Tag growth

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1 Introduction

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Variation among individuals can be included by treating each individual's demographic parameters as a random effect that arises from a population-level distribution. We start with the specialised von Bertalanffy growth function

$$\frac{dL}{dt} = a - kL, \tag{1}$$

where $\frac{dL}{dt}$ is change in length as a function of time t, a scales with energy acquisition, and k represents metabolic upkeep costs. However, individuals that are more highly active may obtain more food (increased a) and simultaneously have greater upkeep costs (increased k). Following **?**, we include the correlation via the following equation

$$a = \gamma k^{\psi}, \tag{2}$$

where γ and ψ approximate the allometric scaling of energy costs and aquisition. Integration then yeilds

$$L(t + \Delta_t) = L(t)e^{-k_i \Delta_t} + k_i^{\psi - 1} \left(1 - e^{-k_i}\right) \gamma \sum_{j=0}^{\Delta_t - 1} e^{-k_i j}. \tag{3}$$

When $\psi = 0$ this model become the classic von Bertallanffy.

$$\begin{aligned} \frac{dL}{dt} &= \gamma k^{\psi} - kL, & (4)\\ &= \gamma - kL \quad \text{if} \quad \psi = 0, & (5) \end{aligned}$$

$$\begin{aligned} L_{\infty} &= \frac{\gamma k^{\psi}}{k}, & (6)\\ &= \frac{\gamma}{k} \quad \text{if} \quad \psi = 0, & (7) \end{aligned}$$

$$\begin{aligned} \gamma &= \frac{kL_{\infty}}{k^{\psi}}, & (8)\\ &= kL_{\infty} \quad \text{if} \quad \psi = 0, & (9) \end{aligned}$$

$$L_0 = L_\infty \left(1 - e^{kt_0}\right), \tag{10}$$

L_0 is the length at time 0.

$$c_v = \frac{\sigma}{\mu}, \tag{11}$$

$$\sigma = c_v \mu, \tag{12}$$

$$\varepsilon \sim \mathcal{N}\left(0, \sigma_o^2 L_t\right), \tag{13}$$

Table 1: The values of the standard von Bertalanffy growth function etsimated bu Dunn et al....

Parameter	Units	Female	Male
t_0	y	0.021	-0.256
k	y^{-1}	0.090	0.093
L_∞	cm	180.20	169.07
c_v	-	0.102	0.012

$$L_t = L_\infty \left(1 - e^{-k(t-t_0)}\right), \tag{14}$$

2 Simulation

A total of 400 different data sets were simulated, 100 relicates for each of four different parameter sets. In all data sets 315 individuals were simulated, the same number as in the actual toothfish data set. The sex, Age1, Age2 and time at liberty were simulated by

- Sampling sex from the observed sexes of individuals (with replacement).
- Sampling Age1, Age2 and time at liberty independently (with replacement) from those observed. Randomly selected one of these variables and calculated this values given the other two.
- Rounding Age1, Age2 and time at liberty off to the nearest integer.

Initial simulations experiments suggested that the parameter ψ could not be estimated reliably so this parameter was fixed at zero. The four different parameter sets used are given in Table 2. The simulated values used are based on plausible parameter values or values calculated from Table 1 above.

Table 2: .

Simulation	v0		v1		v2		v3	
Parameter	Female	Male	Female	Male	Female	Male	Female	Male
L_0	-0.341	3.978	-0.341	3.978	-0.341	3.978	-0.341	3.978
$\overline{k}$	0.00173	0.00179	0.00173	0.00179	0.00173	0.00179	0.00173	0.00179
γ	0.312	0.302	0.312	0.302	0.312	0.302	0.312	0.302
σ_o	0.102	0.102	0.050	0.050	0.050	0.050	0.050	0.050
σ_k	-	-	0.1000	0.200	-	-	0.100	0.200
σ_z	-	-	-	-	0.200	0.400	0.20	0.40

2.1 Fits to simulated data

2.1.1 v0

No random effects. 97/100 pdH.

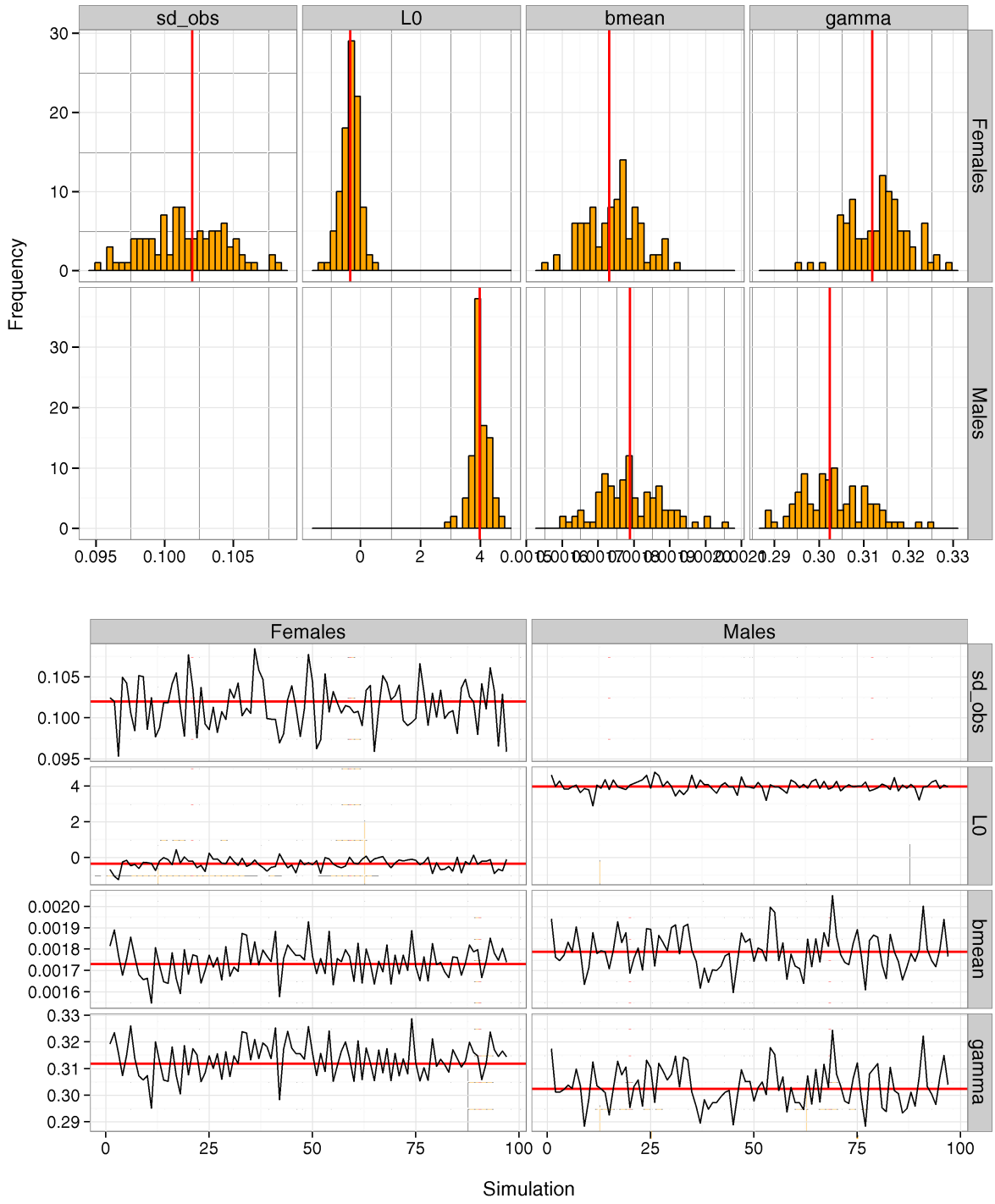

Figure 1: pdH fits plotted only.

2.1.2 v1

Random effects k, 78/100 pdH.

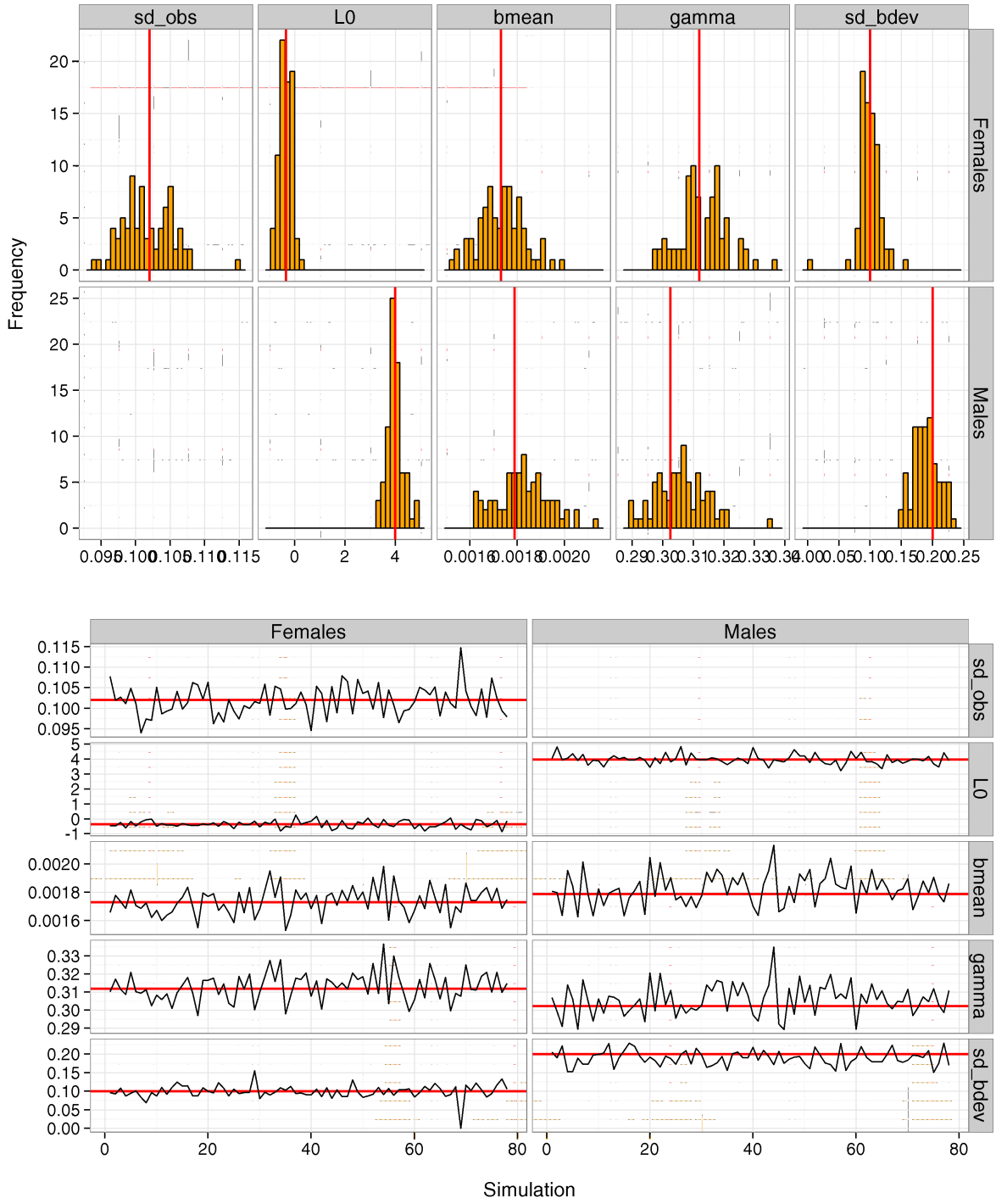

Figure 2: pdH fits plotted only.

2.1.3 v2

Random effects z, 92/100 pdH. Unfortunately I f'ed the estimation of this model up and estimated a single sdz param but simulated two. I'll need to redo the estimation here.

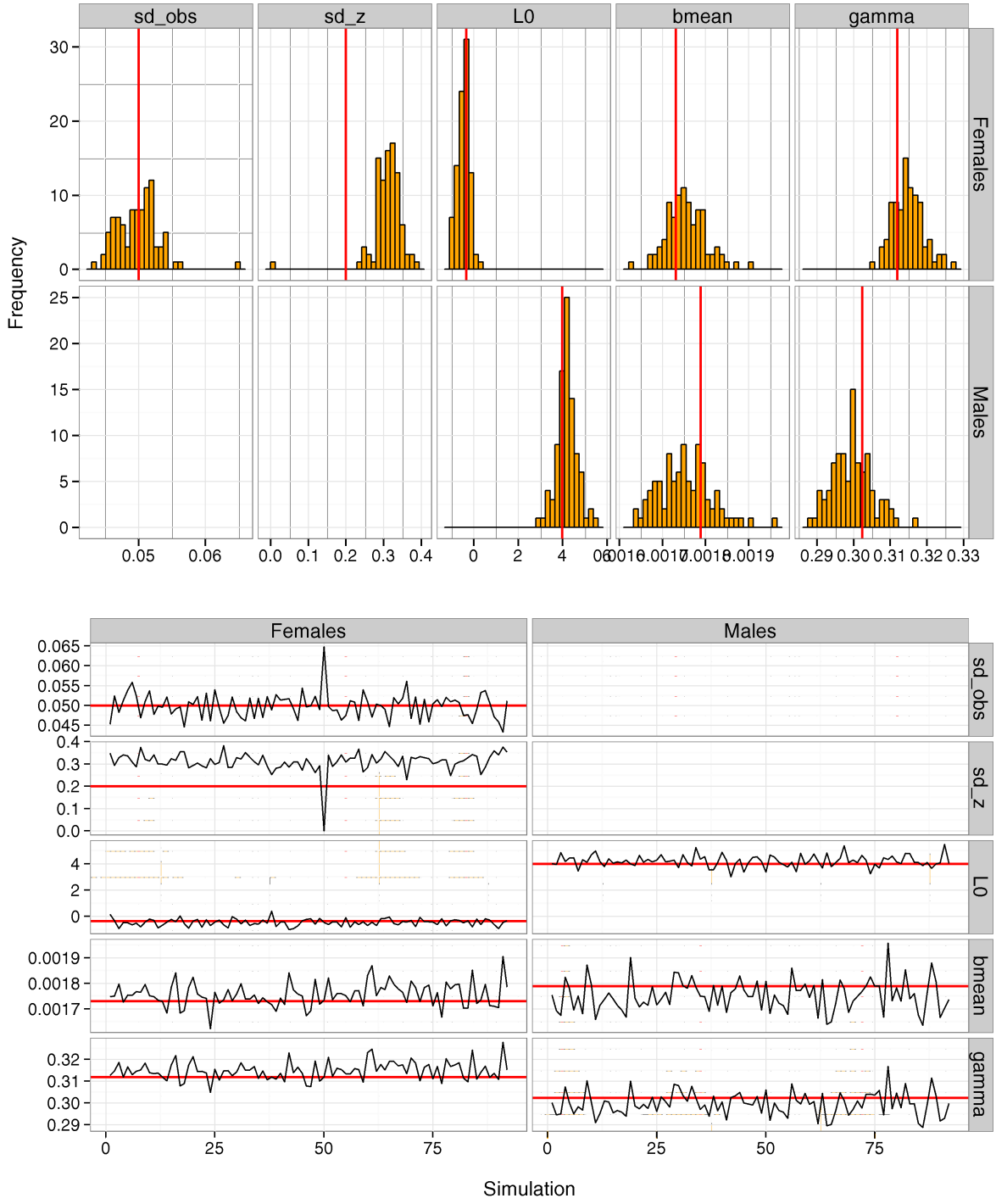

Figure 3: pdH fits plotted only.

2.1.4 v3

Random effects k and z, 81/100 pdH. Unfortunately I f'ed the estimation of this model up and estimated a single sdz param but simulated two. I'll need to redo the estimation here.

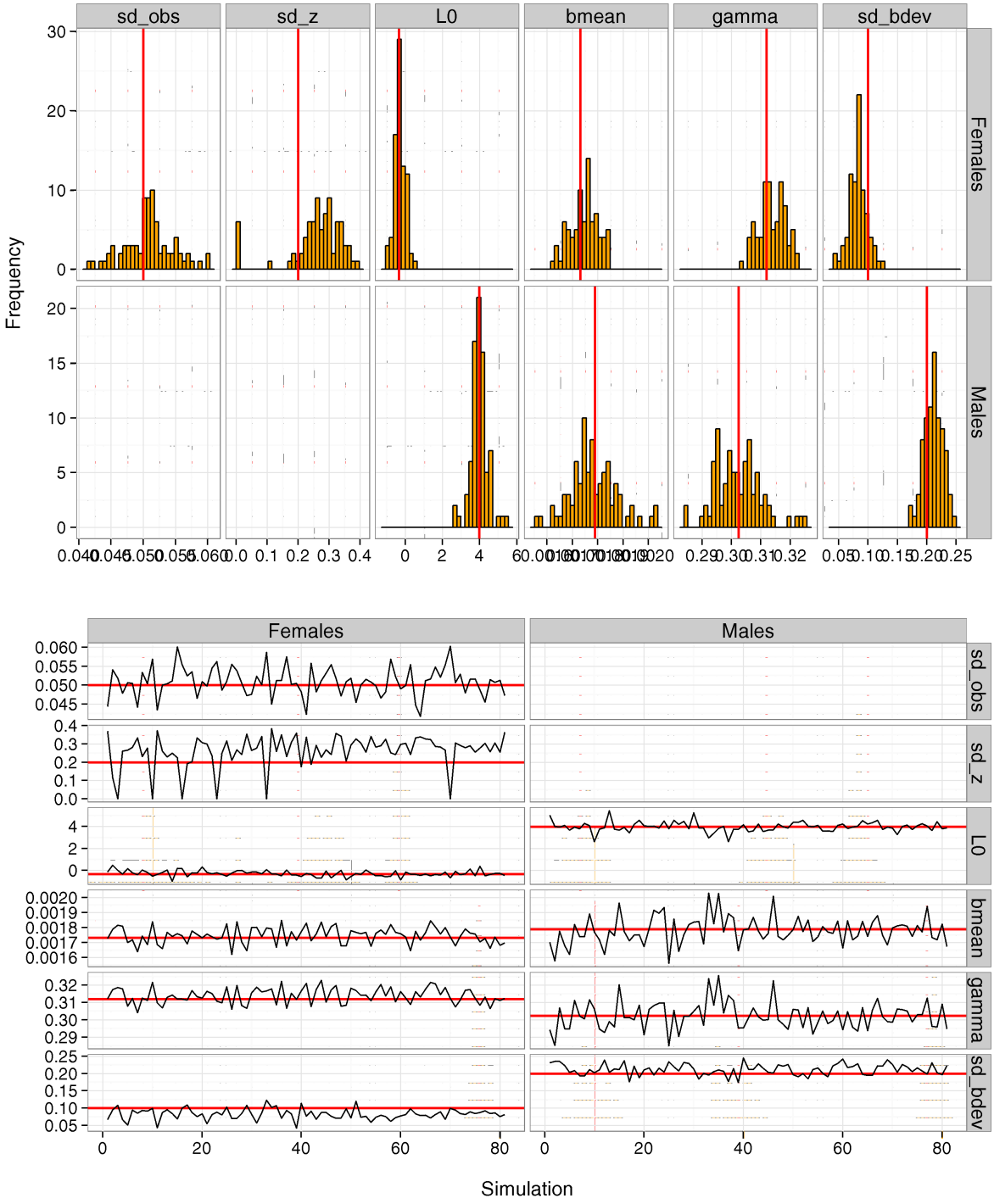

Figure 4: pdH fits plotted only.