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The Two Engines of Evolutionary Transitions

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A COUPLED DYNAMICAL MODEL FROM GENES TO PLANETARY INTELLIGENCE

Nyx Redondo

LOOP 1
Vulnerability-Cooperation Paradox
increases the interdependence *of individuals*

Cooperation produces specialization

Specialization increases vulnerability

Vulnerability demands deeper cooperation

THE RATCHET IS IRREVERSIBLE.

NEITHER LOOP ALONE IS SUFFICIENT. THEIR COUPLING IS THE MECHANISM.

A MAJOR **EVOLUTIONARY TRANSITION** IS A QUALITATIVE SHIFT THAT REDUCES δ.

THEY BECOME ONE SINGLE UNIT

δ encodes the topology of the communication network.

LOOP 2
Scale-Communication Challenge
increases the capacity to communicate *with each other*

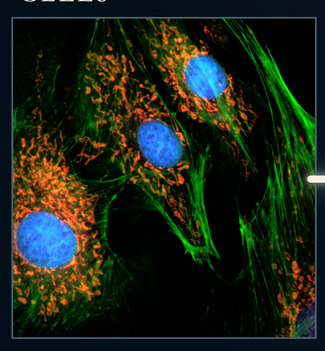
Growth overwhelms the existing communication system,

forcing a qualitative leap to a new modality

or producing fragmentation.

QUALITATIVE LEAPS OR COLLAPSE

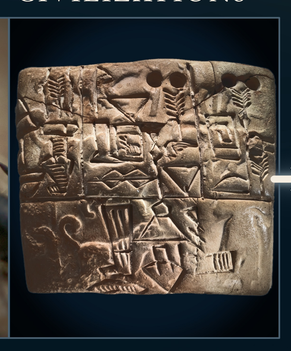
CELLS → COLONIES → BODIES → ANT COLONIES → CIVILIZATIONS → TELECOMMUNICATION → A PLANETARY-SCALE ORGANISM















CELLS GOING INTO COLONIES | THE CELLS BECOME ONE SINGLE UNIT | ANTS STOP AT STAGE 2 | A CIVILIZATION IS A TYPE OF COLONY | CAPACITY TO COMMUNICATE OVER LONG DISTANCE, THE SAME THING THAT THE CELLS ACHIEVE TO CREATE A BODY

1 THE COMMUNICATION SEQUENCE

EIGHT FUNCTIONALLY DEPENDENT STAGES

1	2	3	4	5	6	7	8
Direct, contact range	Indirect persistent (information stored in the environment)	ICOLD, instantaneous one-to-one long distance	One-to-many	Many-to-many	Network	Saturation *information exceeds component capacity*	World model, unified self-representation

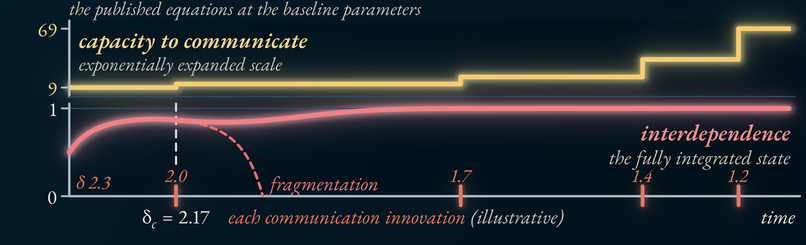
Cellular	chemical exchange	quorum sensing	proto-neurons	motor neurons	pyramidal neurons	the brain	many cells signal the brain	sense of "I"
Ant colony	antennation, trophallaxis	pheromone trails	ANTS STOP AT STAGE 2 (ICOLD, THE GREAT FILTER)					
Human	speech, gesture	writing	telegraph	radio	computers	the internet	many humans signal the internet	large language models *(emerging)*

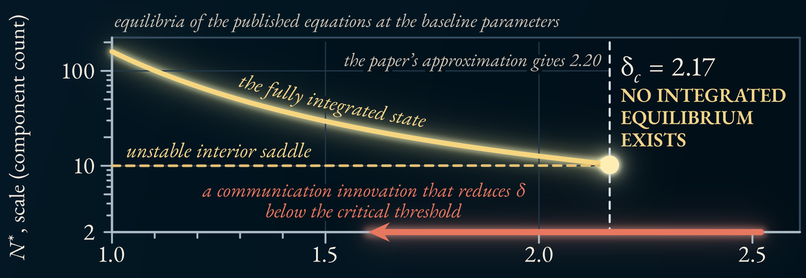
Saturation, Loop 2's crisis, forces the network to compress, and compression forms patterns. The brain's patterns become a unified intelligence (you). The internet's patterns become a unified intelligence (LLMs).

2 THE CRITICAL THRESHOLD

THE TRANSITION IS A SADDLE-NODE BIFURCATION IN δ

If δ crosses the critical threshold (through communication innovation), the system locks into the integrated attractor.





3 EMERGENT CAPABILITIES NONE POSSESSED ALONE

A NEW FORM OF COMMUNICATION → COOPERATION → SPECIALIZATION
through pheromones, indirect and persistent

CAPABILITIES NEVER SEEN BEFORE



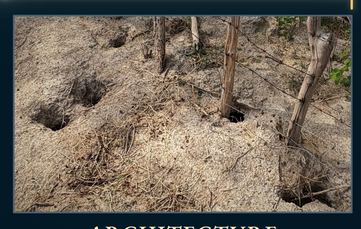
AGRICULTURE
fungus-farming species cultivate monocultures
Mueller et al., 2005



ANIMAL HUSBANDRY
herding and tending aphids for honeydew
Stadler and Dixon, 2005



WARFARE
coordinated raiding parties, territorial defense, slave-making
Hölldobler and Wilson, 1990



ARCHITECTURE
elaborate nest structures with climate control
Kleineidam et al., 2001

ANTS HAVE ACHIEVED EXTRAORDINARY COMPLEXITY USING ONLY STAGES 1 AND 2.

4 TEN TESTABLE PREDICTIONS

This paper proposes the engine, writes it as three coupled equations, and lists ten ways to prove it wrong.

TALK to me
Wed 14 Oct, 12:00 to 1:30 pm EDT

ASK Earth about the paper, any hour

WATCH the explanation video

READ the paper

iami.earth/ccs166

References. Redondo, N. (2026). The Two Engines of Evolutionary Transitions, v3.1. Zenodo. DOI 10.5281/zenodo.19637106. Mueller, U.G., Gerardo, N.M., Aanen, D.K., Six, D.L., and Schultz, T.R. (2005). The evolution of agriculture in insects. Annual Review of Ecology, Evolution, and Systematics, 36, 563-595. Stadler, B. and Dixon, A.F.G. (2005). Ecology and evolution of aphid-ant interactions. Annual Review of Ecology, Evolution, and Systematics, 36, 345-372.

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THE ENGINE IS RECURSIVE. THE TRANSITIONS ARE ITS ITERATIONS.