Diplomats from Day One

—W.A.s Stromatolites—

Near Kalgoorlie, about 2800 million years ago, stromatolites were growing on the edge of volcanic hot springs. Then the volcano erupted or eroded and fragments of stromatolites were carried along with other debris such as volcanic ash and deposited on the ocean floor.

Stromatolites have been around since 'Day One' of the evolutionary story. In W.A. we have some of the finest living examples of this ancient life-form.

Stromatolites —Australia's Ancient Fossils

Three scientists at the forefront of stromatolite research in W.A. are Phillip Playford, head of Geological Survey, Kathleen Grey, also from Geological Survey and Linda Moore from the Microbiology Department at the University of W.A. Phillip is the expert on the stromatolites at Hamelin Bay. Kathleen, a geologist, is particularly interested in the fossil record. Linda is researching living stromatolites at Lake Clifton.

Science fiction authors are fascinated by artificial intelligence and other interbreeding between animate and inanimate. But their wildest imaginings could not improve on the bizzare experiments produced by that 'mad scientist': evolution. One of the earliest forms of life was a tiny non-photosynthetic bacterium which adopted a strange alliance with particles of sand and rock forming growing structures called stromatolites. Over a billion years ago stromatolites dominated shorelines of lakes and seas. Like other forms of early life they have left a fossil heritage. Remarkably, however, such structures are still being formed today in a few places throughout the world. Three of these sites are in W.A. The best known is in Hamelin Pool at Shark Bay but there are important stromatolite sites also in the coastal lakes of the west coast, particularly at Cervantes and Lake Clifton.

Stromatolites offer one of the best records of ancient organized cellular activity, and probably the first indication of life on earth. They offer a golden opportunity for scientists of many disciplines —geologists, organic chemists, microbial ecologists, to mention only a few. With no need for a time machine, they can study both the fossil record and the living representative of an ancient life form.

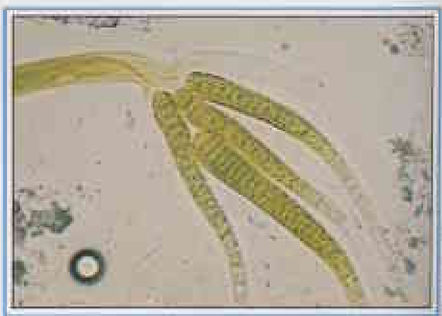
The world's oldest known fossil stromatolites were discovered in the North Pole Mining District of the Pilbara, and are about 3 400 million years old. Non-photosynthetic bacteria living in an atmosphere lacking oxygen probably formed these early stromatolites. They are simple, laminated structures which form a series of small domes about 10 cm in diameter. Filamentous structures have been found in nearby rocks (these are known as black cherts, and are renowned for their ability to preserve fragile structures in great detail). The filaments are thought to be the traces of stromatolite-building organisms.

By about 3 000 million years ago stromatolites were common in shallow marine environments and around the margins of hot springs, and some of the constructing micro-organisms quite probably were photosynthetic, or at least were sensitive to light. Younger examples from the Pilbara and from near Kalgoorlie in rocks 2 8000 million years old form a variety of domes, cones and columns with simple branching, and contain traces of microfossils. Those from the Kalgoorlie area closely resemble forms growing in hot springs at Yellowstone today, and provide important clues about how rocks in the area were formed.

Numerous layers of small, conical stromatolites probably formed around the margins of hot springs associated with a volcano. Because the micro-organisms precipitated silica from the hot water, the stromatolites hardened into rock almost as quickly as they grew. Eventually the volcano either exploded, or was simply weathered away. Debris, including boulders of stromatolites, was swept down the flanks in great flurries of material, dumped in deeper water and eventually buried. After billions of years the ancient horizon is once again at the surface, and the stromatolite boulders can be found weathering out of the softer volcanic ash which surrounds them.

Nearly all carbonate rocks between 2 000 million and 1 000 million years old contain some traces of stromatolites. The constructing organisms are rarely preserved, so identifications have to be based

Some of the organisms which construct stromatolites.



solely on stromatolite shape and structure. Nevertheless, there is now good evidence to suggest that certain shapes are restricted to particular time-periods, and that stromatolites, like other fossils, can be used to date rocks.

The first green algae evolved about 1400 million years ago, and became important contributors to stromatolite growth. Rare, but exceptionally well-preserved, examples of these organisms have been found in the Bitter Springs Chert in the Northern Territory. They indicate a diverse community of both filaments and spherical organisms, some of which were blue-green algae, and others green algae.

Stromatolites continued to show a wide diversity of form and were abundant until the end of the Precambrian about 570 million years ago. Bacteria and simple algae were the only life forms until about 1 000 million years ago. Rapid changes then took place; first with the evolution of more complex algae, and then the development of the metazoans. Nearly all the varied forms of life known today have evolved in the last 600 million years of earth's history.

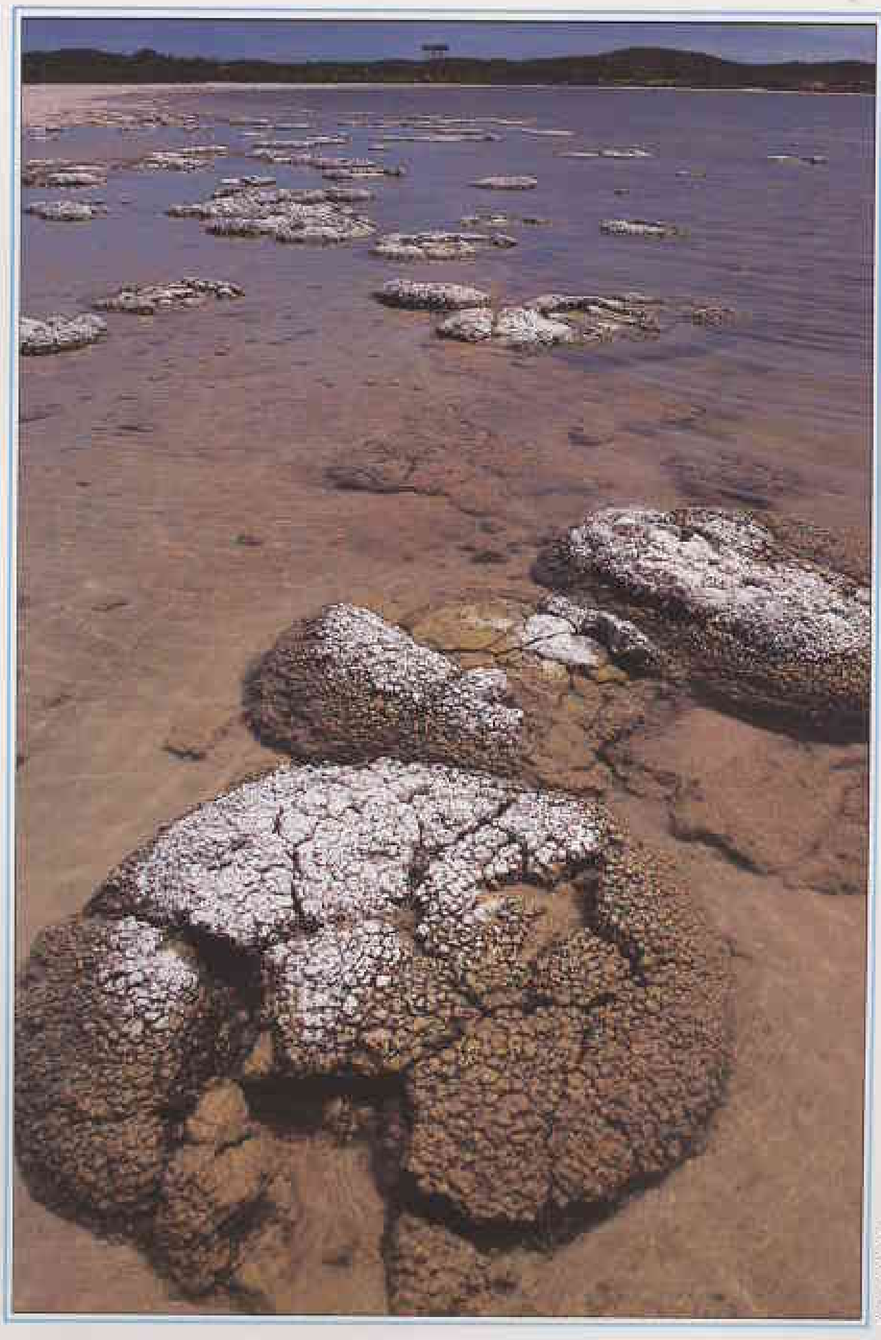
The evolution of the metazoans marked a decline in stromatolites. They became less abundant and occur only sporadically in the later geological record, a factor usually attributed to the development of burrowing and grazing organisms, and to competition for ecological niches.

The Lake That Time Forgot

In 1979 Linda Moore did a year-long study of Lake Clifton's ecology. When she finished there were no avenues for her to continue her research. Recognising the significance of the stromatolites, however, prompted her to send a copy of her thesis to the National Parks Board.

Neville Stanley, Emeritus Professor of Microbiology at the University of W.A., was curious about the strange structures he found growing

Kathleen Grey



Jiri Lochman

Large domed stromatolites at Thuragoody Bore, east of Wiluna. These fossils are 1700 million years old (top).

Stromatolite reef in Lake Thetis, near Cervantes.

on the foreshore near his Lake Clifton retirement home. Extensive enquiries drew a blank until he found the National Parks Board's copy of Linda's thesis. He contacted Linda. The resulting professional alliance produced research which attracted world-wide attention.

Lake Clifton's stromatolites offered unparalleled opportunities for research. For a start they were close to the metropolitan area, which meant access to laboratory facilities. Professor Stanley's home became a base, and work began in earnest at the beginning of 1984. After his untimely death in October 1984, the University purchased it to be used as a headquarters and laboratory for stromatolite research. Linda carried on alone.

So many questions remain to be answered. What are the key environmental factors necessary for stromatolite formation? The relative scarcity of living stromatolites has been attributed to the fact that they were usually found in extreme environments: arid, hypersaline or under frozen-over waters. These conditions excluded those organisms which competed with or predated upon the cyanobacteria which construct the stromatolites. Lake Clifton is low in salinity and abounds in fauna; in fact, numerous crustaceans comfortably co-exist with the stromatolites. The adjacent hypersaline lakes, devoid of stromatolites, offers a chance for comparative studies.

One of the unusual features of the Lake Clifton stromatolites is that they are closely associated with a high bicarbonate freshwater aquifer. Linda hypothesizes that subsurface upswellings of fresh groundwater, within the lake and along the eastern shore, are colonised by cyanobacteria capable of stabilizing the sediment. This forms a microenvironment where the cyanobacteria trap, bind and precipitate calcium carbonate to form stromatolites. The more we know about stromatolite formation the more chance we have of shedding some light on the origin and formation of cyanobacteria — one of the earliest forms of life on our planet.

Hamelin Pool

The world's best known colony of stromatolites is at Hamelin Pool, part of Shark Bay, 735 km north of Perth. The algal stromatolites there are the most abundant and diverse to be found in modern times. They vary from large club-shapes to columns, cylinders, and complex branching shapes.

Hamelin Pool is a classic environment for remnant populations of stromatolites. It is hypersaline — sometimes up to twice as salty as normal seawater — and landlocked on three sides. The north side is partially blocked by the Faure Sill, a shallow sand and sea grass bank. Because of its extreme salinity it is far less diverse in marine life than the surrounding ocean.

Marine gastropods (snails) graze upon algae. Their virtual absence from Hamelin Pool seems a major contributing factor to the survival of the algal mats. These mats from which stromatolites develop cover a large area of the intertidal and shallow-water shelf at Hamelin Pool. They have been known to reach depths of 3 m.

The persistance of such fine examples of stromatolites at Hamelin Pool makes it an area of extreme scientific interest. Hamelin Pool is one of Australia's most important nature reserves, preserving life-forms typical of the period long ago when life on earth began.□

Special thanks to Kathleen Grey

What Are Stromatolites?

Stromatolites differ from normal fossils (such as shells or bones, which are actual parts of animals) because they are formed by the activities of micro-organisms. They result from some combination of trapping, binding and precipitation of sediment. The constructing organisms are mainly bacteria, blue-green algae (cyanobacteria) and various green unicellular algae (particularly green algae).

The micro-organisms form mats of gelatinous, slimy film which traps particles of sediment. Stromatolites will only form when the micro-organisms grow slightly faster than the rate at which sediment is deposited. The mats must also be able to keep pace with destructive grazing by other organisms.

Stromatolites grow as layers of sediment are trapped or precipitated by the microbial mat. These layers, called laminae, are a feature of many stromatolites. Sometimes laminae are related to day/night cycles. At night the blue-green algae filaments are inactive and form a dense mat which becomes a dark, organic-rich lamina when fossilised. Sediment settles on the mat to form a light-coloured, organic-poor lamina. During the daytime some of the buried filaments become active and move towards light. They push upwards through the layer of sediment and form the next organic lamina when night falls. Not all stromatolites follow this simple growth pattern. Some laminae are related to seasonal variations, a little like tree rings; others have more complex patterns of development. Most stromatolites, however, show a distinctive, banded structure of alternate light and dark laminae.

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Editorial

W.A. is a vast, sparsely populated State, and it is not uncommon to hear some parts of it described as 'the last frontier'. But there are few, if any, parts of W.A. that have not been affected by European settlement.

Evidence of western civilization in some of the most remote areas is far too often the empty can. But even where there are no obvious traces, the effects have been profound.

There is compelling evidence, for example, that the displacement of Aboriginal communities from much of inland W.A. — and the subsequent removal of Aboriginal firing practices — is directly responsible for major changes in vegetation, which in turn has resulted in the virtual extinction of many native animals.

It is not always easy to pick the effects of European civilization on the natural environment even when the history is well-documented. This *Landscope's* account of the woodlands around Kalgoorlie talks about the often horrific environmental damage, but an observer of these woodlands today would have difficulty recognizing that vast areas were clearfelled less than 50 years ago.

While the concept that we should 'let nature do its thing' has superficial appeal, the reality is that the purity of nature has been, and will continue to be, distorted by human presence. We have no option if we want to sustain the unique ecosystems of W.A. but to apply management principles.

The history and management problems of Benger Swamp, which feature in this edition, illustrates two fundamental points. Firstly, even the most disturbed areas of W.A. can make a major contribution to conservation. Secondly, we must be careful not to change a system that works even though the way it works may not be 'natural'.

As complex and as difficult as the task of understanding ecosystems is, the social and political factors which influence the type of management that can be applied are often more difficult to deal with.

The key to good management is an understanding of the processes that drive the ecosystem. Once we understand what the natural processes are, we can then devise management systems which will mimic them.

The only way to ensure that rational decisions are made on environmental management is to provide the facts .

COVER PHOTO

Just when you thought you had seen every angle on our State symbol, photographer Jiri Lochman surprises you with a fresh perspective.