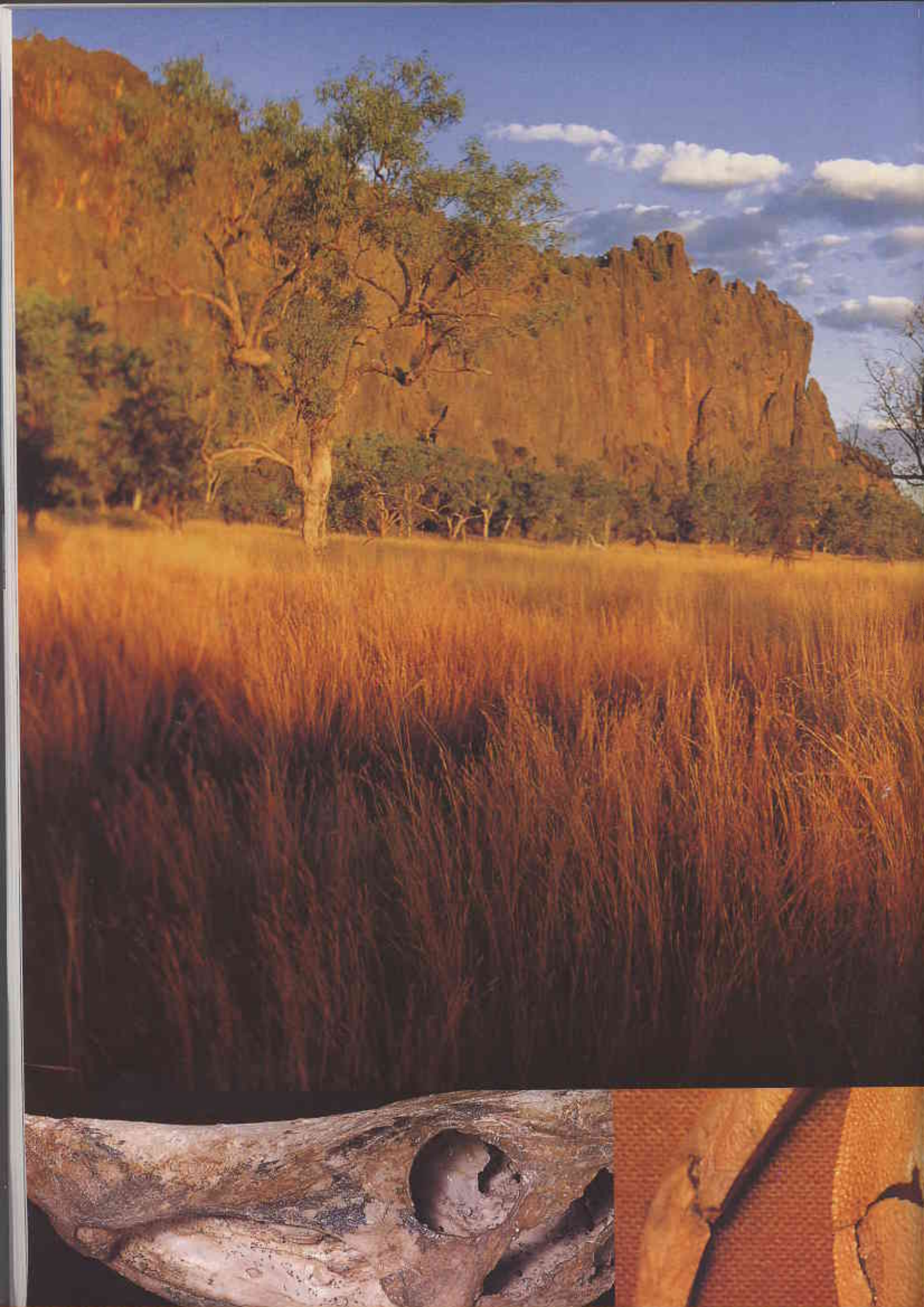


OLD FOSSILS

Windjana Gorge National Park

Windjana Gorge National Park was once part of a barrier reef that teemed with a myriad of life forms. The reef formed around 380 million years ago, in the Devonian period, when a large part of the Kimberley was covered with a tropical sea. Perfectly preserved within its rocks are amazing fossils of a huge diversity of marine animals, including the world-famous Gogo fishes. What did these early creatures look like, and what do they tell us about evolution of life on Earth?

by John Long

Windjana Gorge National Park, covering an area of just 2,134 hectares, lies 150 kilometres west of Fitzroy Crossing and 145 kilometres from Derby. The Gorge was a highly spiritual place to Bunuba Aboriginal people and the Wandjina, powerful creation spirits, reside there. Hence the name Windjana, which was misrecorded by William Forrester, who took up a nearby pastoral lease in 1884 and built Lillimooloora homestead.

In Forrester's time, Windjana Gorge was used as an ambush point and a hideout by the famed Aboriginal leader Jandamarra. Jandamarra (also known as Pigeon) was shot and at first thought to be fatally wounded during a gun battle here in 1894. But you need to go back to even earlier times to uncover just as fascinating a story—one that concerns the very beginning of life itself!

In modern times, erosion has exposed the ancient Kimberley reef and unearthed its fossil treasures. The ancient reefs loom above the vast plains of the southern Kimberley, forming spectacular limestone ranges, which outcrop from near Derby, running by Fitzroy Crossing almost to Halls Creek. The far northern extent of the reef is seen in the Ningbing Range near Kununurra. It seems almost as if the water has only recently retreated, leaving the reefs exposed high and dry in all their splendour. If you walk around the reefs you can still find ancient corals and shells protruding from the rocks, undisturbed from their position while alive, literally frozen in time.

Previous page
Main: Windjana Gorge National Park.
Photo – Bill Bachman
Bottom: Fossils of the Gogo fishes.
Photos – John Long

Below: The ancient barrier reef was built by lime-secreting organisms, mainly calcareous bacteria and extinct coral-like organisms called stromatoporoids.
Photo – Cliff Winfield/CALM

The superb array of fossils found in the sedimentary rocks of the reef system enable scientists to reconstruct what life and death was like in the warm, tropical seas of long ago. The main limestone reefs are built up from the remains of many millions of tiny creatures. Just as today's coral reefs are constructed largely of dead coral skeletons, the Devonian reefs were built up from the remains of many kinds of creatures. There are the cyanobacterial mounds known as stromatolites, layered sponge-like creatures called 'stromatoporoids', many kinds of algae, early corals, shells of diverse shapes and sizes, echinoderms, sea mosses (bryozoans) and single-celled microfossils. Swimming in the waters around the reef were schools of shrimp-like crustaceans, as well as the squid-like ammonoids and nautiloids. Trilobites, small creatures with jointed legs, burrowed and swam around the muddy sea floor.

However, the well-preserved fish fossils of the region are the most extraordinary of these fossils. Their perfect preservation has given scientists much new information on the anatomy and early forms of the first animals with backbones. These fish fossils occur in

limestone concretions known as the Gogo Formation (named after Gogo Station), and so they are commonly known as 'the Gogo fishes'.

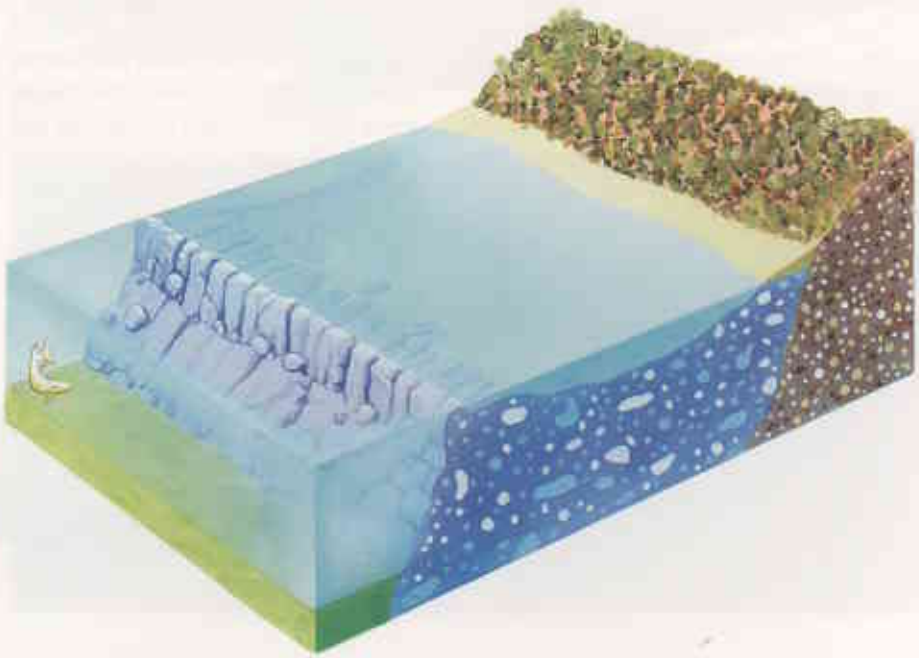
LET THERE BE FISH

Fishes first appeared on the Earth some 500 million years ago, as flimsy, jawless creatures adorned with bony armour and scales. The first jawed fishes came on to the scene about 420 million years ago, probably looking much like sharks do today. By about 370 million years ago, when the Kimberley reef system was thriving, fishes had reached an acme of diversity—many different groups had evolved and they dominated life on this planet for more than 130 million years.

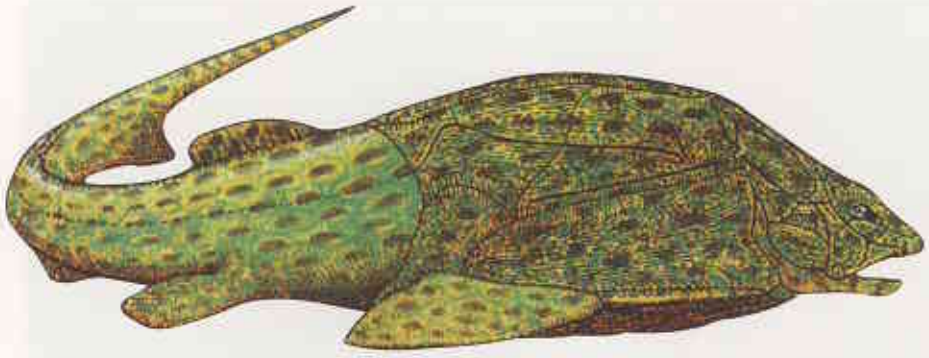
Today, we find the beautiful fossil remains of these fishes, and other reef-dwelling creatures, preserved inside the orange limestone nodules of the Gogo Formation. These rocks represent the deeper, quieter waters well away from the high-energy reef fronts. The fishes found in these deposits are preserved in exquisite detail because the region remained free of major geological activity and large crustal movements, which have deformed and compressed fossils of a similar age in most other parts of the world. In the deep inter-reef basins of the ancient sea, muddy lime-rich sediments slowly accumulated over the dead bodies of organisms. The fish were rapidly encased in fine limey mud, which set as hard calcite crystals soon after burial. This process protected the delicate skeletons from being crushed by the weight of accumulated overlying sediments. When the fossils are treated in weak acid, which dissolves the limestone but not the bone, perfect uncrushed fossil skeletons can be recovered. The delicate bones are hardened with glues as they slowly emerge from their rock casings.

Gogo is one of the most famous fossil sites in the world. Not only do the superb state of the fossils tell us much about the anatomy and structure of

Above: An Early Devonian marine scene with an armoured fish (top left) and a lungfish (bottom right). Invertebrates of the time included the straight orthoconic nautiloid (bottom left), trilobites, corals and crinoids or sea lilies.
Illustration – John Long



Right: A reconstruction of the reef, as it would have looked in Devonian times, 350 million years ago.
Illustration – Ian Dickinson/CALM

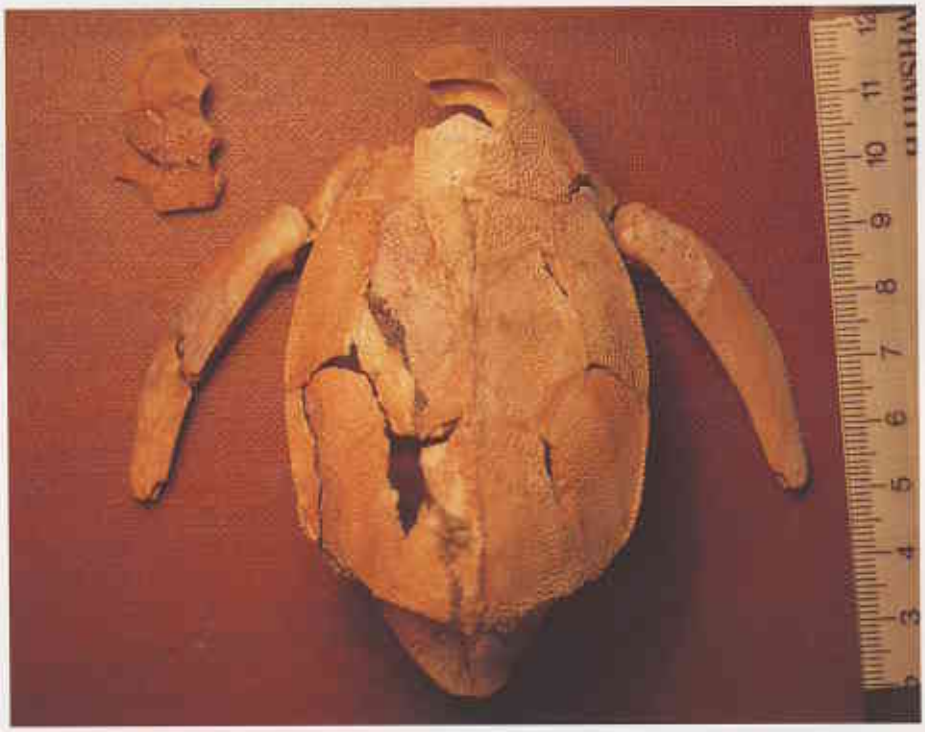


Left: Complete specimens of *Holonema* have been found near Windjana Gorge National Park.

Below left: A three-dimensionally preserved specimen of a *Bothriolepis*.

Below: A reconstruction of *Rolfosteus canningensis* from the ancient Gogo reefs.

Photos/Illustrations – John Long



these early fishes, but the diversity of fishes is astounding. About 40 different fish species have been recorded at Gogo, more than any other site of this age in the world. At the same time that the Gogo fishes were swimming around the Kimberley, the oldest known amphibians were taking the first tentative steps on land in eastern Australia. The ancestral group of fishes (the osteolepiforms) that gave rise to the first land animals are present at Gogo, providing valuable scientific information about this great step in evolution.

THE REIGN OF THE ARMOURED FISHES

The most abundant fish fossils at Gogo are the armour-plated placoderms (placoderm is a Greek word that means 'spiny skin'). Although placoderms had a shark-like body and tail, their head and trunk were covered with bony, interlocking plates. The placoderms from Gogo include predatory forms with sharp, blade-like cutting jaws. The largest of these was *Eastmanosteus*. With a skull up to 27 centimetres long, the total length of the fish is estimated to be about two-and-a-half metres. Its giant predatory cousins like *Dunkleosteus*, which swam around North America, may have reached six to eight metres in length. The sluggish, bottom-dwelling *Holonema* had peculiar tubular ridges on its cup-like tooth-plates, possibly for sifting or grinding fine food from the sediments. Perhaps the most unusual placoderms from Gogo are the streamlined camuropiscids, a family of fast swimmers that lived near the surface. Some of them, such as *Rolfosteus*, developed long, tubular snouts and elongated bodies. *Bothriolepis*, another bizarre little placoderm from Gogo, sports a pair of hinged, bony arms. These may have helped it to dig itself into rich, organic muds, so that it could feed on detritus. The Gogo specimens are so well-preserved that the bony arms can be moved around still attached to their sockets!

One of the Gogo placoderms, *Mcnamaraspis*, was proclaimed as Western Australia's official State fossil emblem in December 1995. This tenacious little battler was armed with fang-like cusps on its jaws, and takes its

Right: Mcnamaraspis, a predatory fish from Gogo, is the State's official fossil emblem.

Below right: A reconstruction of the late Devonian lungfish (*Griphognathus whitei*).

Bottom right: A skull of the Devonian lungfish found near Windjana Gorge.
Photos/Illustrations – John Long

name from Dr Ken McNamara, an internationally renowned palaeontologist at the Western Australian Museum.

The peculiar little ptyctodontids are the only placoderms known to have possessed internal fertilisation organs or 'claspers'. These are seen on the males of all sharks, rays and holocephalans. The ptyctodontids from Gogo reveal the structure of these organs in great detail and female ptyctodontids have also been recognised recently. Further study of these finds will perhaps reveal explicit details of the earliest passionate love affairs on the ancient tropical reef!

EARLY FISHES AND LUNGFISHES

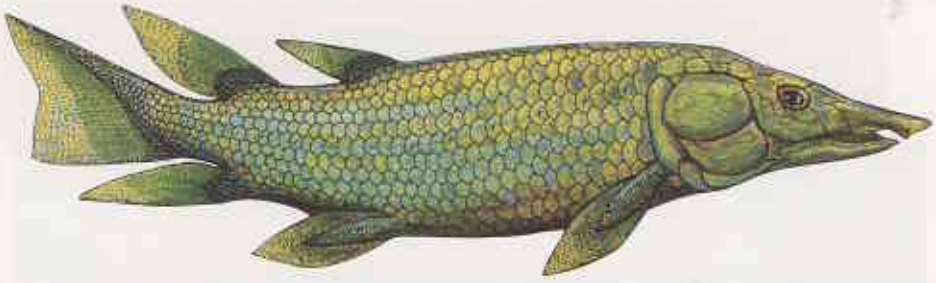
Three different groups of bony fishes (osteichthyans) are also well represented at Gogo. The ray-finned fishes (Actinopterygyii) form the dominant group of fish that populate modern rivers, oceans and lakes. The earliest forms date back to Devonian times, and fossils found at Gogo are the best-preserved examples. The two forms found at Gogo are *Mimia* and *Moythomasia*, both a little smaller than a rainbow trout. *Mimia* takes its name from the Aboriginal spirits that live within the rocks.

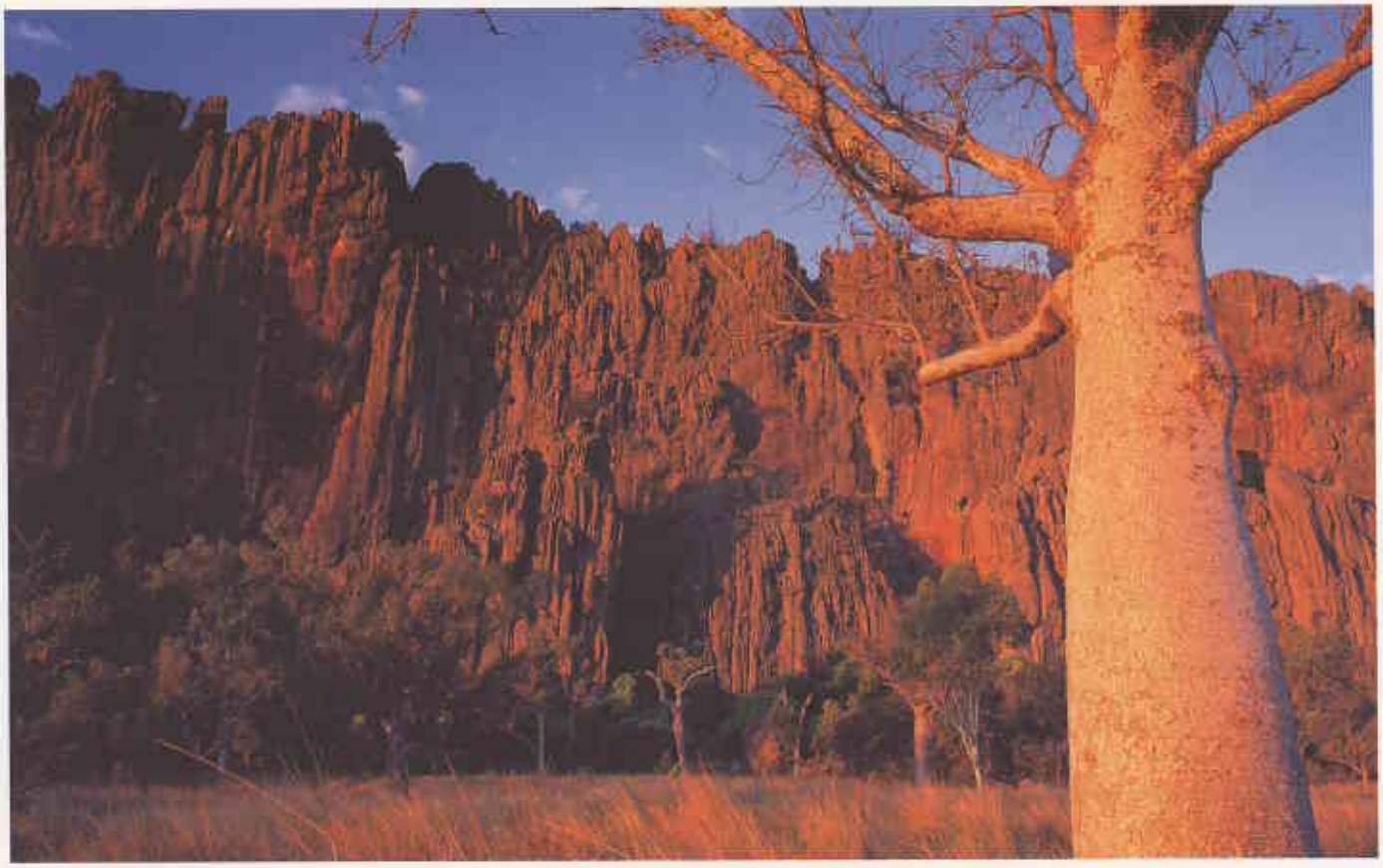
The lungfishes (dipnoans) are another group well represented at Gogo. *Griphognathus*, with its long duck-like bill, grew up to a metre long and probably used its electromagnetic snout to nuzzle for worms and other creatures in the soft muds on the bottom. *Chirodipterus* possessed powerful, crushing tooth-plates. It probably fed in the shallows around the reef, crunching up clams and corals with its powerful jaws. Today, lungfishes are air-breathing fishes that inhabit the rivers of southern Queensland, Africa and South America. Fossils from Gogo provide real evidence that the early members of this lineage dwelt entirely in the marine environment.

The lobe-finned crossopterygian fishes are rare at Gogo, but two species are now known. *Onychodus* was a large, lurking reef predator, much like our modern moray eel. Like the moray it had a flat, snake-like head with enlarged, dagger-like teeth at the front of its jaws. It may have grown up to two metres long. One specimen was found with placoderm bones stuck in its gullet, suggesting that the greedy fish choked itself while attempting to eat a placoderm about half the size of its own body length.

A SIGNIFICANT DISCOVERY

Perhaps the most significant Gogo fish yet discovered, and certainly one of the rarest, is the osteolepiform *Gogonasus*. This fish belongs to the same group that gave rise to the first amphibians and shows many anatomical similarities with the higher





vertebrates, such as having an internal palatal nostril (choana). These fish also have the same pattern of arm bones (a humerus, ulna and radius) in their pectoral fin, a condition seen in all higher land vertebrates. It is through detailed anatomical studies of fish like *Gogonasus* that the complex evolutionary transition between fishes and land animals is becoming more readily understood. Fish like *Gogonasus* already possessed many of the features needed for invading the land—strong limbs with solid arm and leg bones in their fins, a capability for air breathing and strong backbones, a precursor for supporting the body out of the water. Putting it simply, if not for fishes like *Gogonasus* the first land animals may never have evolved and we humans would not exist today.

Despite the passage of some 380 million years, the ancient reef is so well preserved that taking a walk in Windjana Gorge National Park is like stepping back to Devonian times. Today's visitors can return to a time when hardly any life existed on land, apart from a few simple plants and a few primitive mites, spiders and beasts resembling scorpions. It's not hard to imagine the seas about 100 metres or so above the valleys, sweeping vigorously above the tops of the ranges where the active reef front was growing, and see the bizarre forms of long-extinct fishes swimming around you. Really, with a bit of imagination, it's not hard at all.

Above: The western face of Windjana Gorge.
Photo – Col Roberts/Lochman Transparencies

Left: The Lennard River has cut through the ancient barrier reef to form Windjana Gorge.
Photo – Jiri Lochman

John Long is Curator of Vertebrate Palaeontology at the Western Australian Museum, and author of several popular science books and children's novels. He can be contacted by email (long@museum.wa.gov.au).

All photographs and illustrations by John Long were reproduced from his book, *The Rise of the Fishes*, which is available from the WA Museum.

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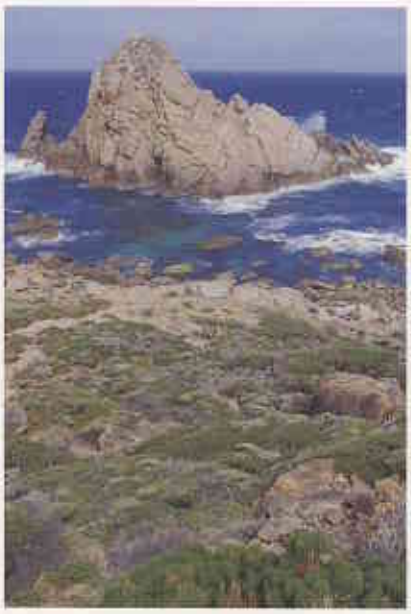
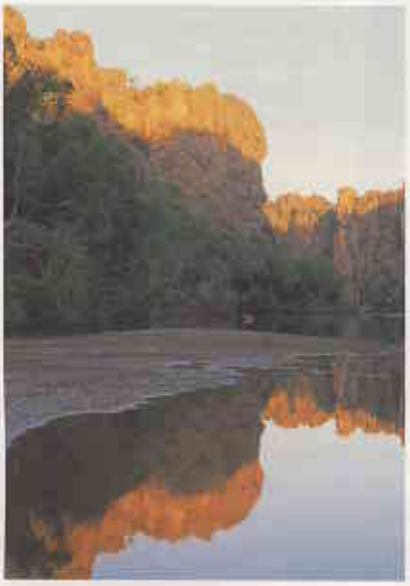


Sugarloaf Rock is just one of the many features that make Leeuwin-Naturaliste National Park the most visited park in WA. (See page 10.)

Premier Park: John Forrest National Park is Western Australia's oldest park, celebrating its centenary year. (See page 22.)

Pinnacle of Parks: These unusual formations make Nambung National Park well known the world over. (See page 36.)



Windjana Gorge National Park holds important clues to the evolution of fish. See 'Old Fossils' on page 28.

William Bay National Park displays a miniature version of karri forest flora. (See page 42.)

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COVER

With 67 national parks spread across the State, park rangers are often the first contact that visitors have with the Department of Conservation and Land Management (CALM). Apart from providing visitors with information and guidance, they perform a vital role in the day-to-day management of their local environment.

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