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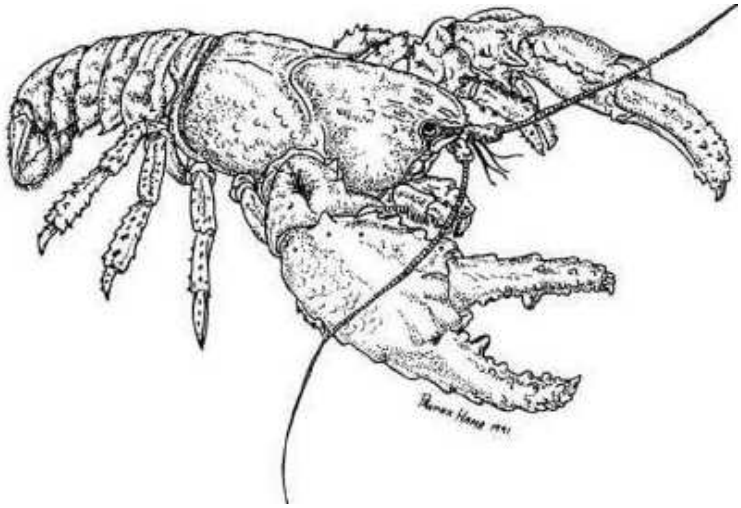

Slime Moulds: the most remarkable organisms.

by **Sarah Lloyd**

Leocarpus fragilis

'Slime moulds' is a not term that elicits excitement in most people, nor does it conjure up images of great beauty. But slime moulds must be among the most remarkable of organisms! At one stage of their life they are single cell amoeba, whose definition is found in a Dictionary of Zoology, then they combine with others of their kind to form either a plasmodium - or pseudoplasmodium - defined in the Dictionary of Plant Sciences.

My fascination with slime moulds has been growing gradually since first reading about them in books about fungi. (They were once placed in the same kingdom as fungi but are now in their own kingdom: the Protoctista.)

Their sudden appearance is particularly intriguing. On one occasion I went outside to find three fruiting bodies in various colours of *Fuligo septica* on logs or stumps about 20-50 metres apart. This left me wondering about the stimulus for their sudden appearance.

Fuligo septica

In an attempt to find out more about slime moulds I purchased *The Social Amoebae: the biology of cellular slime moulds*, a small book written by John Tyler Bonner. Bonner (aka the 'sultan of slime') is professor emeritus of ecology and evolutionary biology at Princeton University who has worked and written about his 'beloved slime molds' for six decades. He writes in the preface that one reason for the book was to clarify in his own mind the complex nature of the subject of his life's work. But rather than clarifying it for me, the information, initially at least, was bewildering. Then, after reading Virgil Hubregtse's account of a talk given by Paul George (Fungimap #28), I realised the reason for my confusion: there are three types of slime moulds! There are the Dictyostelids, the cellular slime moulds so eloquently written about by Bonner (featured on the ABC Science Show 29th Aug 2009), the very obscure Protostelids, and the acellular slime moulds, also known as plasmodial slime moulds or myxomycetes. The cellular slime moulds are mostly microscopic; the acellular slime moulds are the ones we see.

Myxomycetes: Plasmodial or Acellular Slime Moulds

One of the most frequently encountered acellular slime mould is the aforementioned *Fuligo septica*. Its common names of either 'dog vomit' or 'scrambled egg' slime mould evocatively describe its size and consistency. It appears on rotting logs, stumps or live vegetation during summer, first as a moist brightly coloured (usually yellow) blob, then, as the spores develop, it fades and gradually hardens. It is likely, given that many acellular slime moulds have a cosmopolitan distribution, that it was the one that featured in 9th century Chinese writings called 'Kwei hi' which translates to ‘demon droppings’. In an area of Mexico the plasmodium is fried and eaten by some of the indigenous people who call it 'caca de luna' i.e. 'moon's excrement'.

Ceratiomyxa fruticulosa

Other slime moulds have quite different forms. From a distance *Ceratiomyxa fruticulosa* is no more than a white splash on rotting stumps and logs, but closer inspection reveals an intricate architecture of miniature icicles. When it first appears *Stemonitis axifera* resembles a collection of small shiny beads. These gradually elongate and change colour before transforming into a brown fluffy spore-bearing mass. The fruiting body of *Lycogala epidendrum*, whose common name is 'wolf's milk', are 3 - 15mm orbs of pink, red or orange which gradually change to pinkish grey.

What really got me hooked was finding a colony of exquisite 4mm fruiting bodies resembling tiny deep purple mushrooms that were scattered along the trunk of a dogwood (Pomaderris apetala) that had been lying on swampy ground for years, possibly decades. After checking a few websites the distinctive appearance of the slime mould made it easy to identify as *Arcyria denudata*.

Arcyria obvelata

I replaced the slime mould in a shady spot and planned to make regular visits to record its progress. As luck would have it, there was another *Arcyria* species about a metre away that I could also monitor.

I have learnt quite bit about slime moulds since that encounter with the purple *Arcyria*. For instance, slime moulds are apparently very sensitive to

disturbance (they don't like rough handling, but they don't seem to mind loud exclamations of delight on being discovered!) and although a few of the *A. denudata* fruiting bodies on the sodden dogwood matured, I lost track of most of them and presume they did not cope well with being moved. Another mistake I made was photographing the very early stages which can be similar in different species. For example, many fruiting bodies first appear as bright yellow plasmodia, or a collection of small beads or stalked cylinders of jelly. It is only when these mature that their identifying features become obvious. However in many instances, as with fungi, microscopic examination of spores and other structures is needed for identification.

Surprisingly, there have been only about 1000 species of slime moulds recorded worldwide (in comparison, there are believed to be approximately one million fungi). They reach their peak of abundance in temperate forests and can be found on living and dead trees, rotting logs and other coarse woody debris, leaf litter, herbivore dung and bryophytes. There is even one record of a slime mould growing on a living lizard! The lizard *Corytophanes cristatus* is a cryptic species found in the forests of eastern Honduras. Its 'sit and wait' foraging strategy involving periods of immobility meant that a slime mould *Physarum pusillum* could colonize its body. This lizard, which also occurs in Mexico and Costa Rica, is the only vertebrate reported to have a plant (a liverwort, *Taxilejeunea* sp.) occurring on its body.

I was under the impression that the fruiting bodies, many of which are only millimetres high, were delicate ephemeral structures, but some stay around for some time. When you know where to look, you can see quite a few! For instance, in the forest near home I have found numerous old fruiting bodies inside old stumps or in hollow logs. One had been there long enough to have a growth of leafy liverworts on its stem.

It is not only their sudden and sporadic appearance that is fascinating, but also the fact that in their early stages of their life cycle they share some characteristics with animals (i.e. they feed and move about), while their reproductive stage is similar to that of fungi, i.e. they produce spores.

Acellular slime moulds have two different trophic (feeding) stages. The spores germinate into individual, soil-dwelling, single-nucleus, sometimes flagellated amoebae. (The word amoeba comes from the Greek amoiba: to change. It alludes to their ever-changing shape, a result of the expansion and retraction of temporary protrusions on their body called pseudopodia.) The amoebae feed on bacteria and other organic matter, and then divide in two – thus their population increases. Two compatible amoebae fuse to form a zygote, a process that involves the fusion of the protoplasm and the fusion of the nuclei. The diploid zygote feeds, grows and undergoes repeated nuclear division to develop into the plasmodium (pl. plasmodia).

Leocarpus fragilis

The plasmodia are a single cell with multiple nuclei encased in a thin membrane. Because they can move through very small openings of a few micrometres they are able to exploit the microhabitats within decaying wood. There they feed on bacteria, yeasts, algae, cyanobacteria and fungal hyphae and spores. Eventually they move to the surface of the substrate to form fruiting bodies. This transformation is probably triggered by exhaustion of the food supply, and/or changes in moisture, temperature and pH. Wind disperses the spores in most species although invertebrates undoubtedly also play a part in this.

If conditions are unfavourable plasmodia have the ability to transform to a hard structure (sclerotium) and revert to a plasmodium when favourable conditions return. Similarly, amoeboid cells have the ability to change to

microcysts and back again. Sclerotia and microcysts can remain viable for long periods; a strategy that probably ensures their survival in arid and other hostile habitats.

Although slime moulds are usually associated with moist conditions and are most often observed after a bout of rainy weather they are by no means confined to wet habitats. During an expedition to the northern Simpson Desert in 2007 substrates were collected from the Hay River region and taken back to incubate in the lab. Thirty-five species were documented including nine species not previously recorded in Australia. 41% of the species found during the expedition, including one that is considered rare, are also found in the desert of Western Kazakhstan, once again reflecting their cosmopolitan distribution.

Most slime moulds are not slimy, nor do they look like mould; rather, many are exquisitely shaped and quite beautiful. My search for slime moulds continues and while looking for these tiny organisms I have encountered so many other fascinating things. Rotting wood, stumps, logs and leaf litter abound with life! It makes you wonder about the absurdity of the notion of 'waste' on the forest floor.

Slime mould images are linked from another page

We have some time-lapse images showing the development of slime moulds:

- *Arcyria denudata*
- *Arcyria obvelata*
- *Badhamia utricularis*
- *Stemonitis* sp.

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Web:
- Discover Life probably has the most extensive collection of slime mould images on the web (linked from the main page)
- University of Arkansas
- Introductory page on myxomycota from University of Hawaii
- New Zealand's The Hidden Forest has many identified moulds on their site
- The Russians have some beautiful images of slime moulds. (warning: the file contains 33 images totalling 5.3MB.

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