# *M7116 Maticové populační modely*

Populace s interní variabilitou – bifurkační diagramy

18. 5. 2015

# Leslieho model s plodností závislou na velikosti populace

$$\begin{pmatrix} n_1 \\ n_2 \\ n_3 \end{pmatrix}(t+1) = \begin{pmatrix} 0 & g\big(N(t)\big) & 5g\big(N(t)\big) \\ 0.3 & 0 & 0 \\ 0 & 0.5 & 0 \end{pmatrix} \begin{pmatrix} n_1 \\ n_2 \\ n_3 \end{pmatrix}(t),$$

$$N = n_1 + n_2 + n_3, \quad g(N) = R\mathrm{e}^{-0.005N}$$

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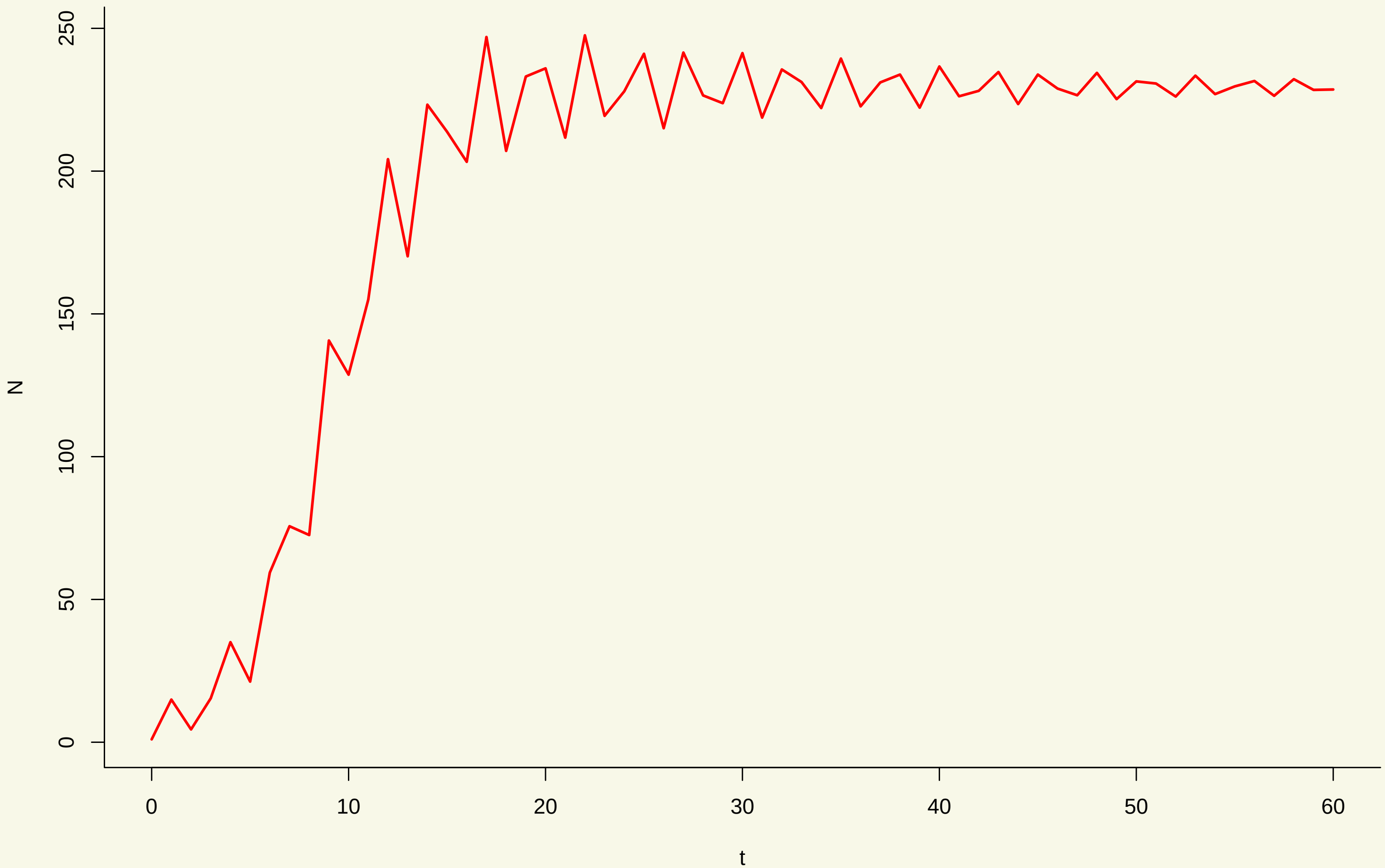
$$N = n_1 + n_2 + n_3, \quad g(N) = R\mathrm{e}^{-0.005N}$$

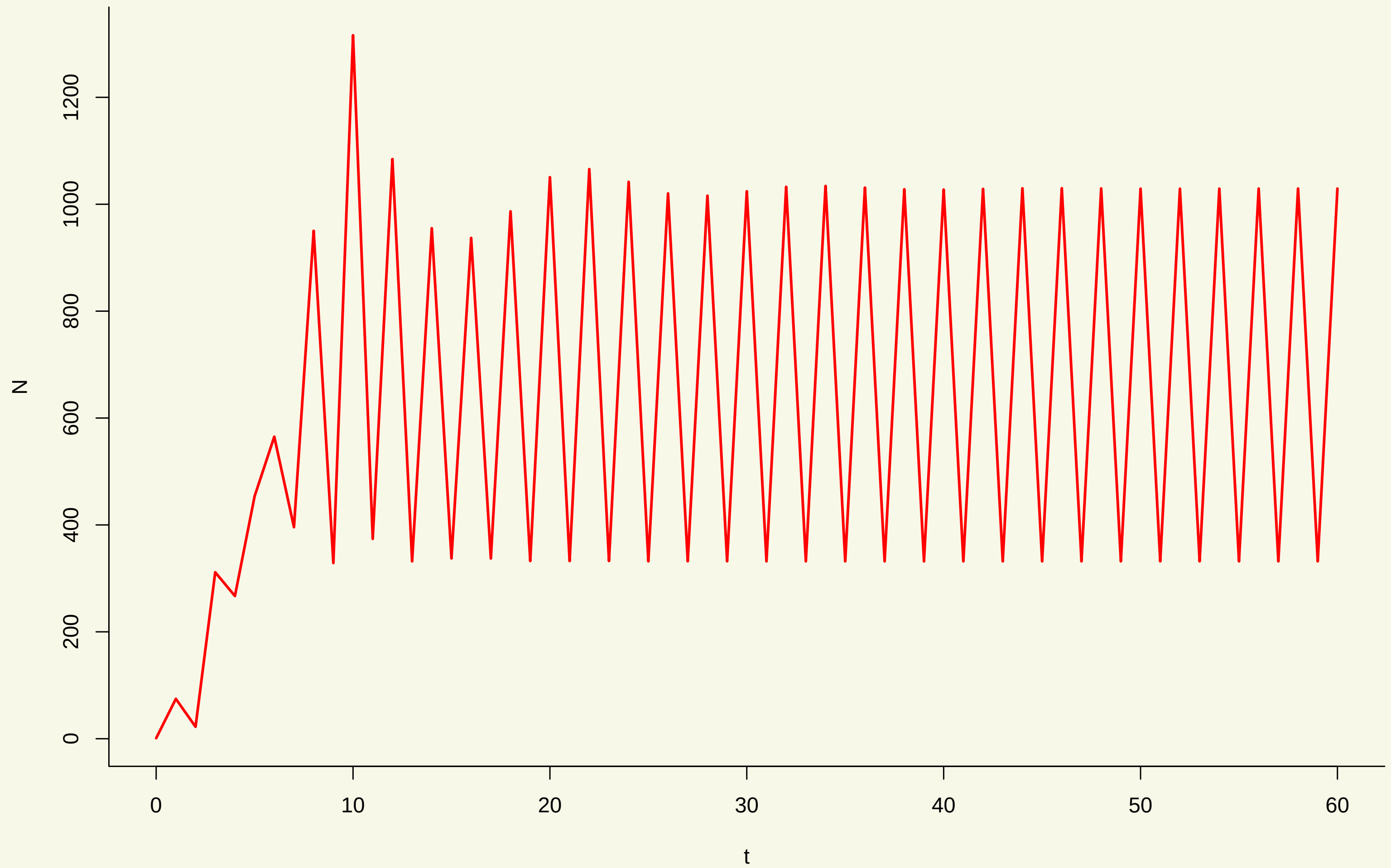



$R = 3$

# Leslieho model s plodností závislou na velikosti populace

$$\begin{pmatrix} n_1 \\ n_2 \\ n_3 \end{pmatrix}(t+1) = \begin{pmatrix} 0 & g\big(N(t)\big) & 5g\big(N(t)\big) \\ 0.3 & 0 & 0 \\ 0 & 0.5 & 0 \end{pmatrix} \begin{pmatrix} n_1 \\ n_2 \\ n_3 \end{pmatrix}(t),$$

$$N = n_1 + n_2 + n_3, \quad g(N) = R\mathrm{e}^{-0.005N}$$

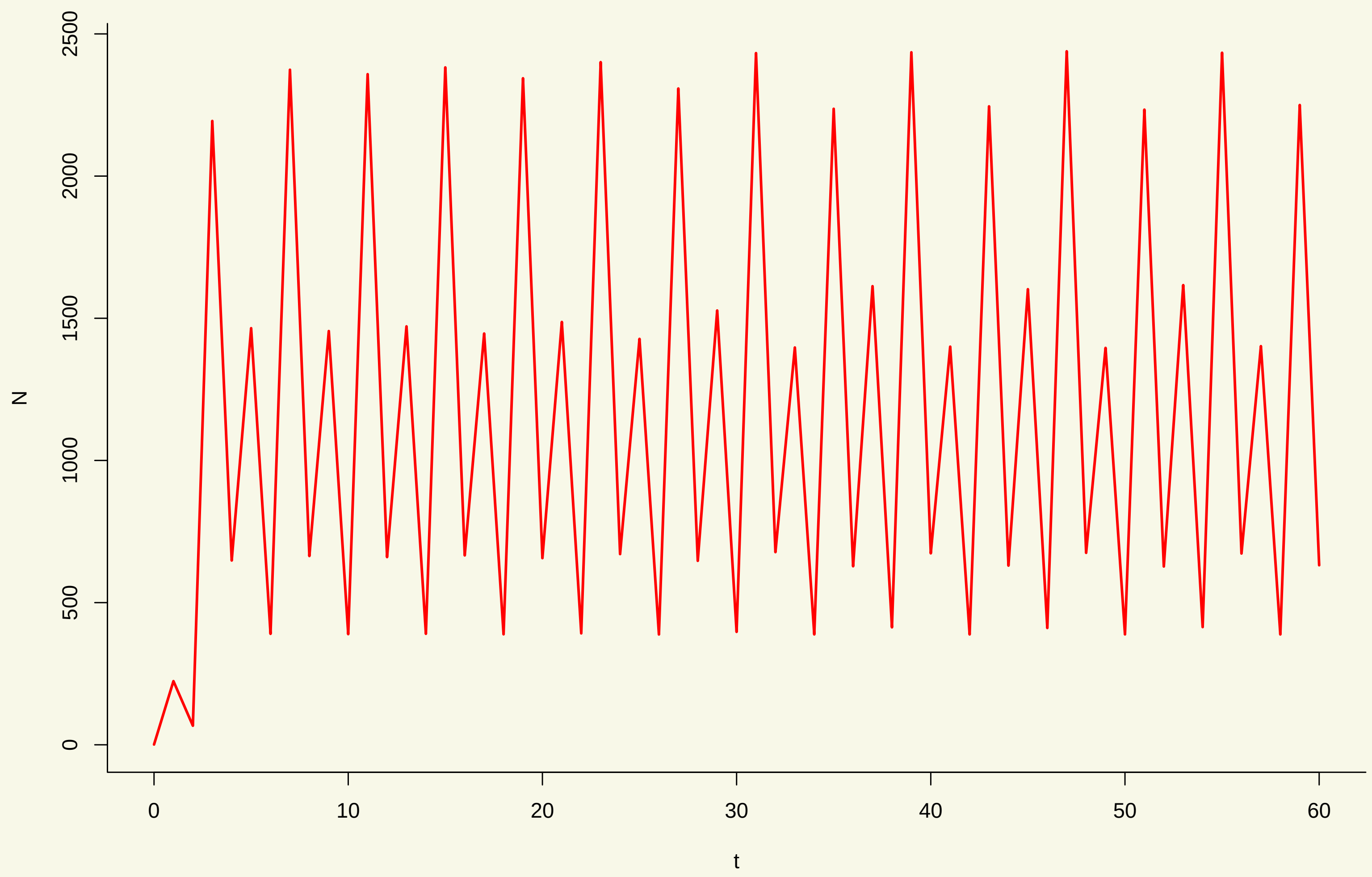



$R = 15$

# Leslieho model s plodností závislou na velikosti populace

$$\begin{pmatrix} n_1 \\ n_2 \\ n_3 \end{pmatrix} (t+1) = \begin{pmatrix} 0 & g\big(N(t)\big) & 5g\big(N(t)\big) \\ 0.3 & 0 & 0 \\ 0 & 0.5 & 0 \end{pmatrix} \begin{pmatrix} n_1 \\ n_2 \\ n_3 \end{pmatrix} (t),$$

$$N = n_1 + n_2 + n_3, \quad g(N) = R\mathrm{e}^{-0.005N}$$

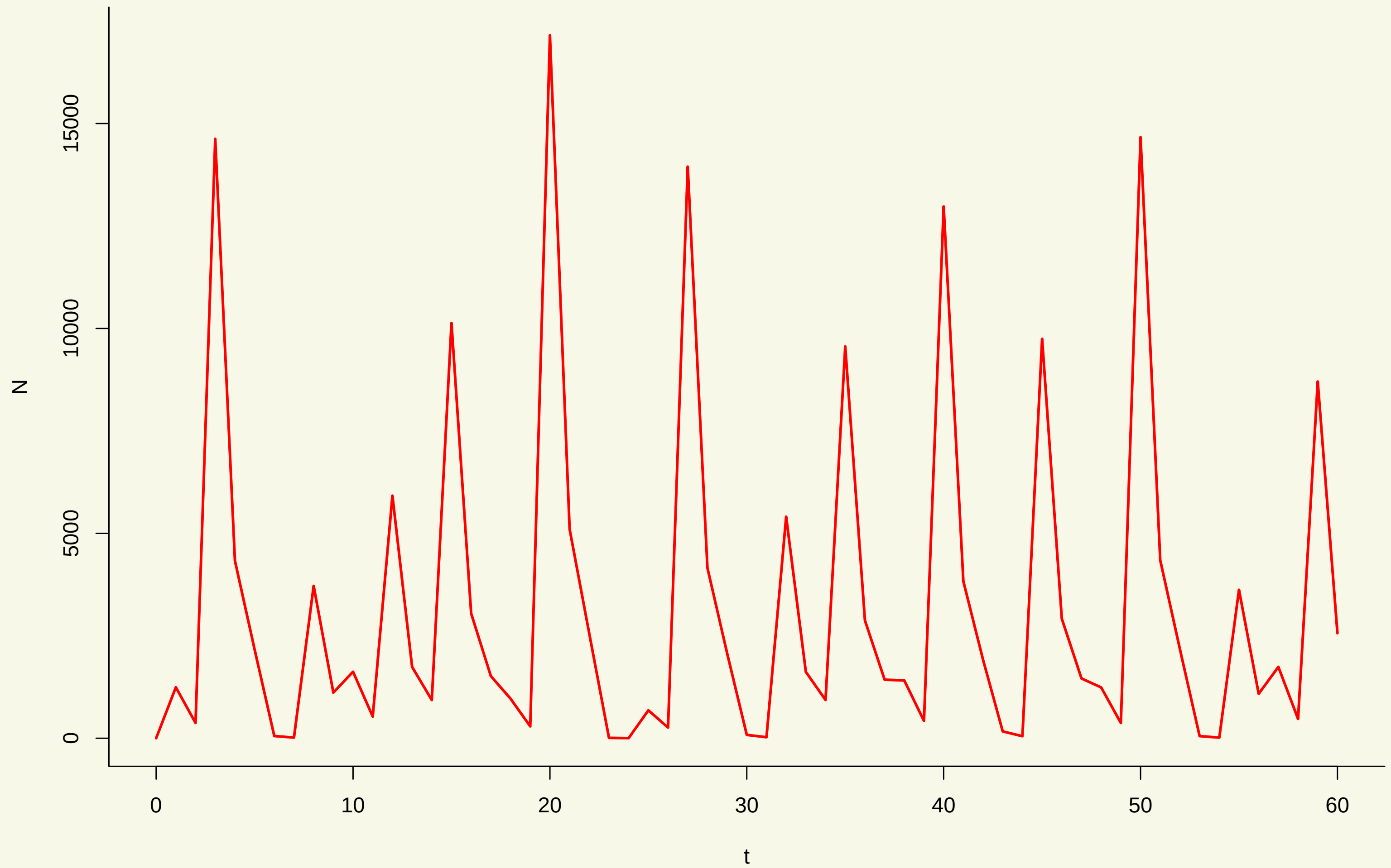



$R = 45$

# Leslieho model s plodností závislou na velikosti populace

$$\begin{pmatrix} n_1 \\ n_2 \\ n_3 \end{pmatrix}(t+1) = \begin{pmatrix} 0 & g\big(N(t)\big) & 5g\big(N(t)\big) \\ 0.3 & 0 & 0 \\ 0 & 0.5 & 0 \end{pmatrix} \begin{pmatrix} n_1 \\ n_2 \\ n_3 \end{pmatrix}(t),$$

$$N = n_1 + n_2 + n_3, \quad g(N) = R\mathrm{e}^{-0.005N}$$

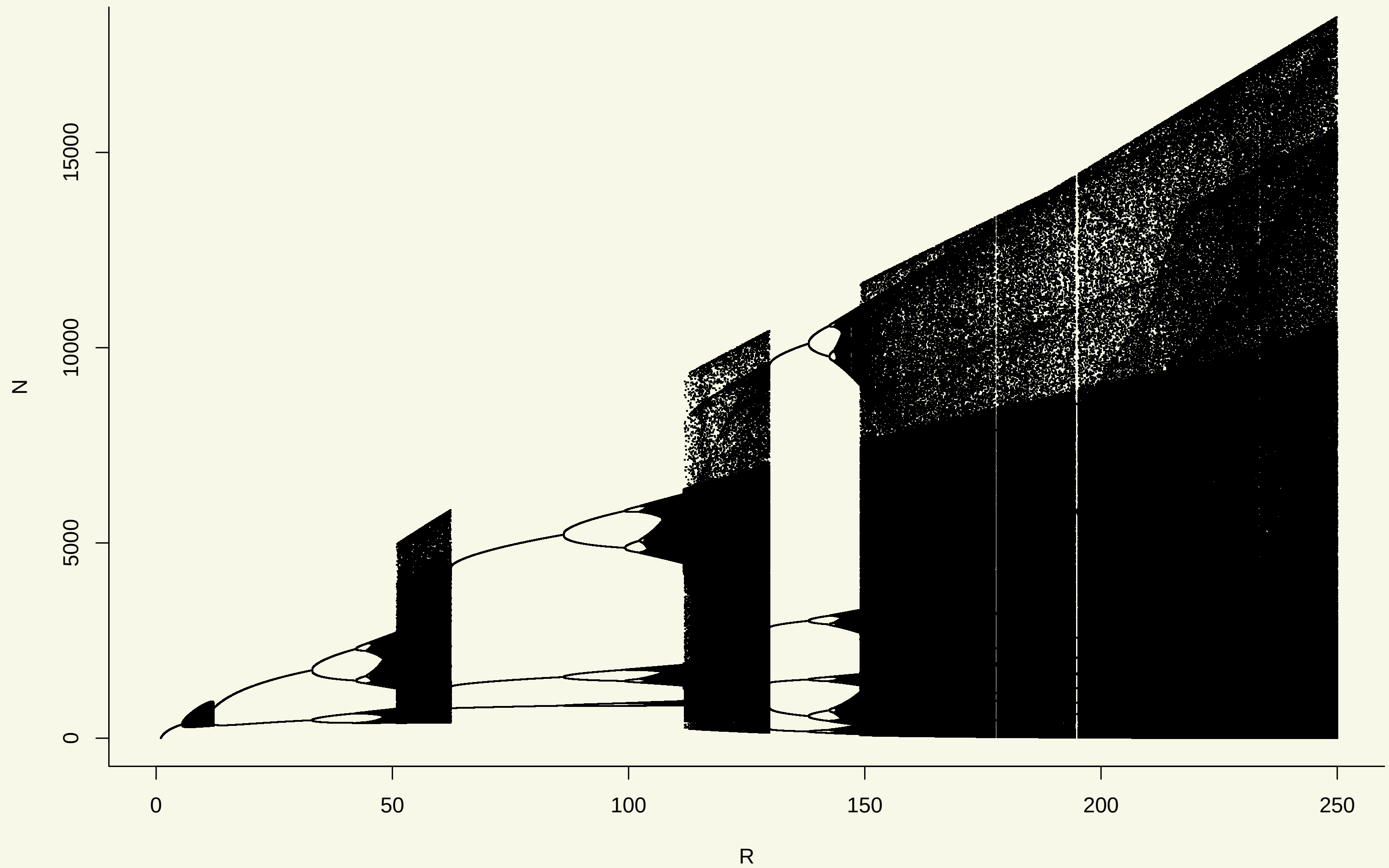



$R = 250$

# Leslieho model s plodností závislou na velikosti populace

$$\begin{pmatrix} n_1 \\ n_2 \\ n_3 \end{pmatrix}(t+1) = \begin{pmatrix} 0 & g\big(N(t)\big) & 5g\big(N(t)\big) \\ 0.3 & 0 & 0 \\ 0 & 0.5 & 0 \end{pmatrix} \begin{pmatrix} n_1 \\ n_2 \\ n_3 \end{pmatrix}(t),$$

$$N = n_1 + n_2 + n_3, \quad g(N) = R\mathrm{e}^{-0.005N}$$



# Model kanibalismu

$$
\begin{aligned}
L(t+1) &= bA(t)\exp\{-c_{ea}A(t) - c_{el}L(t)\}\\
P(t+1) &= (1-\mu_l)L(t)\\
A(t+1) &= \exp\{-c_{pa}A(t)\}\,P(t) + (1-\mu_a)A(t)
\end{aligned}
$$

$L$, $P$, $A$ ... množství larev, kukel a dospělců

$b$ ... počet vajíček jedné dospělé samice za projekční interval

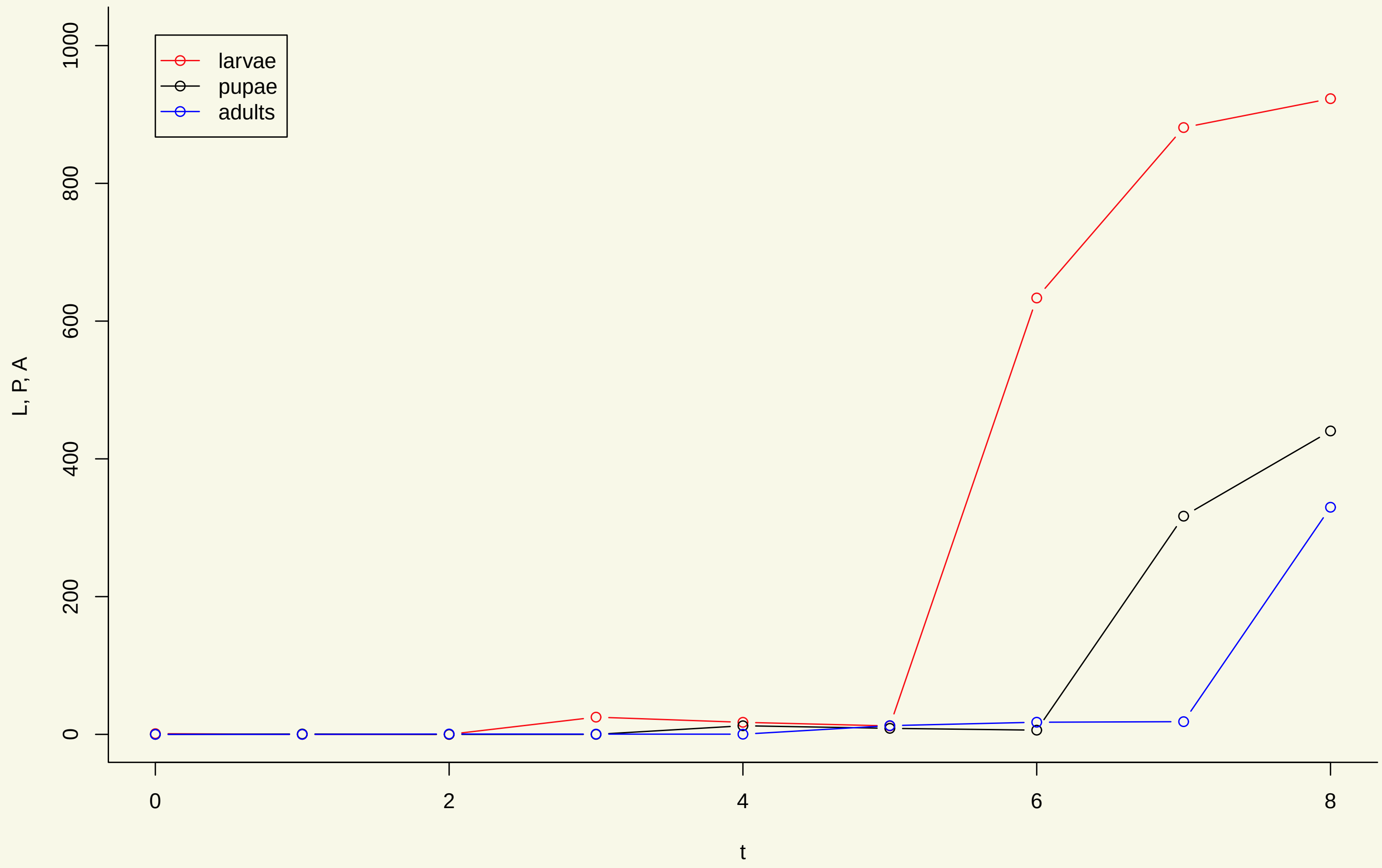
$\mu_l$, $\mu_a$ ... přirozená úmrtnost larev a dospělců

$c_{ea}$, $c_{el}$, $c_{pa}$ ... „míry kanibalismu“

# Model kanibalismu

$$L(t+1) = bA(t)\exp\{-c_{ea}A(t) - c_{el}L(t)\}$$
$$P(t+1) = (1-\mu_l)L(t)$$
$$A(t+1) = \exp\{-c_{pa}A(t)\}P(t) + (1-\mu_a)A(t)$$

$b = 50$, $\mu_l = 0.5$, $\mu_a = 0.3$, $c_{ea} = 0$, $c_{pa} = 0$, $c_{el} = 0$

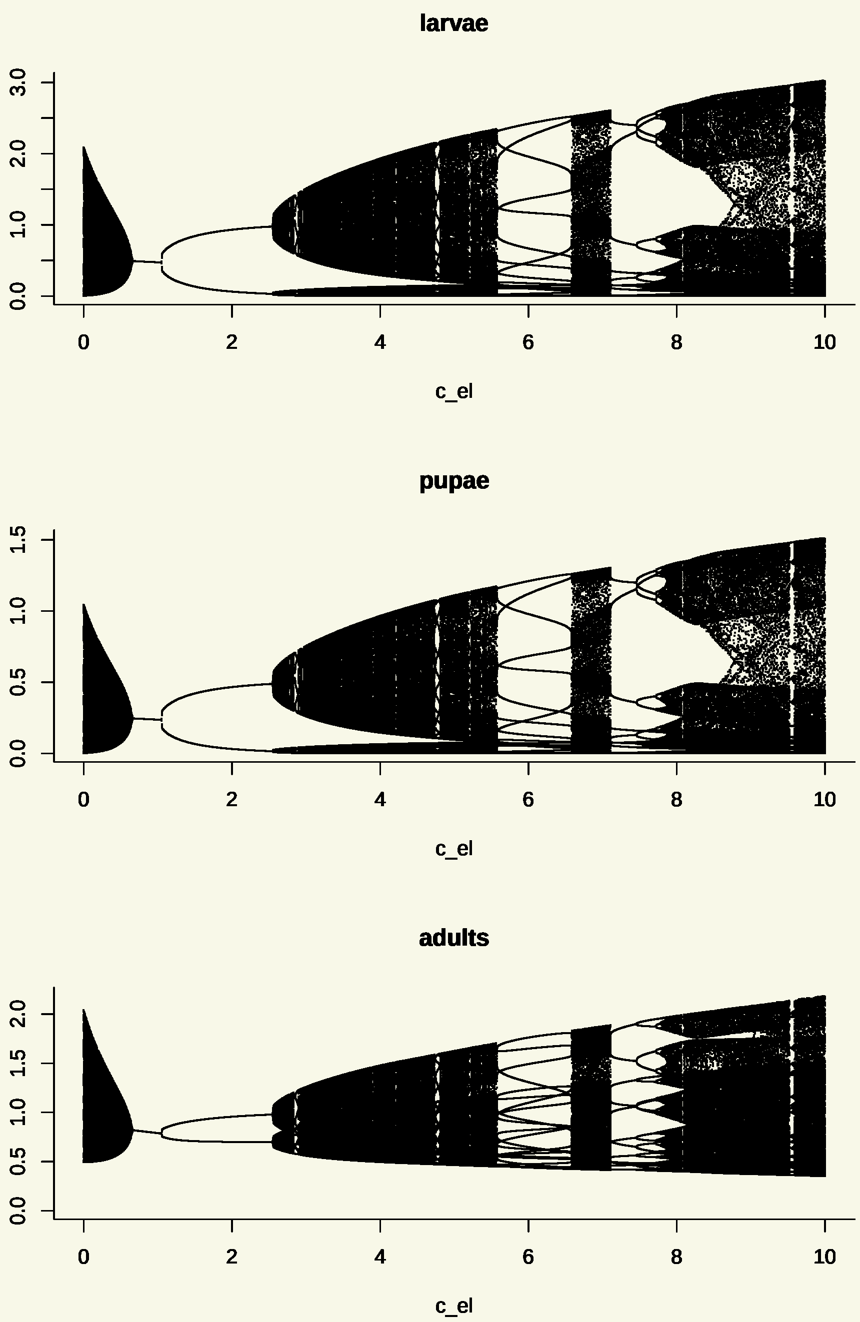


# Model kanibalismu

$$L(t+1) = bA(t)\exp\{-c_{ea}A(t) - c_{el}L(t)\}$$
$$P(t+1) = (1-\mu_l)L(t)$$
$$A(t+1) = \exp\{-c_{pa}A(t)\}P(t) + (1-\mu_a)A(t)$$

$b = 50$, $\mu_l = 0.5$, $\mu_a = 0.3$, $c_{ea} = 5$, $c_{pa} = 0$,

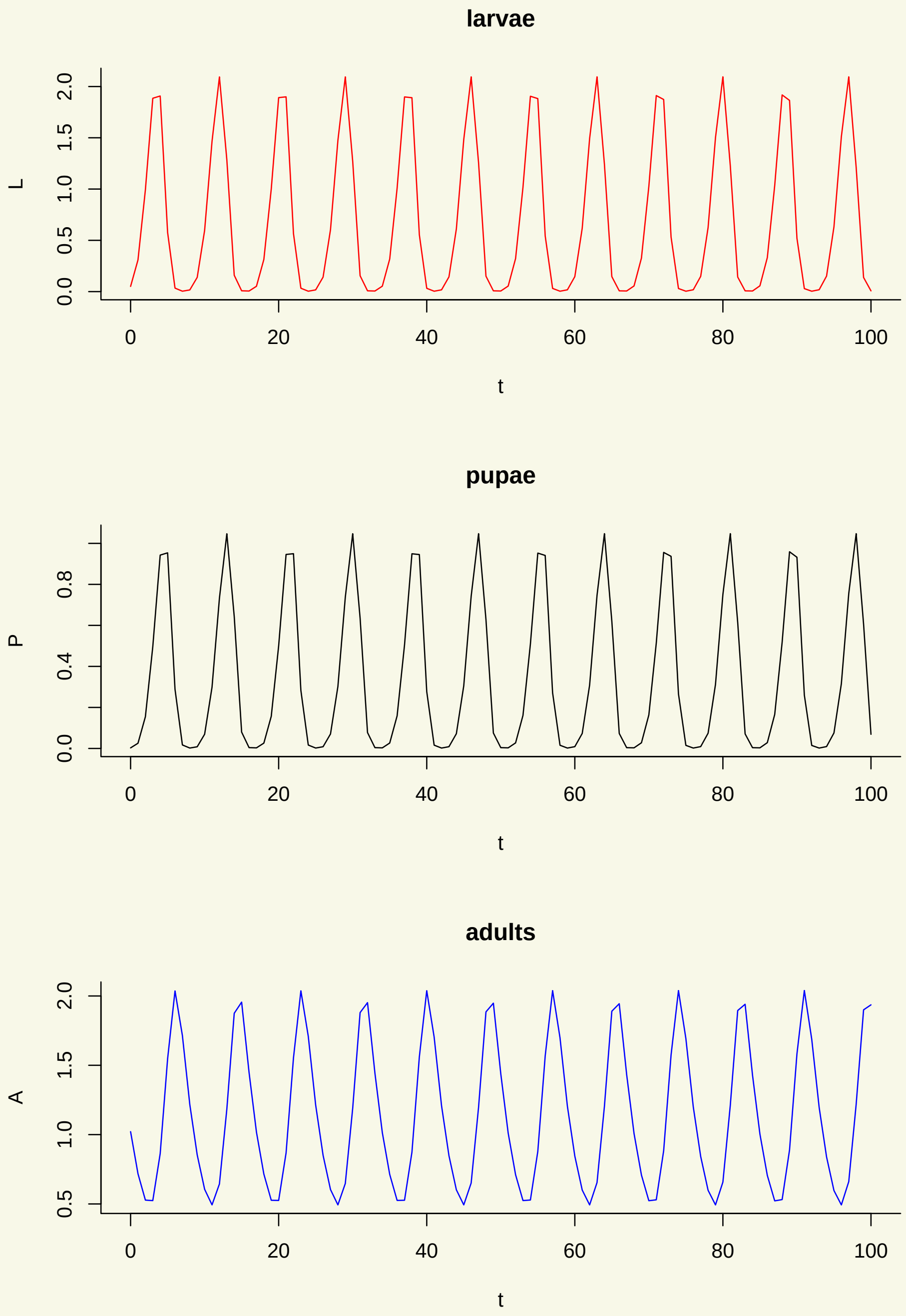
$c_{el} \in [0, 10]$



# Model kanibalismu

$$L(t+1) = bA(t)\exp\{-c_{ea}A(t) - c_{el}L(t)\}$$
$$P(t+1) = (1-\mu_l)L(t)$$
$$A(t+1) = \exp\{-c_{pa}A(t)\}\,P(t) + (1-\mu_a)A(t)$$

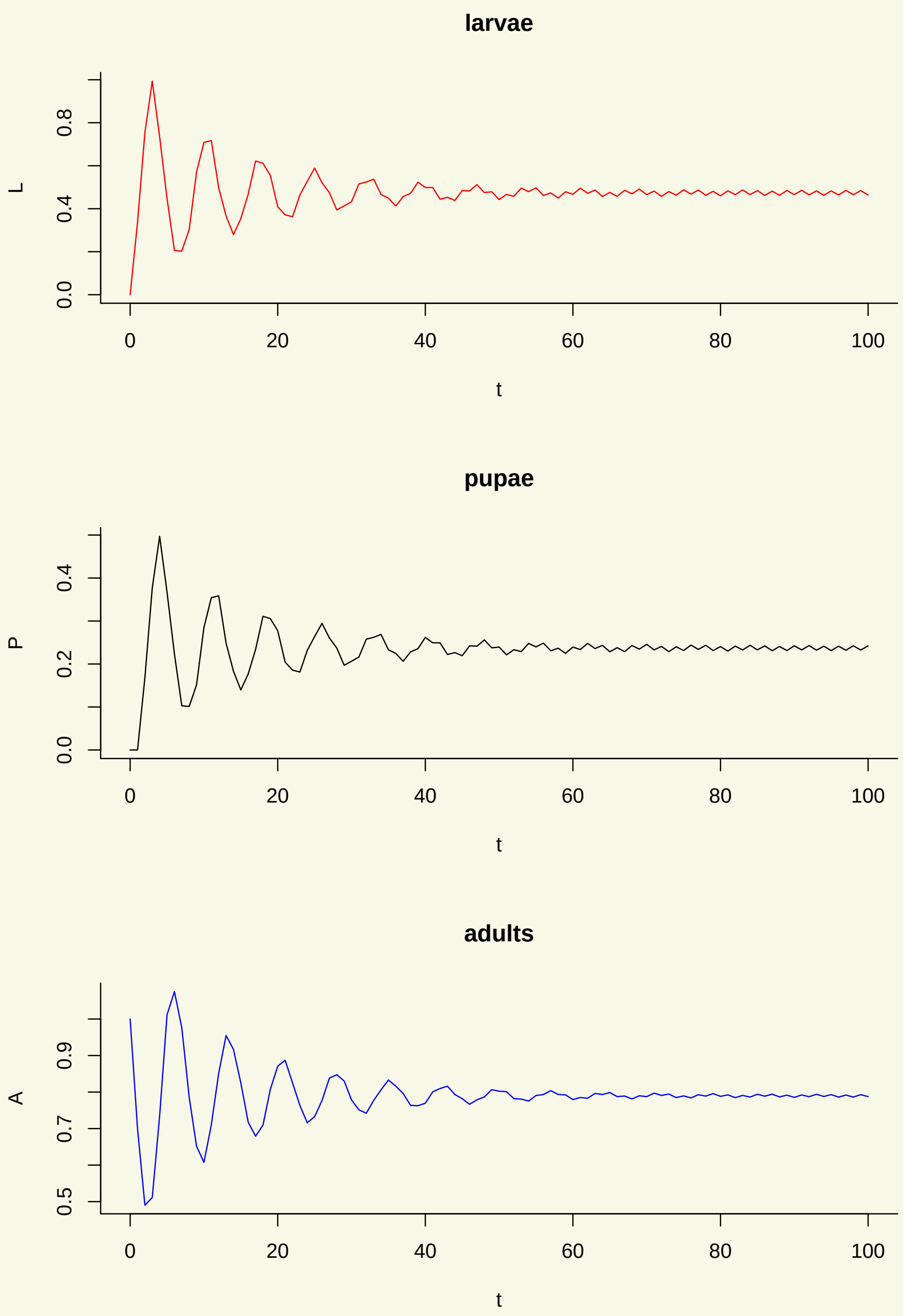
$b = 50$, $\mu_l = 0.5$, $\mu_a = 0.3$, $c_{ea} = 5$, $c_{pa} = 0$, $c_{el} = 0$



# Model kanibalismu

$$L(t+1) = bA(t)\exp\{-c_{ea}A(t) - c_{el}L(t)\}$$
$$P(t+1) = (1-\mu_l)L(t)$$
$$A(t+1) = \exp\{-c_{pa}A(t)\}\,P(t) + (1-\mu_a)A(t)$$

$b = 50$, $\mu_l = 0.5$, $\mu_a = 0.3$, $c_{ea} = 5$, $c_{pa} = 0$, $c_{el} = 1$

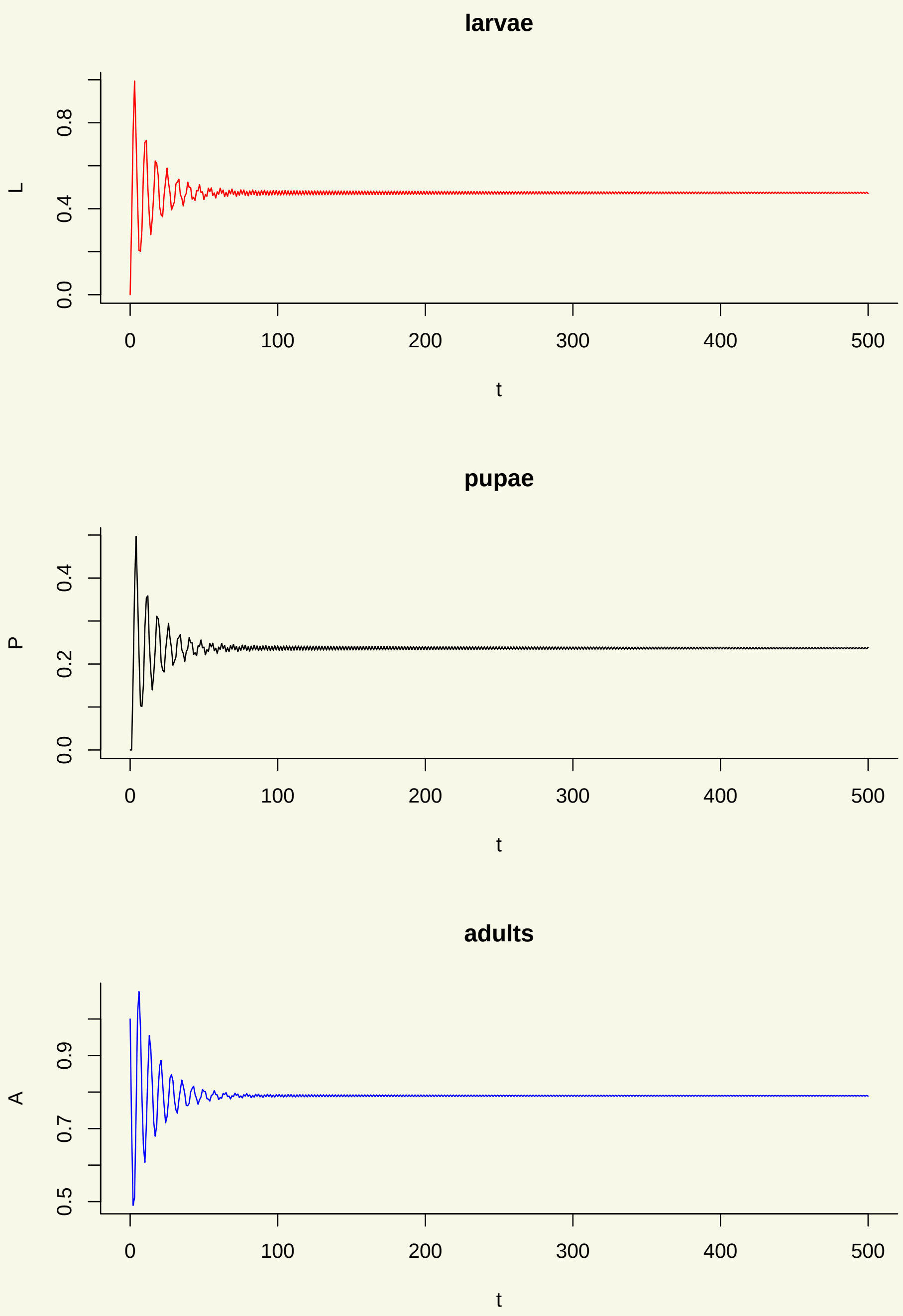


# Model kanibalismu

$$L(t+1) = bA(t)\exp\{-c_{ea}A(t) - c_{el}L(t)\}$$
$$P(t+1) = (1-\mu_l)L(t)$$
$$A(t+1) = \exp\{-c_{pa}A(t)\}\,P(t) + (1-\mu_a)A(t)$$

$b = 50$, $\mu_l = 0.5$, $\mu_a = 0.3$, $c_{ea} = 5$, $c_{pa} = 0$,

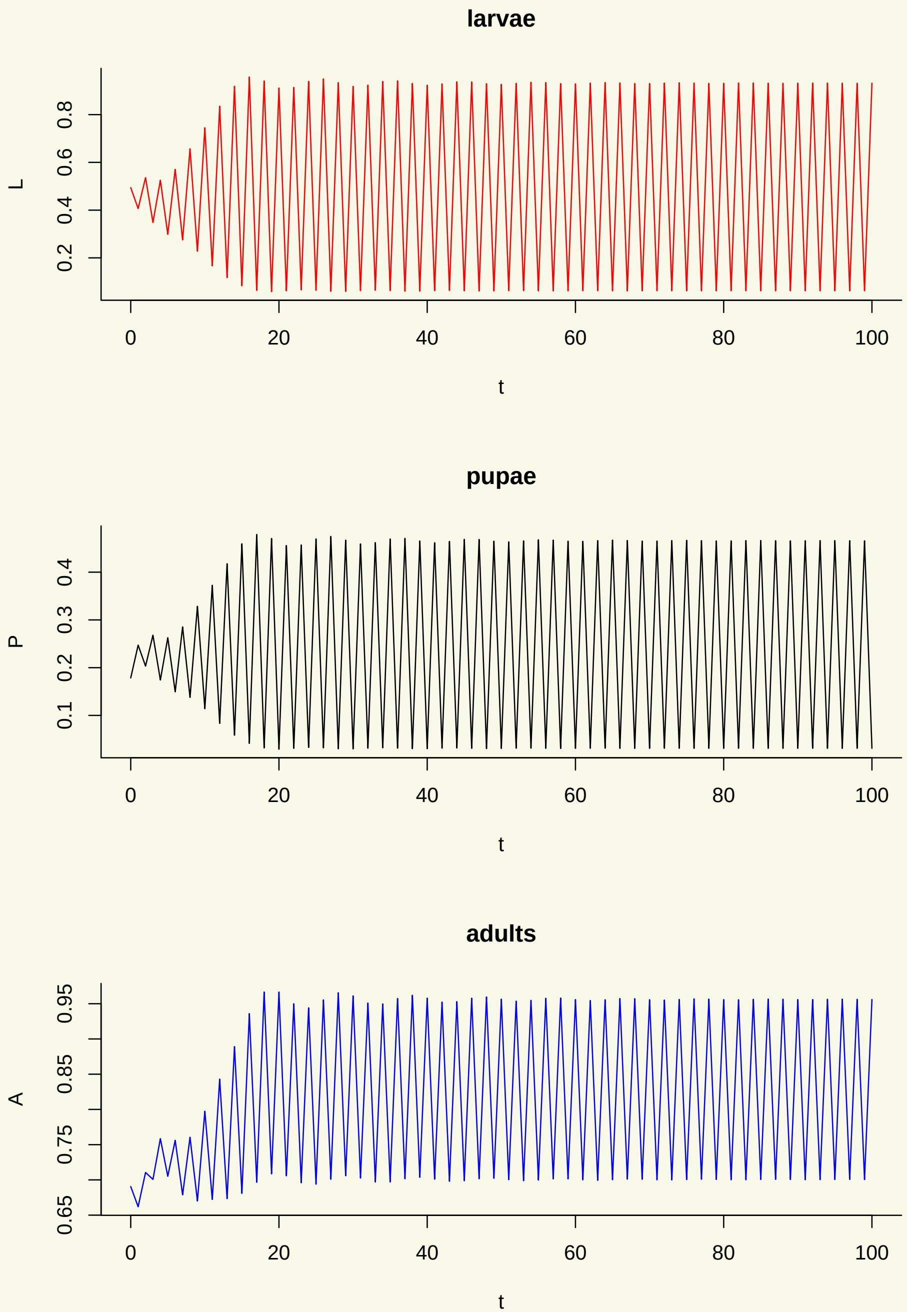
$c_{el} = 1$



# Model kanibalismu

$$L(t+1) = bA(t)\exp\{-c_{ea}A(t) - c_{el}L(t)\}$$
$$P(t+1) = (1-\mu_l)L(t)$$
$$A(t+1) = \exp\{-c_{pa}A(t)\}P(t) + (1-\mu_a)A(t)$$

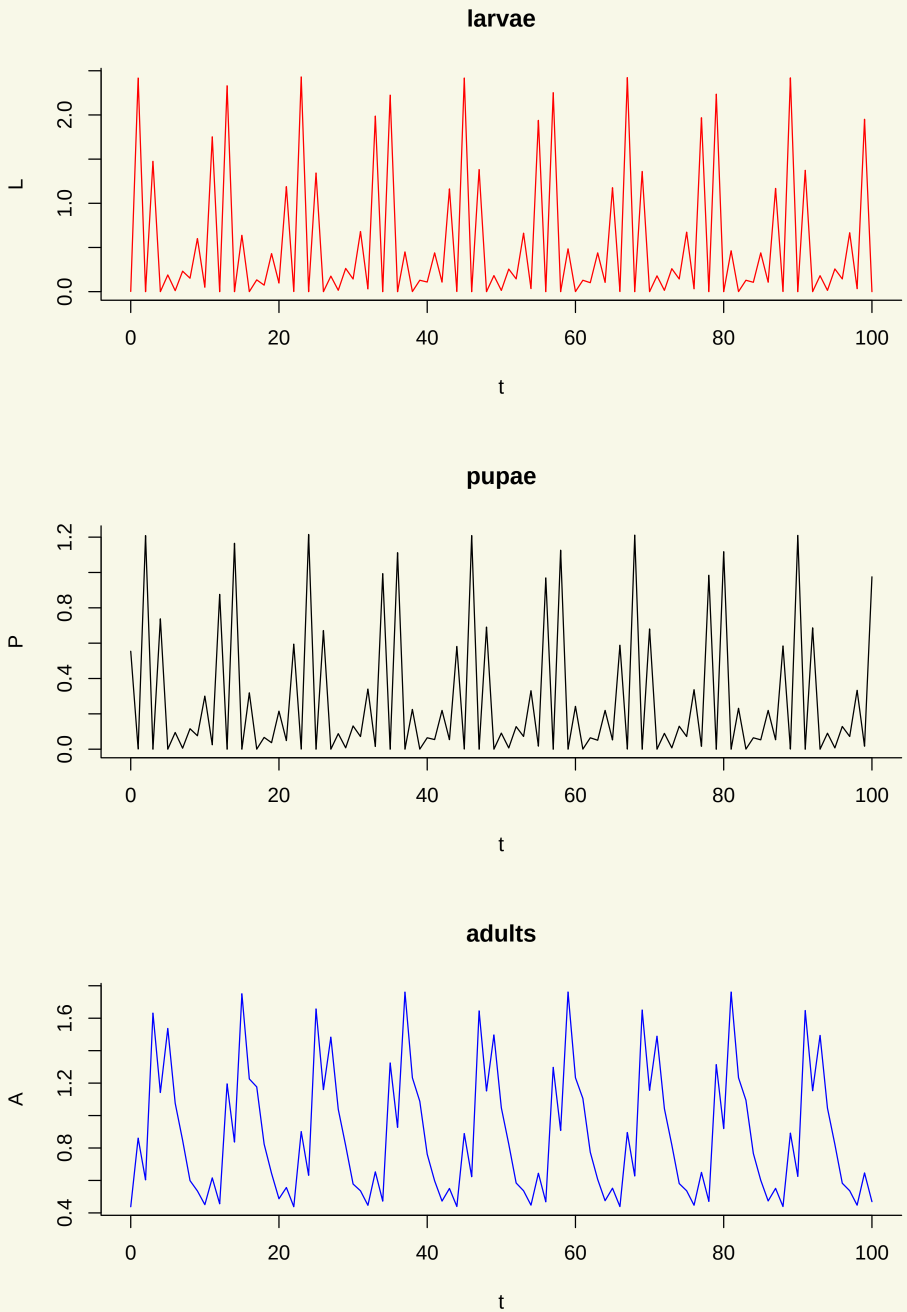
$b = 50$, $\mu_l = 0.5$, $\mu_a = 0.3$, $c_{ea} = 5$, $c_{pa} = 0$, $c_{el} = 2$



# Model kanibalismu

$$L(t+1) = bA(t)\exp\{-c_{ea}A(t) - c_{el}L(t)\}$$
$$P(t+1) = (1-\mu_l)L(t)$$
$$A(t+1) = \exp\{-c_{pa}A(t)\}\,P(t) + (1-\mu_a)A(t)$$

$b = 50$, $\mu_l = 0.5$, $\mu_a = 0.3$, $c_{ea} = 5$, $c_{pa} = 0$, $c_{el} = 6$



# Model kanibalismu

$$L(t+1) = bA(t)\exp\{-c_{ea}A(t) - c_{el}L(t)\}$$
$$P(t+1) = (1-\mu_l)L(t)$$
$$A(t+1) = \exp\{-c_{pa}A(t)\}\,P(t) + (1-\mu_a)A(t)$$

$b = 50$, $\mu_l = 0.5$, $\mu_a = 0.3$, $c_{ea} = 5$, $c_{pa} = 0$,
$c_{el} = 8$