interlocking ecological and evolutionary timescales

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Interlocking timescale: Eco-evolutionary model (van der Laan and Hogeweg)

A simple discrete Lotka-Volterra type model has been used with equations:

$$\frac{\Delta X_i}{\Delta t} = aX_i - bX_i \sum_{j=1}^{n} X_j - cX_i \sum_{j=1}^{n} \alpha_{ij} Y_j + \mu \{0.5(X_{i-1} + X_{i+1}) - X_i\}$$

$$\frac{\Delta Y_i}{\Delta t} = -dY_i + ecY_i \sum_{j=1}^{n} \alpha_{ji} X_j + \mu \{0.5(Y_{i-1} + Y_{i+1}) - Y_i\}$$

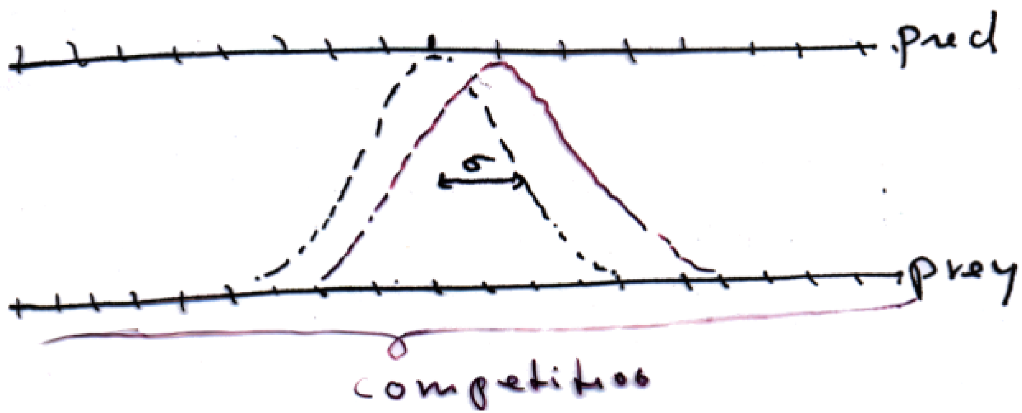
The Gaussian function for the interaction parameter ı

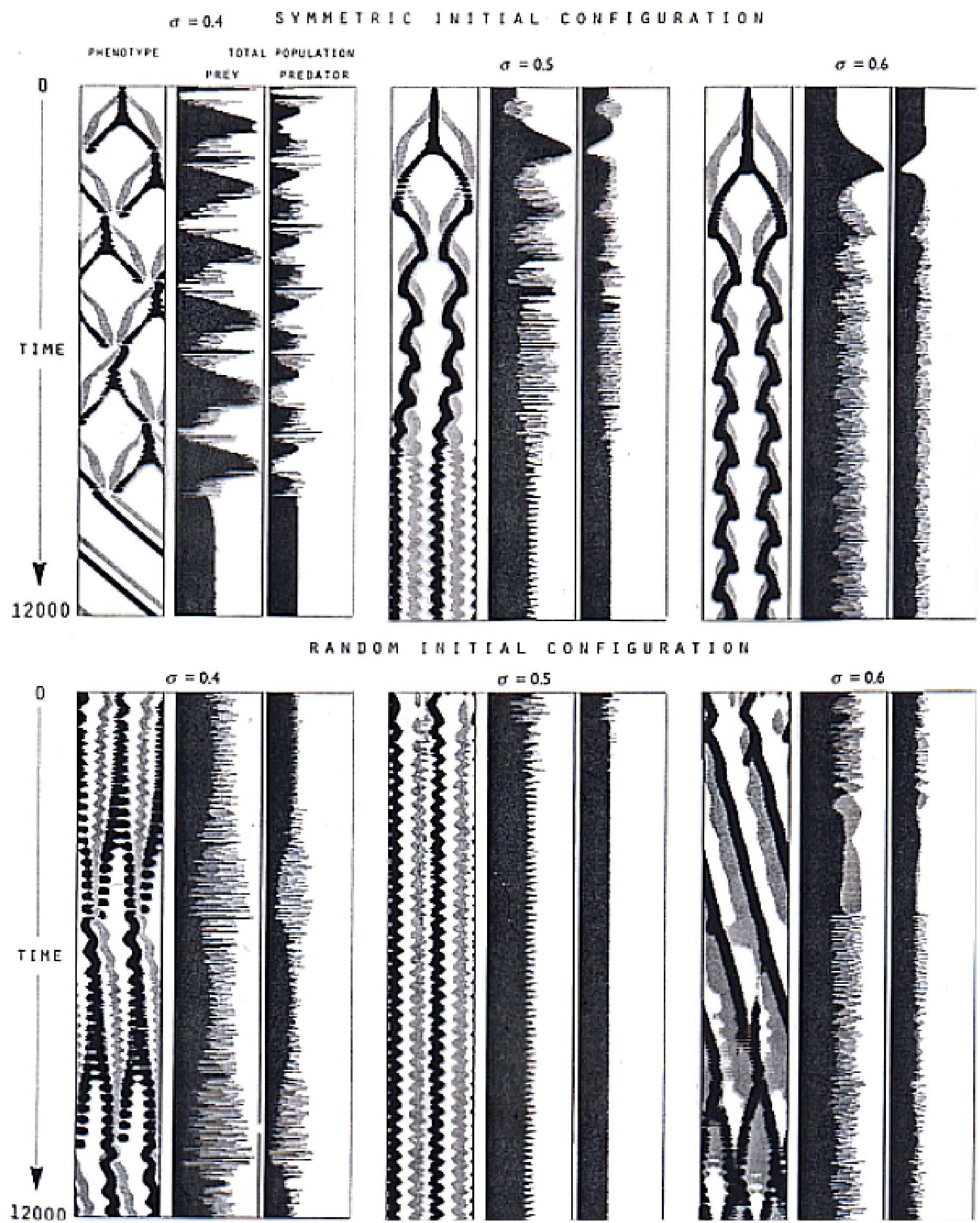
$$\alpha_{ij} = \frac{1}{\sigma} e^{-(Dist(i,j)_{min})^2 \, 2\sigma^2}$$

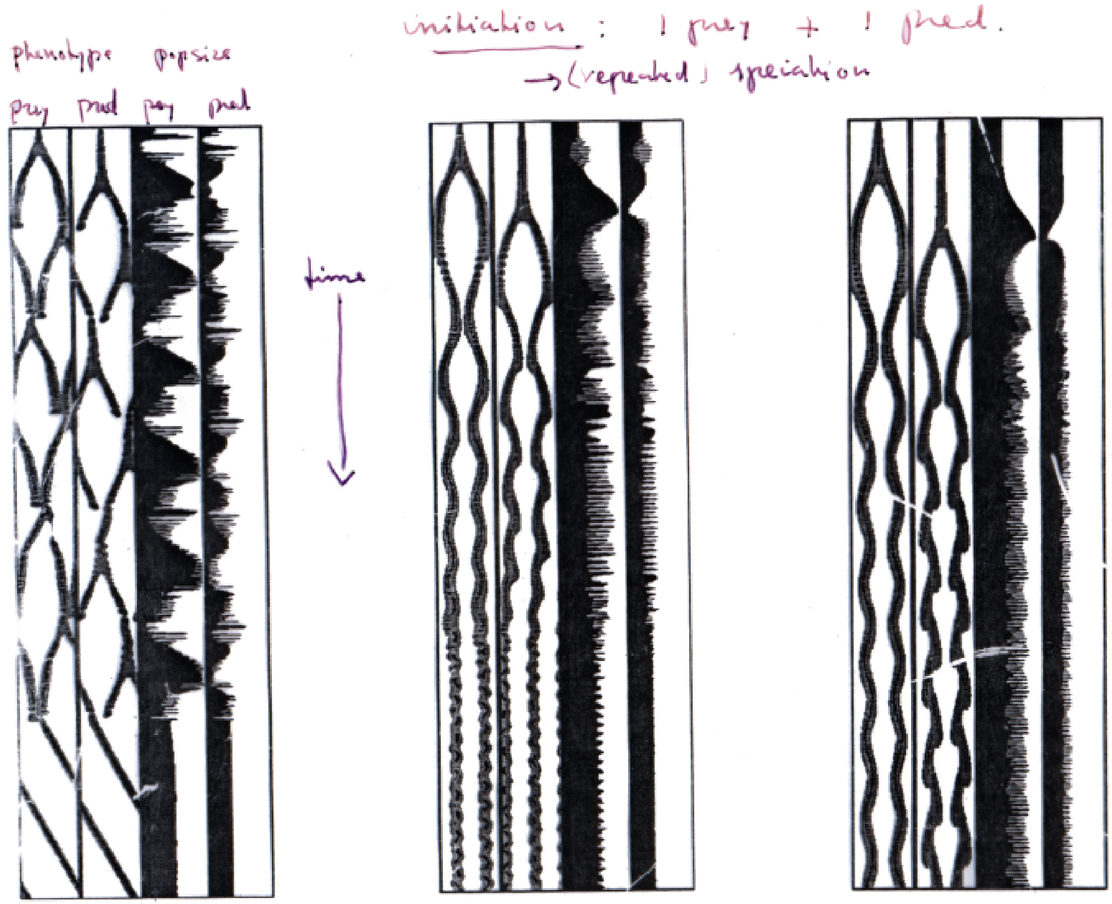
and α ranges from $\frac{1}{\sigma}$ to $\frac{1}{\sigma} e^{-1/2\sigma^2}$.

TABLE 1. Parameters of the eco-evolutionary model

a	1.0	natural rate of increase for prey
b	0.005	prey competition parameter
c	0.0055	interaction parameter (fixed part)
α	variable	interaction parameter (evolvable part)
d	0.5	mortality of predator
e	0.73	efficiency of predator
θ	0.00001	threshold density
n	60	total number of phenotypes (length of axis)
μ	0.001	mutation rate
σ	0.4 to 0.6	standard deviation of Gaussian interaction curve



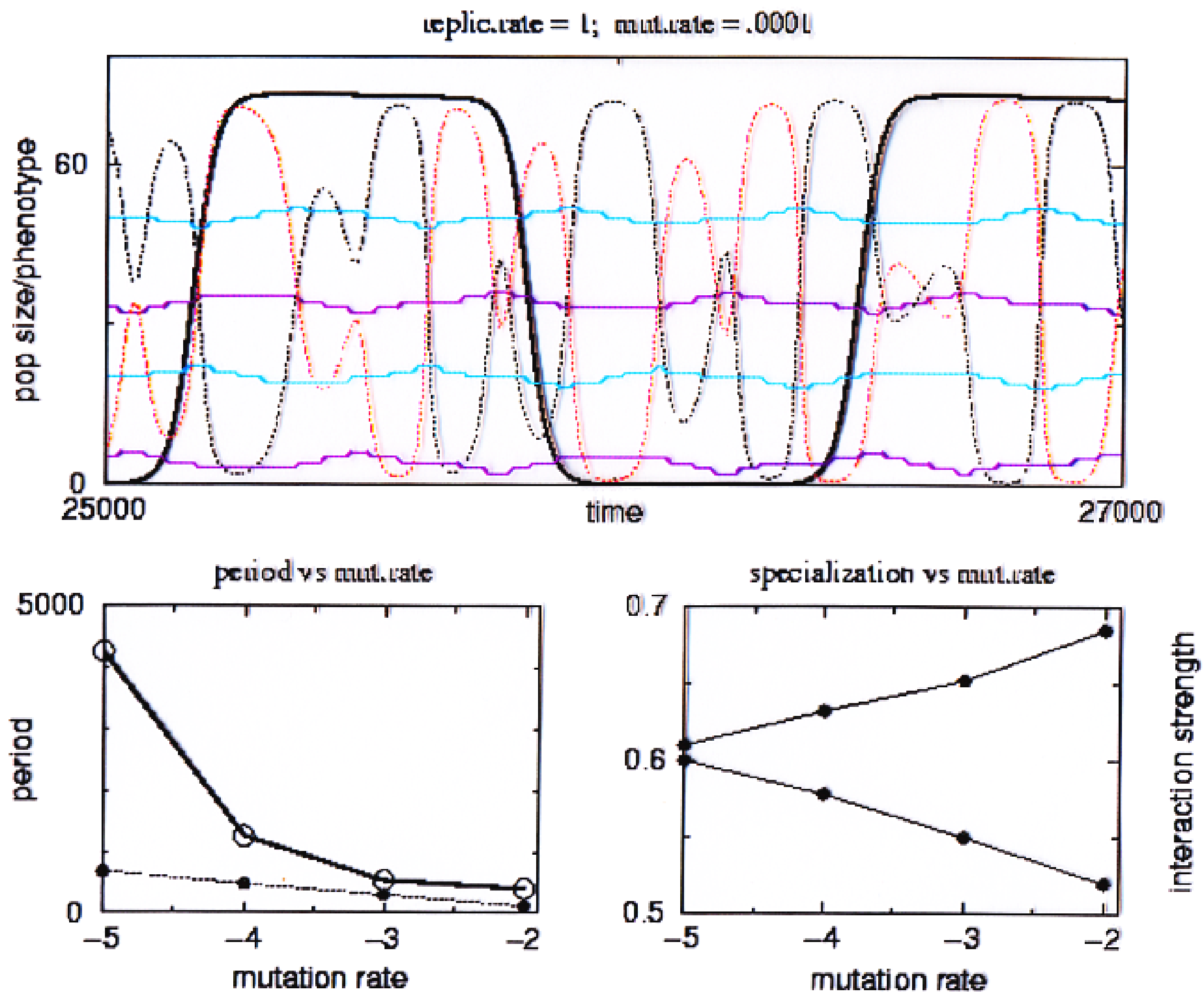

SYMMETRIC INITIAL CONFIGURATION
σ = 0.4
PHENOTYPE
TOTAL POPULATION
PREY
PREDATOR
σ = 0.5
σ = 0.6
0
TIME
12000
RANDOM INITIAL CONFIGURATION
σ = 0.4
σ = 0.5
σ = 0.6
0
TIME
12000


initiation : 1 prey + 1 pred.
→ (repeated) speciation
phenotype
popsize
prey
pred
prey
pred
time

σ = .4 (a) σ = .5 (b) σ = .6 (c)

Fallacy of separation of timescales:
ecological timescale $>$ eco-evolutionary timescale

eco– vs eco–evol dynamics



conclusion: ecological vs eco-evolutionary dynamics

Evolutionary (mutational) variation can stabilize ecosystem

stopping mutation $--$ > collapse of ecosystem

Nevertheless different lineages ('species')
with different niches (ecological functions)

Species and interactions selected for how they cope with mutation rates.

speciation(?)

compare this example, quasispecies, question 5b