SUPPLEMENTARY MATERIAL

van der Vaart, E., Beaumont, M.A., Johnston, A.S.A. & Sibly, R.M.

Ecological Modelling

1. The empirical data

Table S1. Overview of the empirical data.

Study	Worms / Container	Food Quantity	Days Food Manipulated	Container Size	Temperature
Gunadi et al. 2002	5	150 g	0	12 x 12 x 6 cm	20 °C
Gunadi and Edwards 2003	8, 6, 10*	3x 100 g	0, 161, 315	12 x 12 x 6 cm	20 °C
Reinecke & Viljoen 1990: Variable Condition	10	10, 10, 50, -25, 25 g	0, 10, 60, 100, 140	'a flask'†	25 °C
Reinecke & Viljoen 1990: Control Condition	10	20 g each	every 20	'a flask'†	25 °C

*28% of the earthworms died before day 161, and the survivors were subsequently reorganised into groups of ten. The model simulates this by removing two earthworms on day 80, and adding in four new individuals on day 161, with masses and energy reserves equal to the current means.

†As the exact size is not specified, we take it to be the same as in the Gunadi et al. (2002) and Gunadi and Edwards (2003) experiments.

2. The simple model

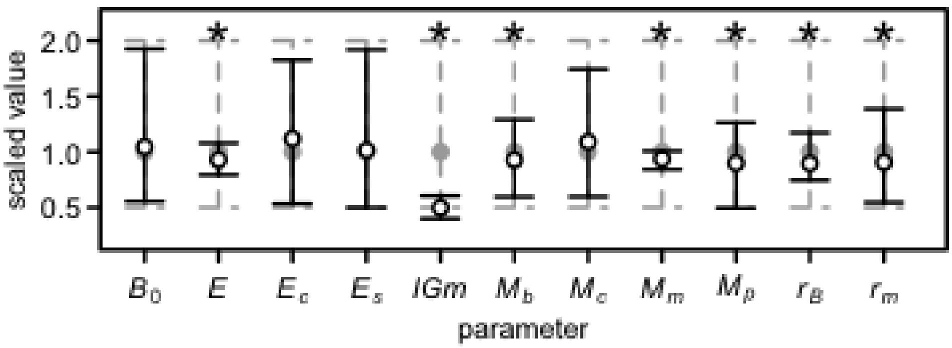

Figure S1. Distributions of parameter values for the simple model. Grey lines show the priors; black lines the posteriors. Circles represent medians, whiskers 95% credible intervals. Asterixes mark significant narrowing. All parameter values were scaled by dividing by the corresponding literature values, so that a value of 1 equals Johnston *et al.*'s (2014).

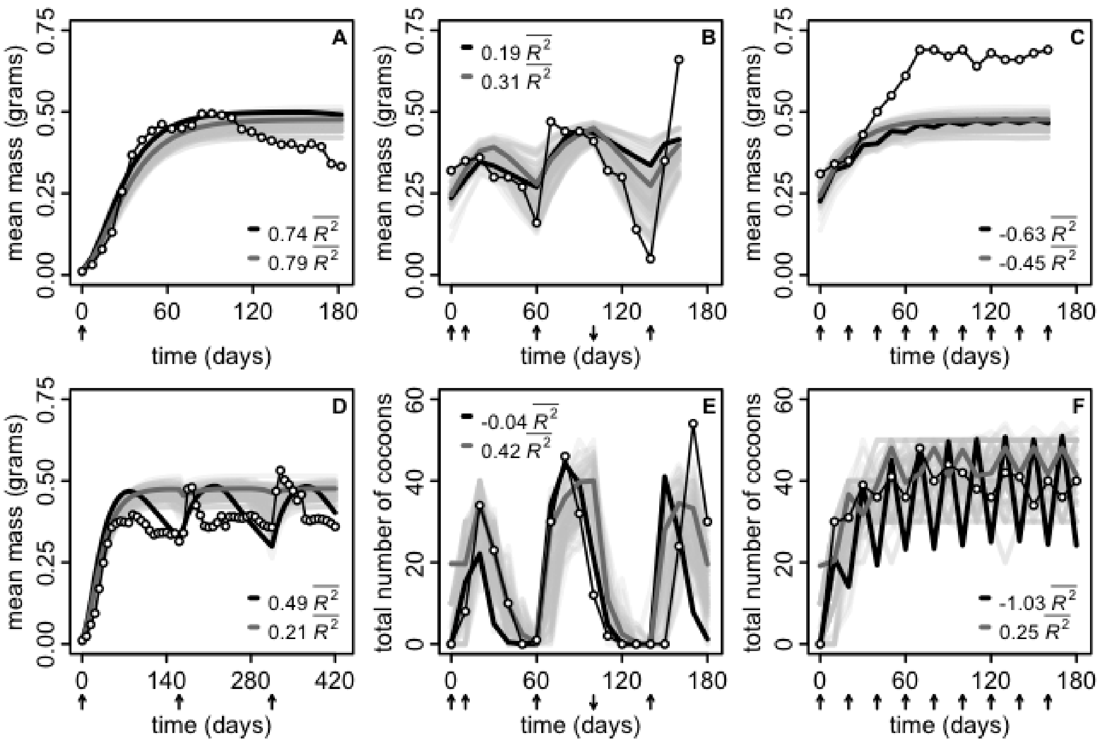

Figure S2. Fits of the simple model to the empirical data. The thick black and grey lines are the result of averaging 100 runs each, using Johnston et al.'s (2014) literature values and ABC's best values, respectively. The open circles are the empirical data, and the semi-transparant grey lines are the 'posterior predictive check', i.e., the the output of 100 new simulations using random samples from the accepted runs. Arrows mark the days when food was either added (↑) or removed (↓). A: Experiment 1 (Gunadi et al., 2002); D: Experiment 2 (Gunadi and Edwards, 2003); B and E: Experiment 3 (Reinecke and Viljoen, 1990, 'variable condition'); C and F: Experiment 4 (Reinecke and Viljoen, 1990, 'constant condition'). R^2 is the proportion of variance explained, a measure of goodness of fit (Equation 7).

3. Varying the acceptance rate

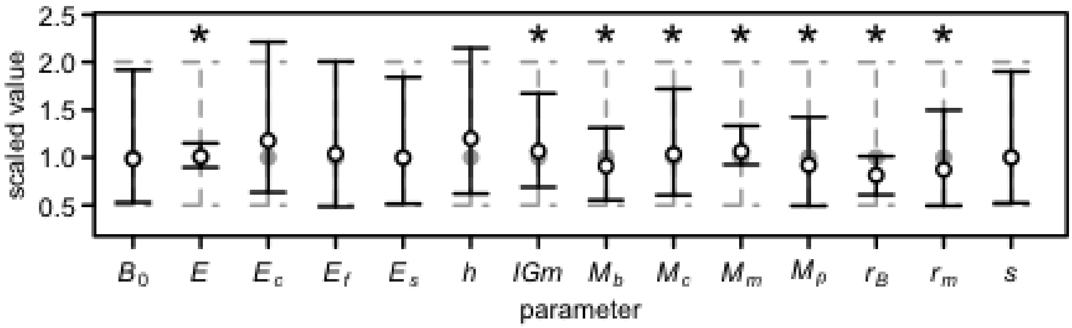

Figure S3. Distributions of parameter values with a 0.001 acceptance rate. Grey lines show the priors; black lines the posteriors. Circles represent medians, whiskers 95% credible intervals. Asterixes mark significant narrowing. All parameter values were scaled by dividing by the corresponding literature values, so that a value of 1 equals Johnston *et al.*'s (2014).

Table S2. Bayes factors with a 0.001 acceptance rate. The table shows how often the model in each row *x* was accepted relative to the model in each column *y*, giving the Bayes factor $B_{x,y}$ (Equation 6).

	Full Model	Simplified Model
Full Model	-	18.8
Simplified Model	0.05	-

4. Cross-validation and coverage

1. Set aside 100 random runs of the model as “pseudo-data”.
2. For each set of “pseudo-data”, do ABC using all the remaining runs.
3. For each set of “pseudo-data”, summarize each posterior parameter distribution by the median accepted value.
4. For each parameter, plot the true versus the median accepted parameter value.

Figure S4. Steps of the ABC cross-validation procedure for parameter estimation. Based upon the procedure described in Csillery et al. (2012).

1. Set aside 100 of the model’s “best runs” as “pseudo-data” – i.e., those minimizing the distance to the empirical data according to Equation 5.
2. For each set of “pseudo-data”, do ABC using all the remaining runs.
3. For each set of “pseudo-data”, summarize each posterior parameter distribution by calculating the proportion of accepted parameter values *p* less than the true value.
4. For each parameter, plot the distribution of these *p* values.

Figure S5. Steps of the ABC coverage procedure for parameter estimation. A less technical description of Algorithm 2 in Prangle et al. (2013).

5. References

Csillery, K., François, O., Blum, M.G.B., 2012. abc: An R package for approximate Bayesian computation (ABC). Methods in Ecology and Evolution 3, 475-479.

Gunadi, B., Blount, C., Edwards, C.A., 2002. The growth and fecundity of *Eisenia fetida* (Savigny) in cattle solids pre-composted for different periods. Pedobiologia 46, 15-23.

Gunadi, B., Edwards, C.A., 2003. The effects of multiple applications of different organic wastes on the growth, fecundity and survival of *Eisenia fetida* (Savigny) (Lumbricidae). Pedobiologia 47, 321-329.

Johnston, A.S.A., Hodson, M.E., Thorbek, P., Alvarez, T., Sibly, R.M., 2014. An energy budget agent-based model of earthworm populations and its application to study the effects of pesticides. Ecological Modelling 280, 5-17.

Prangle, D., Blum, M.G.B., Popovic, G., Sisson, S.A., 2013. Diagnostic tools for approximate Bayesian computation using the coverage property. Australian & New Zealand Journal of Statistics 56, 309-329.

Reinecke, A.J., Viljoen, S.A., 1990. The influence of feeding patterns on growth and reproduction of the vermicomposting earthworm *Eisenia fetida* (Oligochaeta). Biology and Fertility of Soils 10, 184-187.