# THE MARL CRUSTS OF LOUGH CARRA

PHILIP DODDY

# INTRODUCTION

Take a wander along the shore of Lough Carra and you will surely see many things of interest - the beauty of the landscape, a bird dabbling in the water, bright patches of wildflowers, maybe a few sheep quietly grazing in a nearby field. Another thing you might notice is that the rocks along the lakeshore are covered with a curious, whitish, quite slippery layer. This is a marl crust. I have spent the past few years studying these crusts, in Lough Carra and in other lakes, and I would like to tell you about some of the things I have found.

A STONE FROM LOUGH CARRA, COVERED BY MARL CRUST

Here are some of the questions that people have occasionally asked me:

What exactly are marl crusts?
Where do they come from?
Where else can you find them?
What can they tell us about Lough Carra?

A STRETCH OF LOUGH CARRA'S SHORE

In this booklet, I will try to answer these questions. Lough Carra is one of the finest marl lakes in Ireland, and in western Europe, and its marl crust has been a fascinating thing to study. I hope you will also find something to interest you in this short summary of my research.
If you would like to find out more, you can find the publication details of the scientific papers at the end. You can also email me at philipdoddy@gmail.com.

A TINY FERN GROWING ON ERODED ROCK BESIDE LOUGH CARRA

Thank you for taking the time to read this booklet.

Philip Doddy,
November 2019.

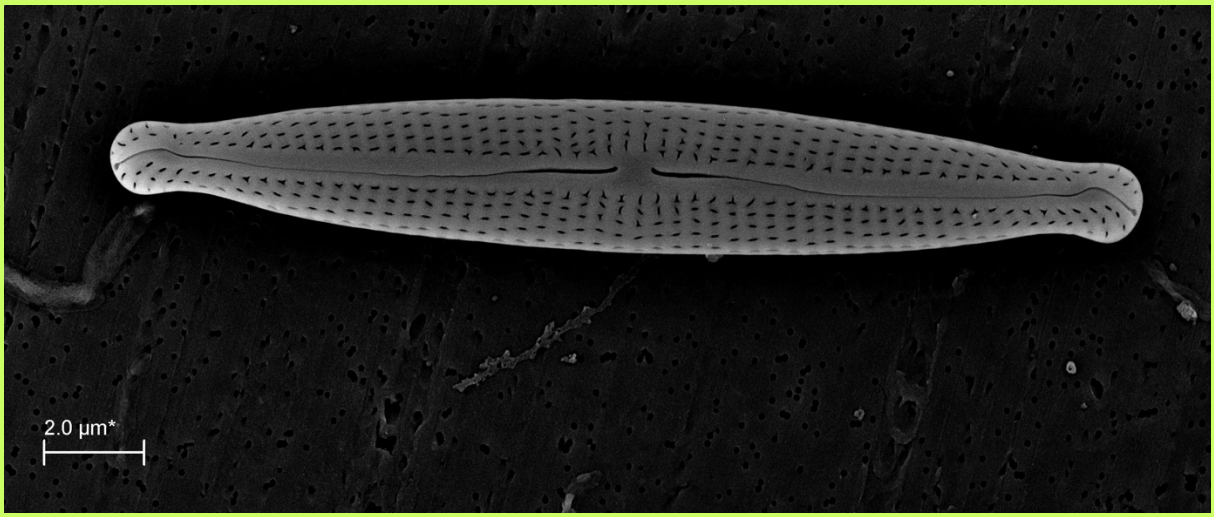
# WHAT ARE MARL CRUSTS?

If you cut a slice of marl crust and look at it closely, you'll see a green layer just beneath the surface. Below this will be a soft, whitish, crumbly layer, made up of quite fine grains. A magnified view of the green material shows that it contains many living things – a community of tiny life forms. The majority of these are cyanobacteria – ancient organisms which can grow as filaments, clusters of cells, or interwoven masses, depending on the species. Cyanobacteria have been around for billions of years; indeed some of the earliest traces of life on Earth are micro-fossils of cyanobacteria.


CROSS SECTION OF A MARL CRUST FROM LOUGH CARRA

CYANOBACTERIA AND ALGAE FROM MARL CRUSTS, AS SEEN THROUGH THE MICROSCOPE

Various sorts of algae can also be seen in the living layer of marl crusts. One especially attractive group are the diatoms. Diatoms are much too small to see with the naked eye, but when you see one through a microscope the amount of detail is startling. Each diatom has an outer transparent shell made of silica. These tiny glassy cases often have exquisite patterns of minute perforations and slits. A recently-discovered species of diatom, which is found in Lough Carra and some other limestone lakes, has been named in honour of Lough Carra - *Encyonopsis carraensis.*




THIS DIATOM, *ENCYONOPSIS CARRAENSIS,* HAS BEEN NAMED IN HONOUR OF LOUGH CARRA. THIS IMAGE IS HIGHLY MAGNIFIED. IF 500 OF THESE DIATOMS WERE LINED UP, THEY WOULD FORM A LINE JUST 1 CM LONG.

Animals also live in marl crusts. Some of these are microscopic, such as the nematode worms that writhe and slither among the marl grains, but bigger animals live in these crusts too. Because thick crusts often have cavities or hollows, animals such as beetles, flatworms, and caddis fly larvae can be found living in them. Often, a water spider will emerge from a piece of crust if you examine it closely. A particularly rare beetle, called *Ochthebius nilssoni*, has recently been found living on Lough Carra crusts.

THE BEETLE *OCHTHEBIUS NILSSONI.* LOUGH CARRA IS ONE OF VERY FEW PLACES IN THE WORLD WHERE THIS SPECIES CAN BE FOUND.

As well as these living creatures, marl crusts contain a lot of small grains of calcium carbonate (the main mineral that makes up limestone). In the upper layers of crust, these grains are bound together by many strands of filamentous cyanobacteria. This is why crusts have a firm texture. These grains also form the whitish material towards the base of the crusts. Because cyanobacteria need light, they cannot grow very deep within crusts, and so the lower parts of crusts are more loose and crumbly in texture.

# WHERE DO MARL CRUSTS COME FROM?

Marl crusts grow slowly, as mineral grains are gradually incorporated into them, often forming thin, consecutive layers. The way this happens is a bit like the way that dental plaque and tartar form on teeth. A biofilm of bacteria grows between teeth and along the gum-line. Saliva contains dissolved calcium phosphate, which solidifies onto this thin film of bacteria. More bacteria grow on top of this layer and the process is repeated. Other particles, such as fragments of food, get stuck in the plaque and incorporated into the growing layer. Before long (if you don't floss) you end up with a hard microbial crust (tartar) between your teeth.

In marl lakes, the water contains a different mineral - calcium carbonate. This also solidifies onto films of bacteria - in this case, the cyanobacteria. Because the cyanobacteria in the living crust community need light, they grow upwards, over this newly-incorporated material. As the structure grows, other particles that may be washing around in the water, such as sand grains or pollen grains, get stuck in the growing crust and are eventually covered over by the accumulating layers of cyanobacteria and calcium carbonate.

IN SOME MARL CRUST, LAYERS CAN BE CLEARLY SEEN

Of course, a marl crust can't keep growing forever. Because cyanobacteria can't live at the base of a thick crust, due to the lack of light, the mineral material there is crumbly and soft, and not tightly attached to the rock underneath. Thick crusts can therefore be dislodged and removed by waves. If this happens, the process starts again, and a new crust begins to form. Sometimes crusts grow on things other than rocks. In Lough Carra, I have seen small crusts growing on old pieces of reeds, and even on an old car tyre.

## WHERE ELSE ARE MARL CRUSTS FOUND?

Lough Carra is unusual in having such a large area of marl crusts, but they can also be found in some other Irish lakes. Some parts of Lough Corrib have similar crusts, as do some of the Burren lakes such as Lough Bunny and Muckanagh Lough. Some limestone lakes in the midlands of Ireland, including Lough Owel and Lough Ennell, also have crusts. Marl crusts have been reported from a few lakes in Yorkshire, England, such as Malham Tarn, and from several lakes in North America. Some of the species of cyanobacteria reported from these lakes are the same or similar to those found in Irish crusts. However, no detailed comparisons have yet been done between Irish crusts and those from other areas.

MARL CRUSTS IN TWO LAKES IN CO. CLARE – LOUGH GEORGE (LEFT) AND MUCKANAGH LOUGH (RIGHT)

# WHAT CAN MARL CRUSTS TELL US ABOUT LOUGH CARRA?

Marl crusts are interesting to people who study cyanobacteria, but can they also tell us useful things about a lake? Can we find out something about the water quality or ecological quality of Lough Carra by examining these crusts?

Let's consider for a moment some of the problems that can affect lakes. Invasive species; nutrients leaking in from agriculture, septic tanks or sewage systems; peat or soil particles washing in, often from forestry or turf-cutting in the catchment; weed-killers or other chemicals entering the water: all of these can seriously affect the ecology of a lake. For marl lakes in Ireland, leaching of nutrients into lake waters is a particularly troublesome problem. This is because these lakes, including Lough Carra, are naturally very low in nutrients, and the creatures that live in them are adapted to that low-nutrient state.

When concentrations of nutrients, especially phosphorus and nitrogen, are increased in lake waters, several things start to happen. The water, which was previously clear and clean, becomes cloudy and greenish in colour. This is due to the proliferation of algal cells (phytoplankton) in the water. The rocks or marl along the shore also start to take on a green colour, again due to algal growth. Floating green scums appear in the water and are often washed up on the shore. Certain underwater plants die, whereas emergent plants such as reeds may spread into areas which before were open water. Some species of insects, including mayflies, go into decline and may eventually disappear. The fish populations are also affected, as some native fish species can no longer survive in these conditions. During my research, I examined marl crusts from many different limestone lakes around Ireland, ranging from very clean, low-nutrient lakes to lakes with quite serious nutrient-pollution. I was trying to find out how the crusts vary in these different conditions, and asking this question: what things do you need to measure in lake crusts to find out about the water quality and broader ecological state of a lake?

Eventually, I came up with three characteristics which were especially useful. The first was the amount of the green pigment chlorophyll contained in crusts. Second, the numbers of a particular kind of algal cells (chlorophytes) in crust samples. Finally, the percentage cover by crust in the sampling area. By measuring these three things, you can find out a surprising amount about a lake. As ecological quality gets worse, chlorophyll and chlorophyte numbers both increase, whereas percentage cover by marl crust goes down. We can summarise this by comparing the appearance of crusts in good, clean lakes and in nutrient-polluted lakes, as shown in the photographs on the next page.

Good lakes:

Plenty of pale or whitish marl crust, with large areas free of plants or visible algae

COOLOORTA LAKE

LOUGH BUNNY

Damaged lakes:

Marl crust becoming scarce & patchy, with visible algal scums

CULLAUNYHEEDA LAKE

LOUGH ARROW

So where does Lough Carra fit in? Interestingly, different parts of Lough Carra have quite different conditions. Some parts of the lake still appear quite good, with plenty of marl crusts, fairly low amounts of chlorophyll and quite low chlorophyte numbers. However, other parts of the lake are very different, with dark, cloudy water, a lot of green algal scums along the shore, and reeds spreading into areas that used to be open water. An area like this typically doesn't have a lot of marl crust, and any remaining crust has green algae growing over and through it, and a partial covering of aquatic mosses. The area near the mouth of Annie's River is a good example of this.

This means that changes are taking place in the ecology of Lough Carra at the moment. I did some experiments to find out more about this. First, I wanted to check experimentally that the changes happening in the marl crusts really are caused by extra nutrients.

Second, I wanted to see if this change can be measured in the lake over short time scales, for example over the course of a year. By growing crusts from Lough Carra in containers, with water of different nutrient concentrations, I was able to show that these changes are indeed caused by increased nutrients in the water.

CHANGES HAPPEN IN MARL CRUSTS WHEN NUTRIENTS IN WATER ARE INCREASED

I was also able to measure these changes happening within Lough Carra, by moving marl-encrusted stones between different areas of the lake. Crusts moved from the north basin of the lake down to the area near Annie's River changed in the same way, with amounts of chlorophyll and chlorophytes in crusts both increasing.

However, there was also some good news, which showed that this process is reversible. When stones, covered with green algae and mosses, were taken from the area near Annie's River to the north basin, there was a surprising recovery, with new crusts beginning to grow back, even within the course of one year.

So how could these findings help in achieving the aims of the Lough Carra Catchment Association, and any future conservation projects on the lake? We know now that marl crusts are sensitive to increased nutrients in lake water. We also know the particular changes that occur, how to measure them, and that such changes can be detected over short time scales.

WHEN WATER CONDITIONS ARE IMPROVED, MARL CRUSTS CAN RECOVER

A good way to put this knowledge to practical use would be to assign particular sampling locations within the lake, and to monitor the marl crusts at these locations on an ongoing basis, in order to recognise any changes or long-term trends. This would be useful in two ways. First, any further deterioration could be measured and tracked, so that problems in particular areas could be identified. Second, if any changes are made in land-use or land-management within the catchment for conservation purposes, the success of these efforts could be recognised and measured. This would be important for an ongoing improvement project, in order to see if any changes being made are working successfully.

Finally, it is important to emphasise how special Lough Carra is, and the rarity of its habitats, biodiversity and beauty. Lough Carra is clearly important to many people, none more so than those who live around its shores and in its catchment, and who drink its water. It is for these people in particular, for their children and the future generations, that Lough Carra should be preserved and treasured.

## Scientific Publications

Doddy, P., Roden, C.M. & Gammell, M.P. (2019) Microbialite crusts in Irish limestone lakes reflect lake nutrient status. *Biology and Environment: Proceedings of the Royal Irish Academy* Vol. 119, No. 1, 1–11.

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Roden, C. & P. Murphy. (2013) A survey of the benthic macrophytes of three hard-water lakes: Lough Bunny, Lough Carra and Lough Owel. Irish Wildlife Manuals, No. 70. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Ireland.

Nelson, B., O'Connor, Á, Foster, G.N., Doddy, P. and Roden, C. (2019). A review of *Ochthebius nilssoni* Hebauer (Coleoptera: Hydraenidae) in western Ireland including a first report from Lough Carra, with comments on the water beetles of the lake. *Irish Naturalists' Journal*, 36, 2.

Kennedy, B., Buckley, Y. & Allott, N. (2019) Taxonomy, ecology and analysis of type material of some small *Encyonopsis* with description of new species in Ireland. *Phytotaxa* 395 (2), 89–128.

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Lough Carra Catchment Association

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