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The First Vampire (*squid): How a Ten-Armed Fossil Rewrote Octopus History

Biology * Evolution * DNA

1. Introduction: Resolving the Vampyropod Ghost Lineage

The evolutionary history of Coleoidea (internally shelled cephalopods) long suffered from a chronological disconnect between sparse Paleozoic soft-tissue fossils and the molecular divergence estimates of modern genomics. While molecular clocks consistently placed the split between ten-armed Decapodiformes (squids and cuttlefish) and eight-armed Octopodiformes (octopuses and vampire squids) in the Carboniferous, the oldest definitive vampyropod fossils dated only to the Triassic.[1][2] The description of Syllipsimopodi bideni (ROMIP 64897) -- a ten-armed vampyropod from Montana's Mississippian Bear Gulch Lagerst tte (~328 Ma) -- closed this 82-million-year ghost lineage.[3]

Paired with the 2025 chromosomal-level sequencing of the Vampyroteuthis infernalis genome, S. bideni allows researchers to triangulate the ancestral state of all crown coleoids.[11][13] Together, paleontological morphometrics and deep-time synteny trace how shallow-water, ten-armed Carboniferous predators diverged into two radically different evolutionary trajectories: the chromosomally rearranged octopuses and the karyotypically conservative vampire squids of the oxygen-depleted deep sea.

2. The Carboniferous Prologue: Syllipsimopodi bideni

Unearthed in 1988 from the Serpukhovian Bear Gulch Limestone of central Montana and formally described by Christopher Whalen and Neil Landman in 2022, Syllipsimopodi bideni owes its preservation to tropical microturbidite burial and rapid diagenetic phosphatization.[1][3][5][6] Early phosphate precipitation replaced labile soft tissues prior to bacterial decay, preserving three diagnostic characters:

* Decabrachian Arm Crown: The holotype preserves ten functional appendages bearing biserial rows of suckers.[1][3] Two appendages are elongated (~4.0-4.1 cm, or ~27% of total body length), demonstrating that specialization into grasping arms and elongated feeding tentacles predated the Octopodiformes-Decapodiformes split.[1][7]

* Chitinous Gladius: Unlike contemporary belemnoids, S. bideni lacked a chambered, buoyancy-regulating phragmocone, possessing instead a flattened internal gladius with a smooth, bipartite median rib -- a core vampyropod synapomorphy.[1][3]

* Functional Ink Sac: A preserved ink sac confirms that basal vampyropods were visual predators inhabiting sunlit, shallow-marine waters.[4][8]

Although Christian Klug and colleagues (2023) questioned whether S. bideni represented a junior synonym of the co-occurring coleoid Gordoniconus beargulchensis with taphonomically split arms, Whalen and Landman demonstrated that Gordoniconus retains a septate phragmocone and primordial rostrum absent in Syllipsimopodi, while

biserial suckers along all ten appendages confirm a true decabrachian crown.[9][10]

3. Genomic Stasis vs. Chromosomal Revolution

While S. bideni anchors vampyropod morphology in the Paleozoic, a 2025 genomic study led by Masa-aki Yoshida and Oleg Simakov decoded the massive (>11-gigabase) genome of the modern vampire squid, Vampyroteuthis infernalis.[11][12][13] Following the Ancient Coleoid Chromosomal Rearrangement Event (ACCRE) in the shared coleoid stem, Vampyroteuthis preserved the ancestral squid-like karyotype of 46 chromosomes with remarkable syntenic stasis.[13]

In contrast, the lineage leading to modern octopuses (Octopoda) underwent an intense genomic restructuring termed Fusion-with-Mixing (FWM), fusing the ancestral 46 chromosomes down to ~30 and scrambling gene order through inter-chromosomal translocations.[13] This chromosomal mixing assembled novel regulatory neighborhoods that catalyzed tandem expansions of protocadherins and G-protein coupled receptors (GPCRs) -- fueling the complex vertebrate-like nervous systems and behavioral plasticity of octopuses while Vampyroteuthis retained ancestral neural baselines.[11][13]

| Feature | | Syllipsimopodi bideni (Carboniferous) | | Vampyroteuthis infernalis (Modern) | | Octopoda (Modern) |

| Divergence / Age | | ~328 Ma (Stem Vampyropod) | | ~183 Ma (Crown lineage) | | ~270 Ma (Split from stem) |

| Appendage Count | | 10 arms (2 elongated) | | 8 webbed arms + 2 retractile filaments | | 8 arms (2nd dorsal pair lost) |

| Sucker Arrangement | | Biserial, non-stalked | | Distal uniserial with paired cirri | | Biserial or uniserial |

| Internal Shell | | Calcified/chitinous gladius | | Broad, uncalcified chitinous gladius | | Vestigial cartilaginous stylets |

| Karyotype & Synteny | | Inferred ~46 chromosomes | | Conserved (46 chromosomes, stasis) | | Derived (~30 chromosomes, FWM) |

| Ecological Niche | | Photic tropical bay predator | | Bathypelagic OMZ detritivore | | Benthic and pelagic predator |

| Primary Defense | | Melanin ink sac | | Bioluminescence (ink sac lost) | | Ink sac and chromatophore camouflage |

4. Ecological Descent into the Oxygen Minimum Zone

As the Mesozoic Marine Revolution intensified predation from teleost fishes and marine reptiles, vampyromorphs migrated vertically from shallow shelves into the bathypelagic realm -- a transition recorded by Jurassic (Simoniteuthis) and Oligocene (Necroteuthis) fossils.[14][15] Adapting to the perpetually dark Oxygen Minimum Zone (OMZ), the vampire squid lineage abandoned active visual predation, losing its ink sac in favor of photophore bioluminescence, lowering its mass-specific metabolic rate to the minimum among coleoids, and modifying its second dorsal arm pair into retractile sensory filaments to harvest sinking marine snow.[8][16][17]

5. Conclusion: A Unified Theory of Vampyropod Evolution

Together, the Carboniferous holotype of Syllipsimopodi bideni and the chromosome-scale genome of Vampyroteuthis infernalis reconcile the paleontological and molecular records of coleoid evolution. Confirming that the vampyropod ancestor was a ten-armed, gladius-bearing predator of Paleozoic seas, these discoveries demonstrate how one descendant clade (Octopoda) harnessed chromosomal fusion-with-mixing and arm reduction to dominate coastal ecosystems, while its sister clade (Vampyromorpha) preserved the ancestral 46-chromosome architecture and ten appendages in the hypoxic refuge of the abyss.[1][13]

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