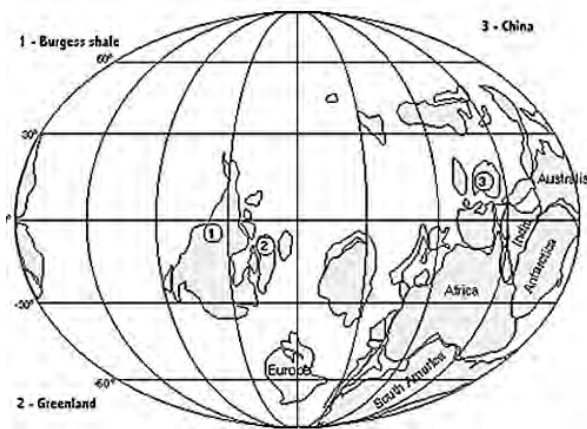
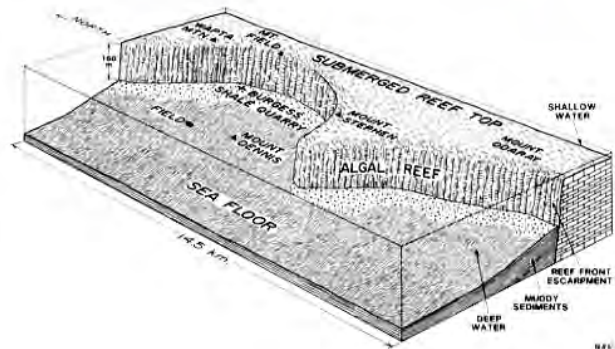


Survivor's Tale

In the shallow oceans of earth 530,000,000 years ago, early animals made their appearance on the stage of life. It was a drama showing the cruel beauty of the mortal state of being. The opening act was the Cambrian explosion of animal diversification, but the second act was all about *decimation* of most of what had emerged. In 1909, a small quarry in British Columbia first exposed traces of what had happened. Very many uniquely organized animals had established themselves on earth, as multicellular life entered the *era of predator and prey*. Very few of the many well-established and successful body plans, however, ever survived to have any remote ancestors. Those few types that made the cut and filled their ecological niches were the only ones whose progeny would continue in the dance of diversification and selection in future worlds that were yet to be. The many creatures that died in that second act now seem strangely beautiful, though bizarre, since they are not our kind.



The Burgess Shale Site 510 Million Years Ago



Sediments of the Burgess Shale were deposited in an equatorial ocean environment which was *uniquely situated near the edge of an undersea cliff* which collapsed with periodic avalanches over a long stretch of time, such that animals which happened to be roaming the shallow seafloor during these formative years of animal development were often trapped and preserved just as they were. Subsequent rare geological processes in small areas of that formation have maintained intact - *for over half a billion years* - not only the fossilized thin exoskeletons of these animals, but even softer parts of internal structures. In addition, some of those animals that lacked a rigid outer surface have been delivered for inspection as filmy layers, trapped now in shale.



The story of *what was* - for a time - alive in that former world raises the question of *what could have been* ... how might things be *now* if only some of those unique and wonderful creatures had lived on for a while more and continued their genetic line in later worlds, where they might have found a viable niche. The brutal force of contingent development, however, has forbidden those alternate realities. At the level of the individual and the small group, evolution is all about managing only with what is currently available, even if it means repurposing existing phenotypic structures.



From the dawn of animals, as cell-number-per-organism expanded, body type at some point deviated from the tube system seen in sponges, where infolding of body surfaces is used to increase area for direct diffusion of oxygen and nutrients to cells, each of which must live or die within its own membrane-bound economy. The anatomic solution that survived occurred when animals developed *vascular systems*. Repurposing actin-myosin contractile elements used for motion in the external environment, the mesodermal space gave rise to branching muscular tubes, capable of distributing interstitial fluid to all cells of even large complex animals. The machine driving fluid throughout the vessels and thus creating circulation was the heart, whose cells specialized the actin-myosin contractile elements into a muscular pump. Rhythmic membrane depolarization generated spontaneous excitation cycles of contraction and relaxation. Valves gave direction to the flow.

William Harvey, in 1628, published *De Motu Cordis: On the Motion of the Heart and Blood in Animals*, giving the first accurate description of the role of the heart and the circulation of blood in animals, including man. In its introduction he wrote: *The heart of animals is the foundation of their life, the sovereign of everything within them, the sun of their microcosm, that upon which all growth depends, from which all power proceeds.*

Since the heart maintains circulation in the vascular system, it plays a central role in the drama of an individual's mortality. In humans, cessation of rhythmic cardiac contraction is followed by loss of consciousness. When this happens suddenly, as in sudden cardiac arrest, injury of brain neurons is usually followed quickly by death. Among a population, its occurrence is a decimating event: few survive. Recently, however, the potential for survival after cardiac arrest has been expanded for those found quickly after the devastating event. Application of standard resuscitative techniques, and intensive care by a skillful clinical team often results in return of spontaneous circulation. After that, continued care and *managed cooling* of the patient gives a chance at meaningful neurologic survival.



When place and time of cardiac arrest is fortuitous ... and when complex care for the sudden disaster is delivered with expertise, then life can sometimes go on: *cardiocerebral resuscitation* is achieved. Following that, an ascent to the Burgess Shale quarry becomes just another glorious trek into the mountains.

There is poignant sadness in mortality, especially in the timing of mortal events - so often, too soon ... There is joy when one is drawn from the edge of a collapsing cliff back onto ground which is again, for the moment, stable.

