Electrodynamic Organisms

Second Edition
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Dedicated to the Kiwi Farms

(*A gardener and his apprentice are at the Party Secretariat Garden for Agricultural Advancement and Collective Horticulture. They have traveled here today, from a far corner of the republic and along a very great distance, to deliver a lecture of novel uniquity and to commune with other like minded individuals.*

The State Secretary of Farming Collectives has designated this school to be the all-republic representative of advanced farming practices, and it is not uncommon for a great many varieties of different individuals to present their idiosyncratic theories here. The greatest party members from these diverse fields have gathered for a reception celebrating the natural and abstract sciences, eager to learn about new ideas originating from the remote regions of their great democratic republic. Biologists, physicists, philosophers, and theorists have come together in a grand conference lasting over the course of a week to share knowledge and hear about the latest advancements in agricultural research. They hope that, through their efforts, they can advance and strengthen not only science but also philosophy and the personal religious beliefs held by each attendee. They are assembled in a vast auditorium, listening to speakers one after another.

They continue all day and into the night, into the next day, the next night, and finally into the following morning. Many different papers have been presented, and quite a few lectures have gone for hours on end.

Finally, it comes time for the gardener to present himself. After allowing the ovation to settle from the previous speaker, he rises at the call of his name and assumes the podium. The audience, of whom some are aware of this speaker, offer a polite applause.)

He begins:

“I have previously expressed an interest in highly theoretical ideas related to the relationship between the Lotka-Volterra model of predator-prey population dynamics and Maxwell’s electromagnetic equations. My endeavors made before were messy. I am now attempting to express this concern more clearly and concisely.

I noticed that there is a unification in the similarity between the mathematical frameworks of both the predator-prey models and the equations for electromagnetism. It is, *as if*, the fundamental mathematical reality of these two disparate areas are actually the same. This is particularly so in the context of differential equations and field theories. Abstracting away all of the irrelevant data leaves a similar mathematical core to each. I will present here my combined model.

We will be assuming that the organisms in the predator-prey equations are abstract mathematical entities that can be represented by charged particles. We will be representing the populations as fields. If we make these assumptions we can consider the dynamics of these interactions in a way that was previously unmodeled. Allow me to describe this model further and in more detail:

1. Variables and Parameters

Population Densities

$x(t)$: Prey population density at time t.
$y(t)$: Predator population density at time t.

Electric and Magnetic Fields

$E_x(t)$: Electric field generated by prey population.
$E_y(t)$: Electric field generated by predator population.
$B_x(t)$: Magnetic field generated by prey movement.
$B_y(t)$: Magnetic field generated by predator movement.

Parameters

α: Prey intrinsic growth rate.
β: Predation rate coefficient.
δ: Predator consumption efficiency.
ϒ: Predator mortality rate.
k_1, k_2: Spatial diffusion coefficients for predator and prey populations.
r_x, r_y: Selection rates for prey and predator.
μ_x, μ_y: Mutation rates.
λ_x, λ_y: Coupling constants for electric field curl terms.
η_x, η_y: Coupling constants for magnetic field terms.

2. Model Equations

Maxwell's Electromagnetic Equations (with curl terms)

Prey-Generated Electric Field E_x:

$$\nabla \times E_x = - \partial B_x/\partial t + \lambda_x(\nabla \cdot x(t))$$

The curl of the electric field represents the feedback between the prey's spatial distribution and population density.

Predator-Generated Electric Field E_y:

$$\nabla \times E_y = -\partial B_y/\partial t + \lambda_y(\nabla \cdot y(t))$$

The curl of the electric field for predators represents the influence of predator density on the field.

Prey-Generated Magnetic Field B_x:

$$\nabla \times B_x = \mu_0 J_x + \mu_0 \varepsilon_0 \cdot \partial E_x/\partial t + \eta_x(\nabla \cdot v_x)$$

The magnetic field generated by the prey population's movement induces rotational feedback. The curl of the magnetic field represents the rotational effects of prey population movement, analogous to moving charges generating magnetic fields.

Predator-Generated Magnetic Field B_y:

$$\nabla \times B_y = \mu_0 J_y + \mu_0 \varepsilon_0 \cdot \partial E_y/\partial t + \eta_y(\nabla \cdot v_y)$$

The magnetic field generated by predator movement influences its spatial dynamics. The curl of the magnetic field for predators represents rotational effects caused by predator movement.

Electric and Magnetic Fields Generated by Population Movements:

Prey-Generated Electric Field:

$$E_x(t) = k_2 \cdot \nabla x(t)$$

The electric-field generated by the spatial distribution of the prey population.

Predator-Generated Electric Field:

$$E_y(t) = k_1 \cdot \nabla y(t)$$

The electric field generated by the spatial distribution of the predator population.

Predator-Prey Population Dynamics with Electromagnetic Effects:

Prey Population Dynamics with Electric Field and Curl Effects:

$$\frac{dx}{dt} = \alpha x - \beta xy + k_2 \cdot \nabla x(t) + E_x(t) + \xi_x \nabla \times (\nabla \cdot v_x)$$

The curl term $\xi_x \nabla \times (\nabla \cdot v_x)$ represents the feedback loop of prey movement affecting its growth and spatial dynamics.

Predator Population Dynamics with Electric Field and Curl Effects:

$$\frac{dy}{dt} = \delta xy - \Upsilon y + k_1 \cdot \nabla y(t) + E_y(t) + \xi_y \nabla \times (\nabla \cdot v_y)$$

The curl term $\xi_y \nabla \times (\nabla \cdot v_y)$ represents how predator movement induced rotational feedback into its population dynamics.

With these equations it becomes very easy to understand second order effects from first order population dynamics like those in predator-prey communities. The model could be expanded to take into account various other physical properties, like relativity, wave dynamics, and spin. As it turns out, electric and magnetic field analogies provide an excellent framework for integrating complex interactions. This model could be used in ecosystem management, epidemiology, and the studies of pattern formation. A comprehensive understanding of these implications would require a fully explicit model, of which is beyond my creative abilities.

To finish I would like to point out a few areas for advancement. I would like to include vectors and velocities in the model to more accurately model the diffusion dynamics and spatial interactions. The model also sets up interesting and very challenging problems in oscillations, perturbations, and equilibriums. The model inherently suggests complex and unpredictably chaotic patterns. Perhaps theoretical-mathematico model species could be developed in this way. Thank you."

References

I was greatly influenced for the project by the paper titled, "Cosmic Life Forms" by Attila Grandpierre that was published in Springer's 2009 textbook titled, "From Fossils to Astrobiology: Records of Life on Earth and the Search for Extraterrestrial Biosignatures".

I have also noticed a distinct similarity between my model and that which is presented by J. S. Wicken in his "Evolution, Thermodynamics, and Information: Extending the Darwinian Paradigm". His model is very similar, with his being a synthesis of Lotka-Volterra population models with thermodynamics, instead of Maxwell's electromagnetism.