April 18, 2022

News and notes

Before going on with a look at some of the plant fossils from the Triassic Period, here are some news items that I thought were interesting.

Easter

Workshop of Peter Paul Rubens - The Women at Christ's empty tomb
Credit: Dorotheum, public domain, Info about artwork

In this time when it looks like the Four Horsemen are gathering to collect their grim harvest, Christians remember the promise of salvation in the story of the life, death and resurrection of Jesus Christ. Christ is risen!

Geopolitics

I wish that it weren't so, but the Ukraine War continues. Remembering that all wars involve deception, here are a few sites to observe changes in the war:

- Daily updates at the Institute for the Study of War.
- Live Map; regular updates to the changes in the on ground situation.
- Oryx: Assessments of battlefield losses.

Research

- Correlation of Cambrian rocks: Synchronizing rock clocks in the late Cambrian.
- Triassic orogeny and granite formation: Reworking of the Juvenile Crust in the Late Mesozoic in North Qinling, Central China; behind a paywall, summary here.
- Using geophysics to study orogenic belts in China: Seismic anisotropy in the central Tien Shan unveils rheology-controlled deformation during intracontinental orogenesis.
- Hot rocks and zircon: Hot rocks: Constraining the thermal conditions of the Mistastin Lake impact melt deposits using zircon grain microstructures; behind a paywall, summary here.

- Fluvial sedimentation: Towards the steady state? A long-term river incision deceleration pattern during Pleistocene entrenchment (Upper Ebro River, Northern Spain).; summary here.
- Hiawatha Crater, Greenland: Impact Structure Hidden Under Arctic Ice Dates to the Paleocene.

Plate Tectonics

- Evidence for a Global Slowdown in Seafloor Spreading Since 15 Mya; includes plain language summary.
- Pace of passive margin tectonism revealed by U-Pb dating of fracture-filling calcite; episodes of uplift and volcanism in response to changes in mantle circulation.
- Oceanic isostasy as a trigger for the rift-to-drift transition; discussion of the Wilson Cycle.

Paleontology Research

- Oldest Microfossils on Earth Found: Metabolically diverse primordial microbial communities in Earth's oldest seafloor-hydrothermal jasper; found in an Eoarchean banded iron formation in the Nuvvuagittuq Supracrustal Belt.
- K/T Extinction: The Chicxulub impact and its environmental consequences; behind paywall.
- Apparent preservation of primary foraminiferal Mg/Ca ratios and Mg-banding in recrystallized foraminifera; mineralogy of fossil forams using stable isotope analysis.
- Earth's oldest living landscape spotted in South African rock cores.
- Fire and evolution: Cretaceous Charcoal Gives a Glimpse of Plant Evolution; pdf of research article here.
- More on the Cretaceous: A fossil assemblage from the mid–late Maastrichtian of Gavdos Island, Greece, provides insights into the pre-extinction pelagic ichthyofaunas of the Tethys.

Climate Research

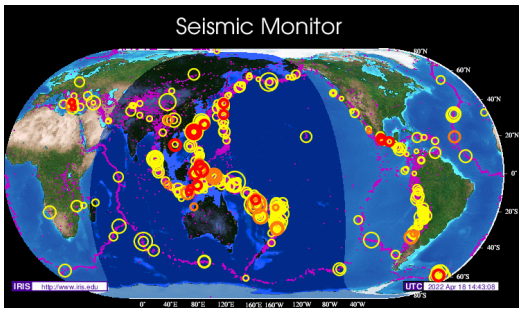
- Changes in vegetation affect global climate: Northern Hemisphere vegetation change drives a Holocene thermal maximum; summary here.
- Ocean circulation: Hidden Upwelling Systems Associated With Major Western Boundary Currents; includes plain language summary.
- More on ocean currents: The Whole Antarctic Ocean Model (WAOM v1.0): development and evaluation.
- Australian history: Past fires and post-fire impacts reconstructed from a southwest Australian stalagmite; behind paywall, summary here.

- Effects of melting permafrost: Representativeness assessment of the pan-Arctic eddy covariance site network and optimized future enhancements. Related: Hydrologic Impacts of Thawing Permafrost—A Review.

Energy and Mining

- Natural gas of radiolytic origin: An overlooked component of shale gas; abiotic hydrocarbons.
- Production of natural gas from coal seams: An optimal selection method of wells for secondary fracturing in a single coal seam and its application.
- It was a cold winter, from the US Energy Information Agency : The United States ended the winter with the least natural gas in storage in three years.
- Russian diamond miner kicked out of exchange: Alrosa Ejected From World Diamond Council, Irish Stock Exchange.
- Mining is the industry most at risk for fraud – report; read the full report here.
- Biden Restarts Oil Leasing on Federal Lands; related: Permian Could See Production Surge As New Permits Reach All-Time High.

Volcanoes, Earthquakes and Geohazards



Link

- A swarm of 85,000 earthquakes at the Antarctic Orca submarine volcano.
- Hawai'i: 2 Early Morning Earthquakes Rattle Pāhala.
- Toward improved urban earthquake monitoring through deep-learning-based noise suppression.
- More on predicting earthquake effects: Deep-Neural-Network-Based Estimation of Site Amplification Factor from Microtremor H/V Spectral Ratio; behind a paywall, summary article here.
- Worldwide Volcano News and Updates.

Events

- Earth Day 2022: Everything you need to know about Earth Day.

April 18, 2022

Terrestrial Plant Life in the Triassic

Figure 1 - Reconstructed Triassic Landscape, Museum am Löwentor, Stuttgart, Germany
Credit: Ghedoghedo, Creative Commons Attribution-Share Alike 4.0 International license

In this week's web log, we'll look at some examples of terrestrial plant life during the Triassic Period. Next week we'll look at terrestrial animals and in the week following we'll look at aquatic life.

Life on Earth took a heavy hit in the End Permian Mass Extinction that marked the beginning of the Triassic Period. Plants, of course, were affected by the severe climate change that caused the extinction. Plant fossils are still rare for the Triassic, but those that are there indicate that a generally dry continental climate dominated Pangaea.

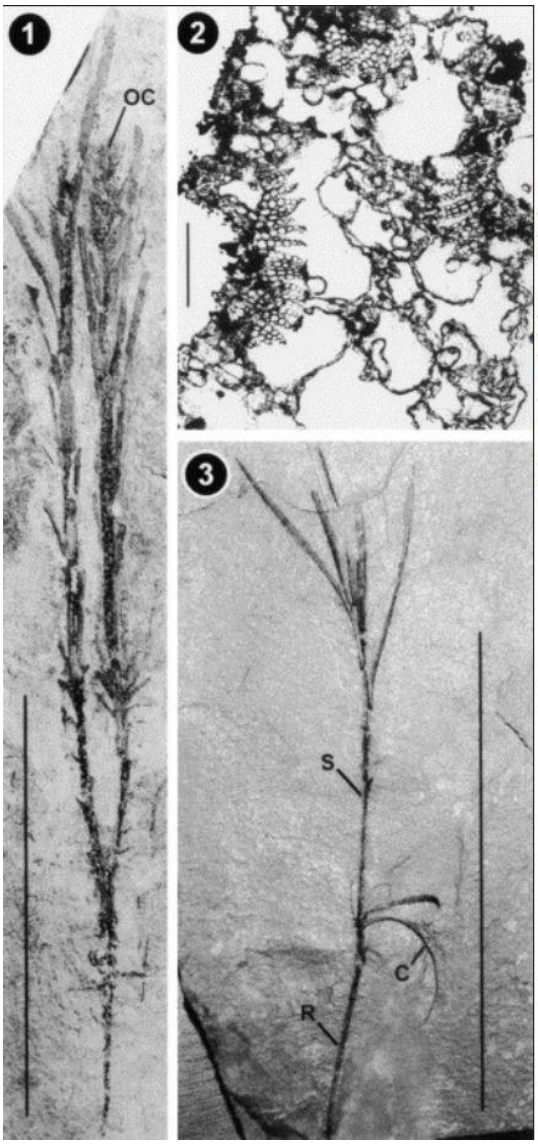
Dominant plants during the Triassic included:

- Conifers, such as *Aethophyllum*, *Araucarioxylon arizonicum* and other spermatophytes (seed plants);
- Lycophytes such as *Pleuromeia* and *Cylostrobus*;
- Ferns and horsetails;
- Seed ferns such as the corystosperm *Dicroidium*;
- Bennettitales;
- Cycadophytes, ancestors of modern cycads; and
- Ginkgoales, ancestor to the modern *Ginkgo biloba*.

Let's look at some of these.

Conifers

Aethophyllum stipulare



1. Smallest fertile plant in the Grauvogel and Gall collections, with two stems extending from the root, and terminal ovulate cone (OC) on one branch (scale bar=10 cm).

2. Cross-section of stem in the Grauvogel and Gall collections showing cauline bundles with scanty wood (at left, top and right) surrounding large pith with large, aerenchymatous lacunae and interspersed pith parenchyma cells. Vascular cambium, phloem, and more peripheral tissues are not preserved (scale bar=200 µm).

3.Seedling in the Grauvogel and Gall collections showing primary root (R), cotyledons (C) and stem (S) with apically borne leaves (scale bar=10 cm).

Figure 2 - Fossils of *Aethophyllum stipulare*
Credit: Rothwell, Grauvogel-Stammb, & Mapesa, 2000

The fossils of *Aethophyllum stipulare* were first found in France during the 1800's in rocks dating to the Middle Triassic. The fossils were from deltaic deposits and showed a small spindly plant. Given the delicate nature of the plant, the preservation was amazing and showed roots, shoots and both male and female cones. Female cones were situated at the tips of the upper most branches while male cones were situated at the tips of lower shoots. Seedlings were also often preserved as fossils near the remains of mature plants.

Also preserved in the fossil record are pollen grains that seem to be from *Aethophyllum stipulare*. Researchers have discovered pollen grains, apparently from *Aethophyllum*, in sediments from western, central, and southern Europe, Russia, Northern Africa, and China. So it looks like *Aethophyllum* was pretty wide spread during the Middle Triassic.

The fossils showed that mature *Aethophyllum* grew to between 30 centimetres and 2 metres in height. The fossils suggests that it was a plant that grew rapidly and began reproduction after reaching its maximum height. The plant was well adapted to living in deltaic environments, able to grow rapidly and produce seeds before being drowned in the next flood event.

Araucarioxylon arizonicum

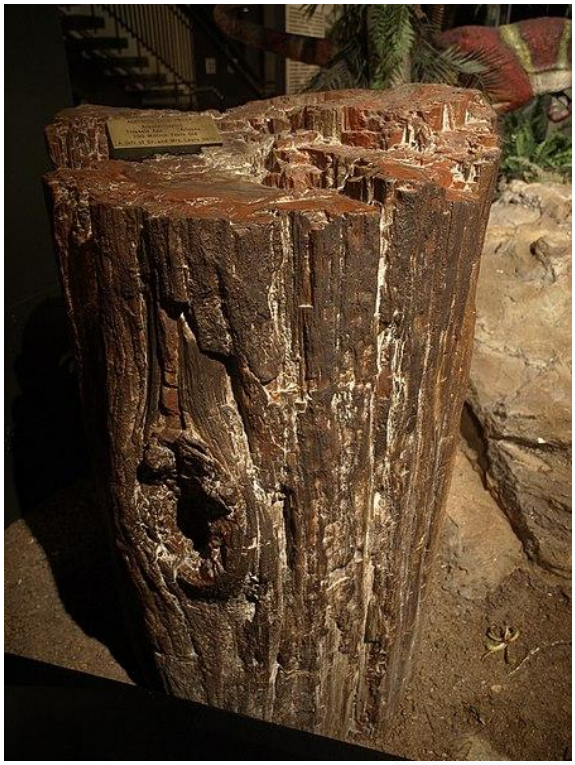


Figure 3 - Section of Petrified Conifer Trunk *Araucarioxylon arizonicum*
Credit: Kamraman, Creative Commons Attribution-Share Alike 2.5 Generic license

The State Fossil of Arizona, petrified wood of *Araucarioxylon arizonicum* are found in the Chinle Formation in northern Arizona and New Mexico and in the Petrified Forest National Park (setting of the 1936 gangster film, *The Petrified Forest*). Fossils of *Araucarioxylon arizonicum* are also found in the Chemnitz petrified forest in Chemnitz, Germany.

First described in 1889 by the American paleobotanist Frank Hall Knowlton, *Araucarioxylon arizonicum* grew tall, up to 60 metres tall. Classified as a member of the Araucariaceae family, *Araucarioxylon arizonicum* is related to the ancestors of the Monkey Puzzle Tree and the Norfolk

Pine. The geology of the *Araucarioxylon arizonicum* fossils suggest that it grew in tropical forests of northwest Pangaea.

At least one researcher questions if *Araucarioxylon arizonicum* is a single species and that the fossils are actually from three, previously described, species: *Pullisilvaxylon arizonicum*, *Pullisilvaxylon daughertii* and *Chinleoxylon knowltonii*.

The fossils of *Araucarioxylon arizonicum* are interesting. The original wood has been replaced by red hematite and yellow limonite giving rise to a description of the fossils as "rainbow wood". Also in some of the fossils are boreholes of insect larvae, possibly beetles similar to members of the modern family Ptinidae.

Figure 4 - *Araucarioxylon arizonicum*
Credit: T-rex-wiki, Creative Commons Attribution-Share Alike 3.0 Unported license

Lycophytes

Pleuromeia

Figure 5 - *Pleuromeia sternbergii*, Natural History Museum, Bonn University
Credit: Ghedoghedo, Creative Commons Attribution-Share Alike 4.0 International license

Apparently related to modern quillworts *(Isoetes), Pleuromeia* fossils are found in the Early Triassic throughout the Eurasian part of Pangaea and were probably the dominant plant form for a while. An opportunistic pioneer plant that reproduced by spores and could grow on otherwise sterile mineral soils, it was ideally suited to thriving in the conditions following the End

Permian Mass Extinction. *Pleuromeia* appears to have been a perennial plant that grew in dense thickets.

Pleuromeia was first described by George Graf zu Munster in 1839 from a fossil found in a block of sandstone dimension stone split open during repairs at the Magdeburg Cathedral.

Figure 6 - *Pleuromeia restoration*
Credit: Looy, van Konijnenburg-van Cittert, & Duijnstee, 2021
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Cylostrobus

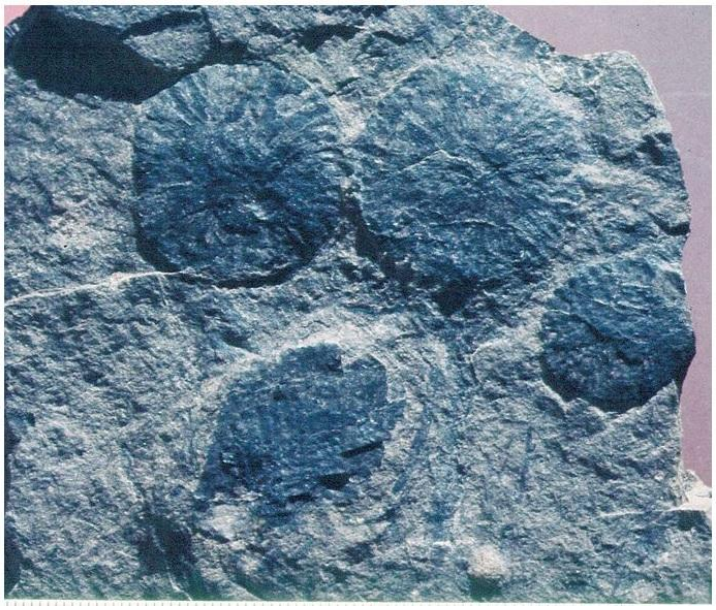

Figure 7 - Fossil Cones of *Cylostrobus sydneyensis*
Credit: Retallack, Creative Commons
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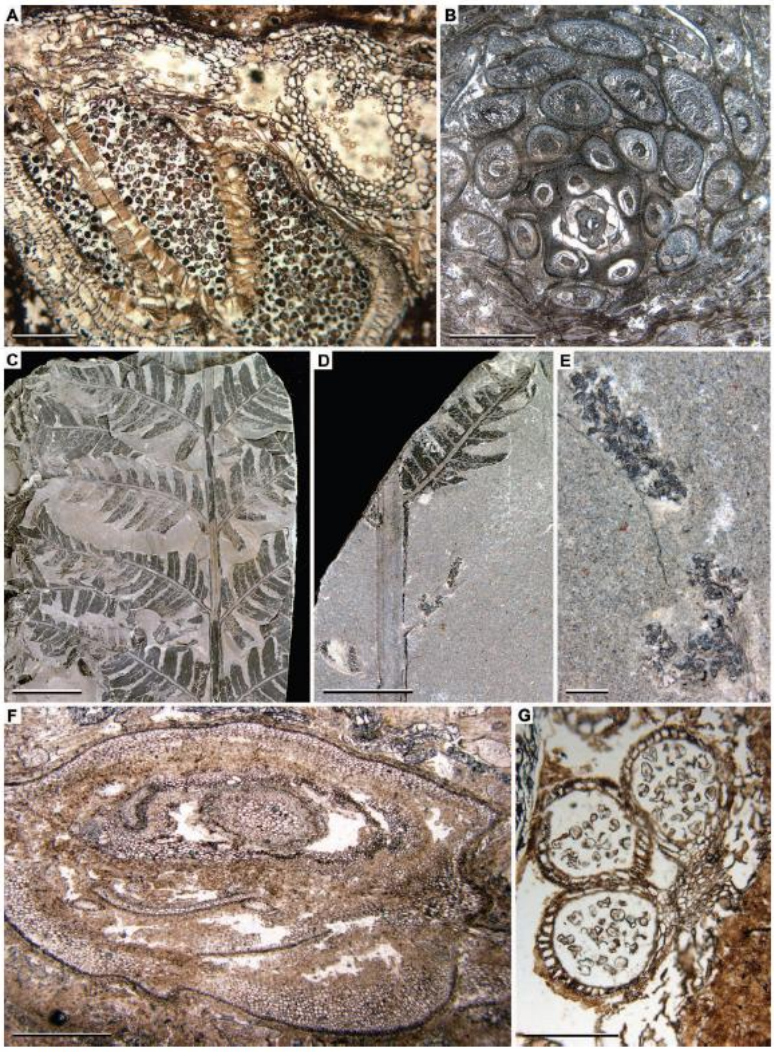
Found in Early Triassic rocks from Australia, *Cylostrobus* was similar to *Pleuromeia* but had compact and round cones, as in Figure 7, above. *Cylostrobus* appears to have been most common in what now Australia and was first described by R. Helby and A.R.H. Martin in 1965. The fossil in Figure 7 was found in the Early Triassic Newport Formation near Narrabeen, NSW, Australia.

Ferns or Polypodiopsida

While the first fossils of ferns were found in the Middle Devonian Period, by the time of the Triassic, polypodiopsida appeared that seemed to be related to modern ferns. Figure 8 shows a

wide variety of fossil ferns from the Triassic rocks of Antarctica.



Fern fossils from the Triassic of Antarctica;

A) Oblique section of permineralized *Scolecopteris antarctica* with thick-walled synangia filled with spores; scale = 2 mm.

B) Transverse section through stem (center) and numerous surrounding petioles of *Ashicaulis woolfei;* scale = 5 mm.

C) *Osmunda claytoniites* sterile frond; scale = 2 cm.

D) *Osmunda claytoniites* showing part of sterile pinna above and two alternate fertile pinnae below; scale = 1 cm.

E) Higher magnification of fertile pinna of *O. claytoniites* showing clusters of sporangia; scale = 1 mm.

F) Stem of *Antarctipteris sclericaulis* in transverse section showing central protostele; scale = 2 mm.

G) Sporangia of *Gleichenipteris antarcticus;* scale = 250 µm.

Figure 8 - Fern Fossils from the Triassic of Antarctica
Credit: Figure 5 in Escapa et al, 2011

Horsetails - Equisetum

Figure 9 - Reconstruction of Triassic horsetail landscape
Credit: drawing by Jorge Gonzalez in Brea, Artabe, & Spalletti, 2009

In 1835 Charles Darwin visited the Agua de la Zorra region near Uspallata, Mendoza, Argentina and he came across a fossilized forest or palaeocommunity of horsetails. This is now called "Darwin's Forest" and is found in rocks now identified as the Middle Triassic Paramillo Formation. The Paramillo Formation was deposited in a fluvial flood plain that was made up of volcaniclastic material. In addition to the horsetails, Darwin's Forest also contained fossil conifers and fossil corystosperm seed ferns.

Seed Ferns - *Dicroidium*

Figure 10 - *Dicroidium zuberi*
Credit: Retallack, Creative Commons Attribution-Share Alike 4.0 International license

A corystosperm seed fern, fossils of *Dicroidium* are widespread throughout the southern

hemisphere and associated with the Gondwana portion of Pangaea. Seed ferns look similar to true ferns but, as the name suggests, they reproduce through seeds. Fossils of seed ferns showed male and female reproductive structures. They were first discovered in Triassic sediments of Tasmania in 1845 by a Mr. J. Morris .

Bennettitales - *Pterophyllum longifolium*

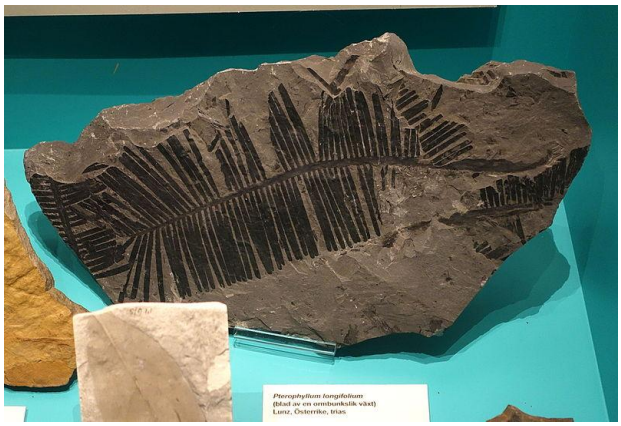


Figure 11 - *Pterophyllum longifolium*
Credit: Daderot, Creative Commons CC0 1.0 Universal Public Domain Dedication

Bennettitales are an extinct order of seed plants that first appeared in the Permian and died out during the Cretaceous. While resembling Cycads, they had complex, flower-like reproductive organs.

Fossils of *Pterophyllum*, shown above in Figure 11, are found from the Upper Triassic Carnian stage to the Maastrichtian, which was the last stage of the Cretaceous. Approximately 50 species of *Pterophyllum* have been identified in the fossil record.

Cycadophytes

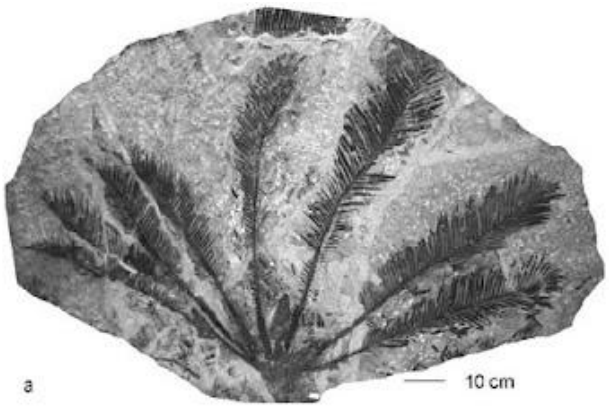


Figure 12 - Complete Triassic Cycad
Credit: Wang, Wang, & Zheng, 2009

The earliest fossils of cycads were first found in the Permian age rocks. Sometimes called a "living fossil" the ancestors of modern cycads appear to have evolved in the last 12 million years. During Triassic times they were not a major part of the ecosystem, but some fossils, such as the one in Figure 12, have been found from that time.

Living cycads are found across much of the subtropical and tropical parts of the world and their distribution appears to be associated with ancient Gondwana. Cycads reproduce through seeds and they exist as male or female plants.

Ginkgoales - *Ginkgoites watsoniae*

Figure 13 - *Ginkgoites watsoniae*
Credit: National Park Service, public domain

Another fossil from the Petrified Forest National Park in Arizona, *Ginkgoites watsoniae* is related to the ancestors of the modern tree, *Ginkgo biloba*. Having diverged from the Cycads in the early Carboniferous, Ginkgoales flourished throughout the Mesozoic Era with a significant radiation of the group during the Late Triassic. Later on, most Ginkgoales become extinct during the Cenozoic Era, except for modern species *Ginkgo biloba*.

Standard Caveat

The purpose of my weblog postings is to spark people's curiosity in geology. Don't entirely believe me until you've done your own research and checked the evidence. If I have sparked your curiosity in the subject of this posting, follow up with some of the links provided here. If you want to, go out into the field and examine some rocks on your own with the help of a good field guide. Follow the evidence and make up your own mind.

In science, the only authority is the evidence.