THE CONVERSATION

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Dig this: a tiny echidna moves 8 trailer-loads of soil a year, helping tackle climate change

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After 200 years of European farming practices, Australian soils are in poor shape – depleted of nutrients and organic matter, including carbon. This is bad news for both soil health and efforts to address global warming.

The native Australian echidna may hold part of the solution. Echidnas dig pits, furrows and depressions in the soil while foraging for ants. Our research has revealed the significant extent to which this soil "engineering" could benefit the environment.

Echidnas' digging traps leaves and seeds in soil. This helps improve soil health, promotes plant growth and keeps carbon in the soil, rather than the atmosphere.

The importance of this process cannot be underestimated. By improving echidna habitat, we can significantly improve soil health and boost climate action efforts.

Echidnas can help improve soil health. Shutterstock

Nature's excavators

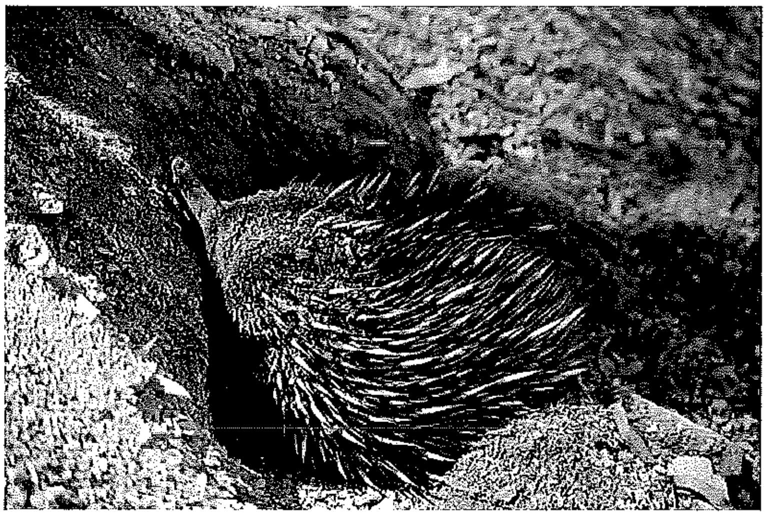
Many animals improve soil health through extensive digging. These "ecosystem engineers" provide a service that benefits not only soils, but plants and other organisms.

In Australia, most of our digging animals are either extinct, restricted or threatened. But not so the echidna, which is still relatively common in most habitats across large areas of the continent.

Echidnas are prolific diggers. Our long-term monitoring at Australian Wildlife Conservancy's Scotia Sanctuary, in southwest New South Wales, suggests one echidna moves about seven tonnes – about eight trailer loads – of soil every year.

Soil depressions left by echidnas can be up to 50cm wide and 15cm deep. When ants are scarce, such as at highly degraded sites, echidnas dig deeper to find termites, making even larger pits.

This earth-moving capacity unwittingly provides another critically important function: matchmaking between seeds and water.



Echidnas' huge digging capacity brings many environmental benefits. Shutterstock

Playing cupid

For seeds to germinate they must come together with water and soil nutrients. Our experiment showed how echidna digging helps make that happen.

We tested whether seeds would be trapped in echidna pits after rain. We carefully marked various seeds with different coloured dyes, and placed them on the soil surface in a semi-arid woodland near Cobar, NSW, where we'd dug pits similar to those echidnas create. We then simulated a rain event.

Most seeds washed into the pits, and those that started in the pits stayed there. The experiment showed how echidna pits encourage seeds, water and nutrients to meet, giving seeds a better chance to germinate and survive in Australia's poor soils.

The recovering pits then become plant and soil "hotspots" from which plants can spread across the landscape.

Our research has also found pits also harbour unique microbial communities and soil invertebrates. These probably play an important role in breaking down organic matter to produce soil carbon.

It's no wonder many human efforts to restore soil imitate the natural structures constructed by animals such as echidnas.

Read more: Curious Kids: How does an echidna breathe when digging through solid earth?

Plant growth in artificial pits used to regenerate degraded semi-arid soils – a method that imitates echidna pits.

Echidnas as carbon farmers

Our recent research also shows how echidna digging helps boost carbon in depleted soils.

When organic matter lies on the soil surface, it's broken down by intense ultraviolet light which releases carbon and nitrogen into the atmosphere. But when echidnas forage, the material is buried in the soil. There it is exposed to microbes, which break down the material and release carbon and nitrogen to the soil.

This does not happen immediately. Our research suggests it takes 16-18 months for carbon levels in the pits to exceed that in bare soils.

This entire process of echidna digging, capture and buildup creates a patchwork of litter, carbon, nutrients, and plant hotspots. These fertile islands drive healthy, functional ecosystems – and will become more important as the world becomes hotter and drier.

Read more: The secret life of echidnas reveals a world-class digger vital to our ecosystems

An echidna foraging pit with litter, seed and soil.

Harness the power of echidnas

Soil restoration can be expensive, and impractical across vast areas of land. Soil disturbance by echidnas offers a cost-effective restoration option, and this potential should be harnessed.

Australia's echidna populations are currently not threatened. But landscape management is needed to ensure healthy echidna populations into the future.

Echidnas often shelter in hollow logs, so removing fallen timber reduces their habitat and feeding sites. Restrictions on practices such as firewood removal are needed to prevent habitat loss.

And being slow-moving, echidnas are often killed on our roads. To address this, shrubs and ground plants should be planted between patches of native bush, creating vegetation corridors so echidnas can move safely from one spot to the next.

Echidna crossing a road

Why did the echidna cross the road? Because there were no vegetation corridors. Shutterstock

And while an echidna's sharp spines give it some protection from natural predators, they're less effective against introduced predators such as foxes and cats. So strategies to control these threats are also needed.

The health of Australia's fragile environment is in serious decline. Echidnas are already providing a valuable ecosystem service – and they should be protected and nurtured to ensure this continues.

Read more: 10 million animals are hit on our roads each year. Here's how you can help them (and steer clear of them) these holidays

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Evidence of mass extinction associated with climate change 375 million years ago discovered in Central Asia

Date: December 13, 2013

Source: Appalachian State University

Summary: Scientists have found evidence for catastrophic oceanographic events associated with climate change and a mass extinction 375 million years ago that devastated tropical marine ecosystems.

FULL STORY

Members of a U.N.-sponsored research team with members from Appalachian State University's Department of Geology have found evidence for catastrophic oceanographic events associated with climate change and a mass extinction 375 million years ago that devastated tropical marine ecosystems.

"The Late Devonian mass extinction was one of the five largest mass extinction events in the history of life," said Professor Johnny Waters, who is a co-leader of the five-year, U.N. International Geoscience Programme project that began in 2011. The research team, which includes Assistant Professor Sarah Carmichael, is examining the relationship between climate change and changes in the ecosystems in the Devonian period, from 419 to 359 million years ago.

"This is the third most significant mass extinction and it was caused by plants," Waters said. "Unlike the dinosaur mass extinction, which was related to an asteroid impact, this one was environmentally related."

In the Devonian period, Waters explained, the world was experiencing super greenhouse climate conditions. This means that it was very warm, there probably were no ice caps, there was a lot carbon dioxide in the atmosphere (with estimates of 4,000 parts per million).

"As plant communities expanded onto land to form the first forests, they depleted the carbon dioxide (CO2) that was in the atmosphere," Waters said. "CO2 levels dropped to 400 ppm toward the end of the Devonian. It got colder. There were glaciation events and the rapid change in the climate caused severe extinction in the tropics and the existing coral reefs became extinct." By comparison, the world's current CO2 level is very close to 400 ppm.

Most of the knowledge that geologists have about this mass extinction comes from North America and Europe. Although these two land masses are far apart now, in the Devonian they were very close to each other. Scientists have tried to make inferences about worldwide events based on sample locations that are really quite limited in terms of their geographic history, or paleogeography. Therefore, it is vitally important to obtain samples from locations outside this region for understanding global climate change during this time period.

Waters' international team of geoscientists has conducted field work in remote areas of western China for many years, in addition to two recent field seasons in western Mongolia near the Russian and Chinese borders. The changing political climate in China, Russia and Mongolia in recent years has now made it possible to do fieldwork in these locations. The strength of these field collaborations is that they draw on the expertise of scientists from a variety of disciplines to add critical climatic information to a limited database. U.N. researchers associated with this project are also collecting related data in Thailand, Myanmar, Vietnam and Northern China.

"The reason we are working in central Asia is that there is a lot of good evidence of what happened at and after this mass extinction -- this is an area that has not been well studied," Waters said. "It's all a part of our work finding the places that give us the best information in sorting out what happened in the extinction event and in its aftermath."

Answers about Earth's climate during and after this mass extinction are contained within rock samples from these new field sites, which were once part of the ocean floor, as geochemical signals preserved in the rocks record devastating climate change. The paleogeography of the field sites indicate that Devonian climate change not only had environmental impacts on life associated with large land masses, but also on life in the open ocean.

"We now have evidence that the radiation of surviving life following the mass extinction was centered in Central Asia," Waters said.

The geochemistry of the samples is being analyzed primarily by students in Appalachian's Department of Geology under Carmichael's supervision, with additional analyses being conducted at UNC-Chapel Hill and a university in Austria. "We are using geochemistry to tie it all together all across Central Asia, which used to be an open ocean, and compare our new data to established sequences in Europe and North America, in order to develop a global understanding of the climate change associated with this mass extinction," Waters said.

"Today we are looking at increases in carbon dioxide causing warming and the negative impacts to the ecosystem. In the Devonian period, we are looking at a rapid loss of carbon dioxide, which in geologic time occurred over millions of years rather than hundreds of years," Waters said. "But the lessons are actually quite similar. We clearly are concerned today about climate change and its impact on the environment and its effect on the ecosystem, and the geologic record is really the only record where we can see these events and compare what happened before and after."

Waters and Carmichael will present the preliminary results of their research at the Geological Society of America's Annual Meeting in Denver in October and at the American Geophysical Union's annual meeting in San Francisco in December.

Next summer, Waters will lead a 20-member team, including Dr. Sarah Carmichael and two students from Appalachian's Department of Geology, for continued field work in Mongolia.

Story Source:

Materials provided by **Appalachian State University**. *Note: Content may be edited for style and length.*

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Temporal changes in soil function in a wooded dryland following simulated disturbance by a vertebrate engineer

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Highlights

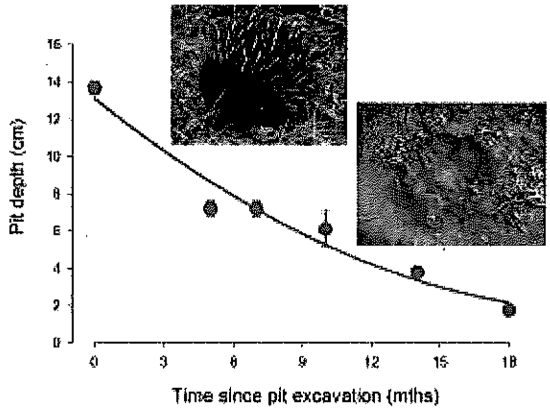
- Pits had greater decomposition, litter, and seeds, but not labile carbon.
- Pits develop into fertile patches and safe sites for plant seeds.
- Artificially-created pits can be used to examine engineering effects.

Abstract

An inherent feature of arid and semiarid environments (drylands) is the importance of landscape heterogeneity in driving soil and ecological processes. Soil disturbance by organisms is an important, but often overlooked, driver of patchiness, but little is known about the temporal changes in soil and ecological processes following disturbance. We used artificial depressions, designed to mimic the foraging pits of the vertebrate marsupial, the Short-beaked echidna (*Tachyglossus aculeatus*), to examine temporal changes in FEEDBACK

carbon, decomposition, litter capture, and plant germination and survival, over an 18 month period. Foraging pits had a half-life of about 7 months, and trapped seven-times more litter than an equivalent area on the soil surface. Larger pits tended to trap more litter than smaller pits. Foraging pits trapped six-times more seed abundance and three-times more richness than the surface. Eighteen months after disturbance, litter decomposition was 30% greater in the pits, and labile carbon concentrations were 8% greater (622 mg kg^{-1}) than the original undisturbed soils (578 mg kg^{-1}). Taken together, we provide strong evidence that foraging by native animals is an important mechanism for driving spatial heterogeneity in dryland soils. Our results also suggest that simulating the activities of short-beaked echidnas may provide a mechanism for rehabilitating degraded soils.

Graphical abstract



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Keywords

Animal foraging; Foraging pit; Ecosystem engineering; Woodland function; Biopedturbation; Pedoturbation; Non-trophic effects

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