The beginnings of communal life – 565 million years ago[1]

Ancient rock strata exposed within the World Heritage Site of Mistaken Point Ecological Reserve, Newfoundland, record one of Life's very first communities of seabed dwelling macro-organisms. Known as the Ediacaran biota, it is around 565 million years old.

In a new field study, employing sophisticated spatial measurement and analysis, Emily Mitchell and Nick Butterfield of the Department of Earth Sciences in the University of Cambridge, show that seabed community structure within the Ediacaran biota was much more complex than previously recognised. Although it is thought that all the organisms fossilised at Mistaken Point lived immobile on the seabed, this new research suggests that several of them had already developed advanced adaptations to the local seabed environment and complex modes of reproduction.

Mitchell and Butterfield's results reveal an important stage in the early evolution of interaction between primitive marine organisms, all of which were marine at this stage in evolution. Although life on Earth originated well over 3.5 billion years ago, it took nearly 3 billion years for the microbial life of the oceans to evolve into the multi-celled and readily visible organisms known as the Ediacaran biota. By 565 million years ago the Ediacaran biota consisted of a number of different forms, all of which were soft-bodied and immobile and lived on the seabed.

Today, marine life is highly structured and interacts in a host of different ways with individual organisms capable of responding to the local physical, chemical and biological environment to competition for food and living space. There are fundamental evolutionary questions about when such interactions first evolved but these have proven difficult to answer from the fossil record because such information is generally lost during the process of fossilisation.

Luckily, the Mistaken Point strata preserve unusually large ancient seabed surfaces with abundant well-preserved fossil remains of the extinct Ediacaran biota. This deeply enigmatic biota is the subject of an active research programme, especially within the Department of Earth Sciences in the University of Cambridge.

The present work by Emily Mitchell and Nick Butterfield is part of this programme. They mapped in detail the spatial distribution of more than 4400 fossils belonging to 10 different species of the Ediacaran biota distributed over two separate ancient seabed surfaces. The data are sufficiently rich and detailed to allow sophisticated statistical analysis of spatial inter-relationships between the different organisms.

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The new analysis shows that the Ediacaran community occupying one of the seabed surfaces had a complex web of spatial interactions and associations between most of the taxa. All six of the most abundant taxa were each found to have a unique set of interactions with neighbouring taxa, reflecting a broad range of underlying ecological responses between the organisms. There were four instances of distinct habitat association, two of which led to detectable competition for resources. Furthermore, there was one case of pre-emptive competition and two instances of possible inter-specific cooperation.

However, no such patterns of interaction were found between taxa on the other seabed surface. According to Mitchell and Butterfield, this disparity is likely the result of a more homogenous seabed environment, which did not allow the development of different interactions.

Nevertheless, it is evident from this new research that by 565 million years ago, some seabed communities of the Ediacaran biota were already complex in their structure and ecology. They had developed a clear ecological differentiation between many taxa which could exhibit different responses to habitat variation. These evolutionary processes were leading to divergent selection. reproductive isolation and ultimately the biodiversification which was to accelerate into the explosion marine life by early Cambrian times, around 541 million years ago.

Mitchell and Butterfield's research pinpoints a vital transformation in the organisation and evolution of seabed life.

Douglas Palmer, Sedgwick Museum

Ref: Mitchell, E.G. and Butterfield, N.J. 2018. Spatial Analyses of Ediacaran Communities at Mistaken Point. in press, Paleobiology

A group of Fractofusus fossils, members of the Ediacaran biota found on a 565M year old seabed, which is preserved in the strata of Mistaken Point, Newfoundland. ©Emily Mitchell