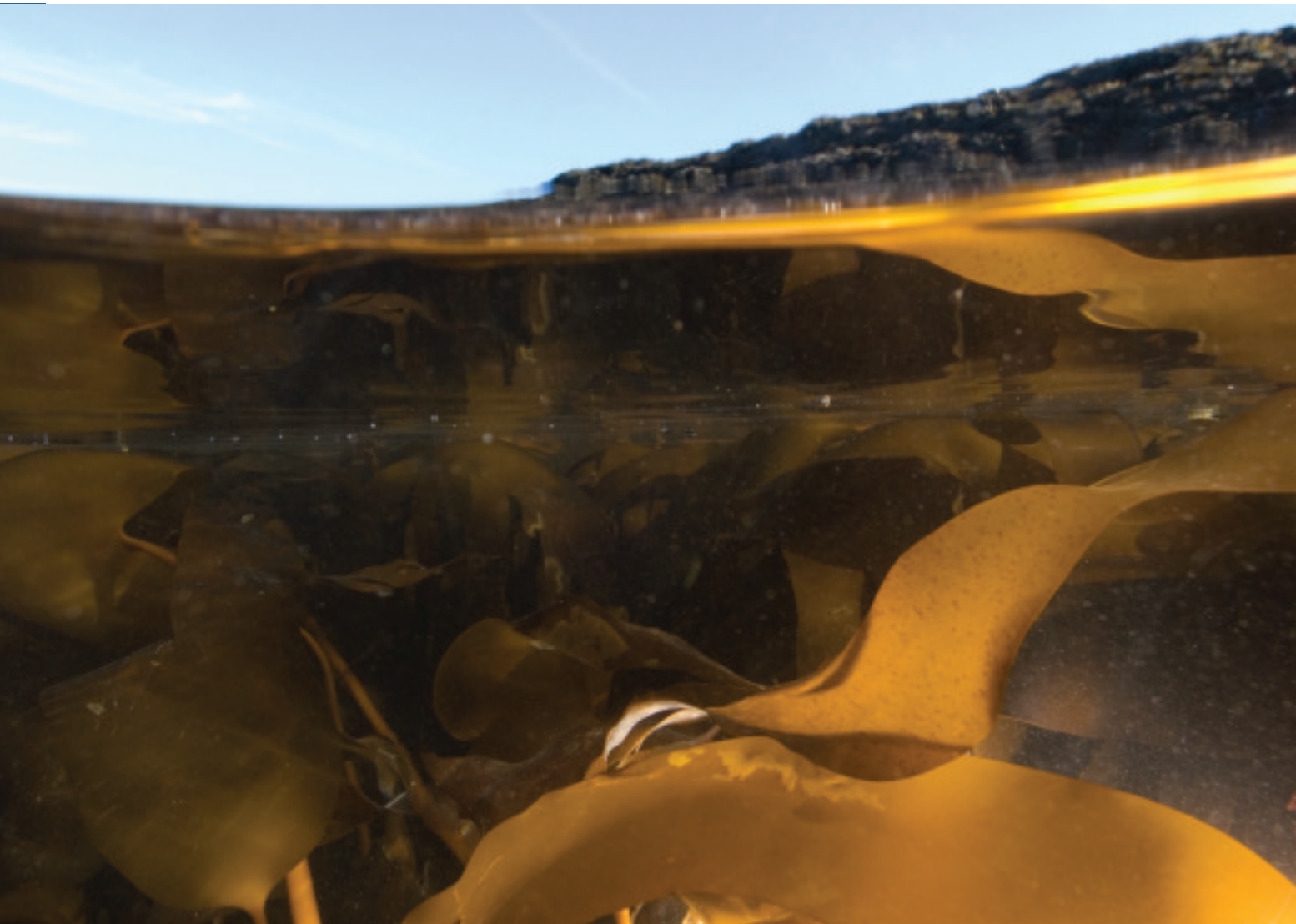
Kelp is at hand

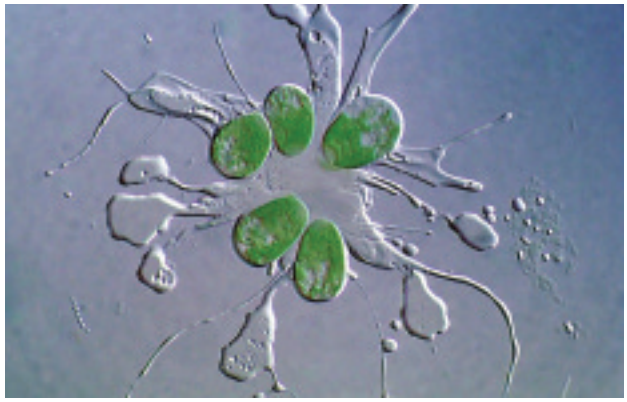
Laila Sadler introduces third generation biofuels - seaweed

As governments strive to reduce carbon emissions and find viable alternatives to fossil fuels, the search is on for sustainable sources of biofuel. First generation biofuels have raised concerns over food security and biodiversity loss as they demand fertile land. Produced from agricultural crops such as maize, sugar cane and rapeseed, the end products (bioethanol and biodiesel) often require intense cultivation and the use of irrigation and chemicals. Though second generation biofuels show promise, they are generally manufactured from fibrous plant materials and require extensive processing to extract useful sugars. It has been suggested that, with processing and transport costs factored in, neither first nor second generation biofuels are actually carbon neutral. Welcome to the third generation.

The oceans cover 70 per cent of the planet and are often more efficient at removing carbon from the atmosphere and utilising sunlight energy than terrestrial systems. They offer vast regions for mass cultivation of biomass, with little competition for space, yet they are relatively underutilised. In addition, temperate seas naturally produce vast quantities of a product rich in biofuel substrate: seaweeds. These marine plants (algae) grow far more rapidly than terrestrial plants and some,



Seaweed under water landscape. (*Photo: Scottish Association for Marine Science*)



ABOVE LEFT: Chinese fishermen seaweed barge. (*Photo: Scottish Association for Marine Science, M. Kelly*)

ABOVE: Microalga producing oil. (*Photo: G.W. Beakes Univ Newcastle*)

for example the large kelps, are among the most productive plants on earth. As they are supported by water, seaweeds do not require the tough, fibrous support structures characteristic of land plants. This makes the carbohydrate fuel locked inside them readily accessible for processing during fermentation (to fuel alcohol) or during anaerobic digestion (to biogas).

Naturally

There is a second potential fuel source from algae: biodiesel. Many single celled plants, invisible to the naked eye but responsible for green blooms in ponds, lakes and the ocean, naturally produce oils. They are far more efficient at converting the sun's energy to biomass than terrestrial plants, and the biodiesel produced from their oils has several advantages: it contains no sulphur, is non-toxic and is highly biodegradable as well as retaining fluidity at low temperatures. It is also readily blended with mineral-derived diesel, unlike dirtier oils derived from agricultural and forestry crops or wastes such as wood chippings and straw.

However, while there is evidence that large-scale biofuel production from algae is technically possible, investigation is needed to identify the most productive algae and to optimise their growth conditions. Only then can algal biofuel be produced on a commercial scale and brought to market.

Over the past few years scientists at the Scottish Association for Marine Science have been investigating the potential of the marine environment to provide energy. With the BioMara project, awarded €6 million by the EU's INTERREG IVA programme, the Scottish, Irish and Northern Irish Governments and the Crown Estate aims to investigate the potential of marine biomass to produce sustainable biofuels. It kicked off in 2009, within months of the EU's Renewable Energy Directive (2009/28/EC) coming into force, with a requirement that, by 2020, 20 per cent of Member States' energy consumption, and 10 per cent of transport fuel, is from renewable sources.

BioMara is a joint UK/Irish research project investigating the feasibility and viability of producing third generation biofuels from marine biomass. Researchers from the Scottish Association for Marine Science; the University of Strathclyde; the University of Ulster; Queen's University, Belfast; the Dundalk Institute of Technology; and the Institute of Technology, Sligo, are investigating the potential use of seaweeds and single-celled algae as alternatives to terrestrial agri-fuel production, putting in place the science to underpin a potential new algal biofuel industry.

There are a number of scientific questions that need to be addressed. Can seaweed fuel crops be grown on an economic scale without damaging the marine environment? Can micro organism help accelerate seaweed fermentation (to yield fuel alcohols)? Can single-celled plants be found that naturally produce higher oil yields than are currently achieved by commercial cultivation? Will these algae produce economically viable outputs of oils suited to conversion to biodiesel? Whilst the biological research will be conducted in Scotland, BioMara partners in Ireland and Northern Ireland will focus on anaerobic digestion and fermentation technologies to optimise the production of biogas and alcohols from the algae. Process control, engineering needs and the supply chain will also be considered.

Methods

The aims of the four-year BioMara project are ambitious: to identify efficient, sustainable, environmentally friendly and cost-effective methods for generating transport fuels and biogas for heating; and to engage closely with the wider community. Platform technologies are already well established. BioMara aims to bring these together in coherent, commercially relevant packages for stakeholder exploitation. Still in its first year, the project is establishing a stakeholder group to ensure wide applicability of the outputs, and to facilitate their dissemination. ■

www.biomara.org