Mycetozoans and the Continuity of Life

Figure 1. *Diderma (possibly "asteroides"*) "sorocarp" June 15 2023, Strathcona Provincial Park

With rotting snow still on the ground in mid-June of this year when the first blueberry blossoms were out in Strathcona Provincial Park I spotted a strange new fungus on the bark of Oval-leaved blueberry (*Vaccinium ovalifolium*) twig. It looked like a diminutive "earth-star" (*Geastrum).* I was not clear as to what it was. It seemed to be a fungus that was not listed in my field guides, so I ran it by my mycologist friends who tried as best they could - but finally came up blank. It was only months later as I was preparing to write something on the evolution of fungi that I stumbled on the answer. It was *Diderma asteroides* ("little star-shaped Diderma") or a close relative thereof. It wasn't a fungus, or a plant, or an animal. It was a mycetozoan, a plasmodial "slime mold" distantly related to amoebas something from the chaotic Kingdom Protista, where nature seems to test run all maner of strange single-celled organisms. The key to identification was that first instinct: "they looked very much like diminutive fungal "earth stars."

Although the Salish Sea region is home to about 90 known species of "slime molds," Mycetozoans are notoriously hard to spot, even if you know what you are looking for. I was used to seeing the usual common slime molds after a rainfall (*Fuligo septica, Physarum polycephala, Lycogala epidendrum, Stemonitis and Trichia,* all of which can be found in guide books.) As one expert aptly notes after forty-five years of experience: *"They are usually hard to find, but their beauty rewards the time, persistence, and luck it takes to find them."*[1] They are ever-present around us microscopically as amoebas, but only fleetingly observable at the macroscopic scale in their inflorescence. They are among the most difficult organisms to explain to a gaggle of naturalists on an outing. In spite of their English name they are neither mold, nor fungus, nor plant, nor animal, but rather a bit of everything shoved into a complex single-cell with a brain, so complex that some taxonomists believe that they should be placed in their own kingdom.

We take for granted too many of the organisms around us, and go about our busy lives largely unaware of our kinship with and dependence on the presence of a multitude of smaller organisms we mistakenly class as "lesser" organisms. That may be particularly true of the "mycetozoans." The mycetozoans used to be generally called "slime moulds," or "Myxomycetes." A few short decades ago they were still studied as primitive fungi, at a time when fungi were lumped with plants in the study of botany. With DNA studies those classifications have been set aside. Of course, it turns out that they were never molds either, and don't belong to the fungal kingdom, which is not part of the plant kingdom.

Mycetozoans are a lesson in, and about, evolution. They are a "polyphyletic," they are a group of unrelated organisms with more than one common ancestor.[2] They are poorly understood amoeboid protists, and they don't fit our normal preconceptions. Their taxonomy is very complicated. It is made even more difficult by the use of the catch-all name "slime molds" which lumps mycetozoans and phytomyxeans together. Phytomyxeans are non-amoebozoan plant parasites, that have an amoeboid-like stage. (Is that confusing enough?)

Fungi originated as a microscopic single flagellated single-celled endoparasite in algae. Mycetozoans are also single-celled protozoans, but they are not parasitic. They merely feed on surface and do not penetrate the substrate. Some scholars suggest that they are not host or substrate-specific, though others group them by

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[1] https://www.wnps.org/blog/slime-mold-interlude

[2] See: https://www.mun.ca/biology/scarr/Taxon_types.htm

substrate. They are sensitive to pH and are therefore grouped in four ranges of pH, which grossly corresponds to the pH variations of their substrates. They feed on bacteria and microbes which are found on a variety of substrates: soil, moss, fungi, decaying wood, tree bark, flowers and leaves, and therefore perform an extremely important role in controlling bacterial and microbial densities. They play a poorly understood essential role in nutrient cycling, on which entire ecosystems depend.

Figure 2. *Fuligo septica* (sorocarp-bearing "aethelium") and *Stemonitis* (sorocarps) in Strathcona Provincial Park

Notably, mycetozoans that have received considerable attention in biomedical research, such as the commonly seen *Fuligo septica* which is known to accumulate a lot of essential elements such as zinc, iron, magnesium, selenium and especially calcium. The high amount of calcium in mycetozoans is of particular interest because calcium is essential for neural function (muscular synapse and brainwork.). Myxozoans are known for being able to compute and solve complex problems. They have been used to operate computer circuitry and to operate six legged robots.[3] As the foremost authority on slime molds, Princeton's late Dr John Tyler Bonner, frequently noted, these simple one-celled organisms are a brain-in-a-bag: "they manage to have various behaviors that are equal to those of animals who possess muscles and nerves with ganglia -- that is, simple brains."

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[3] https://www.researchgate.net/publication/242492553_Importance_of_Myxomycetes_in_Biological_Research_and_Teaching

As the name suggests they are “fungal-animals,” (“myceto” = fungus and “zoan”= animal.) Their life cycle involves the formation of a spore-bearing structure (“sorocarp”) that outwardly resembles, but is not, a fungal-reproductive structure (“sporocarp.”) They all seem to share a similar life-cycle. They begin as haploid spores which develop into microscopic single nucleus “amoebas” or flagellated zooids which aggregate into a multi-nucleated “plasmodium” (slime blob) which mature in an “aethelia” out of which “mold-like”diploid sorocarps emerge, eventually to break and spread haploid spores, which will repeat the cycle.

Mycetozoans are part of number of groups of organisms mainly found among the protists, which merge characteristics of fungi, animals or plants. They defy our normal categories of classification. By doing so they tell is a lot about the dynamism and creativity of nature and biodiversity. Biodiversity is not a collection of species, it is a transition of connected life forms. Darwin’s great challenge to the Victorian world he lived in was a question that remains to this day central to our understanding of biodiversity: “*Is life on earth united in an evolving continuity, or is it a network of competitive hierarchies?”* That is a question for “planetary biology” which traces the evolution and transformation of DNA and proteins through a constantly changing planetary history. Because of DNA we no longer think of Neanderthals as “another race” but as evolutionary cousins in humanity’s journey whose DNA we inherited. The Neanderthals are us, and the mycetozoans are not too far behind!

In classical biology this same question is phrased as: “*Is it better to try to unify organisms by evolutionary history than to divide them?*[4] The concept behind “natural selection” was never meant to be Herbert Spencer’s (1820-1903) unfortunate catch-phrase “survival of the fittest.” Darwin’s “struggle for existence” was meant to connote the fitness of an organism for an ecological place or “niche” in a continuously evolving and changing environment.

Darwin’s nineteenth-century Victorian world was built on the racially- structured and class-obsessed colonial empire that drove the rise of industrial capitalism and reduced nature to “resources.” (A misconception still promoted by our politicians and corporate leaders which is largely responsible for our current climate and biodiversity crisis which endangers humanity’s survival on this planet.)

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[4] https://asm.org/Articles/2021/January/Three-Reasons-Fungi-Are-Not-Plants

Darwin came from a long tradition that saw the earth as a living organism. The challenge that Darwin presented to Victorians was at odds with the popularly endorsed simplistic and misleading misinterpretation of the theory of evolution which suggested that "man descended from monkeys." That was what the popular press, gutter politicians and racist apologists like Spencer would use to promote "social darwinism," a cornerstone of fascism which still finds favour today in right-wing conservatism. Darwin followed in the anti-racist footsteps of von Humboldt, whose works he prized, took and read on the voyage of the Beagle. Long before advent of genetics and DNA, Darwin was awestruck by the relatedness of all life, and man's indebtedness and evolutionary proximity to all other species. Darwin's theory of evolution ties all life together as one large complex interdependent unity.

Unfortunately, over the last 100 years poorly taught science promoted throughout our conventional educational system, which mis-educates children for corporate careers, has often reduced the theory of evolution to hierarchies, levels and categories. Two centuries after von Humboldt and Darwin that approach facilitates the view of nature as just "resources." The inconvenient essential part about the continuity of life, and the sentience of even single-celled organisms we rarely see has unfortunately been overlooked and failed to enter public discourse. We overlook or understate the problem of the unity of life at our expense, as the lack of a public understanding of the linkages between the climate and the biodiversity crises illustrates.

Mycologists often point out that members of the fungal kingdom are closer to animals and human beings than they are to plants.[5] What then of the mycetozoans? They seem even closer to us, though distant in evolutionary time. The division between plants and animals gets blurred when we stop to consider the "plant sentience" and models of sentient forests proposed by Suzanne Simard and others. The division even becomes increasingly spurious when we leave the comfort zones of our accepted categories and mental routines, and take time out to stop to observe and consider the intractable mycetozoans.

The sooner we come to terms with the continuity and interdependence of life throughout nature, the sooner we will be able to address the rights of nature, and overcome the divisiveness that has brought upon us the biodiversity and climate crisis.

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[5] https://www.newscientist.com/article/mg13818773-300-science-animals-and-fungi-closer-than-anyone-expected/ ; https://asm.org/Articles/2021/January/Three-Reasons-Fungi-Are-Not-Plants

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21 January 2024.