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A 567-Million-Year-Old Surprise: New Fossils Push Back the Origins of Animal Motility

Evolution * Animals * Marine Life

Introduction: Rewriting the Ediacaran Evolutionary Timeline

For the first three billion years of Earth's history, the biosphere was dominated almost exclusively by microscopic, single-celled organisms.[4] That microbial stasis ended during the Ediacaran Period (635 to 538 million years ago), which hosts the earliest indisputable record of macroscopic, multicellular animal life.[4] Characterized by soft-bodied architectures ranging from quilted fronds to segmented tubular organisms, the Ediacaran biota established the ecological and anatomical foundations for the subsequent Cambrian explosion.[1][4]

Traditionally, the emergence of complex animal behaviors -- most notably macroscopic locomotion and synchronized sexual reproduction -- was placed late in the Ediacaran, within sunlit shallow-shelf environments dating between 560 and 550 million years ago.[1] However, a landmark fossil discovery in the remote Mackenzie Mountains of Canada's Northwest Territories, located on the ancestral lands of the Saht Dene and M tis peoples, has pushed the record of canonical White Sea taxa -- including motile Dickinsonia, the bilaterian grazer Kimberella, and clustered Funisia tubes -- back to ~567 million years ago.[1][2] Published in Science Advances in May 2026 by researchers led from the American Museum of Natural History and Dartmouth College (with collaborators at Florida State University, Stanford University, and Penn State), the study documents a deep-water paleocommunity demonstrating that complex metazoan evolution was already thriving in offshore marine basins long before colonizing shallow coastal shelves.[1][3]

Geological Context and Re-Os Geochronology of the Blueflower Formation

Establishing the age and depositional environment of the Mackenzie Mountains biota required integrating regional geology across the Windermere Supergroup and Rackla Group with high-precision geochemical and isotopic chronometers.[5][6] The fossils occur within the lower Blueflower Formation, which preserves a continuous shelf-to-slope transect grading from deep-water organic-rich shales in its basal members to shallow-water siliciclastic shoreface deposits above (whose uppermost beds host separate younger assemblages documented earlier), directly overlying the dolostone-dominated Gametrail Formation.[1][7]

Lacking volcanic ash beds for U-Pb zircon dating, researchers integrated rhenium-osmium (Re-Os) radiometric dating of organic-rich marine mudrocks with regional chemostratigraphy.[5][8] In suboxic bottom waters, rhenium and osmium sequester into seafloor organic matter, enabling 187Re-to-187Os decay to anchor the fossil-bearing lower Blueflower horizon at roughly 567.3 +/- 3.0 Ma and 566.9 +/- 3.5 Ma.[1][8] Carbonate chemostratigraphy in the underlying Gametrail Formation

independently records the Shuram carbon isotope excursion (13C down to 13) -- the largest negative perturbation of the global carbon cycle, linked to deep-ocean carbon oxidation and basin ventilation prior to the Blueflower radiation.[5][9]

| Stratigraphic Unit | | Dominant Lithology | | Geochronological Feature | | Paleoecological Significance |

| Risky Formation | | Carbonate | | Overlying unit | | Transition to terminal Ediacaran.[5] |

| Upper Blueflower | | Siliciclastic | | Overlies Re-Os strata | | Shallow-water trace and tubular fossils (Sekwitubulus, Windermeria).[7] |

| Lower Blueflower | | Organic-rich Shale | | Re-Os date: ~567 Ma | | Earliest deep-water White Sea assemblage (Dickinsonia, Kimberella, Funisia, Eoandromeda).[1][2] |

| Gametrail Formation | | Dolostone | | Shuram 13C excursion | | Carbon cycle perturbation and basin ventilation.[5][9] |

| Nadaleen / Ice Brook | | Carbonate / Clastic | | Pre-Shuram baseline | | Early deep-water Ediacara predecessors.[6][8] |

Deconstructing the Three-Assemblage Model and Taxonomic Innovations

Paleobiologists have conventionally divided the Ediacaran biota into three sequential assemblages: the deep-water, frond-dominated Avalon (~575-559 Ma); the diverse, shallow-water, bilaterian-rich White Sea (~560-550 Ma); and the biomineralizing Nama (~550-538 Ma).[2][10] Discovering six groups of White Sea taxa previously unknown in North America -- including Dickinsonia, Kimberella, Eoandromeda, and Funisia -- at ~567 Ma in Laurentia proves these assemblages overlapped temporally and were structured by paleoenvironmental depth and taphonomic facies rather than strict evolutionary succession.[1][3][11]

Preserved across more than 100 soft-bodied impressions in true-substrate bedding planes, the Mackenzie Mountains ecosystem and broader Blueflower stratigraphy illuminate four key biological innovations:[1][16]

* Dickinsonia and Active Motility: A bilaterally symmetrical, quilted oval lacking a mouth or gut, Dickinsonia grazed microbial mats by extruding digestive enzymes ventrally (osmotrophy) and moving periodically across the seafloor.[1][12] Its presence at ~567 Ma in the lower Blueflower horizon -- alongside younger proarticulatans such as eight-segmented Windermeria aitkeni higher in regional strata -- pushes the Laurentian record of active animal locomotion back by millions of years.[1][7]

* Kimberella and Eoandromeda: The lower Blueflower beds also preserve Kimberella, a teardrop-shaped bilaterian that crept on a muscular foot while grazing microbial mats, alongside the eight-armed spiral taxon Eoandromeda, widely compared to early ctenophores.[1][2]

* Funisia dorothea and Broadcast Spawning: Elongate tubular Funisia dorothea grew in dense, size-uniform cohorts diagnostic of broadcast spawning -- synchronized gamete release for external fertilization and pelagic larval dispersal -- extending the

fossil record of coordinated animal sexual reproduction back by millions of years.[1][13]

* Tubular Biomechanics Across the Blueflower Section: Higher in the uppermost Blueflower Formation, rigid, annulated Sekwitubulus annulatus anchored via discoid Aspidella holdfasts, complementing thin-walled tubular morphotypes such as Aulozoon elsewhere in the Ediacaran that maximized surface-area-to-volume ratios for passive oxygen diffusion.[7][14][15]

| Ediacaran Taxon | | Morphological Architecture | | Evolutionary Significance |

| Dickinsonia | | Bilaterally symmetrical, quilted oval (lower Blueflower).[1] | | Early macroscopic motility and ventral osmotrophy.[1][12] |

| Kimberella | | Teardrop-shaped body with muscular ventral foot (lower Blueflower).[1] | | Candidate earliest bilaterian grazer in Laurentia.[2] |

| Eoandromeda | | Eight-armed spiral body plan (lower Blueflower).[1] | | Possible early comb jelly (ctenophore) affinity.[2] |

| Funisia dorothea | | Elongate tubes in uniform cohort clusters (lower Blueflower).[1][13] | | Early sexual reproduction via broadcast spawning.[2][13] |

| Sekwitubulus annulatus & Aspidella | | Rigid, annulated tube and discoid holdfast (upper Blueflower).[7] | | Tough organic wall anchoring in current-swept strata.[7][15] |

| Windermeria aitkeni & Aulozoon | | Eight-segmented proarticulatan oval; thin-walled Ediacaran tube.[7][14] | | High surface-to-volume passive O2 diffusion and disparity.[4][14] |

Paleoecology: The Deep-Water Stenothermal Refuge Hypothesis

Sedimentological indicators confirm that the 567-million-year-old lower Blueflower community inhabited offshore slope environments below the photic zone where photosynthesis occurs and insulated from wave-agitated coastal shelves.[1][2] Rather than originating solely in warm, sunlit shallows, early mobile animals appear to have evolved within a deep-water "stenothermal cradle."[1][17]

In the low-oxygen Neoproterozoic ocean, shallow shelf waters experienced sharp temperature fluctuations that simultaneously reduced dissolved O2 solubility while raising ectothermic metabolic oxygen demand.[17] For early metazoans operating near hypoxic limits, shallow-water thermal volatility posed severe physiological stress, whereas deeper marine slopes offered cold, thermally stable conditions that kept basal metabolic rates low and predictable.[2][17] Thallium isotope ratios (205Tl) in Paleozoic mudrocks from the Yukon and Northwest Territories further show that deep-marine oxygenation fluctuated dynamically for over 100 million years rather than rising in a single permanent step.[18] Under these shifting redox conditions, natural selection favored high surface-area-to-volume morphologies (Dickinsonia, tubular morphotypes) and pelagic larval dispersal (Funisia) within stable deep-water refugia.[13][15][17]

Conclusion: From Abyssal Incubator to the Cambrian Explosion

The ~567-million-year-old fossil assemblage of the lower Blueflower Formation fundamentally revises the chronology and geography of early animal radiation.[1] By demonstrating that active benthic motility (Dickinsonia, Kimberella) and broadcast-spawning sexual reproduction (Funisia dorothea) were established in deep-slope habitats of Laurentia several million years earlier than previously documented for the White Sea biofacies, the Mackenzie Mountains discovery decouples evolutionary origination from shallow-water taphonomic visibility.[1][16] Sheltered within cold, stenothermal deep-sea basins following the Shuram carbon cycle reorganization, early metazoans refined the physiological and reproductive toolkits that later fueled their expansion onto shallow continental shelves and helped set the stage for the Cambrian explosion.[4][8][17]

Updates... (Nov 22, 2026): Corrected Ref. [6] from an erroneous 2013 USGS date to the peer-reviewed Geobiology study by Boag et al. (May 3, 2024; DOI: 10.1111/gbi.12597), and standardized exact publication dates across all 18 cited sources (preserving the Nov 18, 2026 clarification distinguishing the ~567 Ma lower Blueflower White Sea assemblage from Carbone et al., 2015).

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