The Many Gifts of Ferns

by PRU FOSTER

Ferns are some of the most remarkable of plants. For starters, they are very likely the original source of seeds, and hence the progenitors of flowers and fruits. They are one of the oldest plant groups on the planet, with fossil records dating back to at least the Devonian Period 390 million years ago, predating the dinosaurs by 150 million years. During the Carboniferous (300-370 million years ago), ferns dominated the terrestrial landscape. When these ancient ferns died, they piled up in swamps along with other plant material. The layer of dead plant material was subsequently buried, leading to the formation of the global coal fields that literally helped fuel the Industrial Revolution.

The author in front of Ostrich ferns (*Matteuccia struthiopteris*) in her garden. Photo by Dakota Walter.

Climate coolers

Ferns also put a stop to what may have been a runaway greenhouse effect about 49 million years ago. At that time, carbon dioxide (CO_2) levels in the atmosphere were much higher than they are today and the planet was much warmer. A tiny water fern named Azolla was able to thrive in the Arctic Ocean, which was so warm at that time that it hosted crocodiles. It is believed that when the Azolla ferns died, they sank to the bottom of the ocean, taking with them large blankets of carbon.

This went on for about 800,000 years and reduced the carbon dioxide in the atmosphere from 3,500 parts per million (ppm) to about 650 ppm. For reference, humans have "only" increased the CO_2 in the atmosphere from 280 to 419 ppm since the Industrial Revolution. The massive drawdown of carbon, caused by the buried blankets of Azolla, is thought to have driven a global cooling of a whopping 35 degrees Fahrenheit – making the planet hospitable to a completely different set of life forms. Pretty remarkable for a tiny little fern!

Clean Up on Aisle Earth

Another notable fact about ferns is that they are capable of cleaning up toxic messes. In addition to being highly tolerant of many growing conditions and chemical compounds, they are also highly effective at contaminant removal. They've been used to remove heavy metals, radioactive materials, nutrients, hydrocarbons, and volatile compounds from soil and water. In addition, they are able to quickly colonize sites that other plants can not, thus kick-starting the process of soil and ecosystem regeneration.

From Ferns to Flowers, Spores to Seeds

Finally, and perhaps most interesting to us plant lovers, ferns may well have given us flowers. Like all other land plants, ferns have a sexual component to their reproductive cycle, which of course is what flowers are all about. But their reproductive cycle is different from flowers. The fern fronds we recognize are the direct product of sperm and egg union, and are therefore the "baby" stage of the fern. However, the sperm and egg don't come from parents that look like the fern baby. Instead, fern frond parents are very different, looking like tiny pieces of wet kale about the size of a fingernail. Because the fern frond parents tend to lie flat on the ground, only the most avid of naturalists will have ever noticed them. These soggy little kale-like leaves are called *gametophytes*, as they produce eggs and sperm (a.k.a. gametes) and are plants (a.k.a. phyte). To be successful at reproduction, gametophytes must grow in damp areas because the sperm they release need ambient water to swim through as they seek an egg to fertilize.

Continuing the life cycle, mature fern fronds produce spores in little capsules, called *sporangia*, on their surface. The sporangia often appear as little brown spots on the underside of the fronds. At some point, the sporangia capsules open and the spores scatter, often carried by wind to distant places. Fern fronds are thus known as sporophytes (plants that produce spores). If the released spores land in a hospitable spot, they can grow into a gametophyte – those mini kale leaves that can release a sperm or an egg whose union leads to a baby fern frond. There is thus a switching of plant forms from gametophyte to sporophyte to gametophyte and so on. This process of reproduction is known as the *alternation of generations* and it is common in the plant kingdom.

Most ferns produce male and female spores that are microscopic. However, one family of ferns, called "seed ferns" and known only from the fossil record, evolved to produce both the familiar microscopic male spore, and a much larger female spore. The female megaspores are not ejected, but rather they are retained inside of the sporangia. Within this cozy capsule, the megaspore develops into a gametophyte, which in turn produces an egg. In this case, the vegetative phase of the gametophyte is nearly eliminated. Seed ferns also evolved structures to capture

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Watermark illustration of Sensitive Fern by E.C. Fisher

Above: Interrupted Fern (*Claytosmunda claytoniana*) along Cherry Creek, Garrett County, Maryland; Below left: Northern Maidenhair Fern (*Adiantum pedatum*); Middle: Netted Chain Fern (*Lorinseria areolata*); Right: American Wall-rue (*Asplenium ruta-muraria* var. *cryptolepis*) in cracks of Tomstown Formation limestone and dolostone. Photos by R.H. Simmons.

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Fiddlehead of Cinnamon Fern (*Osmundastrum cinnamomeum*). Photo by Lauren Hubbard.

airborne fern sperm, referred to as *pollen* in flowering plants. Even though the "seed" ferns don't actually produce a seed, the process is edging very close to seed production. If ferns were the pathway to seed evolution, it means that ferns have given us fruit and nuts, wheat and rice, tomatoes and cotton.

Rhizing to the Occasion

Now that we've worked our way through fern reproduction, note that most fern individuals do not come from this alternation of generations. Groupings of ferns almost always arise from vegetative reproduction, commonly spreading by rhizomes. Each fern in such a colony is a clone of the first fern, all with the exact same genes as the original plant. Why then, the complicated alternation of generations, if this simple vegetative reproduction is possible? In terms of evolution, sexual reproduction introduces genetic options that are critical during times of stress and when species are faced with unique challenges. Furthermore, spore distribution promotes widespread colonization. Ferns are clearly a successful group of plants because they have survived for nearly 400 million years, a thousand times longer than humans have been in existence.

Ferntastic Diversity

Because ferns have been around for so long, they have evolved into a dizzying collection of forms. There are moonworts (*Botrychium lunaria*), small ferns with halfmoon-like pinnae. Moonworts were much beloved by the witches and alchemists of the past who would collect it during the full moon and use it to stop bleeding, to access the fairy world, and to create gold. Resurrection Fern (*Polypodium polypodioides*) fronds completely dry up under drought conditions and then bounce back to life with the first rains. There's the amazing vine-like Climbing Fern (*Lygodium palmatum*) whose alternating palmate-lobed "leaves" are actually pinnae and the whole "vine" is the frond and the Walking Fern (*Asplenium rhizophyllum*) that strolls along by producing new plants at leaf tips that touch the ground. In contrast are the tropical tree ferns, growing to over 80 feet tall.

Finding Ferns

The MNPS celebrated ferns as the "Plant of the Year" in 2011. At that time, and updated in 2014, Dwight Johnson developed a handy key for identifying the common ferns of Maryland (see link below). This is a fun way to learn to identify some of our ferns. I hope you'll join me in heading outside to seek some of these ancient, world-changing, flower-giving plants. Today, there are more than 10,000 fern species worldwide. And, while most are found in tropical regions, the US and Canada are home to around 450 species. The Maryland Biodiversity Project lists 74 species of ferns that have been observed in the state with Christmas Ferns topping the list at over 1,500 records.

Ferns can be found almost anywhere, but here are a few places in Maryland where there have been at least a dozen or so fern species spotted:

- Gunpowder Falls State Park, *Hereford Area, Mingo Valley Trail, Baltimore County*
- Snyder's Landing, *Chesapeake & Ohio Canal, Washington County*
- King's Landing Park, *Calvert County*
- Wincopin Trail Area, *Howard County*
- Tawes Garden, *Department of Natural Resources building, Annapolis, Anne Arundel*

MNPS has run field trips to the first three sites and there are plant lists from those trips on the MNPS website (see link below).

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