ISSN 1750-855X (Print)
ISSN 1750-8568 (Online)

Graptolites

Dr. Nancy Kirk[1]

KIRK, N. (1982). Graptolites. *Proceedings of the Shropshire Geological Society*, **2**, 5-6. An overview of the basic types of graptolite and their evolution.

Through time graptolites may have been deteriorating because they were becoming simpler, but there is no such thing as retrograde evolution, only the most efficient forms progress. The simpler forms of graptolite were the most efficient. The colonial form was not particularly efficient and once they became free-floating it was better to become an individual. It is therefore quite possible that graptolites still exist in the plankton totally unknown and unrecognised.

[1]*Shrewsbury, UK. E-mail: editor@shropshiregeology.org.uk*

Most people know graptolites as thin 'scratches' on rock. If examined closely through a lens you can see a 'toothed' arrangement on the edges of the graptolite. On very well preserved specimens you can sometimes see that these are actually cups that open on one or both sides of the flat branch. What you actually have in these specimens is the sheath in which the animals lived and which is made from the common building protein collagen. We know nothing of the living animal but assume that it was colonial and each side cup housed a zooid with a feeding organ and these little zooids were connected to the main canal of the sheath. The zooids were 1-5 mm at the largest with a simple structure enabling budding. They evolved from free floating animals in the sea and learned to bud to form a colony, which gave greater protection and enabled them to exploit the food source more efficiently.

One sort of colony rarely seen is a sessile colony where there is a row of zooids connected together and which encrusted shells and rocks on the sea floor. Another kind of colony is the dendroid in which individual zooids were connected to form a tree-shaped colony. This was a successful form for the sea floor with a holdfast, stem and branches with the individual zooids strung out along them. The colony was capable of competing successfully against smaller competitors in much the same way as a tree.

In the early Ordovician there were some very specialised dendroids. In one type the branches form a cone which broadens outwards, strengthened by small cross-bars. A small organism has two ways of gaining food - with tentacles or ciliated feeding organs. The latter set up a current of water towards the organism which filters out the food. The zooids opened into the cone implying that they fed by this latter method. Had they fed by tentacles, it would have been more advantageous to face outwards into the open sea.

Another more familiar form of dendroid is *Dictyonema flabelliformi* from the base of the Ordovician. In this species a delicate stem called the nema replaced the strong holdfast. They lived at least in the early stages attached to the sea floor in an upright position partly by buoyancy and by action of cilia forcing water through the cone. This view of graptolites is contrary to that held by e.g. Lapworth who suggested that *Dictyonema flabelliformi* lived attached to floating seaweed hanging like a bell from a rope. Although held for over a hundred years, this view is not entirely logical. Seaweed does not float unless torn up by storms when it is soon deposited on shore. Also the organism was 4-5 ins. long, very delicate and could not have survived in the rough surface waters of the sea. Furthermore the surface waters contain very little food. The plankton which *Dictyonema* fed are only abundant a few metres down away from wave action.

Dictyonema flabelliformi is found in rocks formed under all sorts of condition, commonly in black pyritous shales, formed where the sea water contained poisonous H_2S. The implication is that the organism became free floating in the adult stage. When free, feeding currents would maintain the cone in an upright position. It would rise as a consequence of feeding activity into higher levels of the sea; when less actively feeding it would sink back. The whole of the plankton does this, rising at night, sinking in the day.

Another form of *Dictyonema* had a nema with three vanes inclined at 120°. These, like flights on a dart, would prevent spinning and keep the nema downwards.

Once free, the colony would be subject to different environmental controls from the sea floor. An upright cone offers too much resistance because of the branches and cross bars, so through evolution branches and cross bars became fewer. Once the cross bars were lost, there was a tendency for the cone to become obtuse and eventually horizontal or for branches to hang down. Again through evolution the number of branches were reduced through four to two and rarely to one branch. This is where the evolution of the graptoloids begins.

A two branched form started horizontal then evolved to point downwards to become more streamlined. Some species became spirally curved and would spiral up through the water when actively feeding. *Nemograptus gracilis* was a horizontal wheel which spun very slowly through a large disc of water containing food.

The most striking consequence of the evolution of graptoloids was to produce biserial forms in which two branches are back to back e.g. *Diplograptus*. There was a form with three vertical vanes on the stalk inclined at 120°, therefore the colony must have been free-floating and non-spiralling. It is significant that vanes had evolved again in this form much later than *Dictyonema*.

In the Silurian uniserial graptoloids with a single row of zooids dominate. These displaced biserial forms by successful competition. Because the uniserial forms are slightly asymmetrical, each theca is inclined at a slightly different angle from the next; this made the colony become a very efficient spiralling feeder.

Certograptus is up to a metre across with branches only as thick as a hair and was almost immobile. The thecae were so balanced that it spiralled only in the youngest stages, but feeding currents held it at a constant level in fairly deep water with a sparse food supply, hence the need for lone branches to capture as much food as possible.

The small monograptids were most successful and go into the Upper Silurian almost to Lower Devonian. Because they were small they became sexually mature and reproduced very quickly. Fish were now evolving and small organisms were liable to be eaten, so rapid reproduction meant a greater chance of success.

During the evolution of the graptolites there were a number of crises, two of which, at the end of the Ordovician and the end of the Wenlockian, were very significant. These crises led to the disappearance of the flamboyant branched forms. The simple forms which survived from the Ordovician led to the next great evolutionary burst into the Silurian. The crisis at the end of the Wenlockian led to the loss of *Certograptus* etc. and only small ones went on into the Ludlovian and led to a new burst of evolution through the upper part of the Silurian.

This probably happened because the spectacular forms lived in deeper layers of the photic zone, the simpler forms in the higher part. Food in the photic zone is not uniformly distributed and is richest over areas of upwelling on continental shelves. When sea level falls, as at the end of the Ordovician and end of the Wenlock, the sea retreats from the shelf and the food rich zone becomes smaller. Greater competition ensures that only the most successful species survive.

At the end of the Devonian there were only small simple uniserial graptoloids an inch or so long with about twenty zooids. When the sea level rose again the graptolites were gone, but had they become extinct? These simple forms only needed to reduce budding a little bit more and they could become sexually mature sooner and could become a single zooid. If this happened, graptolites could live as individuals not colonies, therefore there would be no need for a protein sheath and the animal disappears from the fossil record. It is just possible that this happened at the end of the Devonian.

One view is that through time graptolites were deteriorating because they were becoming simpler, but there is no such thing as retrograde evolution, only the most efficient forms progress. The simpler forms of graptolite were the most efficient. The colonial form was not particularly efficient and once they became free-floating it was better to become an individual. It is therefore quite possible that graptolites still exist in the plankton totally unknown and unrecognised.

A LECTURE BY DR. KIRK - PRESENTED TO THE SOCIETY ON 19th MAY 1982

D.M. Jones

