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Divergent evolution of genetic sex determination mechanisms along environmental gradients

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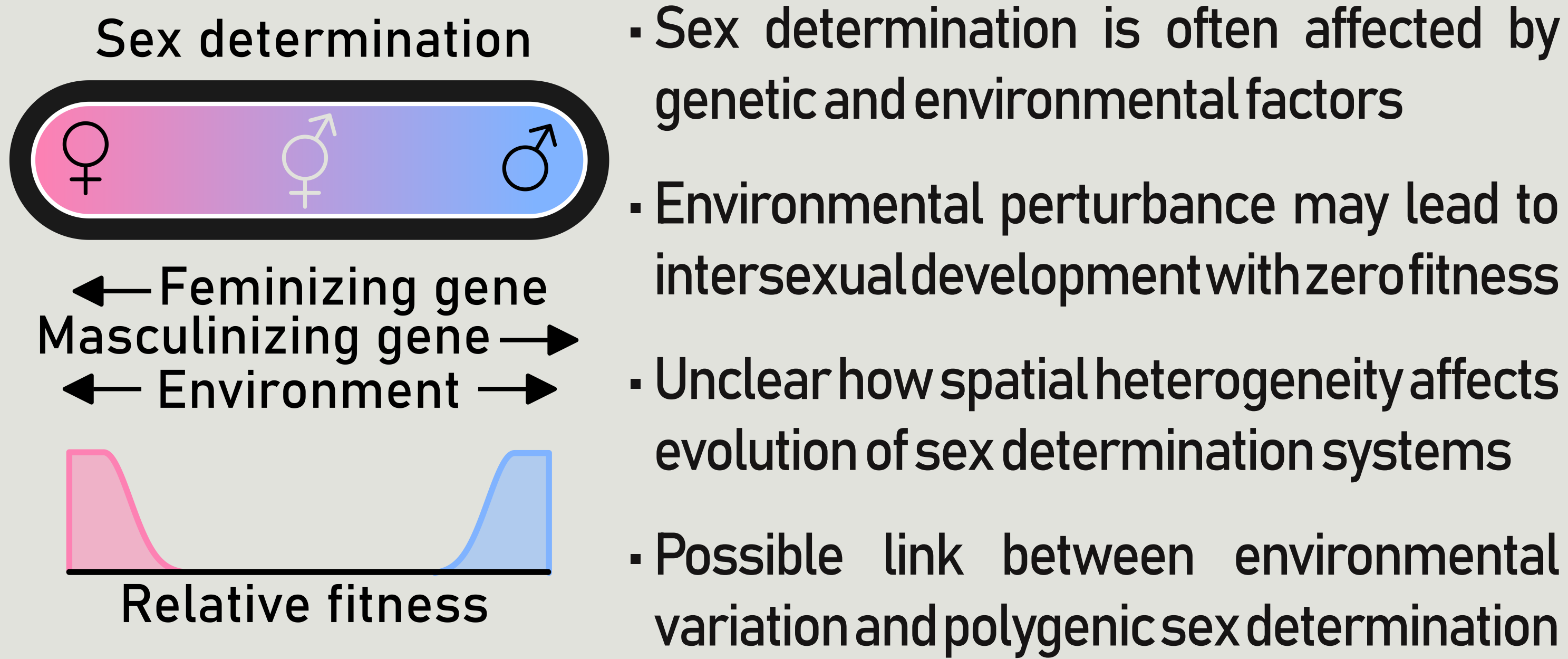
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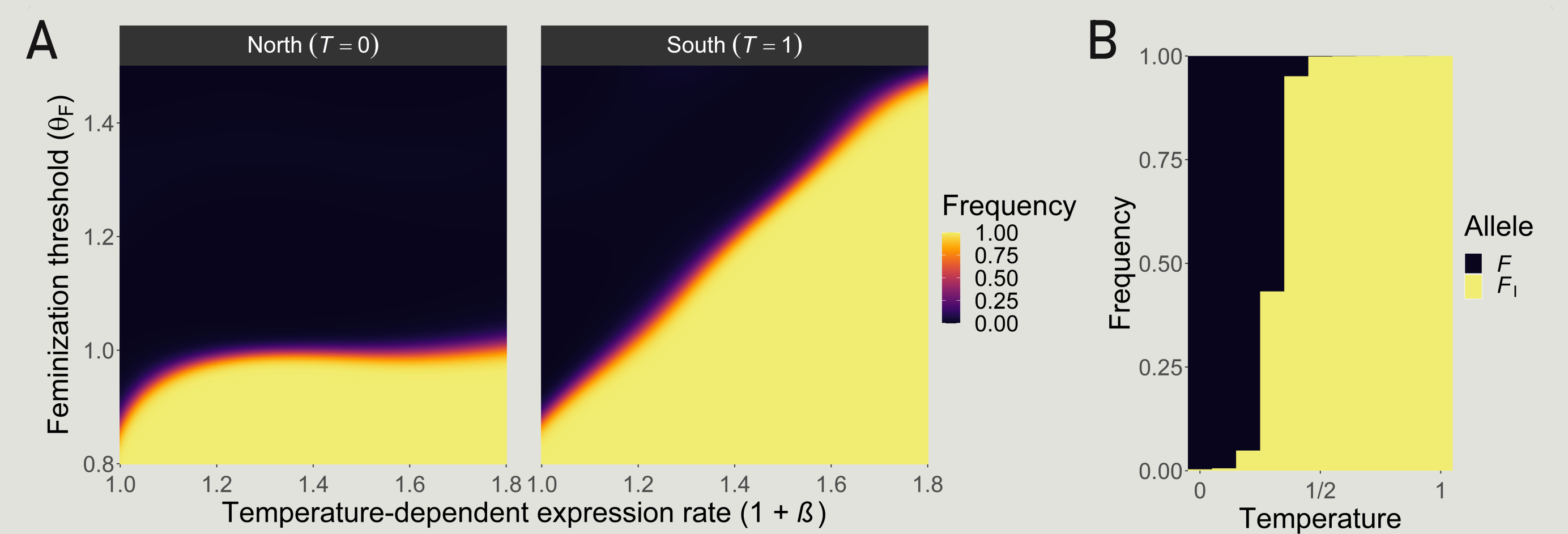
Background information

Main question: How do genetic sex determination systems evolve when gene expression is influenced by environmental conditions?



Evolution of a dominant feminizer F_1

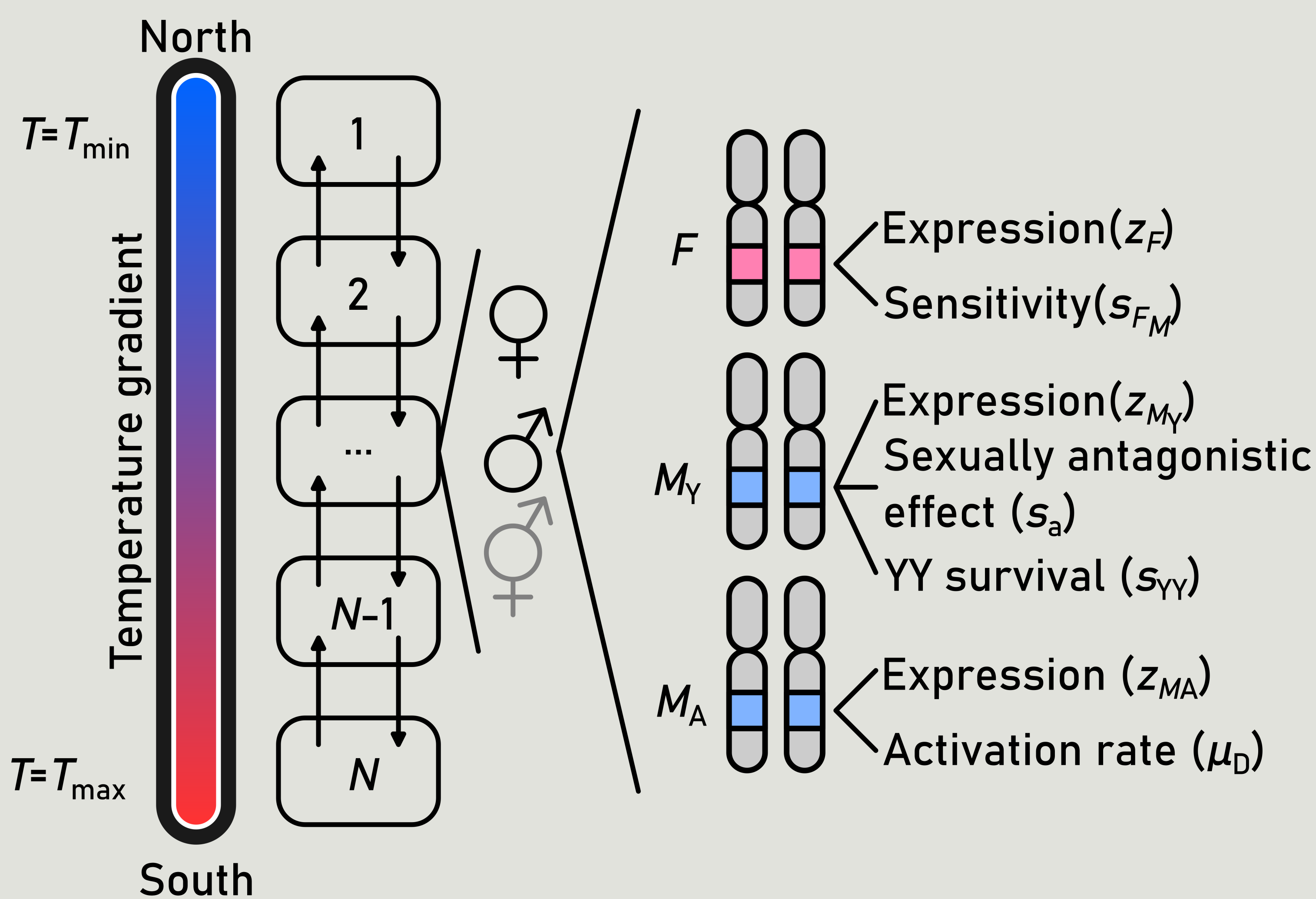
F_1 : fully insensitive to M_Y and M_A , net expression exceeds θ_F , so that carriers are always female



(A) F_1 evolves when feminization threshold θ_F is low (left) or when temperature-dependent overexpression becomes sufficiently strong (right)

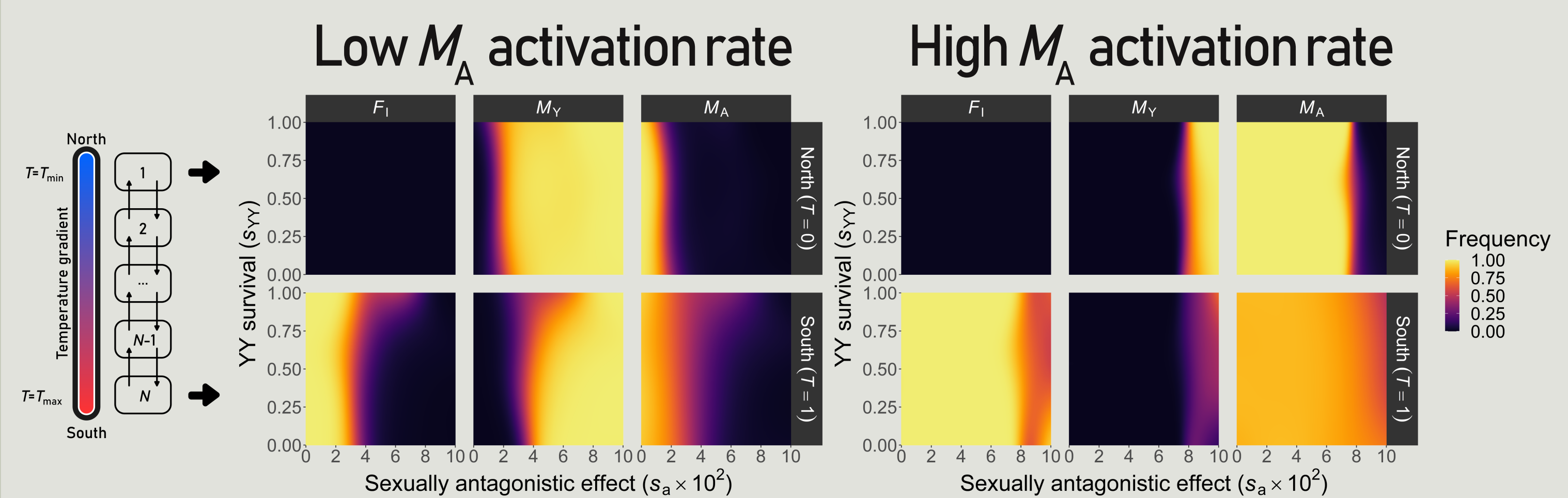
(B) Temperature-dependent invasion of F_1 may be restricted to warmer demes; environmental variation leads to within-population differentiation

Model overview



- Agent-based simulations
- Demic population with dispersal
- Non-overlapping generations
- Ancestral Y-chromosome M_Y with fitness effects
- De novo* evolution of M_A

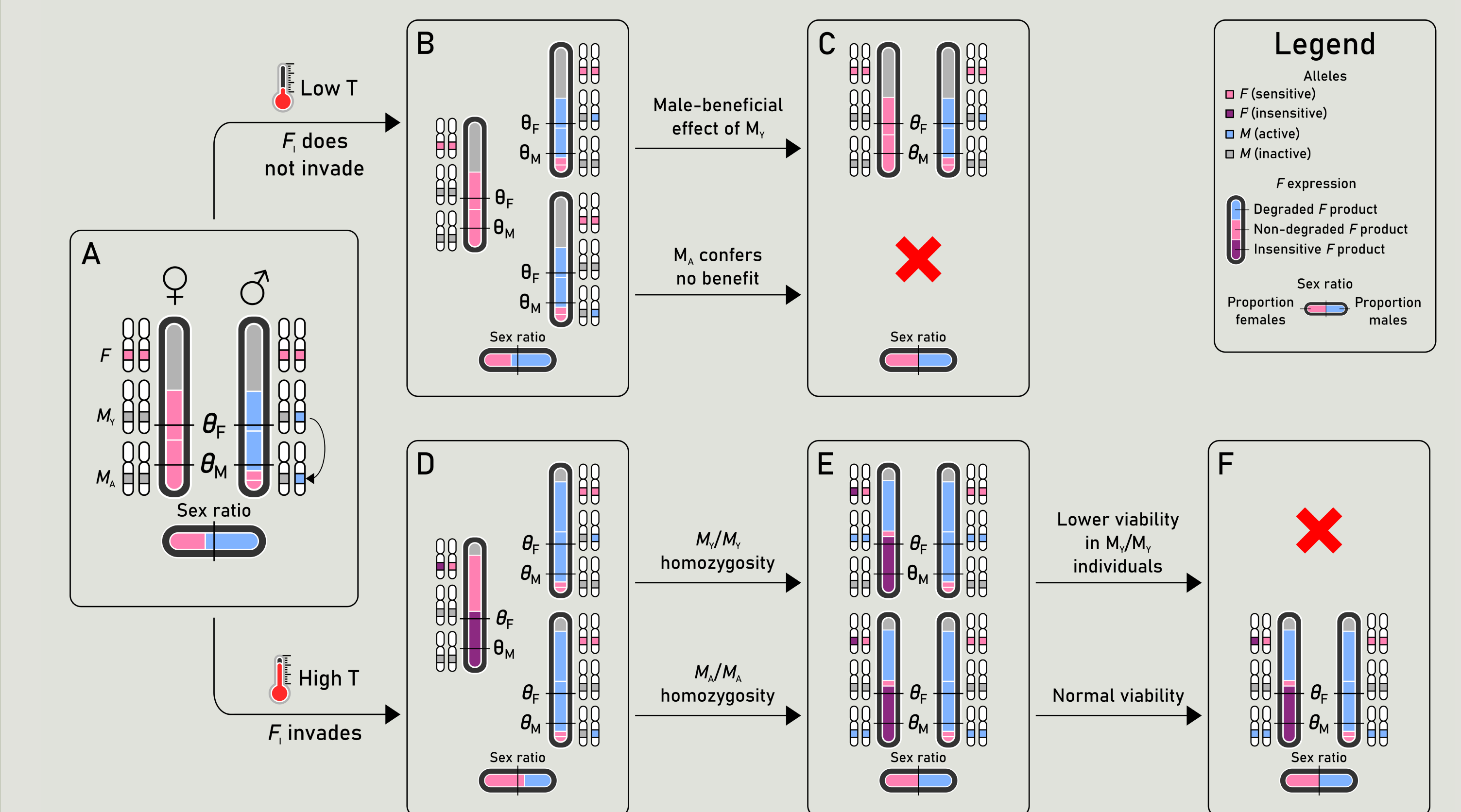
Frequency gradients at multiple loci



F_1 frequency gradients shaped by temperature; net expression too low at $T=0$ for F_1 to evolve, but sufficient at higher temperatures

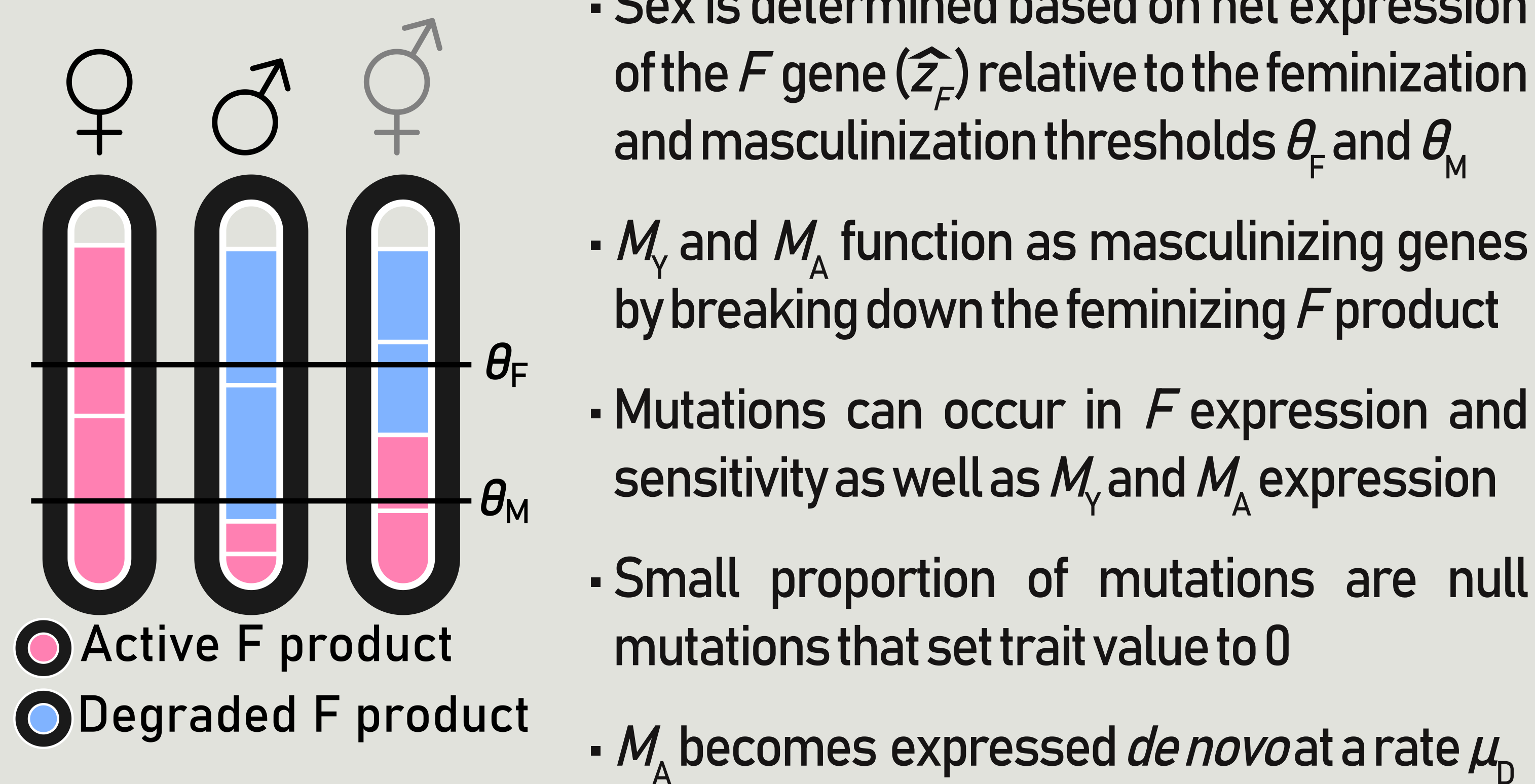
M_Y versus M_A polymorphism: sexual antagonistic selection maintains M_Y over M_A in absence of F_1 ; costs in females and reduced viability in YY homozygotes drive M_Y loss, followed by fixation of M_A in presence of F_1

Conclusion



Environment modulates scope for evolutionary change, promoting divergent evolution leading to polygenic sex determination

Sex determination gene functions and evolution



$$\hat{z}_F = \sum_{i=1}^2 \max(0, (z_{Fi} (1 + \beta T) + \varepsilon) (1 - s_{FM_i} \sum_{j=1}^2 z_{MY_j} + z_{MA_j}))$$

Total F product

F genetic expression level

Local temperature

Sensitivity to M

M_A expression

Temperature effect coefficient

Noise (Gaussian)

F expression (with temperature effects and noise)

Total M expression

M -dependent breakdown rate of F

Funding



Read the paper!

