Dipleurula concept of origin of chordates

The mystery surrounding the emergence of chordates, precursors to vertebrates, has puzzled zoologists for centuries. Although the exact timeline is shrouded in secrecy due to the lack of fossil records, it's widely acknowledged that chordates evolved from invertebrate organisms. The earliest chordate ancestors were soft-bodied creatures, leaving behind no tangible evidence to directly illuminate their origin. As a result, scientists rely on comparative analyses between lower chordates (protochordates) and invertebrates to reconstruct the evolutionary pathway of chordates. Several shared anatomical features among protochordates and invertebrates hint at a common ancestry. Bilateral symmetry, which denotes a left-right body axis, is observed in both groups, suggesting an evolutionary link. The presence of an anteroposterior body axis, characterizing the arrangement of body parts along a front-to-back orientation, further supports this notion. Additionally, both protochordates and invertebrates exhibit triploblastic coelomate traits, signifying the development of three germ layers during embryogenesis accompanied by the presence of a fluid-filled body cavity called a coelom. Metameric segmentation, marked by the division of the body into repeated segments, is another feature shared by protochordates and invertebrates. This segmentation can be observed in various aspects of their anatomy, such as muscle, nerve, and internal structure arrangements. The presence of metameric segmentation in both groups suggests an ancestral link and provides valuable clues about the evolutionary history of chordates. While the absence of fossil evidence from early chordate ancestors poses challenges to fully understanding their origin, the similarities shared with invertebrates offer important insights. By examining the structural features common to both groups, such as bilateral symmetry, anteroposterior body axis, triploblastic coelomate condition, and metameric segmentation, scientists can infer a common ancestry between chordates and invertebrates. As research continues to unfold, further investigations into the molecular and genetic aspects of chordate development may shed more light on the precise origin of these fascinating creatures. By combining paleontological and molecular evidence, scientists strive to uncover the missing pieces of the puzzle, ultimately enhancing our understanding of the origin and evolution of chordates. The debate surrounding the origin of chordates from invertebrates has led to the formulation of various theories. While none of these theories can be considered fully satisfactory or convincing, they hold historical value in understanding the evolution of chordates. Among the invertebrate phyla proposed as potential ancestors of chordates are Coelenterata, Nemertean, Phoronida, Annelida, Arthropoda, and Echinodermata. The deuterostome lineage of chordate evolution is characterized by shared features among all Deuterostomia, indicating a close evolutionary relationship between Echinodermata, Hemichordata, and Chordata. Key characteristics supporting this connection include indeterminate early cleavages in zygotes, the formation of the anus from the blastopore, and enterocoelous development leading to coelom formation. Additionally, biochemical evidence such as creatine utilization and serological tests demonstrate a closer affinity between these deuterostome phyla. While proposals have been made for direct echinoderm ancestry to chordates, further research is needed to clarify the evolutionary history of these groups. Echinoderms and hemichordates share striking similarities in their larval forms and features, leading researchers to propose a common ancestry for these groups. However, the presence of an apical plate with eye spots in the tornaria larva has raised doubts about this direct common ancestry. To address this issue, scientists put forth the Neotenous larva theory, suggesting that the auricularia larva of echinoderms might have undergone sexual maturity to give rise to chordates. Research on Carpoid echinoderms from the Cambrian and Ordovician periods provides further insights into a potential echinoderm ancestry. It is proposed that these creatures might have evolved from tornaria-like organisms that began to settle down and adopt a sedentary lifestyle, leading to the development of their distinctive water vascular system. The similarity in larval forms between echinoderms and hemichordates supports the idea that both groups descended from a common ancestor. However, the exact details of this relationship remain uncertain, with some scientists suggesting that hemichordates may have given rise to chordates through a series of evolutionary transformations. Despite these uncertainties, it is clear that echinoderms and hemichordates share certain characteristics, such as pharyngeal gill slits and a hollow dorsal nerve cord. However, the presence of a true notochord in chordates is lacking in hemichordates, indicating a more distant relationship between these groups. Further research and investigation are necessary to continue unraveling the intricate evolutionary history of chordates and their connection to echinoderms. As new discoveries are made, our understanding of this complex relationship may evolve, shedding light on the origin of chordates and the Deuterostomia group. The idea that hemichordates could have evolved into vertebrates seems unlikely, and they are recognized as a distinct group with their own characteristics and evolutionary history. The ascidian theory proposes that urochordates (ascidians) share a common ancestor with vertebrates. Ascidians in their adult form exhibit primitive marine and filter-feeding traits of ancestral chordates, but the significant differences between ascidians and vertebrates make it difficult to envision a direct evolutionary transformation. However, the larvae of ascidians display tadpole-like characteristics, featuring elongation, bilateral symmetry, and free-swimming capabilities with pharyngeal gill slits, notochord, dorsal hollow nerve tube, and muscular post-anal tail. According to this theory, certain larvae failed to undergo metamorphosis and instead became sexually mature precociously, retaining their larval features. These neotenous larvae then evolved into cephalochordates (such as lancelets) and eventually gave rise to vertebrates. However, the ascidian theory has limitations, including its assumption of sessile urochordates as ancestral to chordates, while in reality, this specialization occurs throughout the Animal Kingdom. Further research is necessary to refine our understanding of evolutionary relationships between urochordates and vertebrates. Cephalochordates and vertebrates have distinct differences in their body plan, with cephalochordates lacking strong cephalization and specialized sense organs. The solenocytes of cephalochordates are not homologous to the kidneys of vertebrates, suggesting that they may have evolved along divergent paths from a common ancestor. While cephalochordates provide insights into the likely ancestral body plan of vertebrates, they represent an independent lineage with primitive chordate characteristics. Barrington's hypothesis proposes that the common ancestor of echinoderms and chordates was a small, sessile or semisessile lophophorate or arm-feeding creature. This ancestral organism utilized ciliary feeding by trapping food particles in its tentacles. From this ancestral stalk, early stalked echinoderms and pogonophores emerged. The next stage in the evolutionary process saw the emergence of a sessile fiber feeder or stem chordate, which replaced external tentacles with an internal filtering apparatus. Cephalodiscus, a living pterobranch hemichordate, represents a transitional stage between these two modes of feeding, exhibiting both gill-slits and a crown of tentacles. The development of a perforated pharynx led to the evolution of free-living hemichordates and sessile ancestral urochordates. Some tunicates gave rise to tadpole larvae with chordate features, which underwent elongation and size increase. The longitudinal ciliary bands shifted to a mid-dorsal position, transforming into the hollow nerve cord. Muscle fibers evolved in the tail, and paedogenesis led to the suppression of the sessile adult stage. Barrington's hypothesis provides an intriguing framework for understanding the evolutionary transitions within the deuterostome lineage, shedding light on the possible origins of chordates from a lophophorate-like ancestor. To accurately determine the origins of chordate groups, it's crucial to rely on evidence and research that validate this hypothesis. A comprehensive understanding can be gained by examining the precise pathways that led to the diverse array of chordates we see today. Various studies have proposed different theories regarding invertebrate ancestry of chordates, with several phyla being suggested as potential sources. A significant amount of research suggests that chordates may have originated from invertebrates, given their shared characteristics such as bilateral symmetry and anteroposterior body axis. However, the exact pathways remain unclear due to a lack of fossil evidence from the earlier chordate ancestors, which were all soft-bodied forms. Theories on invertebrate ancestry include suggestions from various phyla, including Coelenterata, Nemertean, Phoronida, Annelida, Arthropoda, and Echinodermata. While some have received historical value, they remain unsatisfactory and lack convincing evidence. The echinoderm theory has gained some acceptance but will be evaluated in the context of deuterostome line ancestry. The Bilateria group is divided into Protostomia and Deuterostomia based on embryonic and larval developmental differences. The divisions may represent two primary lines of evolution within the Animal Kingdom, with strong evidence suggesting a closer evolutionary relationship between Echinodermata, Hemichordata, and Chordata. Studies have identified common features among deuterostomes, including indeterminate early cleavages and blastopore formation. Further research is needed to clarify the precise pathways leading to chordate diversity. Gastrula forms the anus, while the mouth develops as a secondary opening. Pockets or folds arise from the endoderm of the developing archenteron in the embryo. The fusion of spaces in these pockets creates the coelom (with some exceptions in vertebrates) and its walls become mesoderm. The pelagic larvae of echinoderms and hemichordates show a close structural resemblance. However, vertebrates do not have floating larvae, having lost this ability during evolution. All deuterostomes use creatine as their phosphagen in the energy cycle of muscular contraction, with invertebrates using arginine instead. Certain hemichordates also utilize both arginine phosphate and creatine phosphate. This suggests that hemichordates serve as a link between chordates and nonchordates. Serological tests indicate that proteins from the three deuterostome phyla are more closely related to each other than to those of any other phylum. The exact relationship among these phyla is unknown, but it is clear they share a common evolutionary history. Some workers have proposed various explanations for the deuterostome line of chordate evolution. One theory suggests that chordates originated directly from primitive echinoderms or their larvae. The larva (tornaria) of hemichordates shows striking similarities to the larvae of echinoderms, leading to suggestions of a common ancestry. However, the presence of an apical plate with an eye in tornaria larvae raises doubts about this theory. The Neotenous larva theory proposes that the auricularia larva of echinoderms became sexually mature and gave rise to chordates. Another theory suggests that ciliated bands from the auricularia larva may have concentrated to form ridges, leading to the development of a tube-like structure resembling the nervous system of chordates. Fossil records indicate that Carapoid echinoderms might have evolved from creatures like tornaria, which began settling down to lead sedentary life. The water vascular system may have developed from ciliated grooves in these creatures. Additionally, similarities between larval faunas of echinoderms and Branchiostoma (a vertebrate) are noted. Deuterostomia group's early evolutionary stage is believed to have been sedentary or sessile, with evidence suggesting that hemichordates, urochordates, and cephalochordates share a common ancestor. Hemichordates display pharyngeal gill slits and a hollow dorsal nerve cord but lack a true notochord. This characteristic body plan suggests they are distinct from vertebrates. Urochordates, on the other hand, exhibit primitive sessile marine filter feeding characteristics in their adult form, making it difficult to envision direct evolutionary transformation into vertebrates. However, their tadpole-like larvae show traits closer to ancestral chordates and are thought by some to have evolved into cephalochordates and vertebrates through neoteny. Cephalochordates, such as lancelets (Branchiostoma lanceolatum), possess the basic features of a prevertebrate but lack strong cephalization, sense organs, and exhibit unique excretory systems. These findings suggest divergent paths of evolution from a common remote ancestor rather than direct ancestry to vertebrates. Harrington (1965) proposes a deuterostome-based origin for chordate evolution, suggesting that their common echinoderm-chordate ancestor was likely a small, sessile, or semisessile creature that fed using cilia. This ancestral species gave rise to early stalked echinoderms and pogonophores, which eventually evolved into a sessile fiber feeder or stem chordate. The transition from external tentacles to an internal filtering apparatus marked a significant evolutionary step, as evidenced by the transitional form Cephalodiscus. The development of pharyngotremy, characterized by a perforated pharynx with internal food-trapping mechanism, led to the divergence of free-living hemichordates and sessile urochordates (tunicates). Some ancestral tunicates gave rise to tadpole larvae with chordate features, which eventually evolved into cephalochordates (Branchiostoma), vertebrates, and larvaceans. Fishes thrived in Silurian periods then became plentiful during the Devonian. As for subsequent eras, they demonstrate amphibians' evolution alongside reptiles, birds, and mammals. This document focuses on the dipleurula larva theory, exploring its connection to echinoderm origins. It delves into similarities between these creatures, specifically embryonic development and early life stages. The common ancestor of echinoderms and chordates is still a topic of debate among scientists. The dipleurula concept, which describes the free-swimming bilateral larvae of different groups of echinoderms, may not accurately represent the common ancestor. Instead, it highlights the shared features of present-day echinoderm larvae. The Echinoderm Theory of Origin of Chordates proposes that chordates evolved from invertebrates. However, identifying the exact group from which chordates originated is challenging due to the lack of preserved fossils. Several theories have been proposed, including those suggesting a connection between chordates and various invertebrate groups, such as coelenterates, nemertean, phoronida, annelida, arthropods, and echinoderms. Only the Echinoderm Theory has gained some acceptance, which was first proposed by Johannes Muller in 1860. This theory is based on comparative studies of larval stages of echinoderms and hemichordates, suggesting that these groups gave rise to chordates through a process known as neoteny. Several lines of evidence support this theory, including embryological similarities between echinoderms and chordates, such as the presence of an enterocoelic coelome and mesoderm. Serological analysis has also revealed close similarities in proteins between the body fluids of chordata and echinoderms. The radial symmetry of adult echinoderms may seem to contradict their relationship with bilaterally symmetrical chordates. However, this can be explained by the division of the bilateria into two major divisions: Protostomia and Deuterostomia. The Deuterostome line of Chordate Evolution is characterized by several key features, including early cleavage of zygotes, development of a blastopore into an anus, formation of a coelom from archenterons, and the use of creatinine as phosphogen.