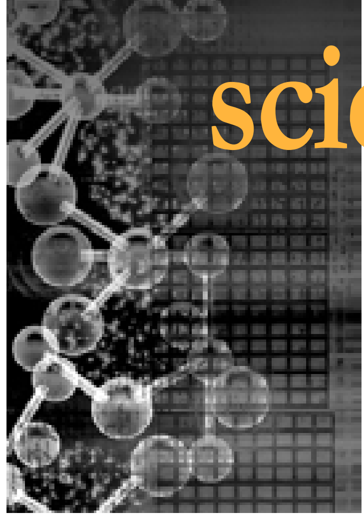
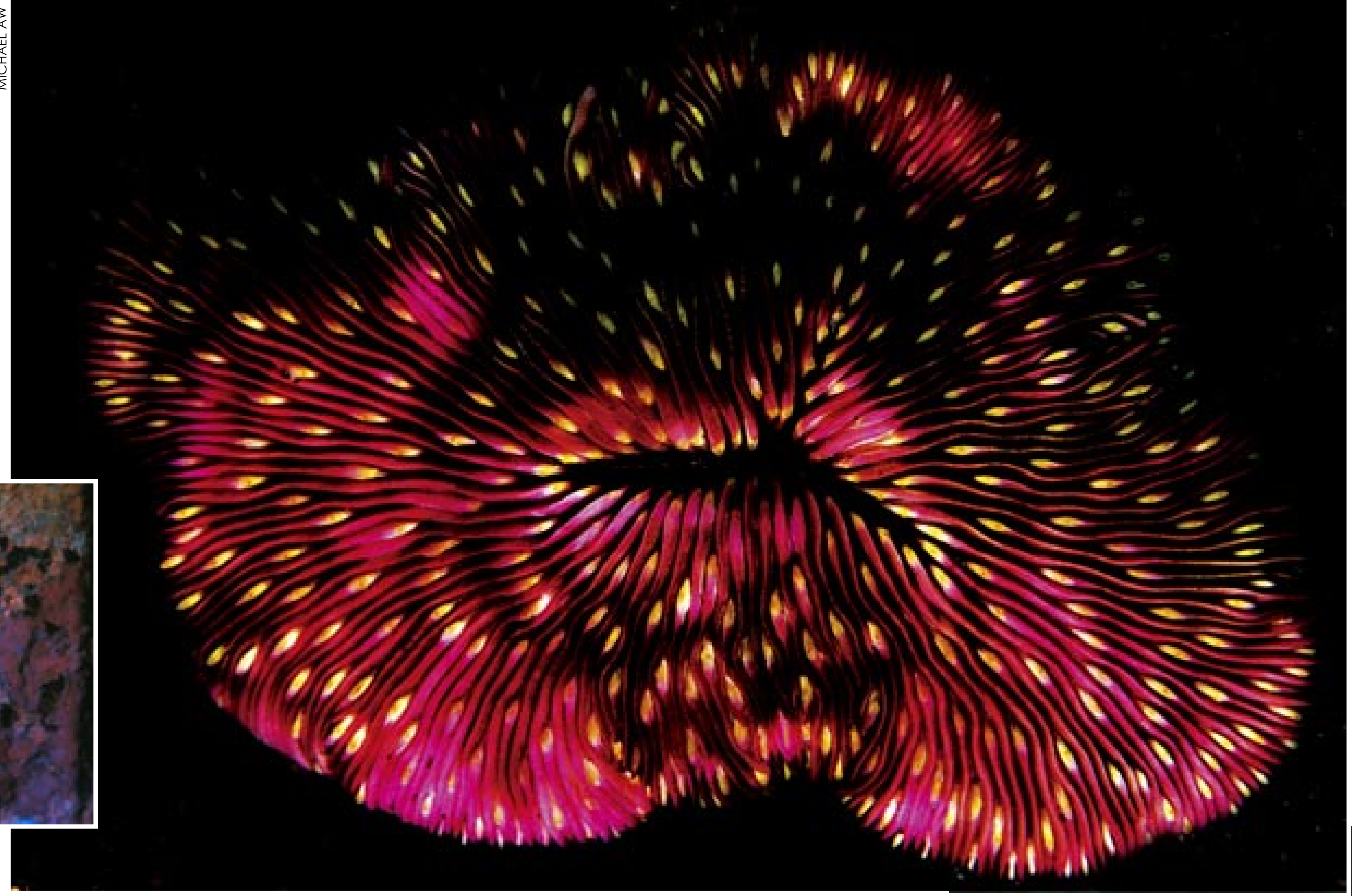


The Attraction of Fluoresent Corals

By Michael Symes
Photos by Charles Maze
and Michael Aw

MICHAEL AW



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A Chiton. Fluorescing isn't restricted to corals

How the corals get their algae

In the previous issue of X-ray Mag the problem of coral bleaching was discussed. Mechanisms were described which might provide resistance and protection to increased temperature and light intensities. It was stated that, due to rising sea-temperatures, the symbiotic algae that help supply nutrients to the polyps of the corals were dying off. These algae, known as Zooxanthellae, are thus vital for the existence of the coral polyps and as a consequence for the life of the reefs. But where do the algae come from, and how do the corals obtain them? Before answering this question, we must first look at what these algae are.

The Zooxanthellae

Zooxanthellae are best known for their role in the life of reef-forming corals. In tropical waters almost all coral animals contain a colony of zooxanthellae. Without these symbiotic plants, the coral animals would be unable to obtain enough nutrients to build their calcium carbonate skeletons, which accumulate to form the vast coral reefs of the tropics. Photosynthesis produces sugars essential for the plants to grow, however with the zooxanthellae enough sugar is produced to allow some to be shared with their hosts. In return, the host will assist the growth of the zooxanthellae by passing on some of its dissolved organic waste. The host animal cannot usually survive if the zooxanthellae are not present.

Acquisition of zooxanthellae

The host animals do not have any zooxanthellae in their larval forms and therefore must acquire them from the water column. Once a few zooxanthellae enter the body of their host animal they are able to quickly build up their population by splitting in half. This is their normal means of reproduction. The juvenile host filters the zooxanthellae from the seawater along with its food, and once in the stomach of the host, the zooxanthellae is passed into the surface flesh. Zooxanthellae multiply within the host due to simple cell division. Some nudibranch species get their zooxanthellae by eating cnidarians in which the zooxanthellae are already living, but how some obtain them is still a mystery.

Reaching the polyps

If they acquire them from the water column, then the algae must be present in the water close to the polyps. Now, although there are so many algae available, the sea is big; so what brings them close to the polyps in the coral reefs? Recent research makes the interesting suggestion that it is the corals themselves that signal their presence to the algae by attracting them by fluorescence.

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Coral animals and other related cnidarians (corals, soft-corals, sea anemones, gorgonians etc) are the most well-known animals containing symbiotic zooxanthellae, but they are also found in other invertebrates such as the Giant Clams (Tridacna) and many nudibranchs. Just as in their free-living relatives, zooxanthellae need to live in the sunlight, so they are usually found in those parts of animals, such as the skin, which are in the sunlight.

Zooxanthellae are thus any of various primitive, chiefly aquatic, one- or multi-celled, nonflowering plants that lack true stems, roots, and leaves, but usually contain chlorophyll. Algae convert carbon dioxide and inorganic nutrients, such as nitrogen and phosphorus, into organic matter through photosynthesis and form the basis of the marine food chain.

Zooxanthellae are thus single-celled plants that live in the tissues of animals, and are a group of microscopic plants which are usually found swimming and floating in the sea. They are dinoflagellates, which means that they have two long, thread-like arms, or flagella, used by many microscopic organisms for locomotion and feeding. Organisms which live like this are called plankton, and those that are plants are called phytoplankton. Like most plants, phytoplankton are able to convert the sun's energy into food through a process called photosythesis, so to survive they are only found in the upper layers of the sea and lakes where sunlight can penetrate.

Many nudibranchs with symbiotic algae have greatly modified the shape of their bodies to provide as many sunlit regions as possible for their 'guest workers' to photosynthesise. ■

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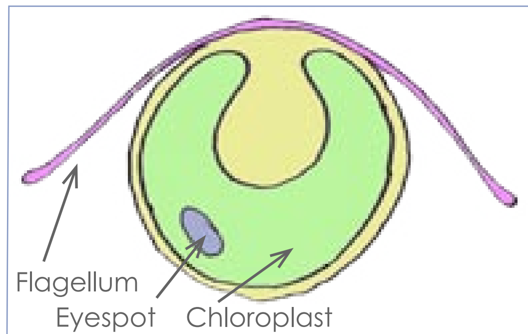
Bristleworm under normal light (far left) and (above) flourescing under specially filtered light

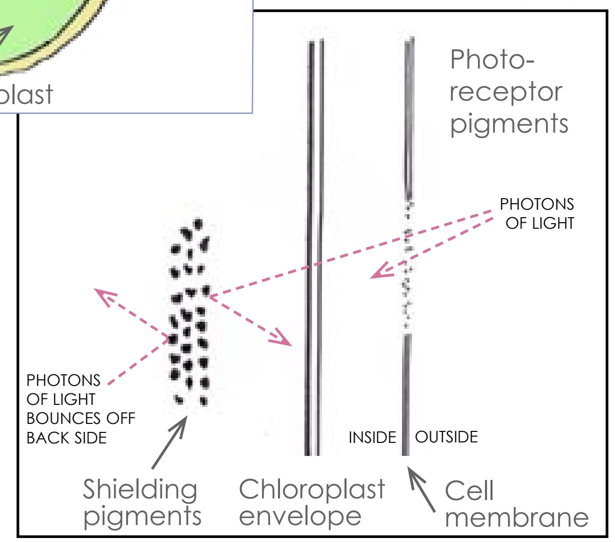
Fluorescent light

Fluorescence is the name for the absorption of light at one wavelength and its re-emission at another wavelength. The wavelength of maximum emission is generally longer than the wavelength of maximum absorbtion. This means for corals that fluoresce green light, which has wavelengths of about 550 nm, they must be absorbing light in the UV-blue region of the electromagnetic spectrum i.e. from about 350 nm to 450 nm. To produce this fluorescent light there are special pigments present in the polyps.



Schematic representation of a Chlamydomonas cell

Schematic representation of the eye spot



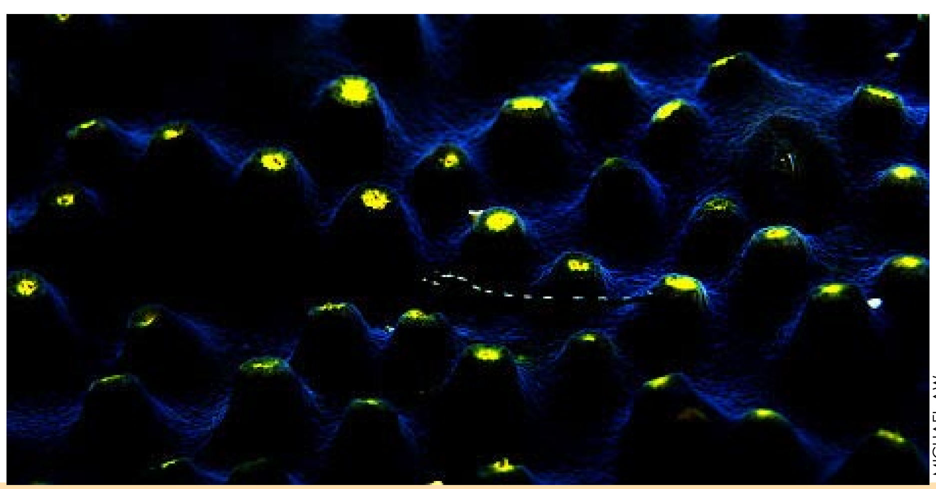
Green fluorescence

A short note in a recent issue of the scientific journal Coral Reefs proposes an interesting new idea for the function of green fluorescence in corals - that it may act in coral larvae as a beacon to attract symbionts. Evidence suggests that the microscopic algae that are symbiotic with corals are attracted to green light. The green fluorescence develops early in some coral larvae, and the note suggests that the green glow could help draw algae to the larvae to initiate the symbiotic relationship.

Now, the main questions here is, how are the algae stimulated to move towards this source of light? For we must remember, these are plants and not animals.

Attraction to light

The algae have an eyespot. This is a swelled area attached to a flagellum that contains pigment. The pigment proteins respond to the presence of light and signal the flagella to move toward it. This movement under the stimulus of light is called phototaxis.



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Phototaxis

This is a very complex phenomenon which is still subject to much research. However, it can be simply described in a phenomenological way using the algae Chlamydomonas as an example. (See diagram.) The cell is about 10 mm in diameter, the eyespot is about 1 mm, and the flagella about 10 mm long. The photoreceptor pigment is localised in the cell's outer plasma membrane. When the photoreceptor pigment is stimulated, it sends an electrical signal to the transponder cells in the flagella. This stimulates the flagella to vibrate and make the algae to move or "swim" through the water. However, the dense pigment layer in the eyespot shields the photoreceptor pigment from light coming from one direction to the other. This causes the flagella to move differently, so that the swimming, rotating algae can continuously sample the spatial distribution of light. Thus, as the cell swims with its two flagella, it also rotates around the axis along which it is advancing. The algae swim towards the source of light. The energy required for this movement is supplied by photosynthesis.

For more information on filters and lights for photography, visit **www.Nightsea.com** ■

Litterature

O.A. Sineshchenkov and E.g.Govorunova, Lomonosov Moscow State University: "Rhodopsin Receptors of Phototaxis in Green Flagellate Algae"

Hollingsworth, L. L., R. A. Kinzie, T. D. Lewis, D. A. Krupp, and J. C. Leong, 2005. Phototaxis of motile zooxanthellae to green light may facilitate symbiont capture by coral larvae. Coral Reefs, 24:523.