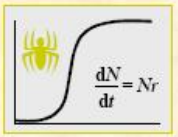

Temperature

„Populační ekologie živočichů“

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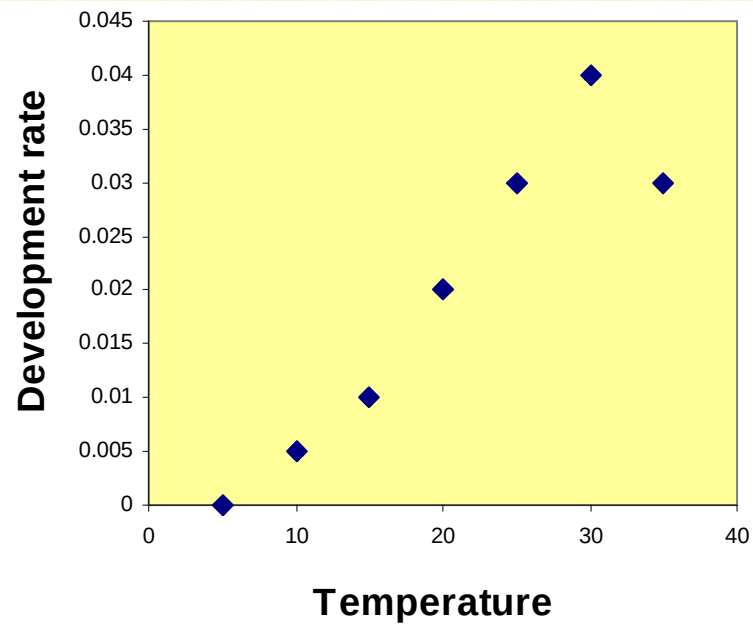
OP Vzdělávání pro konkurenceschopnost
INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

Linear model

- model is based on the assumption that development rate is a linear function of temperature
- valid for the region of moderate temperatures (15-25°)
- at low temperatures organisms die due to coldness, and at high temperatures organisms die due to overheating

D .. development time (days)
v .. rate of development = 1/*D*
t_{min} .. lower temperature limit
- temperature at which development rate = 0



ET.. effective temperature .. developmental temperature between t_{max} and $t_{\min}$

S .. sum of effective temperature .. number of degree-days [°D] required to complete development

.. does not depend on temperature = *D*ET*

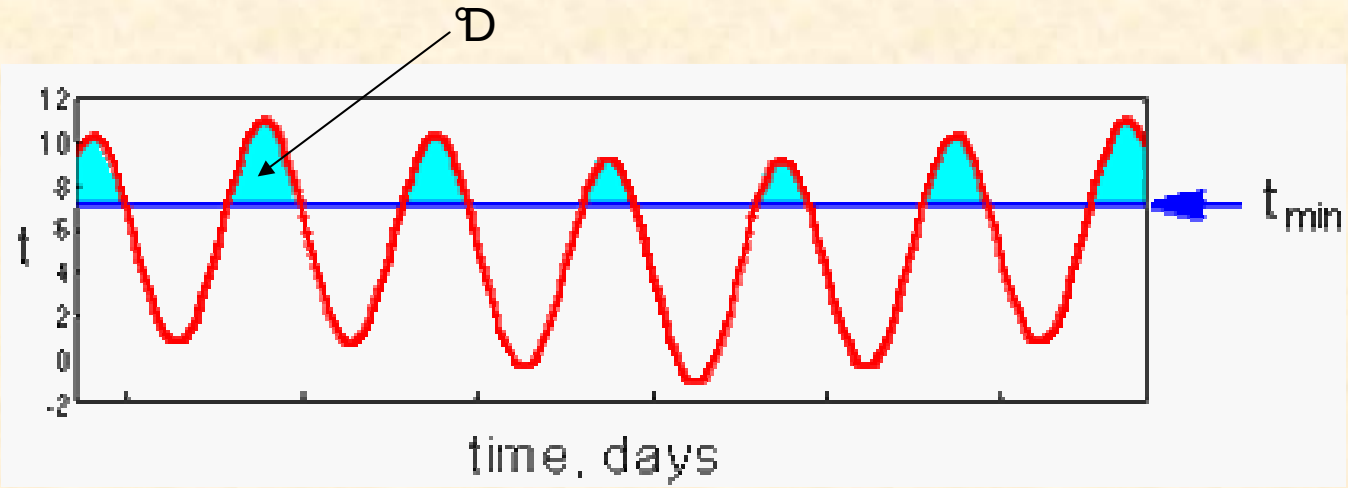
$t_{\min}$ and *S* can be estimated from the regression line of $v = a + bt$

$t_{\min}$: $a + bt_{\min} = 0 \Rightarrow \boxed{t_{\min} = -\frac{a}{b}}$

S : $S = D(t - t_{\min}) = D\left(t + \frac{a}{b}\right)$

$D = \frac{1}{v} = \frac{1}{a + bt} \Rightarrow S = \frac{t + a/b}{a + bt} \Rightarrow \boxed{S = \frac{1}{b}}$

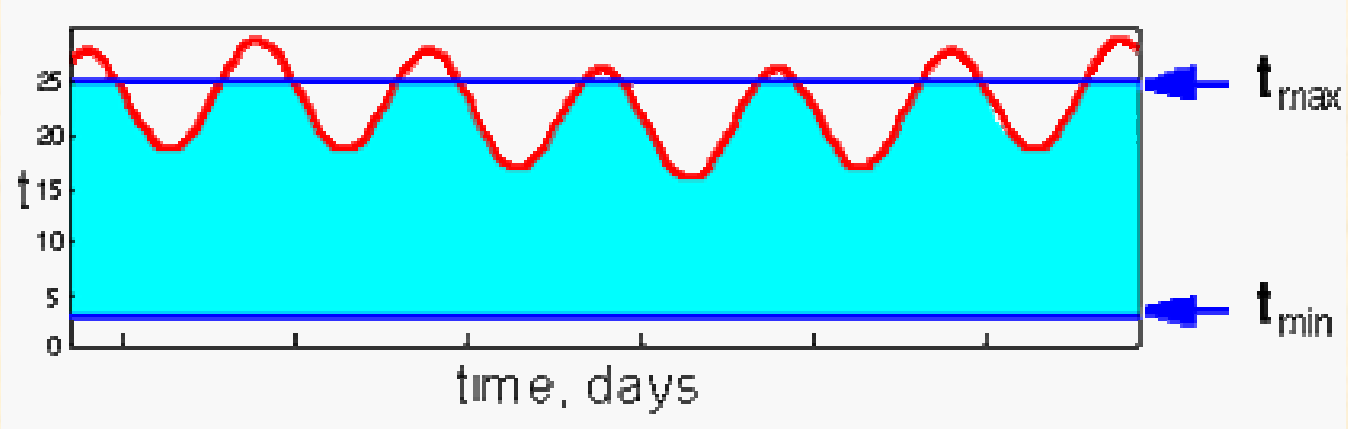
- sum of effective temperature (S) [°D] is equal to area under temperature curve restricted to the interval between current temperature (t) and t_{min}
- biofix .. the date when degree-days begin to be accumulated



$$S = \sum_{i=1}^{n} t - t_{min}$$

Non-linear models

- for temperatures between t_{min} and t_{max} (upper threshold)



- several different non-linear models (Briere, Lactin, etc.)
- allow to estimate t_{min}, t_{max} and t_{opt} (optimum temperature)
- easy to interpret for experiments with constant temperature
- instead of using average temperature, use actual temperature because below and above *ET* model is non-linear

Briere et al. (1999)

$$v = a \times t \times (t - t_{\min}) \times \sqrt{t_{\max} - t}$$

v .. rate of development (=1/D)
t .. experimental temperature
$t_{\min}$ .. low temperature threshold
$t_{\max}$ .. upper temperature threshold
a .. constant

Optimum temperature:

$$t_{opt} = \frac{4t_{\max} + 3t_{\min} + \sqrt{16t_{\max}^2 + 9t_{\min}^2 - 16t_{\min}t_{\max}}}{10}$$

- parameters are estimated using non-linear regression

Lactin et al. (1995)

$$v = e^{\rho t} - e^{\left(\rho t_m - \frac{t_m - t}{\Delta}\right)} + \phi$$

v .. rate of development
t .. experimental temperature
t_m, Δ, ρ, ϕ .. constants

t_{max} and t_{min} can be estimated from the formula:

$$0 = e^{\rho t} - e^{\left(\rho t_m - \frac{t_m - t}{\Delta}\right)} + \phi$$

t_{opt} can be estimated from the first derivative:

$$\frac{\partial v(t)}{\partial t} = \rho e^{\rho t} - \frac{1}{\Delta} e^{\rho t_m - \frac{t_m - t}{\Delta}}$$