An Extendable Software Package for Determining the Effects of Developmental Interactions on Evolutionary Trajectories

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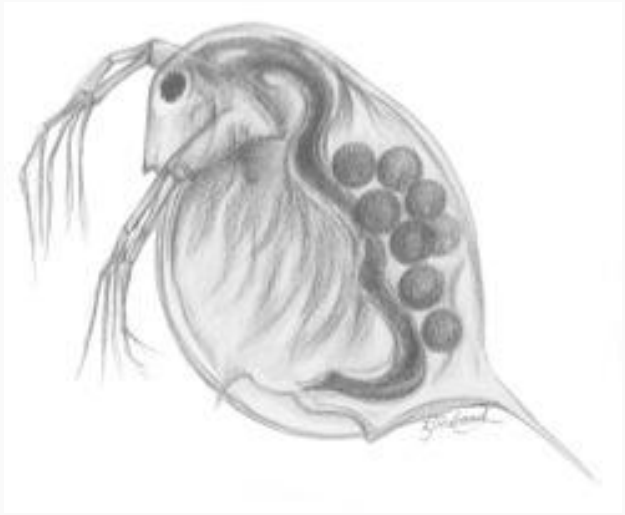
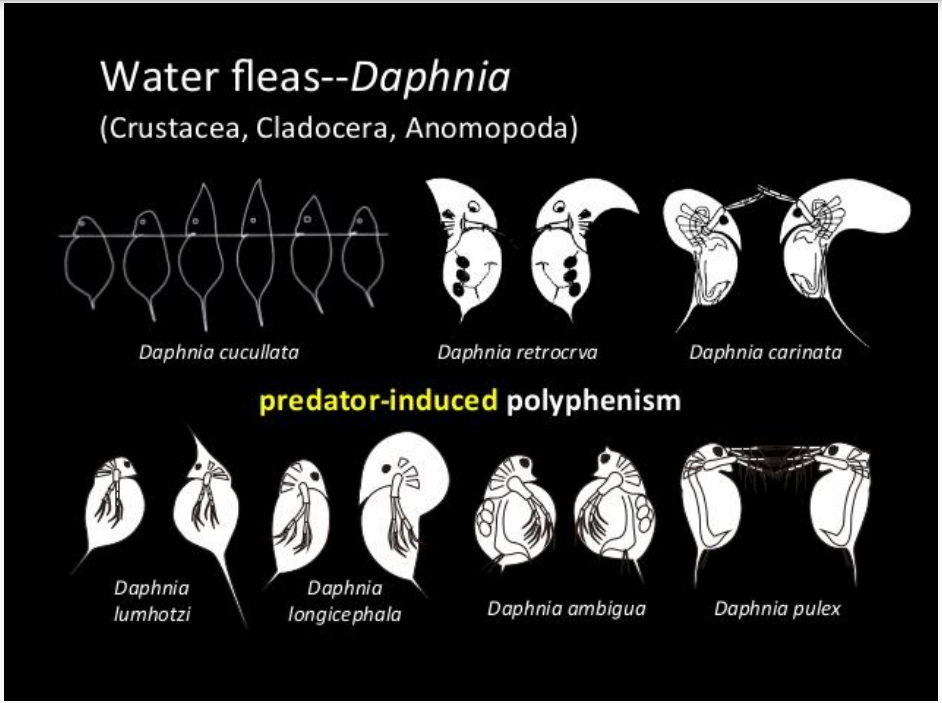
Biological Background Topics

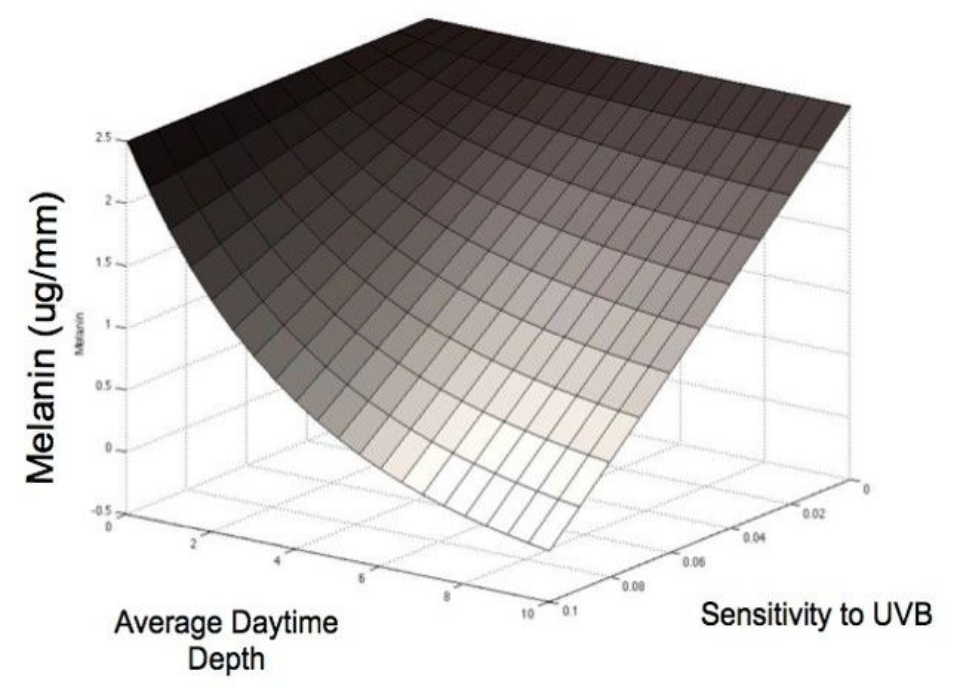
- Evolutionary Development
- Fitness
- Selection
- Developmental Interactions

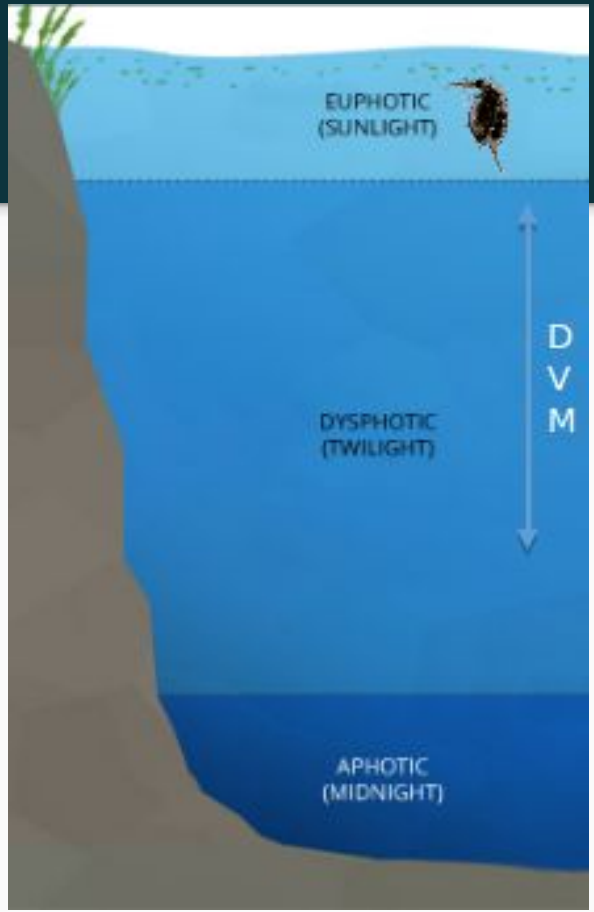


Evolutionary Development



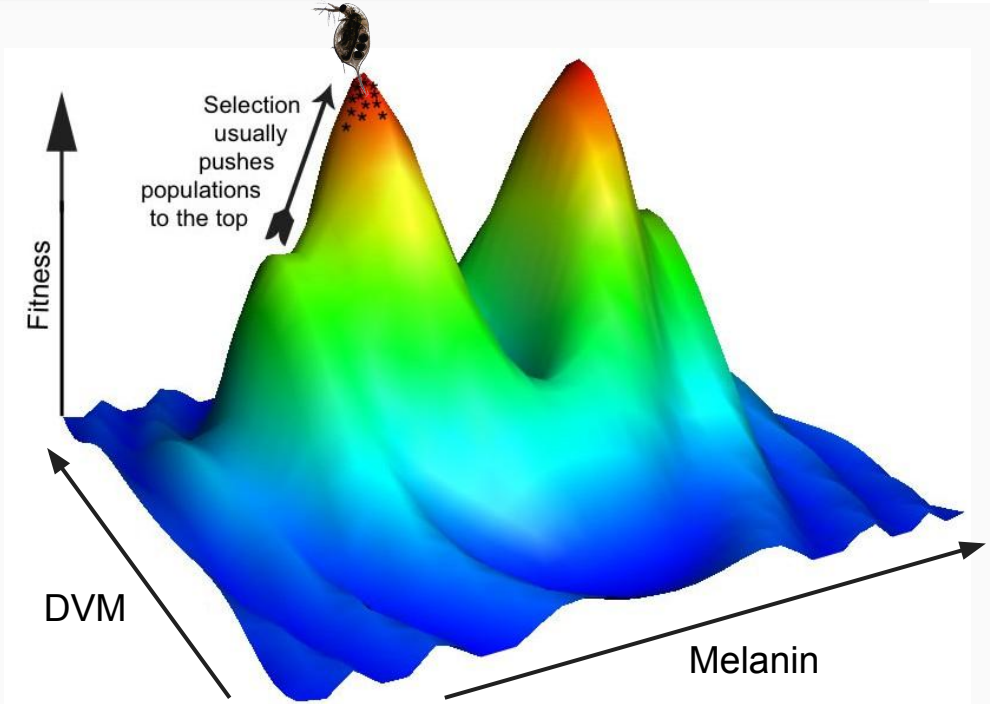
Developmental Interactions

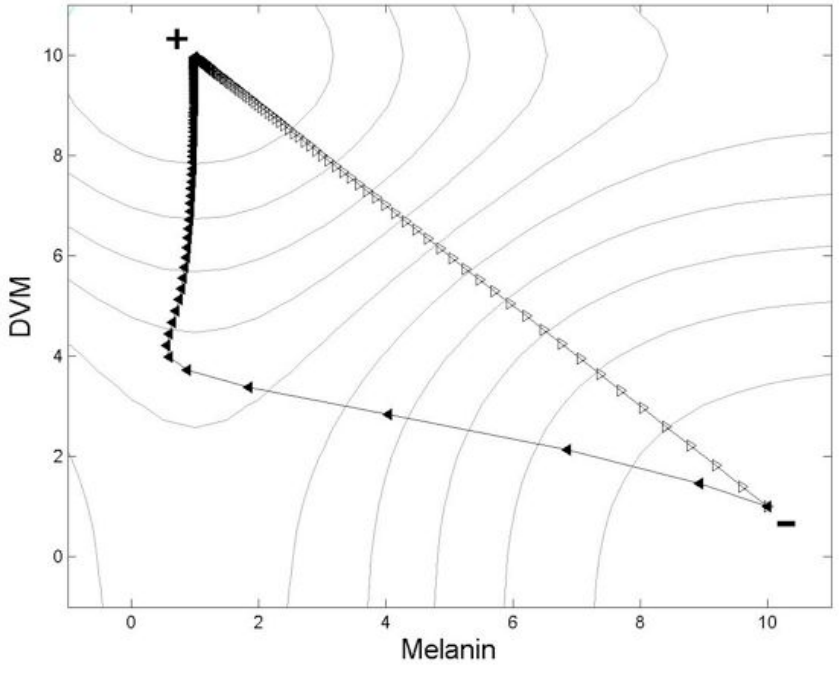




Fitness & Selection

$$w = \frac{1}{\sqrt{v_m 2\pi}} e^{-\frac{(m-\omega_m)^2}{2v_m}} + \frac{1}{\sqrt{v_d 2\pi}} e^{-\frac{(m-\omega_d)^2}{2v_d}}$$





Research Motivation

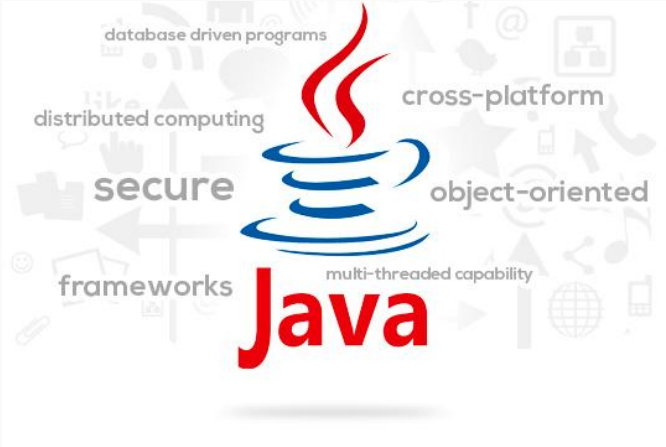
- Genes controlling one trait may overlap with genes influencing other traits.
- Traits often result from nonlinear interactions between developmental factors.
- Developmental interactions may result in large and rapid changes to trait (co)variances and the traditionally used genetic variance-covariance matrix (G-matrix).

Research Objectives

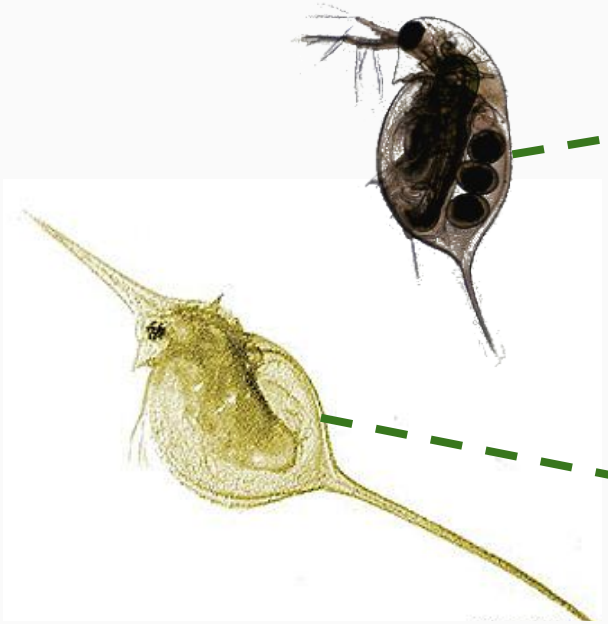
- Program to project the evolutionary trajectories of a given species.
- Implementation of traditional and updated mathematical models.
- Extendable software package for future developments.
- Graphical visualization of model results.

Software Development Topics

- Object-Oriented Program Structure
- Classic Mathematical Model
- Updated Mathematical Models
- Web User Interface
- Visualization of Results



Object-Oriented Program Structure



- Objects model the state and behavior of real-world systems or entities.

Daphnia melanica
Genus: *Daphnia*
Species: *melanica*

Animalia
Kingdom: Animalia
Family: Daphniidae

Daphnia lumholtzi
Genus: *Daphnia*
Species: *lumholtzi*

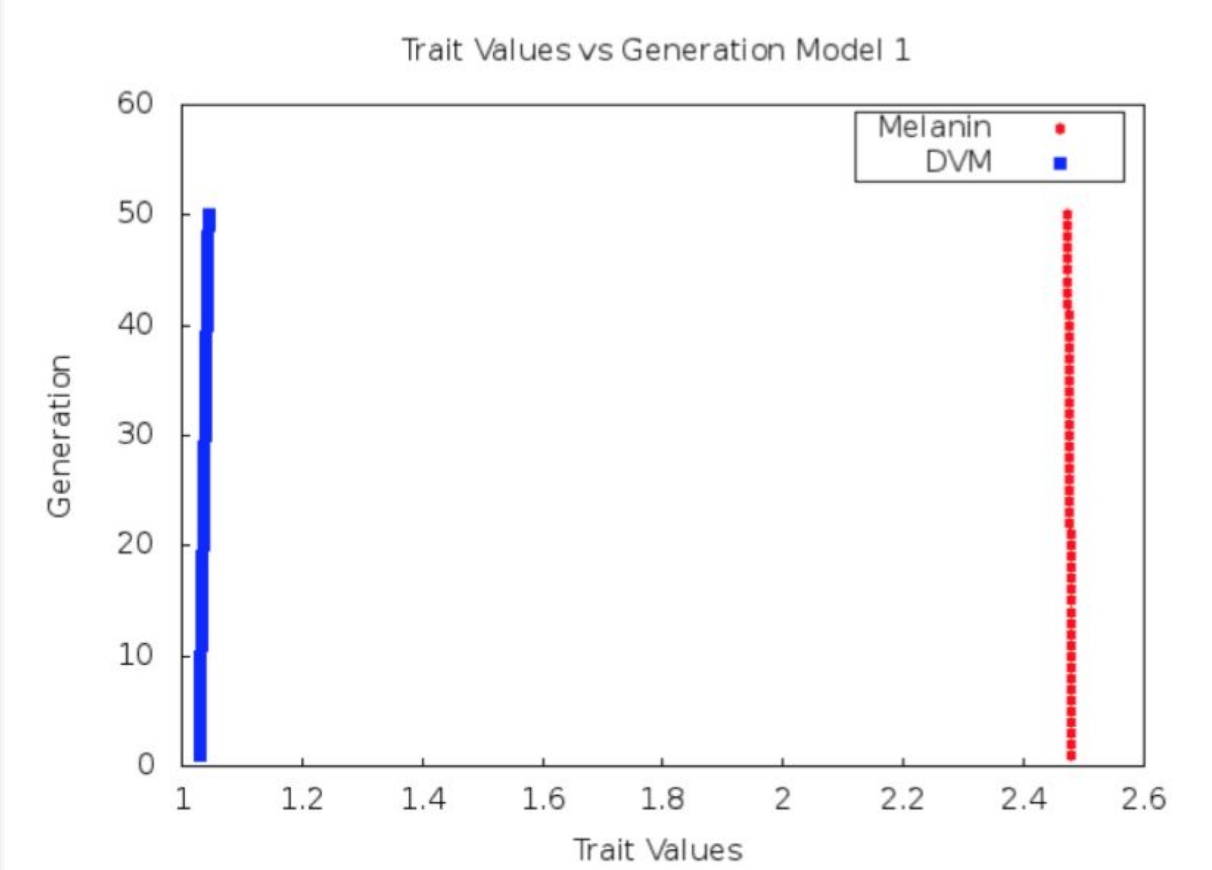
Real-World Domain

Model Domain

Classic Mathematical Model

Predicts the evolution of mean melanin and mean diel vertical migration (DVM) of Daphnia over time, based on the genetic (co)variances (G-matrix) of these traits.

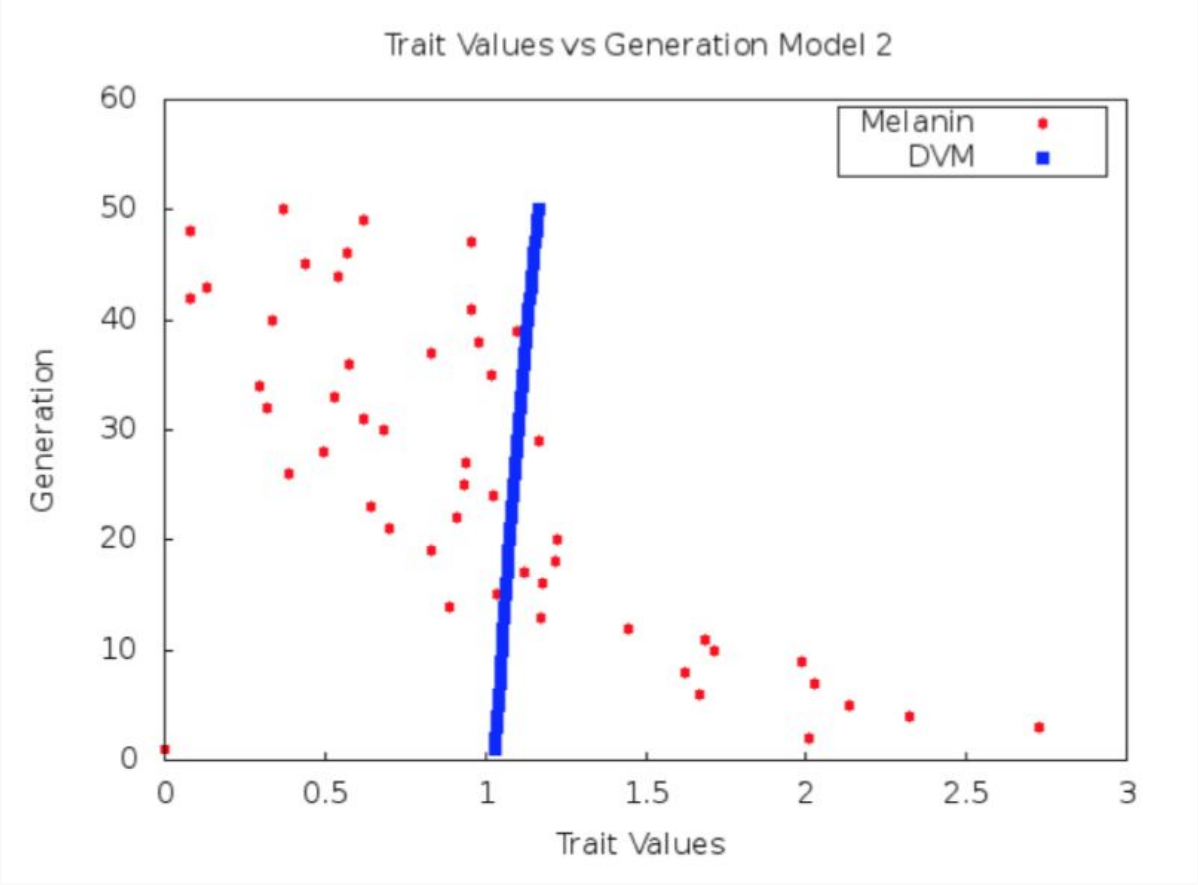
$$\overline{m}_{t+1} = \overline{m}_t + h^2 \frac{1}{\overline{w}} \frac{\partial w}{\partial m} \sigma_m$$



Updated Mathematical Model - Tanning

Predicts the evolution of mean melanin and mean diel vertical migration (DVM) over time, while allowing for nonlinear interactions between these traits.

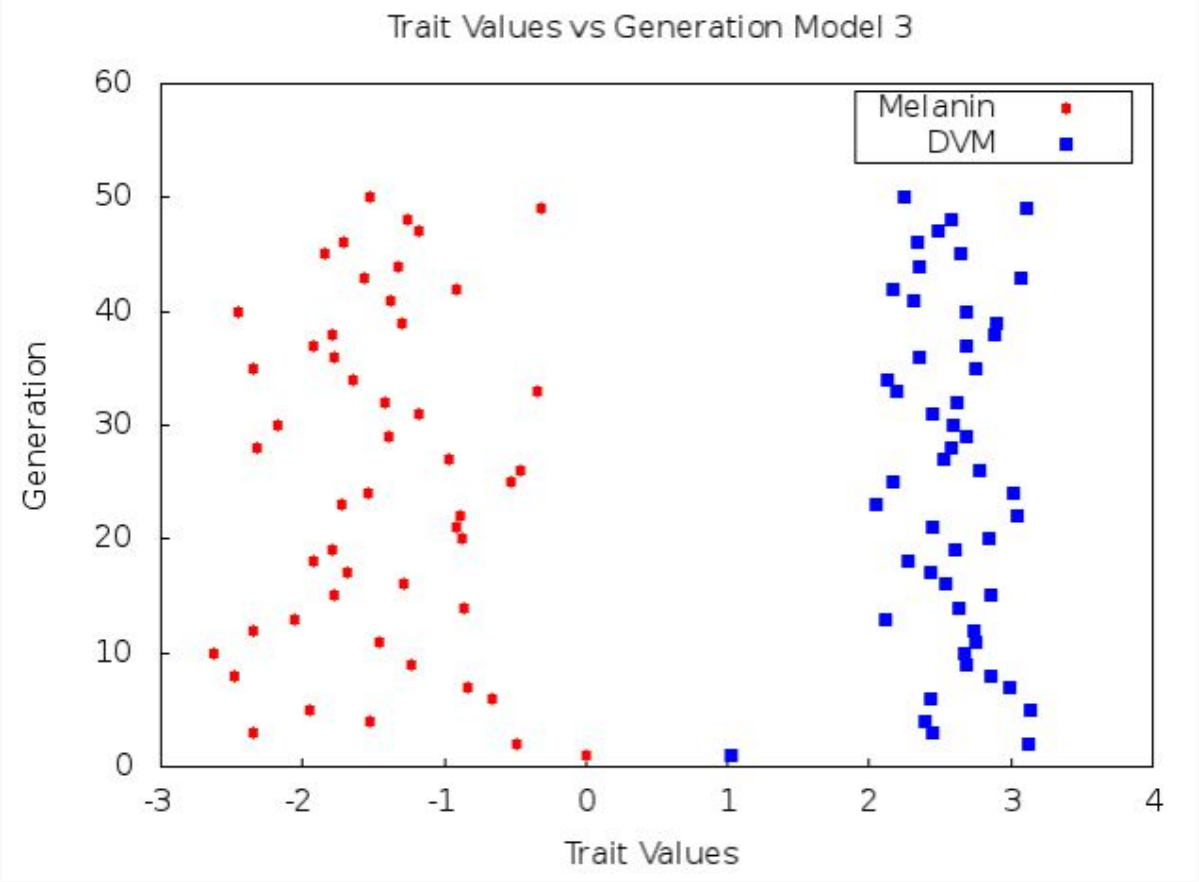
$$\overline{m} = \overline{z} + (-1 + e^{\frac{1}{2}K(-2\overline{d} + K\sigma_d)})\overline{p}u_0$$



Updated Mathematical Model - Tolerance

Predicts the evolution of mean melanin and mean diel vertical migration (DVM) over time, while allowing for more complex nonlinear interactions between these traits.

$$m = -pu_0 + z + \frac{2pu_0u_p}{tu_0 - bpu_0^2 + bu_0z + \sqrt{rbpu_0^2u_0 + u_0^2(-t + bpu_0 - bz)^2}}$$



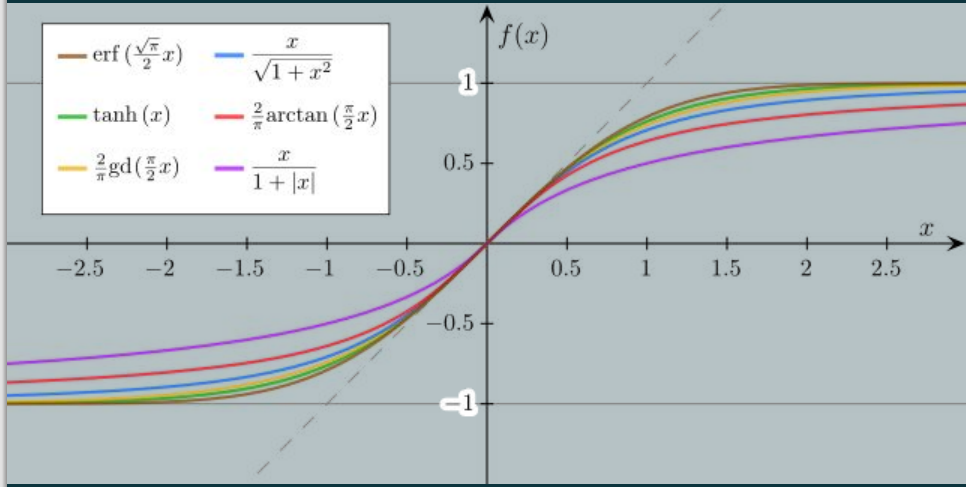
ModEvo Web Interface

Research Objectives - Revisited

- Program to project the evolutionary trajectories of a given species.
- Implementation of traditional and updated mathematical models.
- Extendable software package for future developments.
- Graphical visualization of model results.

Future Work

- Sigmoidal distributions
- User supplied functions
- Program optimization



References & Acknowledgements

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