The Ichthyosaur Cemetery

Some 120 million years ago, the ichthyosaurs died at the edge of the Tyndall Glacier. Now, palaeontologists are getting to the bottom of how such mass mortality in such a confined space came about – looking for clues in the Torres del Paine National Park in Chile

By Wolfgang Stinnesbeck, Eberhard Frey and Marcelo Leppe Cartes

The helicopter, an old Bell belonging to the Chilean Air Force, makes a tremendous noise in the air as it flies over branched rivers that wend their way through the yellowish-green southern beech forests. Our destination is the camp close to the Tyndall Glacier. Gradually we approach the Torres del Paine National Park, with its 20 imposing rocky towers. The forest rapidly becomes thinner and this is then followed by bare, black rock and a lake with small icebergs floating in it. Finally, we fly over the vast expanse of a glacier – it is the Tyndall Glacier at the southern end of the Patagonian Ice Field. The ice shimmers in shades of blue as darkness falls. The research camp can just be made out in the distance, initially just as tiny coloured dots at the edge of a black cliff. We land there briefly, before continuing our flight to the site of the find, higher up the mountain. Here, the layers of rock have been planed down by the glacier, leaving steps in the rock. The landscape looks like a model, as if it were made up of layers of cardboard stacked up on top of each other.

Our team is among the first to arrive. The second flight brings some high-ranking visitors: Crown Prince Willem Alexander and Princess Maxima of the Netherlands accompanied by the Dutch Minister of Education, Ronald Plasterk, and the Chairman of the Netherlands Organisation for Scientific Research

(NWO), Jos Engelen. The previous evening the delegation had already heard about the ichthyosaurs in the glaciers, now this is followed by a field visit to see for themselves. Their visit lasts for three and a half hours, and then the Bell's lights disappear over the mountains again.

Retrospective: Glaciologists first found ichthyosaur remains on the edge of the Tyndall Glacier back in 2003. Since visitors to the area have found numerous skeletons and skeletal remains of these "fish lizards" as well as innumerable fossils, for instance of belemnites (fossilised cephalopods), ammonites, mussels and fish as well as plant remains. The first DFG-funded expedition started the work by sounding out the potential of the new site. Now we are here to reveal the secrets of the ichthyosaur cemetery. We want to find out and understand what happened here about 120 million years ago, in the Lower Cretaceous Period.

Our doctoral researchers Judith Pardo and Christian Salazar as well as the student assistants Luchio, Pato and Esteban from the Universidad de Concepción have already been here at the site for a few days. They have done an excellent job of organising the camp. The kitchen tent is equipped with two gas cookers and there is a dining tent, with a dining table and chairs. A generator provides power for lighting, battery chargers and laptops. Food, cooking and cleaning supplies and toiletries are professionally stowed away in plastic drums. The gas and petrol supplies are stored at a safe distance from the camp. The Rio Tyndall, at just 5 °C, serves as the source of our drinking water, our dishwasher, our shower and, last but not least, as a fridge for our supply of meat.

The fossils we find during the first few days in the field exceed our wildest expectations. Pitch black, the fossilised bones of the extinct fish lizards stand out from the smooth grey surface of the sandstone. Many of the dinosaurs are preserved completely – or at least they were until the glacier started carving the rock away. The skull with the eye sockets and the long, beak-like nose, the rib cage with the long, slender ribs, the mosaic-like skeletons of the rounded fins, and finally the long vertebral column with its characteristic kink, which supported the lower lobe of the semilunate tail fin. Most of the bones are still in exactly the position where they once have belonged anatomically.

The more carefully and precisely we look, the more fossils we discover on the black surface of the polished sandstone. The bright white thunderbolts, also known as "devils fingers" are most obvious fossils. They are belemnites, distant relatives of the modern day squid. Masses of these calcite cones peek out of the dark rock. Ammonites and mussels, on the other hand, are only preserved as flat impressions of their shells. Despite the fact that they are so poorly preserved, it is still possible to identify several different species of ammonites with the naked eye, even here in the field. They are particularly important for identifying the age of the strata and prove that this sediment must be Early Cretaceous.

So far we have found 30, almost completely preserved ichthyosaur skeletons here at the Tyndall Glacier as well as fragments and isolated fins and individual bones. The largest are more than four metres long, but individual vertebrae suggest that there were some ichthyosaurs that exceeded five metres in length. Remains of baby ichthyosaurs less than a metre long are extremely rare.

Such a number on fossilised skeletons in an area of just a few square

Left page: An impressive fossil – the well-preserved front half of an ichthyosaur. The head, with its large eye socket and the spine stand out visibly. Right: The researchers measure the fin of a fish lizard whose fossilised skeleton from over 110 million years ago was revealed and polished by the Tyndall Glacier.

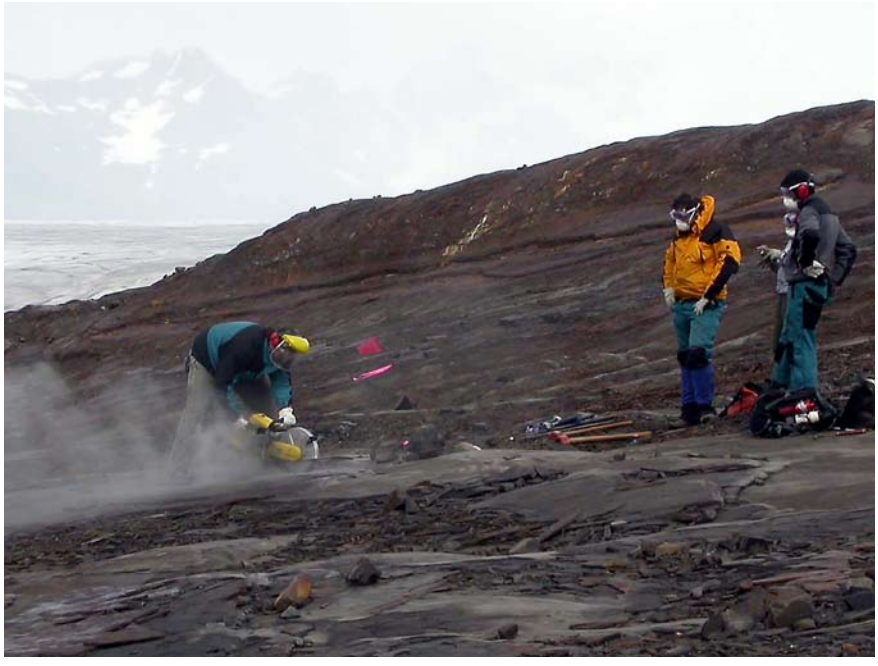
Left: A horseback expedition over rough terrain in the Tyndall area at the southern end of the Patagonian ice field. The researchers have to brave the elements too. During a storm, fossilised bone fragments can only be stuck back together under the cover of a plastic sheet (right).

kilometres is unique for Chile and for South America and indicates that this is a fossil concentration area of international significance. The hunters and the hunted are concentrated in a very small area – a fossilised ecosystem that is coming to light step by step.

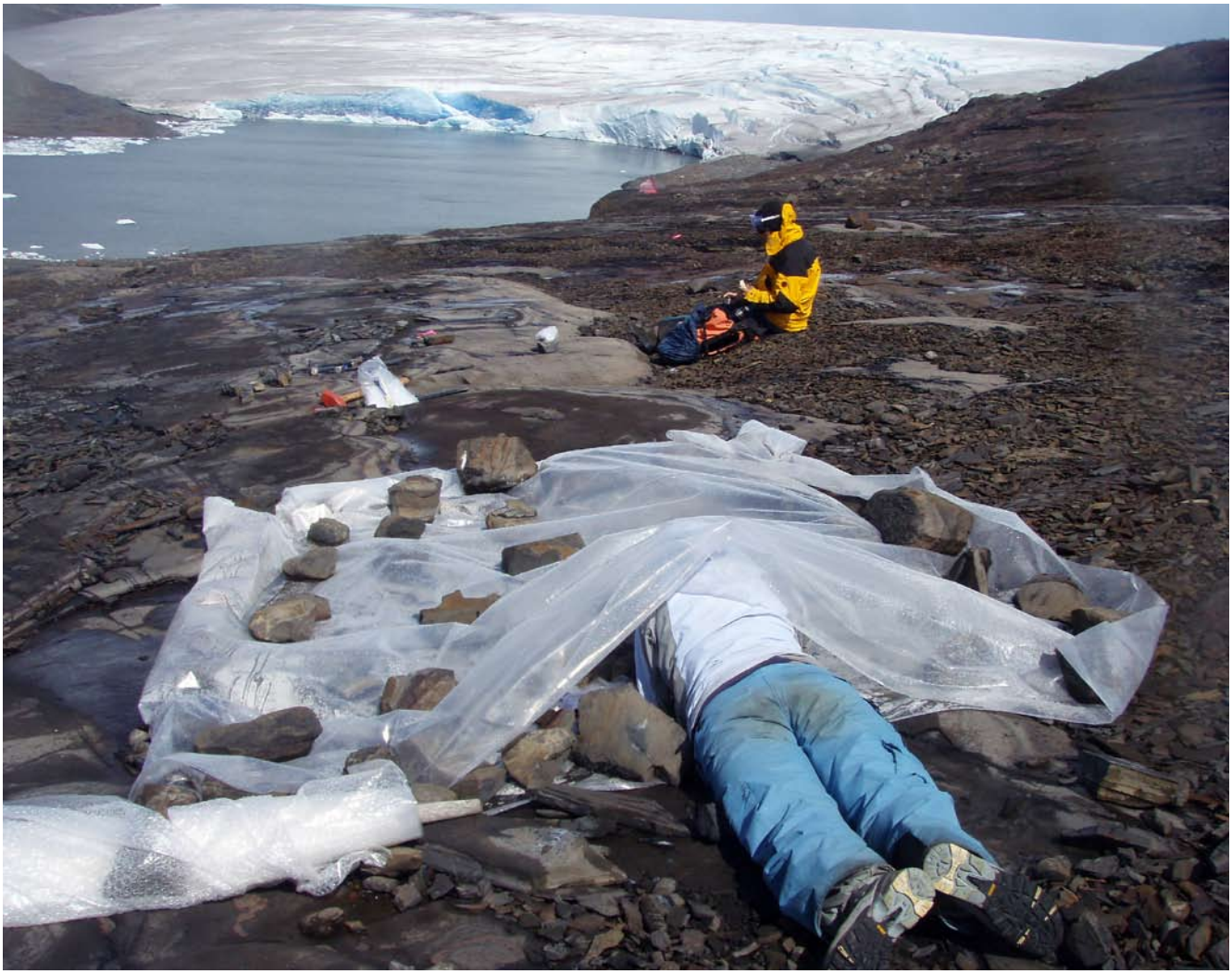
Especially in the light of this significance there are a multitude of questions to be answered, such as: How did the Tyndall ichthyosaurs die? How did such a high concentration of skeletons come to be fossilised in this area? A few of the skeletons are found lying together in the same geological layer. Because each layer of sandstone was the result of a mudslide, the animals must have died more or less simultaneously. In the profile images we discover several layers of differing ages with ancient fossil beds like this. How can these repeated layers of mass mortality be explained? Does the site of these finds reveal any new insights into the lives of the ichthyosaurs?

Firstly, the geological conditions in the area of the finds are important. The Cretaceous strata in the Tyndall area were formed at the base of a continental slope at a depth of around 1000 metres. They were formed by undersea currents of mud, sand and rubble. Triggered by earthquakes, perhaps even due to their own weight, vast quantities of sediment fell from the edge of the continental shelf and slid into the depths. On their way down, the constituents of these underwater avalanches sorted themselves by weight and size. On the ocean bed, the coarse rubble was deposited first, followed in turn by sand and then mud. Geologists call rock formed in layers like this "turbidites". The sandstone in the Tyndall area lies on the bed of an ancient canyon, which evidently became a death trap for ichthyosaurs. Thousands of these sediment avalanches took place in the Cretaceous ocean in the Tyndall area and carried away everything that came into their path.

Due to the abundance of plankton, the edge of the shelf sea was evidently teeming with life. Shoals of fish and belemnites hunted baby fish and small crabs and were themselves hunted by the large marine reptiles, especially ichthyosaurs. When an earthquake triggered a mudslide, everything was sucked down into the depths, including the mighty ichthyosaurs. Despite the fact that they were probably able to dive some 500 metres, these large-eyed creatures hardly stood any chance of survival in the masses of mud and rubble. At a depth of 1000 metres their rib cage and lungs collapsed. At the foot of the slope the mudslide finally came to a standstill with the dead animals buried in and under it. As time passed, the mud solidi-



The search for sea reptiles from the Lower Cretaceous Period demands hard physical work too: Eberhard "Dino" Frey sawing out one of the skeletons



All illustrations: Arbeitsgruppe Stinnesbeck

fied and turned into rock and the carcasses were compressed under an immense weight of sediment.

Millions of years passed before the ocean floor deposited in the Lower Cretaceous Period was squeezed together at the end of the Cretaceous Period, folded, lifted out of the ocean and partially eroded again. In the earth's more recent history, the Pacific plate pushed the layers of rock once again, this time lifting them up to form a mountain range. Volcanic fissures broke open and filled with magma and then the ice came. Glaciers eroded the rocks bare and eventually revealed the ichthyosaurus skeletons again.

Today, now that the Tyndall Glacier has receded, the fossils are on the surface and are exposed to the elements. If they are not rescued they will have been eroded away within a few decades, making it all the more important to salvage them.

After enjoying ideal conditions at the outset, the weather breaks. It becomes stormy, rains non-stop, there are sleet and snow showers. This lasts for nine days, turning the ground around the tents into a quagmire. Little streams flow down the drainage ditches around the tents. There is no hope of doing any field work and even in the camp every step is a hazardous, slippery affair. This weather is unusual for late summer in Patagonia. Not until our final week are we able to do any more work. On our last day there we discover two more ichthyosaur skeletons in a different place. One of them is over five metres long! We dismantle our camp in the rain and await the horses that will finally carry us back to civilisation at the end of a five-hour ride.

The team will be back though. They are already planning another expedition top the Tyndall area next year, with better equipment and more people to help recover the finds. The ichthyosaur cemetery still holds a lot of secrets.

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