from those originally described in O'Neill MC, Ruff CB. 2004. Estimating human long bone cross-sectional geometric properties: a comparison of noninvasive methods. *J. Hum. Evol.* 47: 221-235. The original routines were written in Microsoft Visual Basic for use with Microsoft Excel; here these are converted to simple cell functions. Section moduli about M-L and A-P axes are also now calculated. In addition, an error in the original column headings for Ix and Iy is corrected. Note that the true polar section modulus cannot be calculated from biplanar data of this kind, since it requires knowledge of the maximum radius in any plane. X refers to the M-L axis or direction, and Y to the A-P axis or direction.

Instructions

Sample data are included in the accompanying Excel file. Data are input into columns B, D-F, and H-I. Properties are calculated using cell functions in columns C, G, and J-S. Therefore, copy and paste cell functions for columns C, G, and K-R for as many sections (rows) as required. Then enter external and cortical breadth data in the columns B, D-F, and H-I.:

AP	ap	ac	pc	ML	ml	mc	lc

AP = anteroposterior external breadth
ap = anteroposterior breadth of medullary cavity. Computed automatically as AP-(ac+ap). Leave blank (see below for explanation).
ac = anterior cortical thickness
pc = posterior cortical thickness

ML = mediolateral external breadth
ml = mediolateral breadth of the medullary cavity. Computed automatically as ML-(mc+lc). Leave blank (see below for explanation).
mc = medial cortical thickness
lc = lateral cortical thickness

Properties will be automatically calculated in the other columns. In addition to medullary breadths, these include:

TA	**MA**	**CA**	**Xo**	**Yo**	**Ix**	**Iy**	**J**	**Zx**	**Zy**

TA = total area
MA = medullary area
CA = cortical area
Xo = the new section centroid
Yo = the new section centroid
Ix = second moment of area about M-L (x) axis
Iy = second moment of area about A-P (y) axis
J = polar second moment of area
Zx = section modulus about M-L (x) axis
Zy = section modulus about A-P (y) axis

See above references for the biomechanical interpretations of these variables.

Note: For the EEM to be computed, the following statement must be true: AP-(ac+pc) = ap. However, when all of these measurements are taken by hand (calipers) the following is almost always true: AP-(ac+pc) ≠ ap. We assume this to be the product of measurement error in ap and, therefore compute ap from the external and cortical breadths. This is different from Ohman's (1993) program GEOXRAY, which automatically adjusts the cortical dimensions if the above statement is not true.

References

Biknevicius AR, and Ruff CB. 1992. Use of biplanar radiographs for estimating cross-sectional geometric properties of mandibles. Anat Rec 232:157-163.

Milgrom C, Giladi M, Simkin A, Rand N, Kedem R, Kashtan H, Stien M, Gomori M. 1989. The area moment of inertia of the tibia: a risk for stress fractures. *J. Biomech.* 22: 1243-1248.

Ohman JC. 1993. Computer software for estimating coresstional geometric properties of long bones with concentric and eccentric elliptical models *J. Hum. Evol.* 25: 217-227.