The Silurian Period

IN SILURIAN TIMES LIFE RECOVERED AFTER THE MASS EXTINCTION OF THE ORDOVICIAN PERIOD AND THE LAND WAS COLONIZED BY NEW PLANTS AND ARTHROPODS.

The Silurian age began about 443 million years ago. Although it lasted a mere 26 million years, the strata and fossils from this period in Britain and North America are among the most intensely studied in the world. They were already well known by the mid-nineteenth century, thanks to the efforts of geologists such as Sir Roderick Murchison in Europe and James Hall in North America.

The Silurian period marked a pivotal point in evolution. Following the setback to life caused by the late Ordovician glacial extinction, some animals, including the trilobites, conodonts and graptolites, never fully recovered. In general, however, there was a major revival as oceans became warmer and sea levels rose. This was the period when plants and invertebrate animals first became solidly established on land, even if the seas remained a far easier environment for life.

SEA CHANGES

In Silurian times, the old Iapetus Ocean gradually closed, as the landmasses of Laurentia (North America), Baltica (northern Britain and Scandinavia) and Avalonia (southern Britain, Nova Scotia and Newfoundland) approached one another on a collision course. Another ocean then opened up to the south, separating the newly forming northern continent from the southern continent of Gondwana.

The closure of the Iapetus Ocean created a new environment of shallow seas and basins, providing new habitats and ecological niches in which Paleozoic marine life once again flourished and diversified. Vast coral reefs spread throughout the equatorial waters of Laurentia and Baltica.

Only some of the shells washed up on a Silurian beach would be generally recognizable to us today.

COLONIAL GRAPTOLITE
Monograptus proteus was a coiled colony of 118 tiny creatures in a 0.75-inch- (2-centimetre-) wide skeleton. When the colony died, it sank and was buried, becoming flattened as the seabed was compressed to form shale now found in Germany.

SILURIAN AGNATHANS
Birkenia was a 1.5-inch- (4-centimetre-) long agnathan (jawless fish). This example was found in Scotland, but many similar fish have been discovered in the Baltic region of Europe.

HOW THE SILURIAN AGE GOT ITS NAME

The Silurian period was first identified in 1835 by British former army officer and geologist, Sir Roderick Murchison. Together with the Reverend Adam Sedgwick, a young professor at the University of Cambridge, England, Murchison mapped the strata of Wales, thought to be the oldest stratified rocks lying above the first formed igneous rocks. By studying the positions of various fossils within the sedimentary strata, Murchison distinguished strata that he called Silurian lying above Sedgwick's Cambrian. Murchison named the Silurian period for the Silures, a tribe that lived in Wales at the time of Ancient Rome

SPINY TRILOBITE
The large headshield of this very distinctive Silurian trilobite, *Dalmanites myops*, shows evidence of well-developed eyes and long protective ribs extending down the sides of its body. It grew to 2.5 inches (6 centimetres) long and, like many other trilobites, foraged on the seabed for its food. This fine example comes from Dudley in England.

BRACHIOPOD GRAVE
Numerous rhynchonellid brachiopod fossils litter the surface of this Silurian rock slab. When alive, these shellfish were attached to hard surfaces by fleshy stalks. After they died, their shells were swept together by currents running along the seabed. These fossils were found in Wales, close to the border with England.

They were larger than shells from earlier ages, typically up to 1.5 inches (4 centimetres) long. A few were much larger still, such as the conical shells of the squid-like nautiloids, which reached 4 inches (10 centimetres) or more. Brachiopods, clams, snails, echinoderms (such as starfish and sea lilies) and fish continued to diversify.

The shallow seas and basins of the northern continent became progressively shallower and broke up, eventually becoming isolated from one another as lakes. Jawless fish prospered in these warm waters and grew larger than their Ordovician predecessors, reaching a size of up to 8 inches (20 centimetres). New jawed fish and water scorpions preyed upon the jawless fish, which evolved bizarre forms of heavy armour as a defence against this predation.

Most important for the long-term evolution of life was the spread of plants that were more complex than the moss-like ones of Ordovician times. Through the mechanism of photosynthesis, they eventually created an oxygen-rich atmosphere that was capable of supporting a complex range of terrestrial animal life.

Life on Land and in the Sea

CORAL COMMUNITIES
Silurian corals (above and opposite), which formed the first extensive reefs, look similar to ones alive today, but belong to extinct groups.

Life on land is tough compared with life in water. Animals and plants need to evolve special equipment to make use of the light mixture of gases we know as air. To survive, they must withstand alternate freezing and heating, drying out and solar radiation. Yet in Silurian times the land was increasingly colonized.

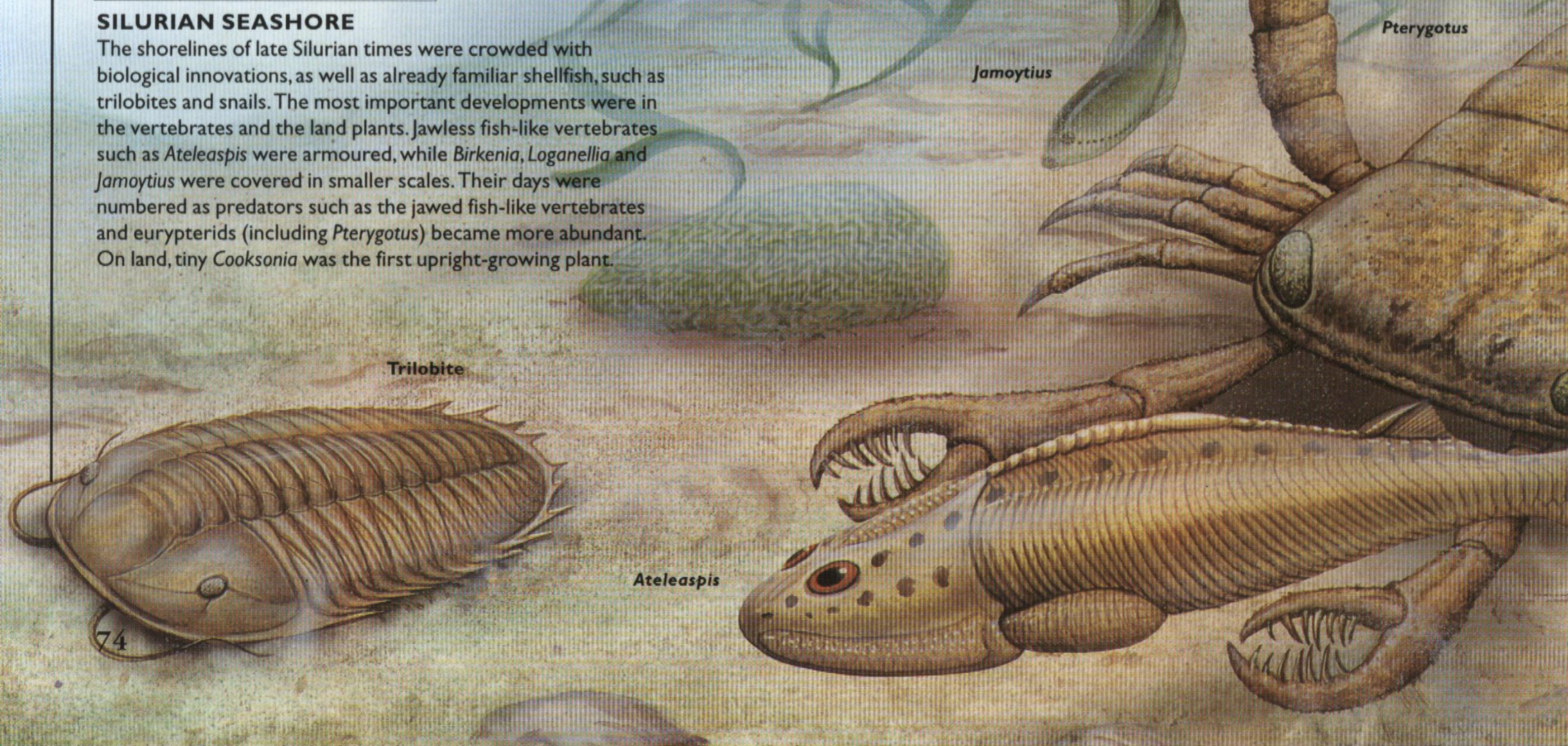
Although pioneering bryophyte-like plants similar to mosses had occupied the land since Ordovician times, they were very limited in form. The Silurian period saw the evolution of the first upright vascular plant that has left a fossil record. Called *Cooksonia*, it featured strengthened stems and tubes for conducting water and nutrients.

Cooksonia was quite unlike modern flowering plants (angiosperms), having no flowers, leaves or seeds. A *Cooksonia* consisted of tiny upright stems, up to 1.5 inches (4 centimetres) high, which forked into two equal branches, ending in club-shaped reproductive sacs full of spores. The plant's primitive method of reproduction depended on living in wet conditions, so that the male gametes could swim to fertilize the female ones.

The evolution of these upright plants was essential to the formation of a terrestrial food chain. Their photosynthesized tissues provided vegetation for plant-eating animals (herbivores) to eat. Once herbivores had established themselves in numbers, carnivorous animals could then evolve to prey on them.

EARLY HERBIVORY
Scattered among the early plant fossils, remains of centipede-like arthropods have been found, along with tiny droppings full of tough plant spores (above). It is thought that these arthropods did not eat fresh plant material, but rather decaying remains of the primitive *Cooksonia* plants.

Digestion of raw plant food is difficult for animals, however. The first herbivores to appear were arthropods that fed on decaying plants. Partly broken down by bacteria, this material was easier to digest. It also incidentally introduced important microorganisms into the herbivore gut that were capable of breaking down plant matter.



SILURIAN SEASHORE
The shorelines of late Silurian times were crowded with biological innovations, as well as already familiar shellfish, such as trilobites and snails. The most important developments were in the vertebrates and the land plants. Jawless fish-like vertebrates such as *Ateleaspis* were armoured, while *Birkenia*, *Loganellia* and *Jamoytius* were covered in smaller scales. Their days were numbered as predators such as the jawed fish-like vertebrates and eurypterids (including *Pterygotus*) became more abundant. On land, tiny *Cooksonia* was the first upright-growing plant.

SEA SCORPIONS

The first giants of the Earth, living in the Silurian period, were the eurypterids or "sea scorpions", which evolved in Ordovician times and survived until Permian times. They were scorpion-like in shape, and some had large pincers. Their elongated, articulated bodies were covered in a tough exoskeleton, making them one of the best-armoured animals of the time. However, because they were arthropods, they had to shed their exoskeleton periodically to allow for growth, a process which left them vulnerable to attack. The eurypterids evolved a variety of lifestyles. Some could swim, some were scavengers, but others were active predators. Eurypterus, *found in the Silurian strata of New York, grew up to 6.5 feet (2 metres) in length. Eurypterids were one of the first animal groups to make the transition from a marine to a freshwater environment.*

TEEMING WITH LIFE

Many creatures living in Silurian seas would seem unfamiliar today. Some belong to extinct groups such as the Paleozoic corals, mobile trilobite arthropods, graptolites, or free-swimming armoured agnathans, eurypterids, conodonts and straight-coned cephalopods. Others, such as brachiopod shellfish and sea-lilies, still exist today but are far less common than they used to be in Ordovician and Silurian times, when they populated the seas of the continental shelf in great numbers and diversity.

THE RISE OF THE VERTEBRATES

The most common vertebrates in Silurian times were the jawless agnathans. They ranged from *Jamoytius*, an eel-shaped, free-swimming creature without scales or body armour, to *Ateleaspis*, a bottom-living creature with its head enclosed in a horseshoe-shaped bony shield. The curious-shaped thelodonts, another type of agnathan, had bodies covered in tiny spiky scales, as sharks have today. There were also more familiar fish-shaped agnathans, such as *Birkenia*.

The biological event that did the most to transform life in the oceans was the evolution of jaws in fish-like vertebrates. The first fish-like jawed vertebrates were the now-extinct acanthodians, which had distinctive spines in front of all their fins. These bony spines are almost all that is fossilized of these small animals, but they are known to have had toothed jaws.