80 measured about half followed the synchrotron law, six per cent showed the expected fall-off, but as many as 30 per cent had a flux increase at decametric wavelengths. So far there is little explanation of this odd result, but one possibility is that the angular diameters of these sources at longer wavelengths are much larger than at short wavelengths.

FRESHWATER BIOLOGY

When Algae are a Nuisance

from our Botany Correspondent

THE unwelcome blooms of algae, which are becoming more prevalent on the surface of fresh water as human interference increases, were the subject of the Leeuwenhoek Lecture, delivered by Professor G. E. Fogg at the Royal Society on November 7. Talking about "The Physiology of an Algal Nuisance", he suggested how certain blue-green algae might become abundant enough to form the thick green coverings on lakes that have been on record in Britain since 1188.

Blooms are formed by a single species, or by mixtures of blue-green algae, including species of *Anabaena*, *Microcystis* and *Gleotrichia*. Some of these algae fix nitrogen in heterocysts—special cells with thicker walls and more uniform contents than the ordinary vegetative cells. But nitrogen fixation cannot be the principal reason for the abundance of the algae that form blooms, because they do not all possess heterocysts.

Another characteristic of these algae is that they are usually abundant in water with a high content of organic matter. It seems possible that these blue-green algae could assimilate organic matter in the same way that the green algae *Chlorella* and *Chlamydomonas* have been shown to use light energy to build up into cell material an already reduced source of carbon—as opposed to carbon dioxide which is the starting material for photosynthesis. The algae could make more efficient use of the available light for photoassimilation than for photosynthesis, and so would be able to thrive at a lower level in the water, where light intensity is less than at the top but where mineral nutrients are more abundant.

Most planktonic algae depend on the turbulence of the water and their small size to prevent them settling on the bottom, and there is very little turbulence in intermediate levels. But many planktonic blue-green algae have gas vacuoles in the protoplasm, which could be significant by regulating buoyancy. These vacuoles, previously thought to contain a gas produced in metabolism, now seem to be spaces formed in the protoplasm, which passively fill with gas. The suggestion is that if the algae sink in the water they produce gas vacuoles—now known to be produced most abundantly in low light intensities—and rise in the water. If the algae are too high in the water the gas vacuoles are diluted out, perhaps as a result of the increased growth induced by a higher light intensity, so that the size of the algae increases, but the number of gas vacuoles does not. Thus the algae sink to a lower level.

If this suggestion is correct, blooms might form if light intensity became high enough to inhibit growth, in which case the gas vacuoles would not be diluted out and the algae would remain at the surface, forming the well known dense scum.

GEOPHYSICS

Dating Submarine Rock

from our Geophysics Correspondent

THE sea floor spreading hypothesis lends itself to a conceptually simple test. If the sub-sedimentary oceanic layer has been drifting outwards from the mid-oceanic ridges for tens of millions of years, as analysis of the magnetic anomalies parallel to the ridges seems to indicate, the age of the layer should increase with distance from the ridges. Thus if well spaced samples from the layer were to be dated radiometrically, a direct confirmation or refutation of the hypothesis would be obtained.

Dalrymple and Moore (*Science*, **161**, 1132; 1968) have now shown that the dating of submarine basalts by the potassium-argon method poses problems which are absent in the application of the technique to continental rocks. Potassium-argon dating depends on the assumption that at the time of rock solidification all radiogenic argon-40, which is continuously generated by the decay of potassium-40, is removed—or in other words, that the "potassium-argon clock is reset to zero". In the case of continental basalts all radiogenic argon-40 is usually removed during the melting which produces the magma, while the magma is rising to the Earth's surface, or as the pressure is released at eruption. Independent evidence (for example, the presence of vesicles in the rock) suggests that the last process is important, if not the most important. If this be the case, it follows that any condition which impedes the release of pressure is likely to prevent the complete removal of radiogenic argon-40. Such a condition in the case of submarine basalts might be the hydrostatic pressure at oceanic depths.

In order to assess the reliability of submarine rocks for dating purposes, Dalrymple and Moore have measured the argon-40 contents (from which "apparent ages" can be deduced) of a set of submarine pillow basalts off the island of Hawaii. Ranging in depth from 550 metres to 5,000 metres, the pillows in question were produced by the Kilauea volcano, the only United States volcano currently active. From geological evidence, they were known to be, at most, a few thousand years old, and so they should have contained no detectable radiogenic argon-40.

Analysis of the outer glassy crusts of the pillows, however, did indicate the presence of excess argon-40 for samples at depths greater than 1,400 metres. Thus although these samples were but a few thousand years old, their apparent ages ranged from 4.3 ± 1.6 million years to 42.9 ± 4.2 million years (errors represent analytical precision at 95 per cent confidence level). Samples from a depth of 550 metres showed barely detectable argon-40 although, because shallower samples were not available, it proved impossible to determine the precise level at which hydrostatic pressure becomes important. Furthermore, a sample from 2,590 metres, examined in detail, indicated younger apparent ages with distance from the outer rim. This shows that a second factor in the retention of argon-40 is the rate of cooling. Towards the centre of the pillow where the rate of cooling is lower than at the quenched rim, argon retention is lower and the apparent age closer to the true age.

The important conclusion to be drawn from all this