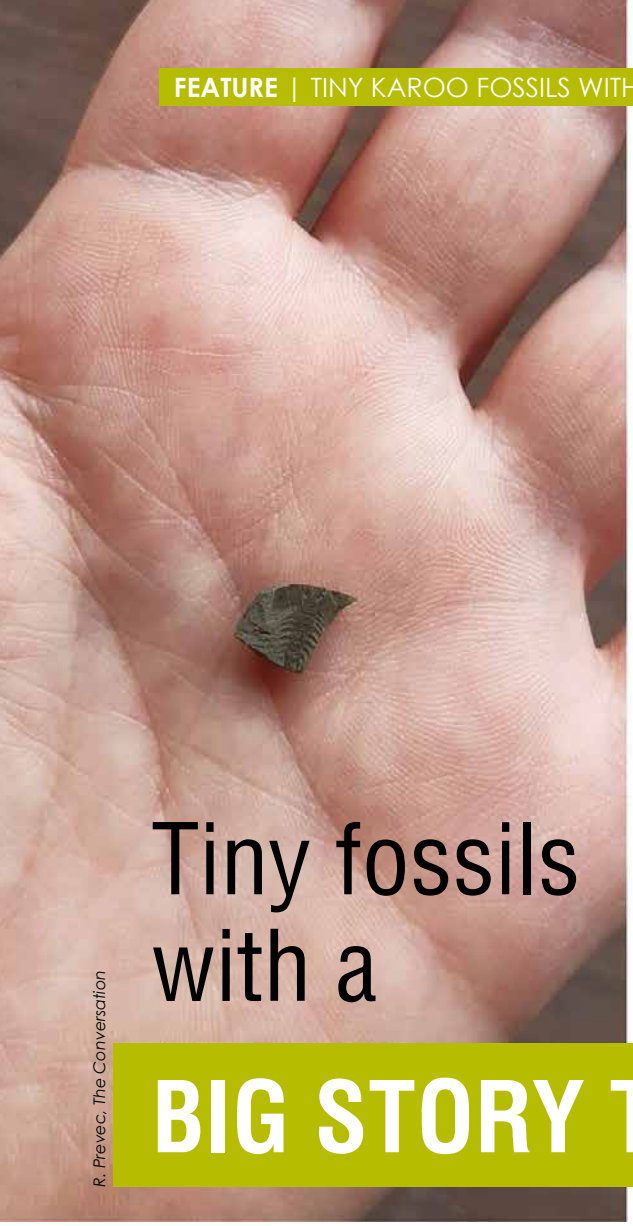

R. Prevec, The Conversation

Fossil of a tiny, extinct, aquatic insect from Sutherland with a hand for scale; the exquisite details are only revealed by a microscope.

Tiny fossils with a BIG STORY TO TELL

Exquisitely preserved fossils of insects and plants from the Karoo, South Africa, have revealed a 266-million-year-old lakeshore ecosystem thriving with life.

A small, unassuming road-cutting is producing thousands of exquisitely preserved fossils in the Sutherland District of the Northern Cape. In a recent paper, we explained how these tiny fossils of plants and insects, many of them only millimetres long, tell us about a previously unknown ecosystem on the quiet shores of a pool 266 million years ago.

Reading this paper is a bit like opening a treasure chest – we have revealed a host of superlative discoveries all at once to show off our site and what we are finding. Plants, insects and small things tend not to share the limelight with dinosaur and hominid discoveries, but the stories they tell can be just as fascinating and their message powerful.

We currently know a fair bit about the reptilian animals that roamed the Karoo of South Africa during the middle Permian Period, a time long before the dinosaurs appeared. These creatures included the predecessors of tortoises and the strange and lumbering therapsids that would later give rise to the mammals, but we have little idea about what else was around at the time.

These new discoveries are therefore filling in some critical gaps in our knowledge of middle Permian landscapes and the plants and smaller creatures that inhabited them.

We are gaining a better understanding of what the world looked like before the onset of two key extinction events in Earth's history, at the end of the Guadalupian Epoch (~260 Ma) and then the largest extinction event ever, at the end of the Permian Period (~252 Ma).

Our new fossils will change ideas about the evolution of some important plant and insect groups and their distributions across the ancient supercontinent of Pangaea. The superb quality of fossil preservation means that soft-bodied organisms that very rarely preserve in the fossil record are present at the site. For instance, the oldest freshwater leech in the world pushes the fossil record of the group back by 40 million years. Perhaps even more extraordinary are the water mites that are 150 million years older than previously known. A new, early damselfly and hundreds of tiny nymphs belonging to the stoneflies (a group that still lives in streams today), are the oldest records from Gondwana. Early relatives of the

cicadas, the strange, extinct Palaeodictyoptera and many sap-sucking bugs (Hemiptera) are just some of the other insect discoveries.

The plants found at the site are mostly *Glossopteris* leaves. This iconic fossil plant is synonymous with the Permian Period across the southern parts of Pangaea, in the region known as Gondwana. Great forests of these trees formed most of the economically important coal reserves in South America, Australia, India, Antarctica, Madagascar, and southern Africa.

Aside from its economic importance, *Glossopteris* is a botanically weird plant. Scientists have been debating where it fits within the Plant Kingdom for nearly 200 years. Textbooks (and Wikipedia!) will tell you it is a seed fern, but our new fossils prove that it produced cones, and is in fact a conifer, the same group of plants that includes the yellowwoods and pine trees that grow today. *Glossopteris* became extinct at the end of the Permian, during the 'Great Dying', a mass extinction thought to have been driven by greenhouse gas-induced global warming. This draws an eerie parallel with our current dependence on these fossilized plants as a fuel source, and the resultant carbon emissions that are contributing to our very own climate crisis.

Questions

The authors answer some of the common questions about their new fossil discoveries:

1. What makes this discovery unique?

The fossils we are finding are very ancient (about 266 million years old) but are beautifully preserved, with more intact organisms than usually found in rocks of this age. Very fine details like the hairs and veins on insect wings, the gut contents of insects, and very soft, squishy things like worms and moss plants are preserved in beautiful detail.

The very high concentration of exceptionally well-preserved plant and invertebrate fossils, means that these rocks can be called a Lagerstätte. This kind of fossil site is extremely rare, and provides a close-up and detailed look at an ecosystem, rather like holding up a magnifying glass to one small part of the world as it was many millions of years ago.

The age of the site is also exciting, as we don't know much about the plants and invertebrates from the middle Permian Period (between 273 and 260 million years ago).

2. What has been the most exciting find from the site so far?

The joy of this site, is that so many exciting things are emerging – it is so hard to choose just one. I think my

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One of the larger insect wings from the new Sutherland fossil site, from a proto-cicada, with hairs and pattern of colouration preserved.

favourite invertebrate finds are the water mites and the leech. These records are just so much older than previously known for these groups, and will significantly impact our understanding of their evolution. It was a huge surprise to find something resembling a big tick under the magnifying glass! It took much longer to realise that the squishy grub we found was a leech, with a perfectly preserved sucker.

All the plants we are finding are new to science, and they are telling us how groups such as the seed plants of the Permian Period evolved. We have found the first seed-producing cones of the *Glossopteris* plant – the tree that formed all of our economic coal deposits. Finding dense accumulations of male and female cones was breathtaking. Scientists have been looking for these for over 60 years.

3. What is the significance of this find?

Sometimes it is the smallest fossils that carry the most powerful message. A huge dinosaur with teeth the size of bananas is massively exciting, but when we want to understand whole terrestrial ecosystems, measure biodiversity and how it changed with shifting climates, we need to look at the small things and the green things. These are the organisms that continue to form the foundations of ecosystems today.

We have a reasonable idea of the bony animals that were around during the middle Permian, but we have no sense of what they were eating or what insects and other life were around. Our current research is an important step towards filling this gap in our knowledge.

A better understanding of whole ecosystems is especially important when considering the two big Permian extinction events, at the end-Guadalupian (about 260 million years ago) and the 'Great Dying' at the end of the Permian (252 million years ago) that caused catastrophic ecosystem collapse. Understanding extinction events in the past can help scientists to predict the effects of the current climate crisis.

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The first seed cones of the enigmatic *Glossopteris* plant, preserved together with its pollen cones, and solving a 200-year-old botanical mystery.

4. How do you know where to look for fossils, and how did you find this site?

There is no doubt that luck plays a big part, but experience teaches you which kinds of rocks are more likely to have fossils. In 2009, I was part of a team searching for fossil plants in the Sutherland area. We were hot and grumpy (it was January, in the Karoo desert), I was six months pregnant with my second child, and we had found nothing. Then, as we drove along a small dirt road, a rock outcrop came into view that was unlike anything we had seen in the area. The fine layering and the particular colour and texture of the rock were ideal for finding plant fossils. Within minutes of digging, we found insect and plant fossils, and I knew this was something very special.

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A reconstruction based on fossils from the Sutherland area, of a calm pool on a delta plain near the shores of the Karoo Sea, as it may have looked 266 million years ago.

5. What is the next step?

Our excavations are continuing – we are still finding new kinds of fossils every field season. We are also working hard to describe each of the beautiful plants and creatures that have emerged and are trying to figure out why fossils were preserved so beautifully in this area.

We are also working on protecting the site and fossils in general in the Sutherland area. In South Africa, fossils form part of the National Estate and may not be excavated without a permit. The challenge is finding a balance between conserving our fossil heritage and encouraging palaeotourism, which can be an important income stream for South Africans.

Article written by lead author Dr Rose Prevec of the Albany Museum, Makhanda, Eastern Cape, as a summary of the study paper, issued by Wits University.

Difosele tše di bolokilwego gabotse tša dikhunkhwane le dimela go tšwa Karoo,Afrika Borwa,di utollotše tshepedišo ya tswalano ya diphedi le tikologo ya tšona ya mengwaga ye dimilione tše 266 ya lebopong la letsha yeo e atlegago ka bophelo. Dintlha tše botse kudu go swana le meriri le methapo ka maphegong a dikhunkhwane,diteng tša mala a dikhunkhwane le dilo tše boleta kudu tša go swana le diboko le dibjalo di bolokilwe ka dintlha tše botse. Difosele tše tše nnyane di na le kanegelo ye kgolo kudu go e anega gomme di utolla bontši bja gore tlhago e be e le bjang ka Afrika Borwa ya pele ga histori.

Translated into Sepedi by Prof. Walter Matli.