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Dear Editors of *Discover Life*,

I am pleased to submit "From Chemistry to Ecology: Codes and Predation Emerge from Coherence Constraints in Protocell Networks" for consideration.

The Gap This Paper Addresses

Decades of experimental work have demonstrated prebiotic nucleotide synthesis (Sutherland, Powner) and protocell assembly (Szostak, Chen). These are major achievements in *chemistry.* But they do not address the *coding* problem: how did discrete symbolic codes emerge from continuous chemical processes? The assignment problem—why UUU encodes phenylalanine—remains unexplained.

We propose a mechanism: **substrate competition**. When multiple output channels compete for a shared resource pool, winner-take-most dynamics discretize continuous inputs without any external digitizer. This is not engineered thresholding; it is the physics of competitive binding (Hill kinetics, $h > 1$).

The Theoretical Contribution

The standard origin-of-life narrative assumes:

chemistry → *molecules* → *replication* → *cells* → *ecology* → *cooperation*

We propose a possible inversion—*ecological dynamics may have preceded molecular codes*:

compartments → *coordination pressure* → *ecological differentiation* → *codes*

While foundational theoretical frameworks (Kauffman's autocatalytic sets, Eigen's hypercycles, Maturana and Varela's autopoiesis) address the dynamics of prebiotic organization, and recent work on autocatalytic chemical ecosystems (Baum, Peng) has established the conceptual possibility of pre-cellular ecology, none directly addresses how *discrete codes* emerge from *continuous chemistry.* Our contribution provides specific mechanisms: (1) substrate competition via cooperative binding (Hill kinetics) produces discrete codes from continuous chemistry; (2) the coordination ceiling derived from signal propagation physics explains group size limits; (3) predator-prey dynamics emerge from asymmetric coordination costs without specialized machinery.

Key Results

Part I: Code Emergence

- 32 environments → 32 distinguishable codes (no collisions)
- 98% decoding accuracy without learning—same chemistry decodes
- Ablations confirm substrate competition is essential ($h = 1$ destroys codes)

- Information-theoretic analysis: 4.9 bits transmitted vs 5.0 bit capacity

Part II: Ecological Differentiation

- Coordination ceiling derived from signal propagation physics
- Predator-prey dynamics emerge without specialized machinery
- Small coherent groups extract from large incoherent aggregates

What This Paper Does Not Claim

We do not claim to have solved the origin of the genetic code. We provide a *mechanism*—substrate competition in coupled compartments—that produces discrete codes from continuous chemistry. Whether this specific mechanism operated in early Earth conditions is an empirical question requiring experimental verification.

Relevance to Discover Life

This manuscript addresses the journal's core interest: mechanisms underlying life's origins. The theoretical framework connects prebiotic chemistry (well-established) to ecological dynamics (well-observed) through a specific physical mechanism (testable). Experimental predictions are provided.

All simulation code is available at `https://github.com/todd866/protocell-codes`.

I confirm this manuscript is original and not under consideration elsewhere.

Sincerely,

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