

THE PARASITE INSIDE THE
PARASITE

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A recent paper packs deltavirus genomes inside the virions of other viruses—vesicular stomatitis, for example—making the deltavirus a parasite inside a parasite. Read as a cybernetic system rather than a taxonomy, what falls out is an architecture of stacked OODA loops; cells run the machinery, viruses enter and steer it, deltaviruses steer the steering. The tidy textbook drawer was never quite as tidy as it appeared.

This recent paper¹ reporting that deltaviruses can be packaged inside other virions (for example VSV) is one of those quiet results that rearranges the conceptual furniture of a tidy office. It looks modest on the surface. But if one approaches biology as a system of control loops rather than a taxonomy of objects, it reveals a structure that has been there all along.

The textbook picture of viruses is tidy. A virus enters a cell, replicates its genome, assembles particles, and transmits onward. The viral genome encodes enough machinery to close that loop; entry proteins, replication factors, packaging signals, assembly logic. A compact but self-contained lifecycle.

Deltaviruses break that picture immediately. Hepatitis D virus, the canonical example, carries a genome of roughly 1.7 kilobases and encodes essentially a single protein. Replication is performed by the host cell's RNA polymerase II. Particle assembly depends on envelope proteins supplied by a helper virus, historically hepatitis B. From an engineering standpoint this is already remarkable. The deltavirus does not implement a full lifecycle. It inserts itself into an existing viral one; hijacking the already hijacked machinery of life.

¹ <https://www.sciencedirect.com/science/article/pii/S0092867426001650>; <https://www.biorxiv.org/content/10.1101/2025.05.09.653040v1.full-text>

That is simply leverage applied to an existing control system. One does not reproduce the propulsion system of an aircraft in order to steer it; one moves the control surfaces. Replication, assembly, and transmission are the decisive nodes in the viral lifecycle. If an agent can couple itself to those nodes, the rest of the machinery runs for free, from the virus's point of view.

The new observations push this logic further. Instead of merely borrowing envelope proteins, the deltavirus genome can be physically packaged *inside the particle of another virus*, such as vesicular stomatitis virus. The virion becomes a transport vehicle containing two replicators. One genome runs the main viral lifecycle. The other genome rides inside it.

A parasite inside a parasite.

At that point the architecture becomes unmistakable. The host cell provides metabolic and informational infrastructure. The helper virus runs a replication loop inside that infrastructure. The deltavirus runs a smaller loop inside the host viral loop.

Nested control systems. . . Matryoshka dolls.

Biology does this everywhere once one looks for it. Genomes contain transposons that exploit chromosomal replication machinery. Bacteria carry plasmids that replicate alongside the central chromosome. Organisms host parasites that use their physiology as infrastructure. Viruses themselves are parasitic control loops inside cells. Deltaviruses represent the next layer down, parasitic loops operating inside viral loops.

Seen from that vantage point the tiny deltavirus genome stops looking mysterious. The genome is small because it does not need to encode most of the system's behavior. The host cell and the helper virus already perform the bulk of the computation. The deltavirus contributes only a steering signal. It biases replication timing, participates in assembly, and ensures that its RNA is packaged and trans-

ported.

Rather cybernetic. *Kyberos*.

If one borrows the language of Boyd's OODA loop, the structure becomes easy to see. Observation is supplied by the biochemical environment of the infected cell. Orientation occurs in the helper virus replication machinery that interprets RNA structures and assembly cues. Decision resides in the regulatory features of the deltavirus genome and its single protein product. Action occurs when the helper virus assembles particles that unknowingly carry the deltavirus genome along for the ride.

The deltavirus does not run its own OODA loop. It bends someone else's.

What makes the system especially interesting is that it sits precisely at the boundary between cooperation and competition. Inside the cell the deltavirus competes with the helper virus for replication resources. Push that competition too far and the helper virus collapses, removing the transport infrastructure the deltavirus depends upon. But if the deltavirus integrates gently enough into the lifecycle, both agents propagate together. Molecularly antagonistic, ecologically cooperative.

Biology repeatedly finds this equilibrium. Plasmids burden bacteria metabolically while sometimes providing antibiotic resistance. Parasites that destroy their hosts too quickly eliminate their own habitat. Evolution tends to stabilize arrangements in which exploitation and coexistence balance one another.

This particular packaging result widens the stage considerably. If deltaviruses can ride inside multiple unrelated viruses, they gain access to the transmission networks of each. Every epidemic of a compatible virus becomes transportation infrastructure. Host range expands. Tissue tropism expands. Transmission opportunities multiply. The deltavirus genome begins to resemble less a standalone

virus than a mobile control parasite capable of exploiting whatever viral logistics happen to be available.

From that vantage point the clean taxonomy of “virus species” starts to look like a pedagogical convenience. What we are actually observing is a layered stack of replicators interacting across multiple control loops. The host cell runs the metabolic machinery. Viruses exploit that machinery to replicate their genomes. Satellite viruses exploit the viral lifecycle. Smaller parasitic RNAs exploit those satellites.

Each layer observes the dynamics of the adjacent layer, orients within that environment, biases decisions through molecular interactions, and acts through machinery it does not itself own.

Stacked OODA loops.

Cells run the machinery.

Viruses enter and steer it.

Deltaviruses *steer the steering*.

Once one sees this sort of thing the world looks different. The tidy office was never quite as tidy as it appeared. We had simply not opened all the drawers.

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