CHAPTER EIGHT

This corridor forest has few monuments,
its Big Trees barely as old as Cook.
What lasts is a seedling's will
to thrust up through seasonal fires, and teeth
–as if the same tree revived
centennially in one place.

CHAPTER 8

A CAST OF MILLIONS

A catalogue of all the species known to science which live and depend on Murray-Darling floodplains would fill many volumes, and is beyond the scope of this publication. A catalogue of all the species which are yet to be described would be very much longer — and, of course, impossible to compile. Instead the next three chapters will look at just a few of the characteristic organisms that inhabit Australian floodplains, and at the ecological parts they play.

The first link in all food chains is photosynthetic life — the plants, algae and some bacteria that capture sunlight and store its energy in their cells (Chapter 4). The largest photosynthesisers are trees, which spend most or all of their lives on dry land. However, there is no clear distinction on river floodplains between land and water habitats. Many water plants and animals spend at least part of their lives on dry land, and many land plants and animals spend at least part of their lives in the water. Some need to do both to survive.

SOLAR POWERED LIFE

The characteristic stands of red gums, for example, which dominate Australian floodplains in many widely different environments, depend on regular flooding and drying — not just for water for growth, but also to set and distribute seed, to break down leaf litter, to control insect pests and to supply them with nutrients and soil. Many other common native floodplain plants, such as lignum, are also well-adapted to take advantage of frequent floods and dry spells. Other, shorter-lived understorey plants which depend on a regular flooding cycle have now all but vanished (Chapter 13).

A survey in 1990 of floodplain vegetation along the River Murray found more than 500 native plants, many peculiarly adapted to floodplain life. The survey also found quite marked differences between plant communities growing on different stretches of the Murray floodplain. It reported river red gums growing all along the river, making the vegetation appear at first glance to be quite uniform. But it found the native understorey vegetation varied widely according to local rainfall, flooding frequency, soil and climate. Aside from river red gums, only 17 native plants grew along all reaches of the river. Altogether the survey identified 37 different native plant communities growing along the length of the Murray. (14)

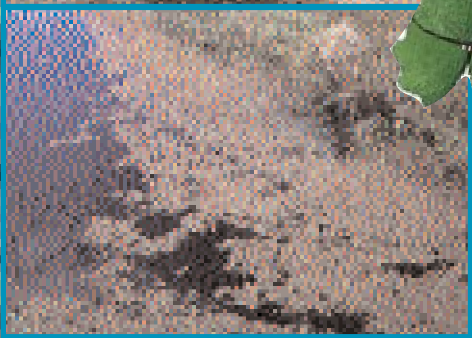
River red gums

Throughout the southern Murray-Darling Basin, and across much of the rest of Australia, river red gums grow near water. They are the most characteristic inland riverbank tree, except where they have been replaced by willows, and they mark the frequently flooded areas of floodplain. Along some stretches of river, red gums grow only three or four trees deep, in other areas they spread out as vast forests, up to 25 kilometres across. The forest bounds are set by the availability of water. Despite widespread removal of trees last century, and deaths of swathes of forest due to permanent flooding and salinity in some areas, the River Murray's floodplain still supports some 196,900 hectares of red gum forest. (15)

River red gums are voracious water users. They can draw water from underground, especially where watertables are shallow and plentiful, but unlike most other eucalypts they thrive especially well in flood-prone soils. Red gums are such water lovers that it takes about 18 months of continuous flooding to kill them. In times of drought they shed leaves to cut their water use (the more leaf area a plant has, the more water it loses by evaporation), but they cannot survive many years without ample water, either from floods or groundwater.

The Barmah-Millewa red gum forests support large and varied wildlife populations, including 206 species of birds, 25 species of native mammals, 27 species of reptiles and 10 species of amphibians.
Photo: *Karen Markwort, CRCFE*

Below, *Cyperus exaltatus* Photo: *Surrey Jacobs*



Below, *Azolla pinnata* Photo: Geoff Sainty

River red gum forests are productive places, far more so than the dry landscape that usually surrounds them. In the Barmah and Millewa red gum forests the average rainfall is only about 400 millimetres a year, but the density and mass of trees is similar to forests receiving 1,200 millimetres of rain a year. (16) The trees produce enormous amounts of organic matter each year, and between a half and a third of it falls to the ground as tonnes of leaves, twigs and bark.

Red gum leaves are one of the great engines of floodplain ecology; they supply much of the energy and carbon to life in the water and on the land (Chapter 6). But eucalyptus leaves are very different from the autumn leaves shed by Northern Hemisphere deciduous forests. Unlike deciduous trees, eucalypts shed their leaves all year, with the highest leaf-fall in summer and the lowest in winter. And gum leaves are tough, waxy, low in nutrients and filled with chemical toxins. It is a harsh diet, but one to which the plants and animals living on Australia's floodplains are well-adapted. In a curious parallel with the biological wealth of floodplains, similarly indigestible raw material in dryland Australian ecosystems has also spawned astonishing levels of biodiversity — there are more than 5,000 known species of mallee moths, for example, all of which feed on fallen eucalyptus leaves. Perhaps there is something about a diet of gum leaves which breeds biodiversity?

Gum leaves break down much faster under water than when they are dry. A wet environment is more congenial to the swarms of bacteria which feed on gum leaves, and to the shredding and slicing invertebrates which break up the leaves and graze on the bacteria (Chapters 6 and 9). Litter builds up under red gums when the floodplain is dry. On the ground leaves dry out, undergo some initial decay and are generally 'conditioned' for several months. Probably rainfall leaches out some of their chemical toxins. Then, in most years under natural flows, a winter or spring flood wets them and starts the rapid breakdown process.

As well as being important for red gum growth and regeneration, regular flooding helps the trees control leaf-eating pests. After a series of dry years, red gum forests can have their leaf canopies stripped bare by swarms of a native caterpillar called the gum-leaf skeletoniser. After flooding, conditions in the treetops are much more humid. High humidity encourages the growth of two species of fungi, which infest and kill the larvae of the gum-leaf skeletoniser. (17)

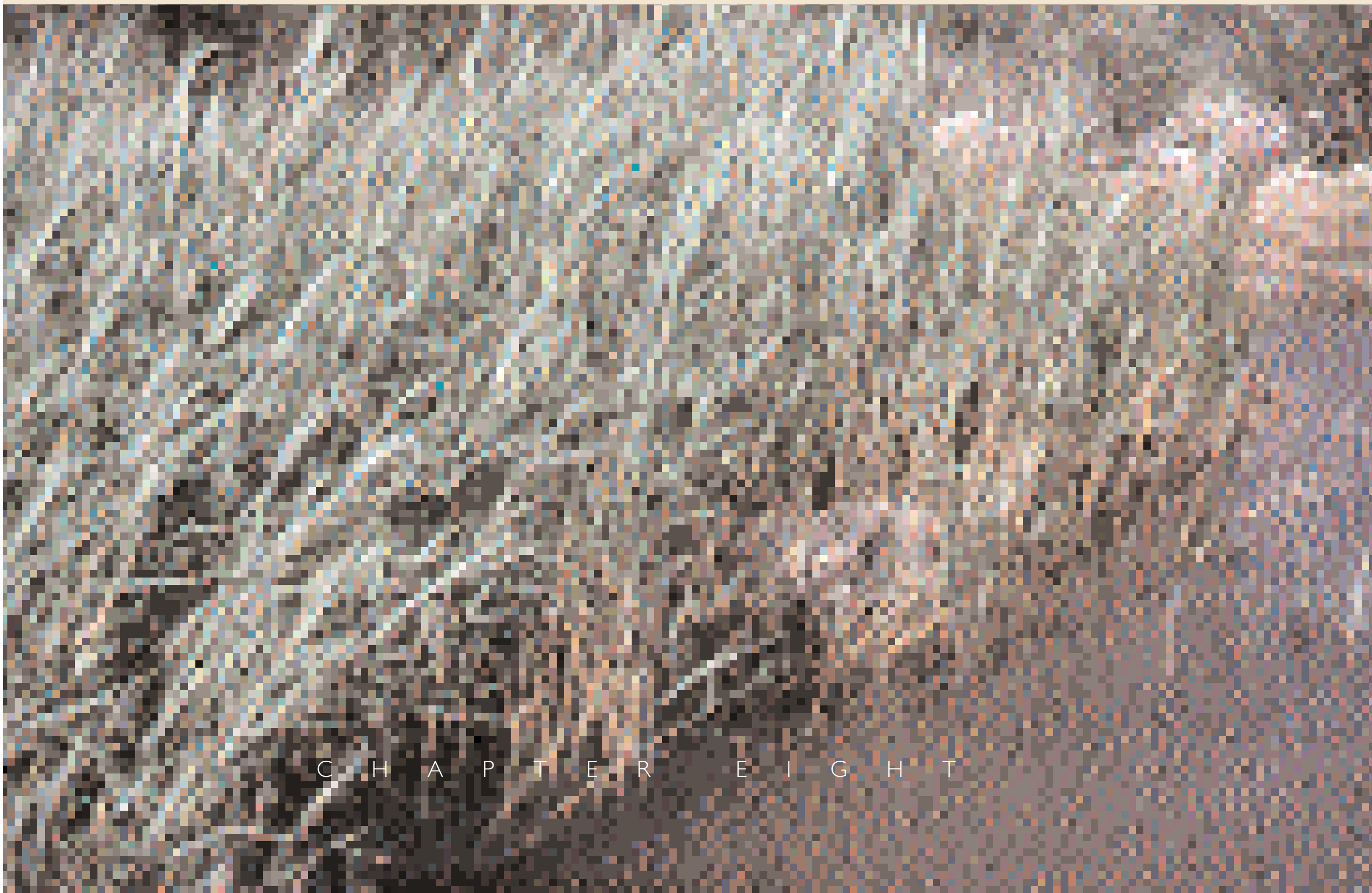
Water plants

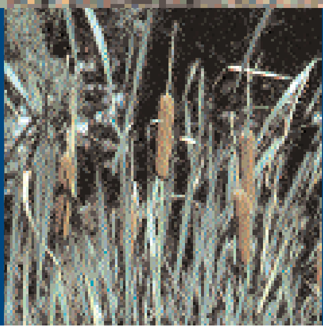
Some floodplain plants spend most, or all, of their lives in water. Many of these water plants are unique to Australia. However, some are also found elsewhere in the world, with the Australian populations representing local varieties rather than distinct species. Scientists call water plants 'macrophytes', and they are important habitats for the swarms of tiny animals that inhabit floodplain waterbodies. Living water plants are also grazed by some aquatic species — such as tortoises and some waterbirds, including coots and swans — but they probably do not represent a major freshwater food source.

Leaves of water plants give off oxygen, which is important in still, oxygen-poor waters such as those of billabongs, swamps and marshes, and they take up carbon dioxide and sometimes nitrogen from the air and water, making it available to other species. The roots of water plants help stop erosion, and their foliage slows flowing water, making floods recede more slowly, reducing the erosive power of currents and allowing nutrient-rich silt eroded from the catchment to settle. They also trap waterborne material, building habitats for aquatic species. In combination with bacteria and other microorganisms, water plants take up nutrients from the water and sediment, improving water quality. These nutrients are released again when the plants die, lose their foliage, or are grazed.

Some plants float on the water's surface, with their roots dangling beneath them like jellyfish tentacles. Often floodplain waters are

The native reed, *Phragmites australis*, has been used successfully to control stream bank erosion in the Murray-Darling Basin. Photo: *David Williams, CRCFE*





A shallow billabong on the Ovens River supporting a bed of the giant rush, *Juncus ingens*. Photo: *David Williams, CRCFE*

Inset: The common rush, *Typha orientalis*, Photo: *Surrey Jacobs*

almost completely carpeted by such floating plants. Two common floating plants are duckweed, which forms a loose green carpet, and azolla, a tiny fern which forms an unmistakable green or maroon mat across the surface of still water. Both duckweed and azolla are individually very small — each azolla plant grows only to about the size of a five cent piece, and duckweed plants are even tinier. But they are typically found growing in large communities, like miniature, floating forests, and like forests they offer refuge and food to many other species.

Other plants have leaves that float on the surface, but roots attached to the sediment below. One well-known Australian species is nardoo, a fern, which is sometimes cultivated in garden ponds. Nardoo was an important food for Aborigines, who knew how to prepare its round sporocarps — a fern's equivalent of seedpods — to make flour. The sporocarps contain poisons that must be removed for them to be eaten safely, something which the 19th century explorers Robert O'Hara Burke and William Wills learnt to their cost. A recent re-examination of the explorers' journals shows that they probably died of nardoo poisoning, after ignoring demonstrations by Aborigines of how to prepare the bush food safely. (18)

Many plants live fully submerged in the water, sometimes free floating but usually with their roots in the sediment. Their leaves, often feathery, reach up to capture sunlight near the surface. They include native pondweeds, often found in farm dams, and milfoils. Perhaps the most common is ribbonweed, which forms a grass-like mat, fully submerged aside from its fruiting bodies, and which can live in quite fast-flowing water.

Still other plants — emergents — have their roots in the sediment, but foliage that emerges out of the water. Often they live near the water's edge, where fluctuating water levels mean they spend part of their lives on dry, or damp, land. Emergents include sedges, rushes, reeds and grasses, often growing in dense thickets. The two largest are the plant, whose roots were eaten by Aborigines, and the common reed. Both can grow up to four metres high.

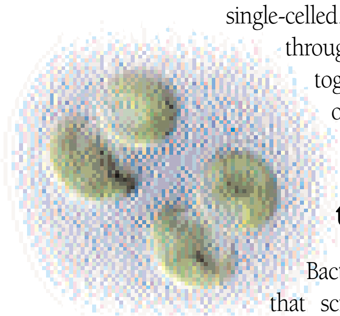
Algae

Including cyanobacteria — which until recently were classified as 'blue-green algae' — more than 150 species of algae have been recorded in the Murray-Darling Basin. Like higher plants, they use photosynthesis to capture energy from sunlight, giving off oxygen in the process. And also like plants they oxygenate water, provide habitat and food for animals, slow down moving water and use nutrients. Algae are among the most abundant life forms on Earth, living in the oceans, in freshwater and on land. It has been estimated that, together with photosynthetic bacteria, they generate 70 percent of the world's oxygen supply. (19)

Some types of algae are multicellular, and are easily visible to the naked eye, often with stem-like and leaf-like structures similar to those of higher plants. The largest in Australia's inland waterways are stoneworts, which grow up to a metre long. Other multi-celled species appear much less plant-like. The green slime that sometimes forms on rocks or on the surface of water is also a form of algae, made up of long, hair-like strands.

However, the vast majority of algae are microscopic; often just single cells floating or swimming in the water. These are known collectively as phytoplankton and, although they are visible only under a microscope, they include some exquisite and fascinating forms. Some single-celled algae, called diatoms, live, either singly or in colonies, inside hard, shell-like skeletons made of silicon. The modern electron microscope has made some of these silicon shells clearly visible for the first time. Most are brown or yellow, and many are stunningly beautiful.

Other algae can swim, using tail-like flagella to tadpole their way slowly across the water's surface in search of sunlight. Many are single-celled, but some form into spherical colonies, rolling through the water — with their bodies tucked in together like a rugby scrum, and their tails trailing outside and stroking them along.



Bacteria and others: the realm of the very tiny

Bacteria are so small, so diverse and so numerous that science doesn't attempt to classify the vast majority of them. A single litre of floodplain water can contain anything from a hundred billion to a thousand billion individual bacteria — in human terms, anything from 17 to 170 times the human population of Earth. A litre of river water typically holds one or two orders of magnitude fewer — perhaps 10 billion individuals, or roughly twice the world's human population.

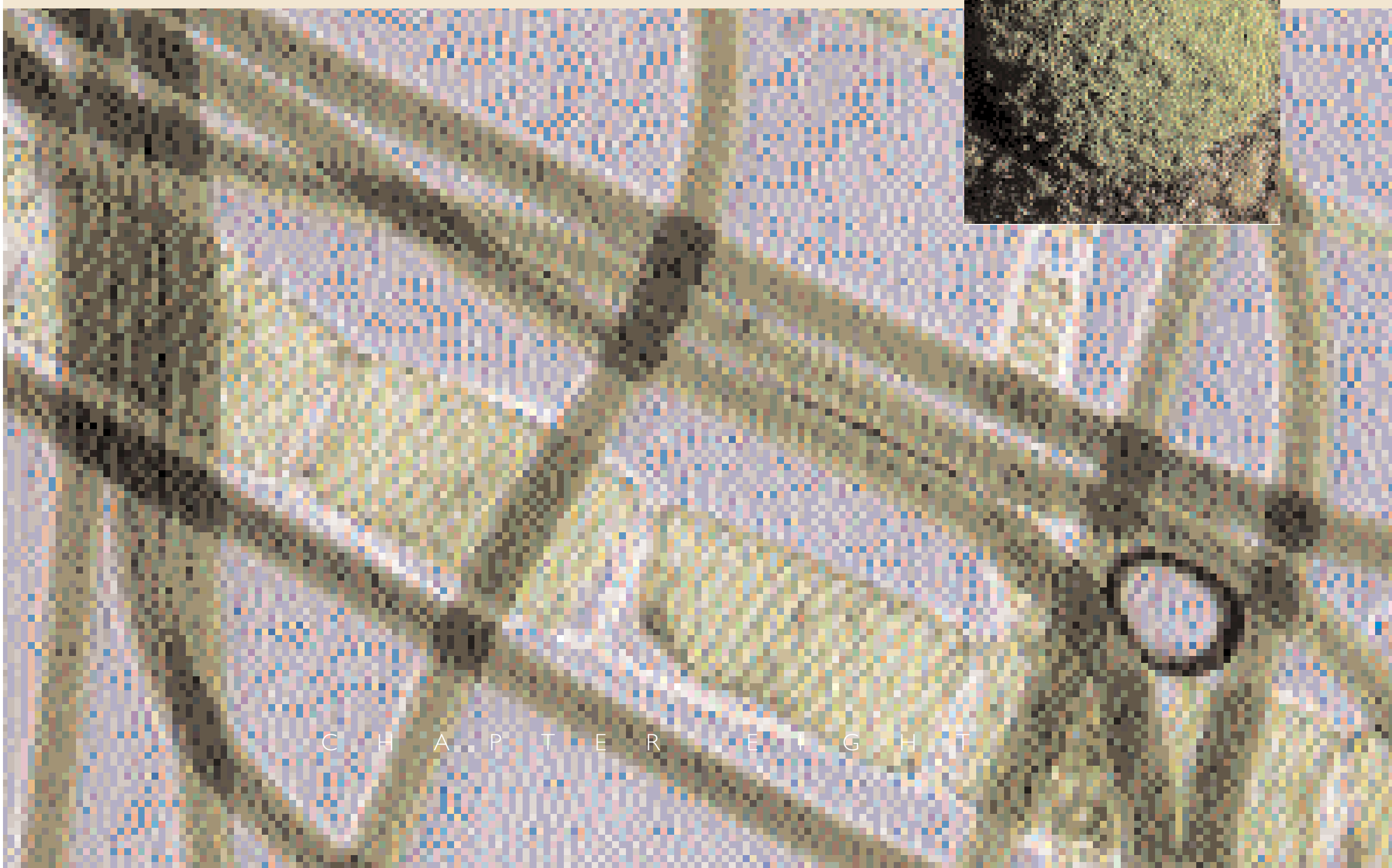
Waterborne bacteria are best known to humans as disease carriers, and such disease-causing bacteria have been more closely studied than other types. Water authorities, for example, test drinking supplies for faecal bacteria as an indicator of sewage contamination. Faecal bacteria can be detected when just one or two individuals are present in a litre of water, and if any are found the water is classified as undrinkable.

However, the vast majority of bacteria living in freshwater are never seen, and never heard of. They represent a taxonomic black hole, and a continuing ecological mystery. For the most part scientists have only a very general grasp of how different groups of bacteria behave in different parts of the aquatic environment: some break down leaves; some process chemicals in the soil; and some inhabit plant roots, animal digestive tracts or other unlikely places. Some breathe oxygen; some are poisoned by oxygen; some can either take it or leave it.

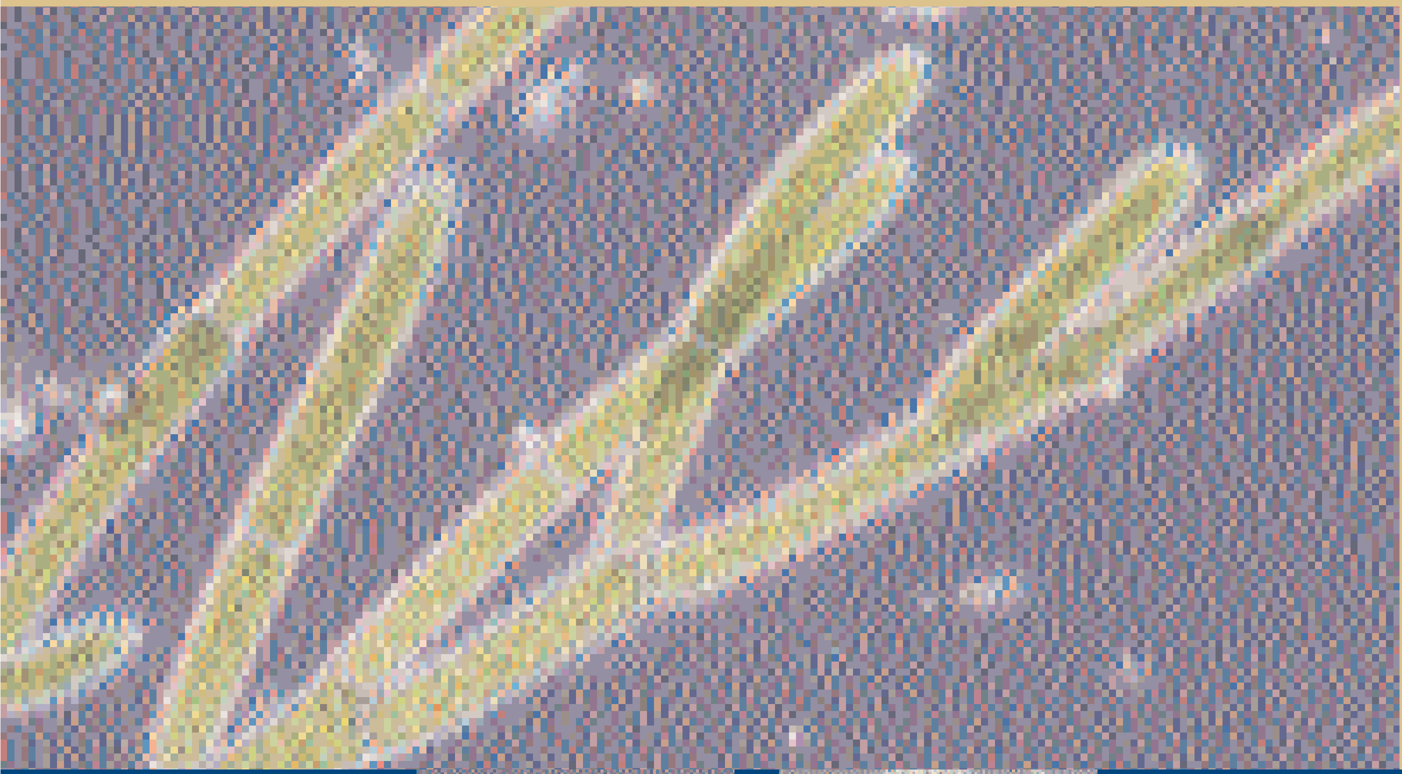
Bacteria are the oldest recorded forms of life on Earth, and are ancestors to all other cellular life. Each bacterium consists of a single, tiny cell, which has no central nucleus and is labelled 'prokaryotic'. Bacterial cells are far smaller than the modern, 'eukaryotic' cells that make up animals and plants. Indeed, eukaryotic cells evolved from prokaryotic cells about 1.5 billion years ago — probably when small, parasitic bacteria invaded larger ones and learned how to live inside them. Eukaryotic cells in turn clumped together, about 600 million years ago, to form the very first multicellular organisms. (20)

We big animals owe our origins to bacteria, and our world has been very much shaped by them. They created the atmosphere we breathe, and laid down many of the mineral deposits that humans now mine. The oldest type of bacteria, 'anaerobes', have been around for some 3.8 billion years. They evolved at a time when there was no oxygen in the air. Anaerobes produced oxygen as a waste, creating the modern atmosphere, but the gas was poisonous to

Above: The green alga, *Oocystis* ***Algae photos: Jason Sonneman***
Below: The green alga, *Spirogyra* and the blue-green alga, *Oscillatoria*

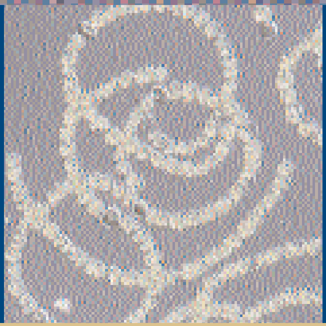


Algae drive more than 70 percent of the world's photosynthesis. There are more than 3000 species of freshwater algae found in Australia, some of which are so small they can only be seen under a microscope. Below: Green alga, *Cladophora*. Algae photos: *Jason Sonneman*



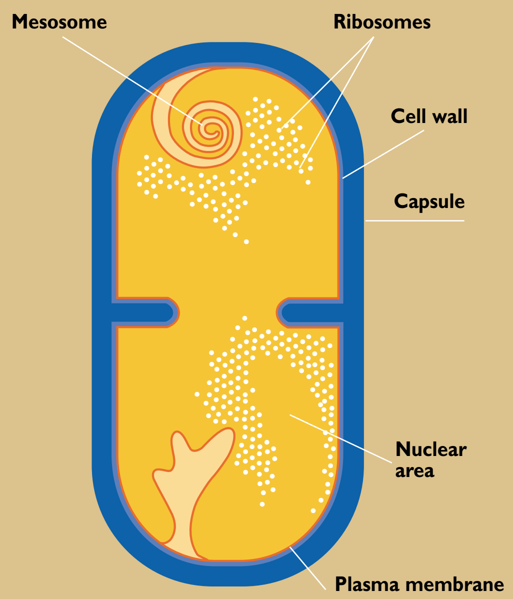
Right: *Staurastrum*, another green alga. This single-celled alga, found free-floating in lakes, is widespread and extremely diverse.

Far Right: One of the toxic bloom-forming blue-green algae, *Anabaena circinalis*.

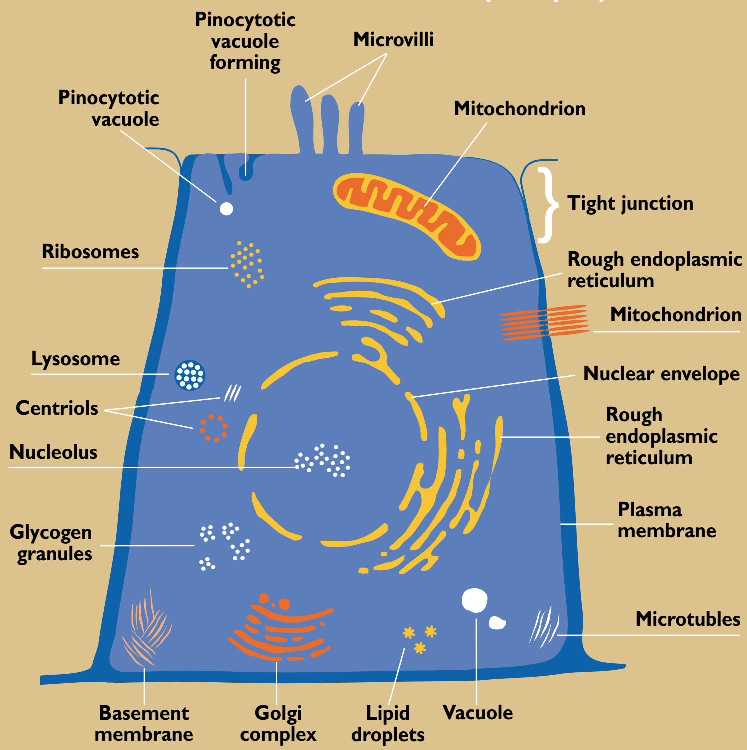


Below:
While this 'representational' animal cell (below) contains organelles that would not normally occur in the same cell, it shows the much greater complexity of eukaryotic cells than prokaryotic cells, of which the bacterium cell is an example.

Bacterium undergoing cell division (prokaryote)



A generalised animal cell (eukaryote)



them. (21) Now that the air is rich in oxygen, most of the world is off-limits to anaerobes. However, they survive, and thrive, in places where air can't reach — in underwater sediments, animals' guts and deep underground. Anaerobic bacteria are especially important in underwater sediments, where they break down organic matter, such as fallen leaves, logs or manure. They release methane gas and nutrients as they consume drowned plants and litter.

Other types of bacteria — aerobic bacteria — have adapted to live in air. They 'breathe' oxygen, and need it to survive. Like plants, many use photosynthesis to capture energy from sunlight. Perhaps the best known are the cyanobacteria ('blue-green algae') which, when conditions are right, can form spectacular blooms on waterways. There are also facultative anaerobic bacteria, which can thrive either with or without oxygen. On a floodplain, facultative anaerobes are particularly important, because wetting and drying switches soil conditions regularly from anaerobic to aerobic.

Bacteria appear to be peculiarly numerous, diverse and important in floodplain waters. They are the base of the floodplain food chain, breaking down leaf litter and other underwater detritus and some, like plants, catching solar energy by photosynthesis (Chapter 4). In the water, bacteria form a slimy film over water plants, and over submerged leaves and twigs as they decompose them. This film plays a crucial role in aquatic ecosystems, releasing the nutrients and energy bound up in the fallen litter to other organisms. Most microinvertebrates cannot themselves digest organic matter: they feed on the bacterial film rather than on the decaying litter itself.

Bacteria control much of the chemistry of floodplain waters. They determine what nutrients are available in the food chain; they tease out chemicals that are locked up as large molecules in soil and make them soluble and therefore available to other organisms. When dry floodplain soil is flooded, the water is infused with a sudden burst of nutrients from the soil. Facultative anaerobes are thought to contribute at least some of this burst, as they switch from aerobic to anaerobic mode (Chapter 6).

Even less well understood, and just as numerous, are viruses. These are far tinier than bacteria, and often consist of little more than a short stretch of the double helix DNA molecule, or its close relative RNA, wrapped up in a protective coat of protein. Viruses are parasites on life, invading living cells and tricking their hosts into making more copies of themselves. This behaviour is not always good for the host, which is why the best-known viruses are those that cause human illnesses. But there are many other kinds, and in the water they prey on all forms of life from bacteria to fish. The vast majority are unknown to science.

Regularly wetted floodplains carry very few species of fungi; so few in fact that a lack of fungi is one defining characteristic of flood-prone soil. Dryland soils are riddled with fungi, which share with bacteria the job of breaking down organic matter. On flooded soils, bacteria do the job mostly on their own. Almost nothing is known about the part played by fungi on floodplains.


Photo: *Jason Sonneman*