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THE PSSA

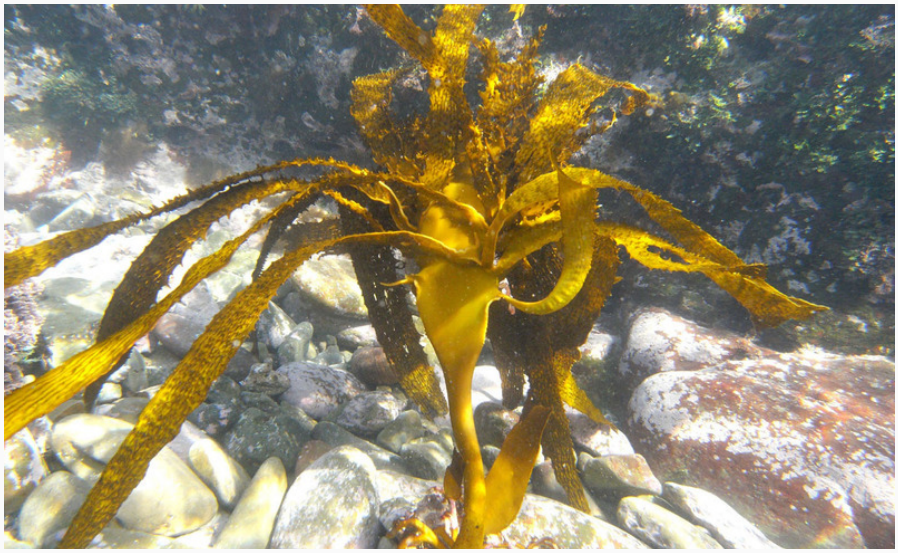
Newsletter series

From the editor

It is with much enthusiasm that I compile this 85th volume of the PSSA newsletter series. The variety of articles is a reflection of the true diversity of the phycological research happening in South Africa. Read more about recent discoveries (pg. 02), international research visits and local conferences (pg. 05, 09, 06), and ground-breaking innovations (pg. 03, 05).

During a recent research visit to the CCMAR in Portugal, my attention was brought to a global initiative to document marine algal diversity, www.marineforests.com. After noticing a serious lack of seaweed records from South Africa (SA), and Africa at large, I was easily persuaded into being the regional co-coordinator for SA. Find out more about how you can contribute to this initiative and put South African seaweeds on the map (pg. 09).

Maggie Reddy



http://southafrseaweeds.uct.ac.za/descriptions/brown/ecklonia_radiata.php

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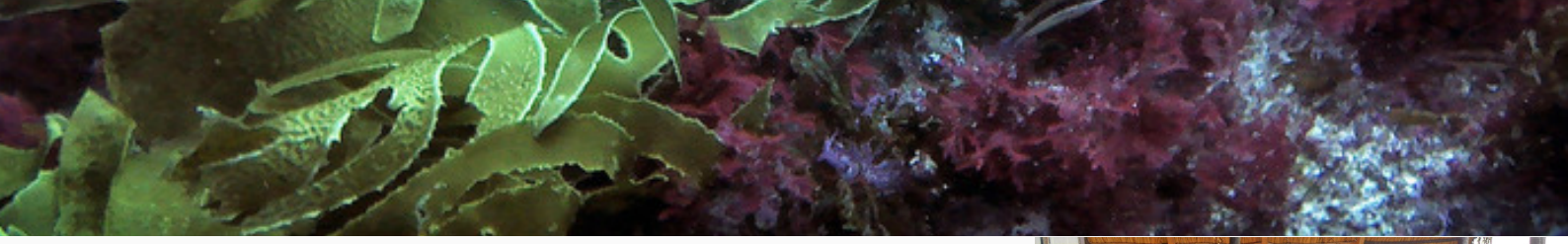
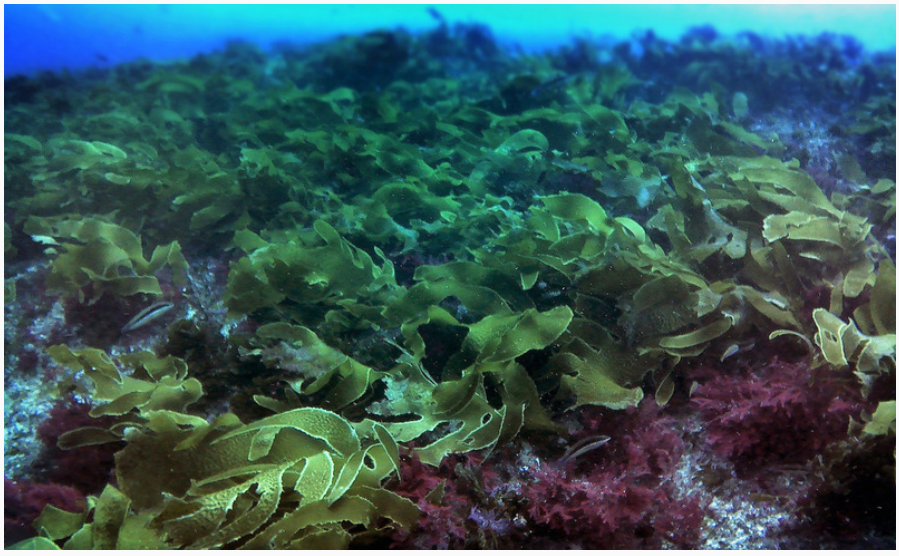


Exploring marine biodiversity in southern Mozambique

BY FREDERIK LELIAERT & OLIVIER DE CLERCK

From the Meise Botanic Garden, Belgium and Ghent University, Belgium

In April 2018, a team of researchers from Belgium and Mozambique set out to southern Mozambique to explore the marine biodiversity in the region, and to train Mozambican students in collecting, identifying and preserving marine organisms.



Extensive kelp beds (Ecklonia radiata) at 34 m depth, off the coast of Zavora, Mozambique (photo: Frederik Leliaert)

The expedition focussed on two neglected taxonomic groups: marine macroalgae and echinoderms. Extensive collections were made in intertidal and subtidal habitats. Identifications are still ongoing, but a first estimation reveals that our samples hold more than 200 species of macroalgae, including many new records for Mozambique, and several new species to science.

A remarkable finding was the discovery of abundant kelp in deep waters. Kelp forests abound in cold, nutrient-rich waters, but they are generally absent in the tropics. The discovered kelp beds also contained several other seaweed species that are only known from cooler waters of South Africa. It is to be expected that southern Mozambique includes other unexplored marine ecosystems, which are likely critically endangered by climate change.

Training Mozambican students in identifying and preserving seaweed collections (photo: Frederik Leliaert)

Sampling of subtidal seaweeds by SCUBA diving (photo: Frederik Leliaert)

The production of bio-energy from a consortium of algal species-Proof of concept trials at the rural Brandwacht domestic waste water treatment plant, South Africa

BY PAUL OBERHOLSTER AND MARONEL STEYN

CSIR Natural Resources Enabling Infrastructure Public and professional Services, Stellenbosch, South Africa

With increased environmental pollution from untreated or partially treated wastewater and resultant eutrophication, there is an increased need for remediation. It is foreseen that treatment of wastewater will form part of the production of goods in the near future. Phycoremediation makes use of macroalgae or microalgae and could be used to treat wastewater. This technique has the potential to be used as an alternative biomass source for bio-energy production. The usefulness of biological wastewater treatment by microalgae coupled with biofuel production, is even more attractive as a result of an increase in global warming, depletion of fossil fuels and the need to manage greenhouse gases. The current study utilizes a specific consortium of algal species (isolated and cultured in the laboratory) to reduce nutrients and create conditions suitable for reduction of E. coli in wastewater as well as the determination of algae biomass for bio-energy production.

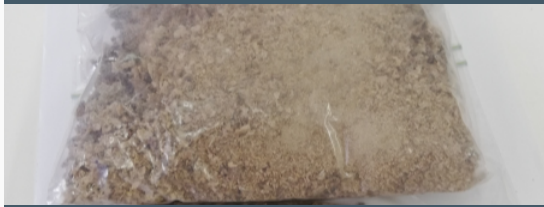
Picture above: After dosing the ponds with the microalgae

Picture to the left: Algae bioreactors at Brandwacht wastewater treatment works

The aim was firstly to implement a self-sustaining system that is independent of electricity or expensive chemicals and that can be effectively operated within the current financial and capacity constraints of SADC countries using existing infrastructure i.e. waste stabilisation pond systems. Secondly, it was to establish the feasibility of algae biomass generated from maturation ponds as bio-energy. Although the low cost green technology for wastewater treatment has already been rolled out with great success in the Limpopo and the Western Cape Provinces, little is known about the feasibility of the algae biomass generated from the system as potential bio-energy source.

Small-scale pilot algae drying system

Under auspices of the African Development Bank's Africa Climate Technology Centre (ACTC), the research team recently started a small scale pilot plant for the drying of algae biomass under natural climate conditions at the rural Brandwacht domestic waste water treatment plant, 30 km from Mossel Bay. The next step will be to determine the algae biomass that can be generated for bio-energy using a specific consortium of algae under natural drying conditions. If enough algae biomass is generated, the team will explore the possibility of using this algae biomass to generate bio-energy for the small rural town of Brandwacht.



Small-scale pilot algae drying system

Epizoic diatoms in zoological collections – what do they tell us about their hosts?

BY ROKSANA MAJEWSKA

From North-West University, South Africa

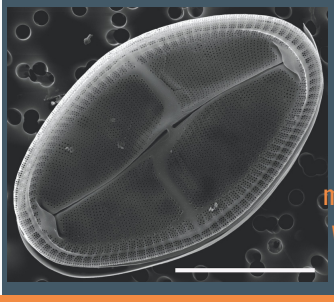
Diatoms, unicellular microalgae enclosed in porous, richly ornamented silica shells, colonize almost all hard-surfaced objects and structures immersed or floating within the photic zone, including aquatic animals. Several studies focused on diatoms growing on marine mammals, reptiles, and seabirds and discoveries made over the decades suggest that epizoic diatoms constitute a common, ancient, and presumably important element of these vertebrates' microbiome. Thus, studying epizoic microbes may complement our knowledge about the host animal biology and evolution, and epizoic diatoms may be used as indicators of, for instance, individual animal health, migration routes, or other behavioural patterns.

Samples taken from the animal museum specimens are ready for sonication that will allow extraction of the epizoic diatoms (photo: Volker Beinhorn, Übersee-Museum)

The museum zoological collections of aquatic animals, both vertebrates and invertebrates, provide a valuable and largely overlooked source of epizoic diatom samples. These specimens can contribute to our understanding of epibiotic and surface-associated diatom dispersal and colonization abilities, their diversity, biogeography, and evolution minimizing the cost, effort, and any possible negative impact of a similarly extensive study involving fieldwork and living animals.

Dr Roksana Majewska (North-West University) holding a Steller's sea cow skin sample (photo: Volker Beinhorn, Übersee-Museum)

The Übersee-Museum in Bremen (Germany) hosts highly unique samples of what is thought to be the skin of the extinct sirenian, Steller's sea cow (Hydrodamalis gigas). The specimens are likely the only such samples in the world, however, their identity has not yet been confirmed. Since modern sirenian species host distinct diatom flora, not found on any other animal or abiotic substratum, it is likely that any diatoms found on the two museum specimens would allow to unambiguously assess the identity of the host animal the samples were taken from.



Scanning electron microscopy image of epizoic diatom Bennettella sp. extracted from the museum specimen of a whale skin (image: R. Majewska, NWU)

Diatoms as an 'early warning' monitoring tool for surface and groundwater contamination: towards a water baseline for the Karoo

BY MARION HOLMES

From Nelson Mandela University, South Africa

As a part time PhD student living in the Karoo, I am testing a novel early warning monitoring tool for surface and groundwater contamination using diatoms. Inhabitants of the towns, farmers and animals in the karoo, are almost totally reliant on underground water for their survival. On farms, the underground water is often pumped into an uncovered storage reservoir before being used. These reservoirs are home to many different types of algae, including diatoms.

View of reservoir with ballvalves (attachment devices for the suspended unglazed ceramic tiles)

This study will determine the qualitative and quantitative data for the diatom community composition. The data will then be compared to physio-chemical analysis of the borehole water (samples taken simultaneously). A diatom baseline must be determined prior to commencement of fracking or prospecting. Once the baseline for each water body is determined, any changes could act as an early warning system for the farmer in the event of any kind of contamination. Field work was conducted in the Eastern Karoo from October 2015 to December 2017. Around 16000 km, of mainly gravel roads, were driven! Sites were reduced to those where 3 samples were collected (one with an annual variation and one with a seasonal variation) for boreholes while fountain sites with 2 or 3 samples will be included.

Ballvalves with unglazed ceramic tiles with biofilm

Main research questions:

- Does the diatom community composition, found in farm reservoirs for storage of borehole water reflect the quality of the groundwater stored in that reservoir?
- If the answer to the above question is negative, can it then be suggested that the groundwater, once stored, becomes significantly contaminated?
- Can this diatom analysis be used as a 'reference state' for that particular borehole?
- Can diatom community composition show trajectories of change as contaminants enter the groundwater, specifically fracking fluids/contamination in mind.
- What recommendations can be made for biomonitoring of these types of reservoirs in South Africa?

Why South Africa should focus on Microalgal Biotechnology

BY JULANIE STAPELBERG

From the University of Pretoria, and CSIR, Pretoria, South Africa

Thick smog hangs over the town, the coal they burn for energy is slowly choking them. The plastic thrown from the cars, lays on the ground forever and the waste expelled ripples across the sea. Our planet is running out of resources, we all know the inevitable story, we have seen the apocalyptic movies where climate change and greed for resources turns the world into a barren wasteland. We all know we must act; but how? At the 2018 annual South African Genetics and Bioinformatics Society joint congress, my simple answer was microalgae.

Julanie Stapelberg stands alongside her poster presentation at the 2018 annual South African Genetics and Bioinformatics Society joint congress

"Microalgae", I enthusiastically announced, "are far more than that green stuff in your pool." Green microalgae are tiny, photosynthetic, predominantly aquatic organisms that may convert the sun's energy into biomass far better than what terrestrial plants do. Thus, the production of algae has the potential to transform things that we currently think of as liabilities, into valuable assets. Simply growing microalgae captures carbon from the atmosphere- reducing greenhouse gas emissions and treats wastewater by removing heavy metals and recycling nutrients. Microalgae use less water than crop plants and they can operate on land unfit for agriculture. Most importantly, the algal biomass generated, has an enormous commercial bonus.

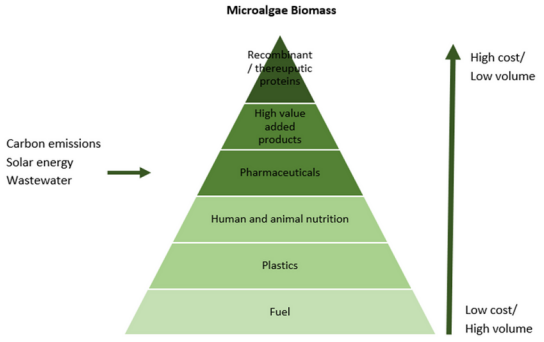


Figure 1: The input for microalgae biomass may produce a range of products which have an inverse relationship between the volume and cost of products produced. Adapted from "Introduction to Algae", Levine 2018

The inputs for algae are simple; with only carbon dioxide, sunlight, water, and some nutrients, microalgae may become a conversion engine with final output products from the biomass such as: recyclable plastics, beauty care products, biofuels, pharmaceuticals, high value-added products and a superfood for both humans and other animals. With its high protein, vitamin, antioxidant and mineral richness, microalgae are an inexpensive way to produce nutrient dense food. Microalgae Chlorella is already on the South African market incorporated into flour, milk, vegan eggs, ice-cream, smoothies and protein powders. The nature's protein smoothie from Kauai? Algae my friend!

However, these microalgae products differ in their monetary value and in a short diagram I explained how there exists an inverse relationship between the volume of that microalgae product that is going to be consumed and the cost of the product (Figure 1). That means the larger the volume the lower the cost. Fuels are by far the largest commodity on this planet. We burn about 4.5 trillion litres of petroleum every year. In South Africa we all dread hitting an empty gas tank and filling up at R 16 a litre, but microalgae biofuels falls into the high volume, low cost margin. On the other end of the spectrum are very low volume, very high cost products such as beneficial recombinant proteins, which can sell for millions of dollars per kilogram. In fact- today the algae market is worth $ 14 billion dollars worldwide. "This is where we would obtain the greatest return on investment for microalgae research," I explain, with my Masters project focusing on the biotechnology potential of indigenous South African microalgae.

Julanie Stapelberg answers a few questions after her presentation

Scientific progress in microalgal biotechnology would offer a range of benefits to the socio-economy and have a big impact on our future South African society. I encourage experts across disciplines: phycology, genetics, bioinformatics, environmental science, product development and engineering to collaborate for the establishment and innovation of microalgae products. Furthermore, as South Africans we should all work together, promoting the use of microalgae.

South Africa boasts one of the most bio-diverse regions globally, with tremendous species richness in our eco-systems. Many unidentified microalgae exist in our freshwaters with potential for species to surpass the industrial microalgae biotechnology potential, cultivation and recombinant protein production of current commercial microalgae.

The climatic condition within South Africa is also the perfect microalgae growth environment that many countries are trying to simulate. The benefits of microalgae have been realised since the 1980's in countries such as the United Kingdom, America and China but the environmental conditions in these countries are not ideal for growing algae. For example, in the Czech Republic their raceway ponds have run over 25 years. Over this period, they realised during the sunny summer months the temperatures allow for high yields, which drops completely in the harsh winter months. In contrast South Africa has prime environmental conditions, with more stable temperatures and consistent sun exposure, allowing for algae production all year round.

South Africa has great potential, it is essential that we start investing in Microalgal Biotechnology research so that we may deliver tangible sustainable products as solutions to society's largest challenges of resource depletion, food, fuel and water security as well as climate change. The long-term reward will be invaluable to our society and the global community at large.

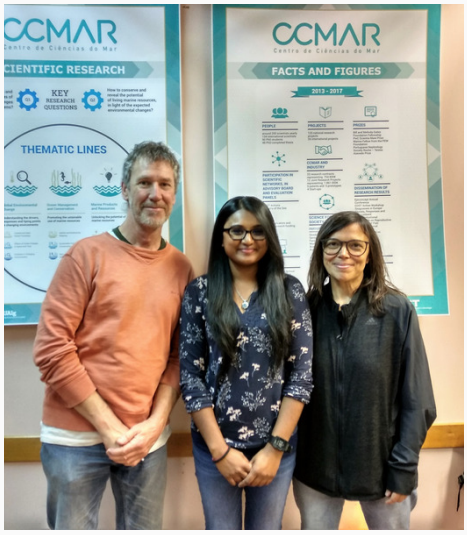
Gene flow in South African kelps

BY MAGGIE M. REDDY

From the University of Cape Town, South Africa

http://southafrseaweeds.uct.ac.za/descriptions/brown/ecklonia_radiata.php

Kelp forests are some of the most productive habitats in the ocean, supporting diverse and ecologically or commercially important ecosystems. Unfortunately, many kelp forests are increasingly under pressure from global climate change, and many others are affected by these changes in some way or the other. A global analysis showed contrary responses in kelp forests to climate change in different parts of the world. In South Africa, kelp forests ecosystems are thriving and a range extension has been document in at least one endemic species, Ecklonia maxima. However, elsewhere in the world, such as in southern Portugal, kelp populations are declining and their ranges are contracting.



Gareth Pearson, Maggie Reddy and Ester Serrao at the CCMAR after a seminar by Maggie Reddy

Along the coastline of South Africa, four species of kelp occur in the nearshore and offshore environments. Two habitat-forming and endemic species, Ecklonia maxima and Laminaria pallida dominate the temperate western coastline, and co-exist along isolated populations of the non-endemic Macrocystis pyrifera.

Along the warmer temperate south coast, Ecklonia radiata populations occur inshore, with isolated, deeper offshore populations presumably extending northwards into Mozambique (see pg. 02). Gene flow patterns in all but one species of kelp occurring in South Africa are largely unknown, and could explain the unusual positive response (biomass increase and range extensions) in our kelp forests to climate change. A recent collaboration between the Biogeographical Ecology and Evolution (BBE) group at the Centro de Ciências do Mar (CCMAR) and the phycology group at the University of Cape Town (UCT) was formed as part of an EU project— GeneKelp, to study patterns of gene flow in South African kelp species.

Maggie Reddy standing outside the CCMAR building at Ualg

In March 2019, I was fortunate to visit Portugal as part of this collaboration and work with the dynamic BEE research team lead by Marine Pew fellow and world-renowned phycologist Prof. Ester Serrao. The CCMAR is based at the University of the Algarve (Ualg), in Faro, the capital city of the picturesque Algarve. My research visit was intended to enhance capacity building and skills development. During my visit I was involved in barcoding South African kelps, developing skills in generating and analysing microsatellite data and gaining new insight into oceanographic modelling and it's application in disentangling complex genetic patterns. Much work remains for this project, but a preliminary assessment suggests some interesting results. I will report back on the exciting developments of gene flow in South African kelps in the next newsletter or PSSA conference.

Marineforests.com: A Citizen Science Project

BY NUNO PADRÃO, DIOGO PAULO, JORGE ASSIS, AND ESTER A. SERRÃO

From the Centro de Ciências do Mar, Universidade do Algarve, Portugal

Marine "structuring" species modify habitat as they colonize new areas like coral reefs, seagrass beds, mangroves, and seaweed communities. Among these ecosystem builders are populations of seaweeds and seagrasses that can be broadly designated as "marine forests." Marine forests are of biological, economical, and ecological importance. They offer a number of ecosystem services, including:

Scientific divers monitor a seagrass restoration project

1. Increasing biodiversity by providing shelter, nursery, and feeding areas for many species.
2. Increasing shoreline protection by retaining sediment (decreasing coastline erosion), attenuating currents and waves, and creating job opportunities in areas such as ecotourism.
3. Producing oxygen and retaining atmospheric carbon, as well as improving water quality.

Marine forests are declining in many regions of the world. In addition, some have seen their distributional ranges shifting to different depths or to different coastlines. Much of this loss stems from human activities, from local changes in water and substrate quality to global climatic changes.

Given the ecological significance of these habitats, why not join scientists in their effort to protect them? Citizen science is a crucial component in the development of an informed and proactive society. It raises public awareness and leverages scientific efforts.

The project marineforests.com aims to connect citizens and scientists with the common goal of determining seaweed and seagrass species distribution around the globe. Volunteer reports of marine forests around the globe will provide information to scientists, managers, conservation biologists, divers, naturalists and the general public about where these species exist over time and space. This information can then be used in research areas as diverse as marine ecology, evolution, physiology, genetics, or conservation biology.

Contributing to the project is simple. Volunteers can create a profile on the website www.marineforests.com. Once logged in, go to "Add Reports" in the upper menu. A small box will open in which a user can upload a photo of the observed seagrass or seaweed species and designate where the data were collected on the provided world map. If a volunteer can identify the species, either by the common or scientific name, the website allows a user to select the degree of confidence they have in their identification. A team of scientists will review all the species identified by the volunteers and identify undetermined species from the uploaded photos.

Join us in these initiatives and help us protect the marine forests!

Marineforests.com is funded by the Pew Charitable Trusts (Pew Marine Fellowships) and the MARFOR partnership.

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Take a picture, go to marineforests.com
and help these beautiful ecosystems.

Marine forests are disappearing due to ongoing climate change.
Help the conservation of marine biodiversity.

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