Dynamic Energy Budget (DEB) theory summary notes

Matthew Malishev[1]*
[1] *Department of Biology, Emory University, 1510 Clifton Road NE, Atlanta, GA, USA, 30322*

Contents

Date: 2018-11-05
R version: 3.5.0
*Corresponding author: matthew.malishev@gmail.com

List of parameters and variables

Parameter	Definition
E	energy reserve
$[E]$	energy reserve per volume (reserve density)
e	scaled energy reserve
$[E_M]$	maximum reserve density
f	functional feeding response
L	structural length
$\dot{p}_{AM}$	maximum assimilation rate
$\dot{v}$	energy conductance

Overview

Summarised notes from DEB workshops, telecourses, lectures, and discussions.

Reserve mobilisation

Conductance determines mobilisation rate from reserve to structure
The larger the surface area of reserve, the more mobilisation is possible and thus faster maintenance and growth due to more surface area.
- surface area scales slower than volume-specific energy flows.

Reserve dynamics f = 1 (max feeding rate)

$$\frac{dE}{dt} = \frac{f\{\dot{p}_{AM}\}}{L} - \frac{\dot{v}[E]}{L}$$

$[E_M]$ = max reserve. Reserve doesn't change.

$$= \frac{\{\dot{p}_{AM}\}}{L} - \frac{\dot{v}[E_M]}{L}$$

$$\therefore [E_M] = \frac{\{\dot{p}_{AM}\}}{\dot{v}}$$

Scaled reserve

$$e = \frac{[E]}{[E_M]}$$

$$\frac{de}{dt} = \frac{[E]/[E_M]}{dt} = \frac{f\dot{v}}{L} - \frac{e\dot{v}}{L}$$

$$= \frac{\dot{v}(fe)}{L}$$

Under steady state, reserve doesn't change

$$0 = \frac{\dot{v}(fe)}{L} \quad \text{or} \quad f = e$$

Length

Getting maximum length L_m

$$\frac{dV}{dt} = V\dot{r}$$

Can rewrite r using scaled reserve e

$$\dot{r} = \dot{v}\frac{\frac{e}{L} - (1 + \frac{L_T}{L})/L_m}{e + g}$$

Getting L_m

$$\frac{dV}{dt} = V\dot{r}$$

To find $V_m = Lm^3$, set $f = 1$ and $\frac{dV}{dt} = 0$, then solve for $V = V_m$

$$L_m = \frac{\kappa\{\dot{p}_{Am}\}}{[\dot{p}_M]}$$

Weak homeostasis

Structural isomorphy implies weak homeostasis
Weak homeostasis depends on ratio of reserve to structure $\frac{d[E]}{dt}$