Forum Phycologicum

Newsletter of the

Phycological Society of Southern Africa

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At De Hoop, good sunsets are widely appreciated. (Photo: Gavin Maneveldt).

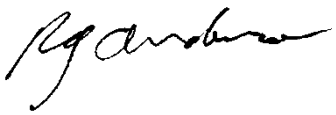
From the Editor

Longstanding members who were at our 30th Congress at De Hoop will, I am sure, agree that the attendance was probably a record for the PSSA. There were more than seventy at the meeting, including a large contingent of students. Our file photo of the inaugural PSSA meeting at Wits (in 1983) shows forty delegates, and successive meetings have generally attracted about that number, so seventy indicates a society that is doing very well! Back then there was no mention of biofuels, living stromatolites, and several other topics, so perhaps the Age of Algae is arriving!

My apologies for a very long newsletter, but it is customary for the volume following each congress to mainly serve as a record of that event, and many delegates meant many abstracts. More (but shorter) volumes will follow, so please use the newsletter to let us all know what you and your research groups are up to.

IMPORTANT NOTE: This newsletter was sent together with a BALLOT FORM for the election of new PSSA office-bearers, so please be sure to look at that, and to consider nominating candidates for the various offices that keep the PSSA running!

Yours in Phycological Endeavour,



Robert Anderson

Potjie evening at De Hoop

Prize-winners, 30th PSSA Congress, De Hoop 2017

Student posters

Guest speaker Andrzej Witkowski presented Donna Wosniak with first prize for her poster entitled

"The effects of different algal substrates on larval settlement, and the effects of algal feeds and temperature on the growth and survival of post-settled *Tripneustes gratilla* (Linnaeus, 1758) sea urchins".

Michael Fleischman received second prize from Andrezj Witkowski, for his poster entitled "Cultivating *Macrocystis pyrifera* (Laminariales) 'angustifolia' ecomorph for abalone feed, through holdfast fragmentation and vegetative propagation".

Etwarysing Lekraj won the Klaus Rotmann Memorial Award for the best presentation on applied seaweed research. The prize was presented by Adèle Geldenhuys of Taurus Chemicals (Cape Kelp) (Pty). Ltd., who sponsor this annual award. Lekraj's talk was entitled *" Ulva* phagostimulants for the sea urchin *Tripneustes gratilla"*.

Student oral presentations

Gavin Rishworth won first prize for his talk entitled "Microalgal dynamics associated with living stromatolites along the Eastern Cape coastline of South Africa"

Prizes for the orals were presented by guest speaker Thomas Wernberg (right).

Maggie Reddy won second prize of a Reef backpack for her talk entitled "A rosette by any other name: species diversity in the bladed Bangiales along the South African coast".

Third prize of a Reef cap went to Andrew Ndhlovu for his talk on "A red-tide forming dinoflagellate *Prorocentrum triestinum*: identification, phylogeny and environmental impacts in St Helena Bay, South Africa".

An impromptu "students' choice" prize was won by Gordon Dodge for his talk on "Phycoremediation of industrially generated heavy metal contaminated water streams". The prize included some student essentials like one-minute noodles, and was presented by PSSA President, AJ Smit.

30th PSSA Congress: Office-bearers' reports

President's Report

AJ Smit

This year's PSSA meeting, hosted by the Seaweed Unit (Department of Agriculture, Forestry and Fisheries) and the University of Cape Town, marked an important milestone in our Society's history. PSSA celebrated its 30th anniversary, and a large and diverse contingent of delegates – about 75 people from some 17 institutions, more delegates than we have ever had at one of our meetings – joined us at the De Hoop Nature Reserve from 12-17 January.

That the Society has continued to grow over the years shows that phycology as a research field has increased in breadth. Generally, this diversification of research has kept pace with international research trends.

Applied phycology

Prof. Sue Harrison's group at the Centre for Bioprocess Engineering Research (CeBER), situated in UCT's the Chemical Engineering Department, has in recent years provided stronger links with Industry. Studies by this group include "techno-economics" of biofuels produced from algae, anaerobic digestion of *Spirulina* and *Scenedesmus*, and reviews of commercial products from micro-and macroalgae. Dr. Thomas Dempster of the Arizona Center for Algae Technology and Innovation (AzCATI), the Algae Testbed Public-Private Partnership (ATP^3) provides a link with the international algal biotechnology community. In fact, this latter link has already resulted in some PSSA's members spending time at the facility in Arizona. In terms of algal metabolites, some collaborations between Profs. John

Bolton (UCT) and Denzil Beukes (UWC) are looking at the anticancer and antimicrobial properties of silver and gold nanoparticles synthesised in *Sargassum* aqueous extracts. At the UKZN, various people associated with Johannes van Staden's group, primarily Drs. Wendy Stirk and KRR Rengasamy, examine growth stimulants, phytohormones and other bioactive compounds from micro- and macroalgae. This year delegates from CSIR, with strong industrial interests, also attended our meeting. Clearly, algal biotechnology seems to be growing in South Africa.

Another avenue for applied phycology is aquaculture. Aquaculture research also links with Industry – historically this link was with the seaweed industry itself (i.e. algal biomass for phycocolloids and kelp extracts to stimulate agricultural/horticultural plant growth), then the abalone industry, but today there is also a developing interest around sea urchin cultivation. Aquaculture research started in the mid-1980s at the Seaweed Unit, but later UCT, NMMU (then University of Port Elizabeth) and the University of the Western Cape joined in the efforts. In most cases research focuses on developing technologies to boost algal production or to incorporate algae as nutritional additives to manufactured aquaculture foods. There have also been some studies into using seaweeds to remediate waste waters emanating from aquaculture systems. Today fewer people are working on seaweed aquaculture. Prof. John Bolton and his students are the major contributors to this field at present, but Dr. Deborah Robertson-Andersson (UKZN) and Prof. Gavin Maneveldt (UWC) also maintain a presence in this field.

There is also applied phycology in the form of resource management. DAFF's Seaweed Unit maintains a primary focus on the commercially important seaweeds of South Africa.

Algal biology

In this section I include also systematics and ecology. What is noteworthy here is the wide-ranging collaborations with overseas colleagues, as well as International scientists appearing on the PSSA's membership list.

It is generally difficult to distinguish between the seaweed research being done at UCT and at the Seaweed Unit, as phycologists at those two institutions tend to collaborate closely. Between them, Profs. John Bolton and Robert Anderson and Dr. Mark Rothman have collaborations elsewhere in South Africa and in Australia, Mozambique, Belgium and Japan (and others). In recent years, the collaborations have been around morphological and molecular studies of the genera *Ecklonia* and *Sargassum*, DNA barcoding of geniculate coralline algae, as well as surveys of the macroalgal flora of the Mozambique Channel and on high latitude coral reefs in South Africa.

In addition to the DNA barcoding research mentioned above, Japanese phycologists have produced research on extracellular calcification of Prymnesiophytes, but also pubslished widely on the biogeography and phylogeography, evolution, and systematics of brown macroalgae, green algae, Dinophyceae and Cryptophytes through the application of a variety of morphological, genetic, transcriptomics and DNA barcoding studies. The Japanese

maintain some links with Profs. John Bolton and Robert Anderson, and with Stuart Sym (Wits).

At the UWC, Prof. Gavin Maneveldt's interest is primarily on the morphological and molecular systematics of non-geniculate coralline algae. Recently he has updated the keys to non-geniculate coralline algae of South Africa. He has also looked at the Mozambique Channel seaweed flora and the high latitude coral reefs in South Africa (collaborating with Profs. Bolton and Anderson). At the same University, I work on macroalgal ecology and ecophysiology, and coastal oceanography.

Our Polish colleagues have attended the last three or four PSSA meetings. The Polish contingent is headed by Prof. Andrzej Witkowski, who together with his team of students has been studying benthic diatoms using a variety of morphological, ultrastructural and molecular techniques, as well as doing ecological and physiological studies. Prof. Witkowski has established a research strong link with Dr. Tommy Bornman (SAEON) and has been visiting South Africa now for several years to collect diatoms along the entire coastline of our country.

At Wits University there is a strong history of ultrastructural studies on the Prymnesiophytes, with this legacy being carried forward by Dr. Stuart Sym. At the same University, Dr. Pierre Durand and his students have made important contributions in fields such as programmed cell death in algae.

The phycological contributions from SAEON are made by Dr. Tommy Bornman. Strong research links also exist with myself at the UWC. Notable research papers look at the role of pioneer species as indicators of climate change; nutrient dynamics around sea mounts and in estuaries; some research in the Southern Ocean and the Agulhas Current; and effects of sea level rise on intertidal salt marshes.

This year Prof. Renzo Perissinotto, the SARChI Chair in Shallow Water Ecosystems at the NMMU, attended PSSA for the first time. Prof. Perissinotto's research interest is integrated ecosystem processes focusing particularly on estuaries, but at our meeting this year we heard about the fascinating topic of stromatolites along the Eastern Cape coast.

Prof. Guy Bate was a frequent attendee of the PSSA meetings in the past, and this year he made a re-appearance. Prof. Bate specialises in the ecology and biodiversity of South African estuaries. Studies include research into buffer zones in rivers, wetlands and estuaries; estuarine microalgae; nutrient regeneration of N and P through benthic processes in estuaries; the role of benthic macrophytes in nutrient dynamics within estuaries; and the definition of a new kind of estuary (a micro-estuary) based on a classification of South African estuaries. Many links exist with NMMU colleagues and with SAEON.

Last but not least in this non-exclusive list of PSSA contributors is Dr. Thomas Wernberg from the University of Western Australia who was our invited guest speaker at the 30th PSSA meeting. Dr. Wernberg's keynote address was on his work on the kelp beds (or "kelp prairies" according to Robert Schlegel).

This summary above was not an easy task. Our members are from a diverse array of backgrounds, and it is often difficult to know who are still active members or who are no longer active in our field (once a name appears on the PSSA membership list it tends to stay there, so once a phycologist, always a phycologist). But I managed to come up with a list of publications: PSSA members contributed a total of 204 papers to the peer-reviewed scientific literature since our last meeting in 2015. This count includes contributions by all the members listed above, as well as a few others. The growing membership list (and number of attendees to our meeting this year!) as well as the far-reaching collaborations show that phycology as a field of research is prospering in South Africa. The contributions above show that our society's members have been able to follow international research trends (and in some cases set them), and have also responded to the country's developmental needs.

The strength of PSSA resides with a handful of (mostly) academic phycologists – about 13 by my count – and their students. It is the students, in fact, that form the bulk of the society's members, and this has always been the case. Personally, I think that PSSA is the most welcoming, least intimidating and most down-to-Earth academic life-science society in South Africa, and therefore the best place for students to come together and practise their presentation skills and do some networking.

Looking over all the contributions above, one slightly less positive observation emerged. Our society's name is the Phycological Society of *Southern* Africa. In past years phycologists from Namibia and Mozambique also attended the PSSA Congress, but now they are lacking. We have even had meetings in Namibia and Mozambique. We need to actively engage with our neighbouring countries again and add credence to the 'Southern' in the society's name.

Lastly, this year's meeting was important for another reason. This 30th PSSA meeting is the last that John Bolton and Rob Anderson will attend as non-retired phycologists, and it also more-or-less marks the period over which they have been employed as phycologists. They have become very central to the Society, and that their coming retirement will mark the change of an era. I like to think that the record number of attendees of this year meeting celebrates everything that John and Rob have done for phycology in Southern Africa!

Secretary/Treasurer's Report

Mark Rothman

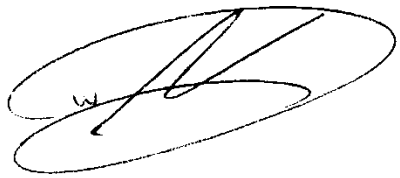
The Society has a Money On Call Account that is held at First National Bank. This account has a basic monthly charge, a small cash handling fee and a higher interest rate than conventional current accounts. There is a cheque book linked to the account but most transactions are done via internet banking because it is convenient. There are two signatories for the cheque book (currently John Bolton and Mark Rothman), although withdrawals or cheques only require one signature. Currently all our transactions are done electronically.

At the moment I cannot complete the financial report because too many congress payments are still outstanding. We paid R150 000.00 deposit for the conference, and the balance will be paid on at the end. A financial report will be published in the newsletter.*

We thank the industry for their continued support of phycology, this meeting and the Society. Reef South Africa sponsored certain prizes and Orca Industries sponsored the torches for our welcome pack. Taurus Chemicals (Cape Kelp) (Pty). Ltd. are sponsoring the Klaus Rotmann Memorial Award for the best talk/poster on applied seaweed research. Both Taurus Chemicals (Cape Kelp) Pty and Kelp Products)Pty) Ltd. made generous financial contributions towards this conference for which we are very grateful.

It is a great pleasure serving the Society in the capacity of Secretary/Treasurer.

Mark Rothman



***Financial update supplied by treasurer in March 2017 (below)**

Financial report for the period 4 September 2015 till 28 February 2017.

Opening Balance	**R 31 903.75**
Expenses	
Total conference cost	R 281 568.15
Banking cost	R 4 620.78
T-shirts	R 9 195.24
Gifts	R 12 711.22
Pens and bags	R 1 830.84
Total	R 309 926.23
Income	
Interest received	R 11 385.49
Sponsorships	R 21 500.00
Conference income	R 288 426.23
Total income	R 333 668.84
Closing Balance	**R 67 387.69**
Profit for period	R 35 483.94

This year the society made a very good profit from the conference due to large sponsorships and a huge discount from De Hoop Nature Reserve. However, late payments of accounts by some delegates' organisations made it very difficult to balance the budget during the congress, and organisers of future PSSA congresses might have to be very strict about payment deadlines! Our healthy closing balance should assist with organising the next conference.

Thank you for placing your trust in me to manage the society's finances: I regard it as an honour.

Yours faithfully,

Mark Rothman

Membership Secretary's Report

Chris Boothroyd

Membership numbers have increased substantially, so that the PSSA is at present in a very healthy state. This increase in members is largely the result of the high attendance at this meeting, because delegates at PSSA congresses automatically become members for two years.

The breakdown of present members is below (including the 29th and 30th PSSA Congresses).

	Local	International
Life	10	1
Corporate	4	
Ordinary	30	10
Student	54	4
Totals	98	15

Chris Boothroyd

Seaweed Research, Department of Agriculture, Forestry and Fisheries

Student Representative's Report

Thanks to the three students who contributed to newsletters since our last PSSA Congress: Maggie Reddy, Jonathan Featherston and Kirtanya Lutchmanarayan. I encourage students to contribute articles – get your name out there by letting others know what you are doing!

In future the student rep will follow up regularly with the development of the PSSA website.

Robert Schlegel

PROGRAMME: 30th CONGRESS OF PSSA, De Hoop Nature Reserve
*Denotes a student presentation

Thursday 12 January

CONGRESS KEYNOTE 1: Chair - Rob Anderson

Thomas Wernberg: Hot, heatwaves and herbivores – drivers of climate-mediated changes in kelp forests and rocky reef communities

SESSION 1 ECOLOGY: Chair - AJ Smit

*__Robert W. Schlegel__: Changing climates along rocky shores: the exceedance of temperature thresholds and what this may mean for kelp forests
*__Andrew Witte__: Benthic Algal Community Structure and Complexity of Shallow Reefs; selecting suitable habitat for abalone ranching
*__Yonela Mahamba__: Fine-scale mapping of seaweed zonation in Silaka Nature Reserve along the Wild Coast, South Africa
*__David Dyer__: Variability in stable isotope signatures of *Ecklonia maxima* and *Laminaria pallida*: implications for kelp forest food web studies
__Robert Williamson__: Long-term monitoring of South African coastal water
*__Lulama L Matshamba__: The effects of habitat heterogeneity on the spatial distribution of seaweeds in Dwesa MPA along the Wild Coast
*__Ross Coppin__: The recovery of the kelp *Ecklonia maxima* and its associated benthos from a pulse disturbance event between two different temperature regimes along the coast of South Africa

SESSION 2 TAXONOMY & BIODIVERSITY: Chair - Grant Pitcher

*__Ewa Górecka__: 13 years of Polish-South African cooperation in research of marine benthic diatoms and perspectives for the future
__G.W. Maneveldt__: A new genus for South African species of coralline algae ascribed to *Spongites*
__Stuart Sym__: The flagellar apparatus of a novel haptophyte from Japan, South Africa and New Zealand
*Courtney Puckree-Padua: Hybridization or Speciation? Understanding cryptic diversity in a reportedly widespread species of non-geniculate coralline red algae
*__Maggie M. Reddy__: A rosette by any other name: species diversity in the bladed Bangiales along the South African coast
*__Allison Haywood__: A new name for South African '*Spongites yendoi*'
*__Chunlian Li__: A contribution to the biodiversity and phylogeny of small-celled araphid pennate diatoms (Bacillariophyceae) of worldwide distribution

CONGRESS KEYNOTE 2: Chair - AJ Smit

Renzo Perissinotto: Extant marine stromatolites of the Eastern Cape: a window into the earliest life on Earth?

SESSION 3 BIOGEOGRAPHY: Chair - Gavin Maneveldt

Thembinkosi S Dlaza: Models for depicting the spatial distribution of crustose algae along the Wild Coast of South Africa
*__Przemysław Dąbek__: Is Langebaan Lagoon an example of refugium for the marine benthic diatoms?
*__Zizipho Mnyaka__: Seasonal effects on the diversity of seaweeds from different sites along the Wild Coast
*__Phumlile L. Cotiyane__: Towards the biogeography of marine benthic diatoms along the coast of South Africa
*__Debbie P. du Preez__: Isolating the South African *Asterionellopsis*
Guy Bate: The impact of tourism on the microflora in two freshwater lakes and an important estuary in KwaZulu Natal

Saturday 14 January

Field trip and excursions

POSTER SESSION

Sandra Barnard: Analysis of land use and its influence on the water quality of the Sabie River catchment
*__Samuel Bolton__: The effects of kelp forests on the inshore physical environment
*__Olona Buswana__: Shell morphology and reproduction of *Scutellastra longicosta* along the Wild Coast, South Africa
*__Yandisa Cwecwe__: Mapping the zonation pattern of both limpets and seaweeds in Hluleka Marine Protected Area
*__Anrie Erasmus__: Common terrestrial algae and cyanobacteria of Southern Africa
*__Michael J. Fleischman__: Cultivating *Macrocystis pyrifera* (Laminariales) '*angustifolia*' ecomorph for abalone feed, through holdfast fragmentation and vegetative propagation
*__Kirtanya Lutchminarayan__: Environmental Control of Distribution in South African Kelps
*__Vuyokazi Nibe__: Growth and reproductive seasonality of *Helcion concolor* along the Wild Coast of South Africa
*__Oko Sotshongaye__: Habitat preference of intertidal organisms on rocky shores of the Wild Coast, South Africa
Paul-Pierre Steyn: Macroalgal distribution in peritidal seeps on the Port Elizabeth coast
*__Donia H. Wozniak__: The effects of different algal substrates on larval settlement, and the effects of algal feeds and temperature on the growth and survival of post-settled *Tripneustes gratilla* (Linnaeus, 1758) sea urchins

Sunday 15 January

CONGRESS KEYNOTE 3: Chair - John Bolton

Andrzej Witkowski: A multigene approach to documenting the biogeography of diatoms (Bacillariophyceae) from the marine littoral zone: are species cosmopolitan or restricted in their distribution?

SESSION 4 CULTURE & AQUACULTURE: Chair - Thomas Dempster

Pierre Durand: The South African National Phycology Culture Collection

Grant C. Pitcher: *Pseudo-nitzschia* spp., domoic acid production and shellfish culture in Saldanha Bay
*__Lekraj Etwarysing__: Ulva phagostimulants for the sea urchin *Tripneustes gratilla*
*__Kathryn Morrissey__: Game of Microbes – exploring algal-associated bacterial diversity in green algae
*__Andrew Ndhlovu__: A red-tide forming dinoflagellate *Prorocentrum triestinum*: identification, phylogeny and environmental impacts in St Helena Bay, South Africa

SESSION 5 BIOTECHNOLOGY: Chair - Wendy Stirk

Dheepak M. Maharajh: Microalgal Technologies: An Economic Game Changer for South Africa
Edith M. Antunes: Supported gold nanoparticles synthesized by living marine seaweeds as a catalyst for reduction reactions
Sue Harrison: Enhancing resource productivity and the circular economy through algal carbon capture for bioproducts
*__Tarryn Terry-Meredith__: Selection and isolation of microalgal species with high growth and carbon assimilation rates and assessment of resulting biomass value
Monique Smit: Screening for Bioenergy Indicators in Indigenous Microalgal Isolates
*__Qubekani Ngulube__: Investigation of carbon dioxide capture using microalgae in different CO2/HCO3- ratios
*__Gordon Dodge__: Phycoremediation of industrially generated heavy metal contaminated water streams
Denzil R. Beukes: Chemical and biological diversity of halogenated monoterpenes from *Plocamium* spp

SESSION 6 MICROALGAL APPLICATIONS: Chair - Stuart Sym

Wendy A. Stirk: Effect of two drying methods on the phytochemical and auxin content in *Chlorella* biomass produced in a semi-continuous mass culture system
*__Fru Azinwi__: Dinoflagellate diversity along a subtropical Permanently Open Estuary: emphasis on potential harmful species
*__Kelly L. Kirsten__: The development of the Wilderness Embayment during the Holocene based on micropaleontological evidence
Sandra Barnard: Problematic cyanobacterial blooms in water abstracted from the Vaal dam
Thomas A. Dempster: Pulsed Electric Field Application to Algaculture: Predator Control and Product Extraction
*__Anrie Erasmus__: Algal assemblages of the Mooi River System and the correlation with the anthropogenic activities in the surrounding area
*__Gavin M. Rishworth__: Microalgal dynamics associated with living stromatolites along the Eastern Cape coastline of South Africa

ABSTRACTS OF ORALS

Listed in order of presentation (presenting author underlined)

Congress Keynote 1

Hot, heatwaves and herbivores – drivers of climate-mediated changes in kelp forests and rocky reef communities

Thomas Wernberg

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The global environment is changing, rapidly breaking down long-standing biogeographic boundaries and paving the way for novel ecosystems, where new species interact with unknown long-term ecological consequences. Kelp forests, some of the most prominent marine ecosystem on the planet, are at the coal face of these changes. Globally, almost 40% of kelp forests have declined in recent decades and ocean warming has been the root cause in many cases. In southwestern Australia decades of ocean warming and recent marine heatwaves have transformed temperate marine communities through a combination of direct physiological impacts and indirect ecological interactions. As temperatures soared, a threshold was passed and kelp forests contracted >100 km poleward in less than two years. Temperate species vanished or declined, but were replaced by seaweeds, invertebrates, corals and fishes characteristic of warm and tropical waters. Turf forming seaweeds and herbivorous fishes have now established feedbacks providing resilience to the new tropicalized ecosystem state. This community-wide phase shift provides a powerful example of the potent consequences of interacting climate-mediated pulse and press perturbations. Early signs of similar changes are seen in temperate ecosystems worldwide, and the extensive degradation of an Australian kelp forests ecosystem is a strong warning of what might be in store for temperate marine ecosystems globally.

Session 1 – Ecology

Changing climates along rocky shores: the exceedance of temperature thresholds and what this may mean for kelp forests

Robert W. Schlegel, Albertus J. Smit

University of the Western Cape, Robert Sobukwe Road, Bellville, 7535; 3503570@myuwc.ac.za

It is now known that the coastal waters of South Africa have been experiencing a mean decadal increase in seawater temperature of ~0.1°C/ decade since the 1970s, similar to the average for the entire ocean. The measurement of simple decadal trends however is not sufficient to fully appreciate the effects a warming ocean may be having on the kelp species found along the west coast of South Africa and throughout False Bay. More important are the frequency and duration at which certain biological significant temperature thresholds are being exceeded. We see that not only are these temperature thresholds exceeded in all historic records of the study area, but that the exceedance of these thresholds is increasing in frequency, intensity and duration. In spite of these findings, many of these kelp forests have been expanding. It is therefore necessary that other biotic and abiotic variables be considered when assessing the long term health and viability of the kelp species of South Africa.

Benthic Algal Community Structure and Complexity of Shallow Reefs; selecting suitable habitat for abalone ranching

Andrew D. Witte, P.P Steyn, D.R. Du Preez

Department of Botany, Nelson Mandela Metropolitan University, Institute for Coastal & Marine Research. PO Box 77000, Port Elizabeth 6031, South Africa
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Shallow reef communities remain poorly studied in the Eastern Cape region. Since the initiation of the abalone ranching project between Cape Recife and Skoenmakerskop (2014), an urgent need for benthic habitat data for this area has emerged, particularly to identify suitable areas for abalone seeding, and to measure the potential impacts of released abalone on the benthic community. The main aims of this study were to describe the Macro-benthic community structure in the Cape Recife area, and investigate effect that the re-introduction of abalone may have on these communities. Data was collected with the aid of transect surveys (n=49) along which quadrats ($0.25m^2$) photographed (n=1157), with selected quadrats scraped (n=14). Results indicate that the benthic community in the area is dominated by four biotopes down to a depth of 10 metres, with only one biotope represented on reefs deeper than 20 metres. The five biotopes included Group 1: Rocky Reef habitat which had predominantly *Pyura stolonifera, Parechinus angulosus , Plocamium corallorhiza* and the coralline turfs associated with the biotope, Group 2; Boulders and Pebble habitat and associated Opisthobranchia and Prosobranchia, Group 3: High Relief Rocky Reef Pinnacle habitat associated with *Turbo sarmaticus, Pyura, Parechinus, Plocamium, Laurencia flexuosa* and the coralline turfs, Group 4: Sandy habitat associated with Foliose/fleshy turf and *Dinoplax gigas* and Group 5: the deep habitat (<20 metres) and associated with colonial invertebrates habitat and biotope diversity was significantly correlated ($r=0.45$; $p<0.005$) to rugosity. The study showed the high complexity and variability of the temperate shallow reefs in this area. Abalone show the greatest association to groups 1 and 3. No significant differences between the community structure of reefs seeded with abalone and unseeded reefs were found.

Fine-scale mapping of seaweed zonation in Silaka Nature Reserve along the Wild Coast, South Africa

Yonela Mahamba[1], Thembinkosi S Dlaza[1] and Sherwyn C Mack[2]

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Rocky shore species follow a specific zonation pattern from high to low shore. However, zonation of seaweeds has always been studied on a coarse scale and thus tends to omit most of the information on local environmental heterogeneity. On the other hand, fine-scale mapping covers a small area but portrays a detailed account of that area. One meter intervals, along line transects, were therefore used to collect seaweed data on the rocky shores of Silaka Nature Reserve. A total of 31 seaweed species were recorded in this area. GIS maps reflected that the density of seaweeds increased from high to low shore. GIS also showed that seaweeds predominantly occupied furrows on the low shore while rock pools were preferred in the mid shore. ANOSIM reflected that there were intertidal variations in the percentage cover of seaweed in this area ($R= -0.023$, $p=0.65$). SIMPER reflected that there were 93% differences between high and low shore cover. The dissimilarity was 90% between high and mid shore while low and mid shore were 87% different. Habitats also showed variation in seaweed cover ($R= -0.083$, $p=0.97$) with rock pools being 86% different to outcrops. Rock pools were 92% different to crevices, 82% to furrows and only 12% similar to the mixed habitats. Diversity indices reflected that the crevices had the lowest diversity while mixed habitats and furrows had the highest diversity. They also showed that species diversity increased from high to low shore.

Variability in stable isotope signatures of *Ecklonia maxima* and *Laminaria pallida*: implications for kelp forest food web studies

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Stable Isotope Analysis (SIA) has become an indispensible tool for investigating food web characteristics, with particular focus on trophic structure and functioning. Variability of basal food web components is poorly understood and often neglected, despite being a key assumption of food web models. Kelp forests provide an excellent ecosystem to evaluate the scale and implications of this variability as they exhibit "bottom-up" control. In South Africa, kelp forests are primarily formed by two species, *Ecklonia maxima* and *Laminaria pallida*, which occur along the temperate regions of the coastline. This study highlights the natural variability of stable isotope signatures ($\delta^{13}C$ and $\delta^{15}N$), at different scales, within these two species. Kelp tissue was collected from different parts within a single plant (holdfast, stipe, primary blade and frond) and at different positions along the length of a single frond (from primary blade to frond tip). Representative samples were also collected at nine different geographical localities between Port Nolloth and Betty's Bay. SIA revealed a range of 1.65‰ and 3.75‰ within an *E. maxima* plant, for $\delta^{13}C$ and $\delta^{15}N$ respectively. The $\delta^{13}C$ and $\delta^{15}N$ range within a *L. pallida* plant was 1.52‰ and 4.21‰ respectively. There were also consistent variability patterns along the length of a single frond in both species, for both isotopes. Across localities, *E. maxima* and *L. pallida* were highly variable in $\delta^{13}C$ (9.37‰ and 11.22‰ respectively) and $\delta^{15}N$ (3.44‰ and 4.51‰ respectively). Within-site variability was a major contributor to the overall spatial variability for both species. Although the cause of the variability is not entirely understood, it can create erroneous conclusions if not considered when modeling these food webs. Therefore, the nature and scale of variability within kelps is imperative for gaining an accurate understanding of South African kelp forest food web functioning.

Long-term monitoring of South African coastal water

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Temperature is a well-documented indicator of ecosystem fluctuations as it has implications for ecosystem characteristics such as fish and zooplankton distributions, fish recruitment and phytoplankton bloom phenology. For kelp, spatial variation of temperature at local scales has been linked to the extent of species, biomass and species diversity, while warming trends and anomalous warm events have contributed to altered kelp forest structure. The spatial and temporal dynamics of kelp have highlighted the need for a better understanding of how these macroalgae respond to temperature as a stressor with respect to predicted environmental change. However, estimates of

temperature trends and magnitudes may conflict due to: (1) the way in which temperature data are obtained, via either in situ observations, satellites or reanalysis products: (2) the specific sea surface temperature (SST) sensor and the resolution of the data: (3) the exact spatial regions or temporal periods considered.

We aim to investigate correspondence among temperature trends extracted from various sites along the South African coastline from various sources of coastal temperature data. These include 127 *in situ* temperature time series of 1 to 43 years length and numerous satellite products utilizing infrared (e.g. AVHRR, MODIS) and/or microwave (TMI, AMSR) datasets. The *in situ* dataset consists of hourly underwater temperature recorder (UTR) and thermometer time series at precisions ranging from 0.1°C to 0.001°C, while the satellite products are produced daily and range from 1 to 25 km spatial resolution. In addition to trend analyses, this study will highlight the advantages and disadvantages of each product and the caveats associated with trend analyses.

The effects of habitat heterogeneity on the spatial distribution of seaweeds in Dwesa MPA along the Wild Coast

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The density and spatial distribution of species is determined by numerous factors such as habitat heterogeneity along the rocky shores. However, the effect of habitat heterogeneity on seaweeds has received little attention. This study thus aimed to use different methods in order to quantify the effects of habitat heterogeneity on the distribution, diversity and density of seaweeds in Dwesa MPA. The various habitats on the rocky shore were thus grouped into four major habitats which were termed: 1) emergent rock outcrops, 2) rock pools, 3) crevices and 4) mixed habitats. QGIS revealed that the number of seaweed species increased from mid shore to high shore in crevices. In emergent rock outcrops species increased from high shore to low shore. In rock pools there were no clear patterns recorded. ANOSIM showed that species composition varied between the tidal zones (R= -0.047, p=0.867) and various habitats (R= -0.017, p=0.572). SIMPER detected that *Ralfsia verrucosa* was the main species leading to 92% differences between high and mid shore, 86% between low and mid shore as well as 88% between high and low shore. *Ulva rigida* was responsible for the 84% difference between mixed habitats and emergent rocks, while *Hildenbrandia lecanellierii* resulted in 95% differences between crevices and outcrops. Rock pools were 85% different to emergent rocks, 82% dissimilar to mixed habitats and only 8% similar to crevices. Results from this study showed that tidal zones and habitats are important in seaweed distribution.

The recovery of the kelp *Ecklonia maxima* and its associated benthos from a pulse disturbance event between two different temperature regimes along the coast of South Africa

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Kelp forests are important, highly productive ecosystems which play a significant role in temperate coastal food webs. Kelps themselves are regarded as 'ecosystem engineers' that structure the surrounding environment (light, water motion, etc.), while also providing a habitat for various fauna and flora including economically important species such as rock lobster, abalone and fish. Environmental variables have been shown to affect kelp, with temperature being the main driver. Any warming or cooling of ocean waters under climate change will therefore have significant consequences for kelp forests. The increased frequency and severity of disturbance events such as storms, which are also associated with climate change, may also have effects on these ecosystems. The aim of this study was to investigate the recovery of kelps and associated benthos following a pulse disturbance event under two different temperature regimes. Two sites with differing temperature regimes were selected on the coast of South Africa: Oudekraal on the cold Atlantic side of the Cape Peninsula and Bordjiesrif on the warmer False Bay side. At each site, four 200m^2 circular plots were marked (two controls and two experimental plots) at similar depths (5-7m). In the two control plots kelps were left intact and in the two experimental plots all adult and juvenile kelps were removed. Benthic invertebrates and algae were recorded in eight 0.25m^2 quadrats in each of the plots before and after (3, 6 and 13 months) the removal experiments. Smaller foliose seaweeds dominated recovery on the Atlantic side, while juvenile kelp abundance was higher on the False Bay side. We discuss reasons for the differences in recovery and highlight the importance of this study in the context of climate change.

Session 2 – Taxonomy and Biodiversity

13 years of Polish-South African cooperation in research of marine benthic diatoms and perspectives for the future

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Cooperation between Polish and South African diatomists started over 13 years ago, beginning with research on diatoms described by one of the most prominent South African specialist in this field: Professor Malcolm H. Giffen. Professor Giffen has described over 130 taxa inhabiting South African marine coasts and river estuaries, from samples collected for 24 years (1946-1970). The diatom taxa described by Prof. Giffen were exclusively observed with light microscopy and documented almost thoroughly as line drawings, though access to original slides and to unmounted material housed in CSIR Durban have made EM observations possible. Now, almost all of the taxa described by M.H.

Giffen have been imaged under LM and many also under EM (SEM or TEM). The next stage has been initiated with the project on "Taxonomy and biogeography of marine benthic diatoms: is there really everything everywhere? An attempt to determine possible dispersion mechanisms" funded in 2010 by the Polish Ministry of Science and Higher Education. Within the frame of this project many of Professor Giffen's sampling sites have been revisited and recollected. A subsequent research project-"Diatom (Bacillariophyceae) assemblages of the marine littoral zone in regional and global scale in the light of morphological and genetic analyses. Phylogenetic, biogeographic and taxonomic implications"--was funded in 2012 with the intent on increasing diatom sampling in South Africa. In this latter project, diatomologists from various countries in Europe and Africa have also been cooperating on the study of biogeography and phylogeny of South African diatoms using traditional (microscopy) and molecular (DNA sequence data) tools. As a result of these efforts, in 2016 a bilateral research project with the South African Environmental Observation Network (Port Elizabeth, South Africa) on "Temperature as a factor determining biogeographical distribution of the diatoms (Bacillariophyta) and the ecosystem processes off the coast of South Africa as a result of modern climate change" was funded by the National Centre of Research and Development in Poland and South African Science Foundation. The main purpose of this ongoing project is to explain the dispersion of diatoms along South African coast driven by temperature in context of present climatic changes.

A new genus for South African species of coralline algae ascribed to *Spongites*

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The non-geniculate coralline algal genera *Spongites* and *Pneophyllum* (Corallinales, Rhodophyta) are morpho-anatomically distinguished from each other by their tetrasporangial conceptacle roof formation. Based on modern molecular analyses, using a multi-gene analysis (LSU, SSU, *psb*A, COI) integrated with histological comparisons of type material and recently collected specimens, these genera were shown to be polyphyletic. A reassessment has led us to provide a new circumscription for the two genera, including among other genera, the description of Chamberlainoideae subfam. nov. and *Chamberlainia* gen. nov.. *Spongites* and *Chamberlainia* both have Type 1 tetrasporangial conceptacle roof formation in which the development is only from filaments peripheral to the fertile area. They may, however, be distinguished by a combination of characters, including the diameter of the tetrasporangial conceptacle chamber (>300 µm in *Spongites vs.* <300 µm in *Chamberlainia*), the tetrasporangial conceptacle roof thickness (>8 cells in *Spongites vs.* <8 cell in *Chamberlainia*), and the trichocyte development (Type N-M in *Spongites vs*. Type J in *Chamberlainia*). Species of *Spongites* from South Africa will need to be transferred to *Chamberlainia* Caragnano, Foetisch, Maneveldt & Payri.

The flagellar apparatus of a novel haptophyte from Japan, South Africa and New Zealand

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The phylum Haptophyta comprises two distinct classes, the Prymnesiophyceae and the Pavlovophyceae. An unusual member of this phylum, with many features apparently intermediate between these two classes, was initially encountered in South Africa in the epipelagic waters of Gansbaai in 1997, but later rediscovered in False Bay (2000) and in the surf at the mouth of the Groot Brak Rivier near Mossel Bay (2010). It was independently discovered in the mid 1990s in Tokyo Bay and more recently in the coastal waters of New Zealand. Superficially, it has a tadpole-like shape and many of its features make it anomalous for the phylum. These include its relatively large size, four rather than two chloroplasts and the presence of non-ejectile mucocysts. A recent phylogenetic analysis, incorporating the South African material from Mossel Bay, suggests the need for a new class, separate from the Prymnesiophyceae and the Pavlovophyceae and probably intermediate between the two. The organism not only has a unique set of features and DNA signature, but it also has unusual flagellar behaviour. The flagellar apparatus itself has been characterised from numerous sets of serial sections and has been shown to be spectacularly unique for the phylum, with a number of connecting fibres an order of magnitude greater than that displayed by any other characterised haptophyte. Only three microtubular roots have been unequivocally identified, two of which are among the broadest known, but are not crystalline as in the coccolithophorids. The haptonema is long and non-contractile and is the deepest set in the cell, extending well below the flagellar basal bodies to the nucleus. The entire apparatus apparently is linked by a distinct contractile fibre to the tail of the organism, which allows for the rapid rounding up of the cell when stressed. Although anomalous, the apparatus has most affinity with that of the Pavlovophyceae.

Hybridization or Speciation? Understanding cryptic diversity in a reportedly widespread species of non-geniculate coralline red algae

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Coralline algae are widespread in all of the world's oceans. Despite their ubiquity, they are a comparatively poorly known group of algae. Ongoing taxonomic changes have meant that the classification and characterisation of these algae have been in constant flux. Recent molecular-assisted alpha taxonomy has demonstrated that coralline algae are generally not widely distributed across ocean basins and that we have highly underestimated the diversity of these algae, largely due to high levels of cryptism. For South Africa, the reported widely distributed *Spongites yendoi* has been demonstrated to be no fewer than six different cryptic species. Along the South African west coast, three morpho-anatomically indistinguishable species (here referred to as *Spongites* sp.6, 7 and 8) have been established to occur, all of whom have distinct geographic distributions. Based on *pbs*A sequences, *Spongites* sp. 6 and *Spongites* sp. 8 share seven unique single nucleotide polymorphisms (SNPs). *Spongites* sp. 7 and *Spongites* sp. 8 share six unique SNPs at different base pairs (bp). *Spongites* sp. 8 has five unique bp that it shares with neither *Spongites* sp. 6 nor with *Spongites* sp. 7. *Spongites* sp. 7 has four other bp that are variable. The initial interpretation of these results were that *Spongites* sp. 6 and *Spongites* sp. 7 are different species, but in some places are hybridizing, resulting in *Spongites* sp. 8. Similarly in *rbc*L, *Spongites* sp. 8 is matching either *Spongites* sp. 6 or *Spongites* sp. 7. However, sea surface circulation patterns are suggestion that we may rather be

documenting two separate speciation events, and that separately *Spongites* sp. 8 has given rise to both *Spongites* sp. 6 and *Spongites* sp. 7. We are currently interrogating these suggested opposing events.

A rosette by any other name: species diversity in the bladed Bangiales along the South African coast

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The Bangiales is a widely distributed order of Rhodophyta, known for its economic value. The morphological simplicity of the group offers limited distinguishing characters for taxonomy. In 2011, a taxonomic revision of the Bangiales based on a two-gene phylogeny identified 15 genera. Since then an additional bladed genus and many species have been added to the Bangialean flora. In South Africa a single species, *Porphyra capensis* Kutzing was recognized until 1997, when three species were recorded and three new species described based mostly on morphology. In 2004, a preliminary genetic survey along the South African coast suggested a much higher species diversity in the foliose genera than previously documented. Three genera, the filamentous, *Bangia* and bladed *Porphyra* and *Pyropia* have been recorded in South Africa. In the present study we delimited species from the most comprehensive collection of Bangiales from >30 sites along the South African coast. Two unlinked loci, the mitochondrial, *cox*1 (*n*=187) and the plastid, *rbc*L (*n*=78) were amplified, sequenced and used to construct phylogenetic trees. Three DNA species delimitation methods (ABGD, GMYC, PTP) were applied to the datasets and complemented with haplotype networks. In the present study 10 *Porphyra* and 3 *Pyropia* putative species were recognized, 3 of which have already been described. Two additional entities based on genetic data and three other species based on morphology have been previously recorded along the South African coast. Tentatively, 15-18 Bangiales occur along the South African coast; roughly 80-90% are endemic. This extensive genetic diversity has been concealed under the umbrella term *P. capensis*. Our results compare well with other southern hemisphere countries, such as Chile and New Zealand. The Southern Hemisphere, suggested as the origin and centre of diversity for the Bangiales, remains relatively unexplored and, is likely to yield further species and species links in the Bangiales.

A new name for South African '*Spongites yendoi*'

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Non-geniculate (encrusting) coralline red algae are widespread in all the world's oceans where they are often the dominant cover on shallow, hard-bottomed marine environments. The South African rocky intertidal and subtidal habitats in particular are rich in diversity of these algae. The ecologically important, *Spongites yendoi* is reported to occur around the entire South African coastline and forms a characteristic band on the mid- to low shore, particularly in association with the territorial, gardening limpet *Scutellastra cochlear*. Molecular-assisted alpha taxonomy, that combines molecular and classic morpho-anatomical data to identify and describe organisms, has revealed a number of cryptic species within the *S. yendoi* complex. New research is currently proposing a new genus name, *Chamberlainia* Caragnano, Foetisch, Maneveldt & Payri to accommodate South African specimens ascribed to *Spongites*. The aim of the current study was to provide a new name (*C. cochlearis*) and description for those specimens found, through molecular analyses, to conform to the ecological concept of South African *S. yendoi*. *Chamberlainia cochlearis* is not as widely distributed as previously reported for *S. yendoi*. The species can be characterised by a suite of morpho-anatomical characters and unique *psb*A sequences. Additionally we provide a key to the South African species ascribed to *Spongites* and *Chamberlania* taking congnisance of the field and histological characters useful in delimiting them. This study has highlighted the need to reassess all South African names for non-geniculate corallines based on type localities of species from other continents and ocean basins, using DNA sequence data.

A contribution to the biodiversity and phylogeny of small-celled araphid pennate diatoms (Bacillariophyceae) of worldwide distribution

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Araphid diatoms, which lack raphe slits on the valve surface, constitute an important component of diatom assemblages in the marine littoral. Their still poorly-known diversity is largely based on morphological characters, and the small size and simple diagnostic characters of some araphid taxa can make identification and taxonomy difficult. During our investigations of marine littoral diatom assemblages, we isolated and cultured twenty-five strains of small araphid diatoms by the single-cell isolation method. The strains treated in this paper originate from the Pacific Ocean (Japan, Korea, Vietnam), Indian Ocean (South Africa, Madagascar), Atlantic Ocean (South Africa, Nambia, Senegal) and the Mediterranean Sea (Turkey and Croatia). Morphological observations (light and electron microscopy) and DNA sequence data (nuclear-encoded small subunit ribosomal RNA and chloroplast encoded *rbcL* and *psbC*) were collected and analyzed. Phylogenetic analysis of the DNA sequence data revealed that all the clones fell into a monophyletic group (the „staurosiroid" clade), which was divided into three sub-clades. All of the strains share a similar morphology and growth habit: clavate, heteropolar cells without rimoportulae forming radiate colonies through the contact of well-developed apical pore fields (APFs) with striae consisting of one areola with branched volae on the valve face and mantle. The strains also have few open and plain copulae. Based on our mophological and molecular observations, we propose a new genus for these strains and allocate them into several new

species, distinguished by the shape of areolae, the presence of marginal spines and size dimensions. Our study demonstrates that the diveristy of araphid diatoms is still far from satisfactorily understood.

Session 3 – Biogeography

Congress Keynote 2

Extant marine stromatolites of the Eastern Cape: a window into the earliest life on Earth?

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Stromatolites date back in the fossil record at least 2.7-3.5 billion years, thus the study of the few extant colonies remaining in the marine environment may help understand the hydrospheric conditions that prevailed at the onset of life on Earth. In the Archean eon, the cyanobacteria involved in the formation of hard deposits and reefs that formed stromatolites comprised the first photosynthetic algal organisms responsible for transitioning the Earth's atmosphere into its current, productive oxygen-rich state. Modern stromatolites are scarce globally for two primary reasons: firstly, ocean chemistry has shifted from conditions which were once rich in calcium carbonate; and secondly animals and higher-level algae have now evolved which can outcompete or graze upon and disrupt the stromatolite matrix. Over 500 living marine stromatolites systems have been discovered recently along a 200 Km stretch of South African coastline, between Cape Morgan in the east and the Storms River mouth in the west. This has posed the inevitable question of what allows these stromatolites to form along this coastline. This presentation addresses some specific findings that help answering this question and sets them in the contest of current threats caused by anthropogenic activities and climatic change along this coastline.

Models for depicting the spatial distribution of crustose algae along the Wild Coast of South Africa

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The spatial distribution of species may either be uniform, random or clumped. This has led to various species distribution models being formulated to quantify the distribution of species. However, these models have traditionally been selective in species such that geographic distribution models have gained popularity lately. This study thus compared the effectiveness of different indices and models in depicting the distribution of selected seaweed species. QGIS detected that *Hildenbrandia llecanellierii* and *Lithothamnion* spp were restricted to emergent rocks while *Ralfsia verrucosa* was found in four different habitats on the high shore. MDS grouped Silaka habitats apart from Hluleka

and Dwesa. The high shore assemblage in Silaka was different from the other sites. ANOSIM detected that the order of importance in determining crustose algae was sites (R=0.162, p=0.007) followed by tidal zones (R=0.134, p=0.008) and then habitats (R=0.076, p=0.096). SIMPER showed that *R. verrucosa* was responsible for the 59% difference between Dwesa and Mkhambathi while *Phymatolithon foveatum* resulted in 44% similarity between Silaka and Dwesa. When using PASSaGE, the distribution indices reflected that none of the crustose algae were uniform or randomly distributed but were rather clustered in their distribution.

Is Langebaan Lagoon an example of refugium for the marine benthic diatoms?

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Diatoms (Bacillariophyceae) are a group of unicellular eukaryotic siliceous microorganisms, which are an important component of marine ecosystems. They significantly contribute to the production of oxygen and are the biggest biomass producers in the Ocean. Diatom distribution in the oceans is related to the numerous environmental factors, e.g., latitude, type of substrate and physicochemical conditions of the water (temperature, salinity, nutrient concentrations, waves, currents, upwelling events, etc.), but this knowledge is still incomplete and unclear.

The present study aims at resolving the taxonomic composition and the possible mechanisms controlling the distribution of the marine benthic diatom assemblages inhabiting (1) a semi-closed Langebaan Lagoon, (2) Saldanha Bay and (3) Tsaarbank - an open Atlantic Ocean coast. Together with the taxonomic analysis we present also some preliminary results of the experiments on temperature impact on diatoms isolated from the Langebaan Lagoon and Tsaarbank. Our taxonomic observations indicate the existence of specific diatom composition in the sheltered and warmer Langebaan Lagoon and Saldanha Bay, which is almost absent in samples from the open ocean coast (Tsaarbank), despite the short distance between sampling stations. We suggest also that potentially the water temperature is the most crucial factor for the distribution of the marine benthic diatoms along the South African coasts.

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Seasonal effects on the diversity of seaweeds from different sites along the Wild Coast.

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South Africa contributes more than 10% of the global seaweed diversity with most of these species being found on the country's east coast. However, some seaweed species have a seasonal life history thus resulting in the presence and diversity of seaweed species being controlled by seasonal variations that occur yearly. This study thus quantified the effects of different habitats, sites, shore level and seasons on the diversity of seaweeds along the Wild Coast. Seaweed diversity was compared in rock pools and emergent rock outcrops across six sites over a 12 months period. The highest diversity on the emergent outcrop was found in the low shore of Dwesa-Cwebe Nature Reserve during the spring season (d=5.17). In the mid shore, the highest diversity (d=4.926) was recorded in Nqabara during spring. However, the high shore reflected that the highest diversity was during winter in Mngazana (d=4.17). Inside rock pools, the highest diversity was found in the low shore of Dwesa-Cwebe Nature Reserve during summer (d= 7.673). Overall, the results revealed that seasonal effects on the diversity of seaweeds were more pronounced on the emergent rocks than inside rock pools.

Towards the biogeography of marine benthic diatoms along the coast of South Africa

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Marine botanical biogeography has been extensively documented in South Africa with a specific focus on macroalgae (seaweed). The knowledge of patterns in the geographic distribution of diatom flora is limited and the diversity of marine benthic diatoms along the coast of South Africa remains unknown. Due to changing ocean temperatures and increased anthropogenic impacts, there is a degree of change with respect to species distribution in the marine ecosystem. Despite temperature being identified as the main determinant of biogeographical patterns and ecosystem processes, the aim of the research is to determine the diversity and biogeography of marine littoral diatoms along the coast of South Africa by determining the main environmental drivers responsible for such geographic patterns. Diatoms are excellent bio-indicators of their environment, and once the diversity, biogeography and environmental drivers are known, species can be used to detect change in the marine environment. The main hypotheses to be tested are: a) seawater temperature is the main environmental driver of marine benthic diatom biogeography and b) marine benthic diatoms exhibit the same biogeographic patterns as the intertidal macroalgae around the coast of South Africa.

Isolating the South African *Asterionellopsis*

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The diatom *Asterionellopsis glacialis* sensu lato has recently been found to have cryptic diversity and what was once considered a single species has been discovered to be six genetically distinct species across the globe. *Asterionellopsis glacialis* sensu lato has been found along the South African coast but its taxonomy has not yet been clarified using genetic methods. *Asterionellopsis glacialis* was collected and cultured from Algoa Bay and the regions ITS1-5.8s-ITS2 and RbcL were used for identification. The species found was *Asterionellopsis lenisilicea* (type specimen from Canada) suggesting that it was brought in due to shipping. Further study is needed to discover if South Africa has a natural cryptic species of *Asterionellopsis*.

The impact of tourism on the microflora in two freshwater lakes and an important estuary in KwaZulu Natal

Guy Bate

The population in the Mgobezeleni catchment in Maputaland, northern KwaZulu Natal, has expanded considerably since the establishment of forestry in the 1960's and the development of substantial tourist facilities since the 1980's. The soils in the area are paleodune with high flow-through characteristics. Being essentially a rural area, there are no municipal facilities for dealing with sewage which is disposed of in septic facilities and long-drops that soak into the groundwater feeding two lakes and the small but important Mgobezeleni Estuary. The effect of the sewage disposal has been to raise the nitrogen and phosphorus levels in the groundwater but macrophyte and microalgal growth in the lakes appears to have considerably reduced these levels in the lakes and estuary water. While this appears to be beneficial the consequences to the microalgal populations does not appear beneficial because diversity is low and a high density of cyanophytes has developed in what otherwise appears to be a pristine lake system.

Congress Keynote 3

A multigene approach to documenting the biogeography of diatoms (Bacillariophyceae) from the marine littoral zone: are species cosmopolitan or restricted in their distribution?

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Presented in this lecture are some preliminary results from research on diatom assemblages of marine littoral habitats isolated from Atlantic, Indian and Pacific Ocean coasts. The diatom assemblages are based on cultures established from environmental samples originating from marine littoral and supralittoral zone collected in different seasons between the years 2010-2015 and supplemented by measurements of environmental variables, such as salinity, pH, O_2 and temperature. Altogether a few hundred strains have been identified and studied by means of LM and EM, followed by the extraction of genomic DNA and sequencing the *rbc*L, *psb*C and SSU markers. Examples of our best studied families included Cymatosiraceae, Plagiogrammaceae, Naviculaceae, Stauroneidaceae and Bacillariaceae. Through phylogenetic analysis of multi-gene concatenated sequence data, we have identified several groups of putatively conspecific taxa (particularly in the genera *Nanofrustulum*,

Amphora, *Navicula* and *Nitzschia*), which show no morphological differences but a wide range of genetic distances, isolated from different locations. Taking into account the total number of the diatom species our results on marine benthic diatoms performed in this survey are the very preliminary ones. Although it is highly speculative statement, based on our research there appears to be at least some evidence for true cosmopolitanism among marine benthic diatoms. *Cymatosira belgica* Grunow in van Heurck seem to be a good candidate for a truly cosmopolitan species. Nevertheless most taxa studied with the molecular data set seems to have restricted geographic distribution, although again it is much too early for such a conclusion.

Session 4 – Culture and Aquaculture

The South African National Phycology Culture Collection

The SANPCC committee

P Durand, S Sym, N Dhar and A Ndhlovu (University of the Witwatersrand); W Stirk (University of KwaZulu-Natal); T Dempster (Arizona State University); G Pitcher (Dept of Agriculture Forestry and Fisheries). Email: pierre.durand@wits.ac.za

The South African National Phycology Culture Collection (SANPCC) was initiated in 2015 with the aim of providing a national biorepository for freshwater and marine microalgae. The SANPCC is used for basic phycology research in taxonomy, phylogenetics, environmental monitoring and ecology, evolution, teaching, bioprospecting and biotechnology applications. Custodianship is ultimately under the Phycological Society of Southern Africa and the property of the people of South Africa; however, some specific intellectual property rights are associated with the relevant national funder (the Council for Scientific and Industrial Research). The current collection is maintained according to the quality control requirements of the UWC Hebarium and registered under the acronym 'UWC' in the Index Herbariorum. It comprises approximately 50 strains of micro-algae, 23 of which have been isolated to an axenic and clonal state. These include *Eutreptiella*, *Ankistrodesmus*, *Nephroselmis*, *Pyramimonas*, *Prymnesium*, *Cymbomonas*, *Prorocentrum*, *Chlorella* and *Chlamydomonas* species. They have mostly been isolated from regions in Southern Africa although some isolates, for example, the *Chlamydomonas* species are used as model organisms in basic phycology and evolution research. The collection will be summarized with regards to organism identity (morphological and genotypic), collection sites, growth characteristics, culture maintenance and biochemical properties like lipid and carbohydrate content. This seminar will deliver an update on the status of the project. It will include details of the management and data sharing policy; logistics for sample processing, characterization, maintenance and quality control; funding and intellectual property. The current SANPCC policy is viable for three years. The long term strategy for sustainability is discussed.

Pseudo-nitzschia spp., domoic acid production and shellfish culture in Saldanha Bay

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Pseudo-nitzschia is a globally distributed diatom genus, some species of which produce the neurotoxin domoic acid (DA) responsible for the human poisoning syndrome known as Amnesic Shellfish Poisoning (ASP). Species of this genus are common members of the coastal phytoplankton communities of eastern boundary upwelling systems, but their impacts vary between systems. Our study investigates the threat posed by *Pseudo-nitzschia* spp. to shellfish culture operations in Saldanha Bay. Initiated in 2012, the study undertakes identification of the *Pseudo-nitzschia* spp. present within Saldanha Bay, assessment of their frequency of occurrence, their ability to produce DA, and the uptake of DA by the cultured mussel *Mytilus galloprovincialis*. Results show *Pseudo-nitzschia* spp. to be an important component of the phytoplankton community of Saldanha Bay. The relationship between *Pseudo-nitzschia* abundance and particulate DA concentrations varied, reflecting either changes in the dominant *Pseudo-nitzschia* species or in the suite of environmental factors influencing toxin production. *Pseudo-nitzschia* assemblages characterised by low toxicity tended to be dominated by species of the *Pseudo-nitzschia delicatissima* [<3 µm] complex, while assemblages characterised by high toxicity were dominated by species of the *Pseudo-nitzschia seriata* [>3 µm] complex. Particulate DA concentrations as high as 2 µg l^{-1} were measured in Saldanha Bay at which time the dominant species was identified by light and scanning electron microscopy as *Pseudo-nitzschia australis* (confirmed by LSU phylogeny). Cultures of this species were shown to produce DA with cell toxicity varying from 0.002 – 0.5 pg $cell^{-1}$. DA concentrations in mussels cultivated in Saldanha Bay nevertheless remained below the regulatory level.

Ulva phagostimulants for the sea urchin *Tripneustes gratilla*

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Aquacultured *Ulva* is known to elicit phagostimulatory responses in the sea urchin *Tripneustes gratilla*. Several studies have shown the feeding preference of *Tripneustes gratilla* when it comes to *Ulva*. The identification of chemical compounds in aquacultured *Ulva* that attract/stimulate sea urchins could be an advantage in the emergence of a local sea urchin aquaculture industry. This study was carried out to investigate the feeding preferences of sea urchin *Tripneustes gratilla* to several *Ulva* fractions. In total, nine different *Ulva* fractions were tested in a circular tank using a modified Avicel plating technique adapted from Sakata *et al.* (1984). Four Ulva fractions containing highly polar compounds were found to attract and trigger the feeding responses in *Tripneustes gratilla.* Polar compounds such as glycolipids such as DGDG and MGDG have previously reported to cause this

type of behaviors in sea urchin. Further isolation and characterization of these compounds still need to be done.

Game of Microbes – exploring algal-associated bacterial diversity in green algae

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Siphonous green seaweeds are among the morphologically most complex algae and also among the most notorious invasive species in many parts of the world. Their ecological success has repeatedly been linked to their association with endo- as well as epiphytic bacteria. The competitive advantage of invasive species may also be at least partly shaped by associated microbes. Indeed, recent studies revealed rich associated bacterial communities. However, little is known about their functional diversity as well as the principles underlying their assembly. To address this, a 16S rDNA metabarcoding approach was applied to analyse the bacterial diversity of epi- and endophytic bacterial communities associated with native and invasive species of *Caulerpa*, namely *C. prolifera* and *C. cylindracea*. Natural populations of both species were sampled from three regions along the Turkish coastline of the Aegean sea. To further explore bacterial diversity and assembly, in situ experiments were performed focussed on changes in bacterial community structure due to temperature stress as well as increased nutrient load. This study aims to elucidate the natural microbiome structure of both the native and invasive *Caulerpa* species and their response to alterations in environmental abiotic conditions.

A red-tide forming dinoflagellate *Prorocentrum triestinum*: identification, phylogeny and environmental impacts in St Helena Bay, South Africa

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Harmful algal blooms (HABs) are a pressing human health, ecological and economical challenge in South Africa. The identification and documentation of the causative species is a key step in understanding HAB or red tide dynamics. A non-toxic red tide resulting in anoxia was the cause of large marine mortality, including an estimated 415 tons of rock lobster (*Jasus lalandii*), in St Helena Bay, Cape Town, South Africa in February 2015. The event was observed along approximately 200

km of the Namaqua coastline extending well north of the Olifants River and southward into St Helena Bay. The dominant HAB forming organism was isolated from field site samples and identified using partial sequences of the 18S small sub-unit (SSU) rDNA and 28S large sub-unit (LSU) rDNA. Three molecular phylogenetic approaches were employed (Neighbor-Joining, Maximum Likelihood and Bayesian Inference) and the dominant organism was identified as *Prorocentrum triestinum* (Dinophyceae). Cell concentrations of 14.32×10^6 cells L^{-1} were recorded in the southern reaches of the bay and O_2 concentrations declined to 0.06 ml l^{-1} in the shallow waters off Dwarskersbos. The global incidence of *P. triestinum* dominated events is low with hot spots limited to the Eastern Chinese and Mediterranean coastal areas where they are sometimes associated with anthropogenic nutrient pollution. The Benguela region in South Africa is the only major eastern boundary upwelling system in which *P. triestinum* forms significant bloom events. These data contribute to the body of phycological and environmental data used to develop a comprehensive understanding of HAB dynamics.

Session 5 – Biotechnology

Microalgal Technologies: An Economic Game Changer for South Africa

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South Africa is identified as one of the best locations globally for commercial manufacture of algal based products due to the lower rainfall, high solar radiation and the availability of infrastructure in arid regions. Some of the challenges facing South Africa are; lower economic growth, food shortages, limited arable land (12-13%), low rainfall, malnutrition, waste water remediation and unemployment. Algae produces lipids, carbohydrate, proteins and many other valuable compounds which makes it a potential candidate to address all of these challenges.

The Bioprocess research group at CSIR have commenced research into the use of algae for commercial and economic benefit in 2001. The areas of research have been focused on High value compounds from algae such as Beta Carotene and Omega 3 fatty acids as well commodities like biodiesel, waste water treatment and fish feed. In 2009 the CSIR with collaborators from DUT and MUT commence a national bioprospecting program that yielded over 800 microalgal isolates from various environments across the country. From these isolates 2 have been selected for commercial applications in biodiesel and omega 3 fatty acids production. The lipid producing isolate was cultured in laboratory scale raceway ponds and demonstrated lipid productivities of ~25 g/m^2/day. The results from this study were used to develop a preliminary techno-economic model to evaluate the commercial feasibility of the process. The model concluded that there is critical relationship between plant scale, lipid productivity and key financial indicators (IRR and NPV).

The samples collected during the bioprospecting program were subjected to various isolation and screening protocols of which the most useful was Flow Cytometry cell sorting. During these experiments, protcols for cell sorting were developed and validated to be able to isolate single populations from a mixed sample based on chlorophyll autofluorescence and lipid fluorescence.

The presentation presents the past case studies on Beta Carotene commercialization, the current research initiatives and the future potential applications for algae within the bioeconomy of South Africa. This presentation aims to demonstrate how algal research can be translated into commercial products that can positively impact on the socio-economic potential of South Africa and position SA as a country of choice for algal-related business globally.

Supported gold nanoparticles synthesized by living marine seaweeds as a catalyst for reduction reactions

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Plants and seaweeds, with their well-known capacity to take up metals from contaminated soils or aqueous waste, has long been recognized as a potential method for environmental cleanup [1,2]; though the promise of this technology has yet to be fully realized. Metallic nanoparticles (MNPs) have garnered a great deal of interest due to the extraordinary properties they present compared to their bulk counterparts [3] and the use of plant extracts, algae, bacteria and viruses to form bio-MNPs, have shown enormous promise *e.g.* in catalytic reactions [4, 5]. However, issues with using bacteria to form NPs, where the bacteria may not be stable under certain reaction conditions or that the conditions required to maintain the cultures, *e.g.* using sulfur, which poisons the catalyst [5], preclude their application in a variety of fields. Live plants and seaweeds offer a possible route to the synthesis of MNPs, since they are known to take up metal salts and reduce them to form nanostructures. Extraction of the MNPs from the biomass is often a laborious, energy intensive process, often destroying the MNP structure [4]. This work demonstrates the first production of gold nanoparticles by live *Ulva lactuca* and their direct use as effective catalysts for 4-nitrophenol reduction, a common toxic pollutant found in the waste waters of dye industries. The accumulation of gold by the *Ulva* and fate of the metal once it is accumulated is also presented.

References:

1. Salt DE, *et al.* (1995). *Nat Biotechnol* **13** 468–474.
2. Zhou Y, *et al.* (2006) *Aquaculture* **252** 264– 276.
3. Astruc D, *et al.* (2005) *Angew Chem Int Ed* **44** 7852–7872.
4. Iravani S (2011) *Green Chem* **13** 2638.
5. De Corte S, *et al.* (2012) *Microbial Biotechnology* **5** 5–17.

Enhancing resource productivity and the circular economy through algal carbon capture for bioproducts

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Algae are being considered for carbon capture and recycling to reduce atmospheric CO_2 and related environmental risks. In South Africa, relatively cheap coal energy hampers the rapid move to low-CO_2 alternative energy. Algal production facilities placed near coal burning power stations may have the dual purpose of CO_2 uptake and revenue generation through algal bioproducts. Similarly such algal facilities can be used with bioethanol generation. Algae are a rich source of bioproducts ranging from high value extracted compounds to large volume commodity products. Of the global production of algae, including seaweeds, of more than 20 million tonnes per year, the majority is macroalgae for food products with growing potential in other markets. Global markets for microalgae currently include health foods, pigments, polyunsaturated fatty acids and aquaculture feed supplements, with commercial interest in biofuels, fertilizer, livestock feed and bioactive compounds. The type of algal products to be produced is linked to the sources of water, carbon and other nutrients. Commodities such as biodiesel and fertilizer require use of wastewater and flue gas to reduce input costs with the additional incentive of remediating these waste streams. However, potentially harmful contaminants must be avoided for products for human and animal consumption, so relatively clean water and gas streams are required. In this case, the off-gas gas may need to pass through a scrubber before entering an algal cultivation facility. Similarly wastewaters need to be partially cleaned or chosen based on their composition. The product selection influences the bioreactor system. Low cost production of algae using off-gas requires covered channels or ponds to reduce to the loss of CO_2 to the atmosphere. Water, nutrients, energy requirements, productivities and cost are all important considerations for cost- and environmentally-effective bioproducts from algal cultivation as an interesting method of CO_2 recycling and generation of valuable bioproducts.

Selection and isolation of microalgal species with high growth and carbon assimilation rates and assessment of resulting biomass value

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Microalgae utilise CO_2 for autotrophic growth and may be used to reduce the concentration of CO_2 being released into the atmosphere as a result of industrial activities. To ensure efficient CO_2 biomitigation, algal species capable of high CO_2 assimilation rates need to be identified. Microalgal species, 63, were isolated from environmental samples collected close to proposed CO_2 biomitigation sites in the Mpumalanga and Gauteng provinces, South Africa. These isolates and 98 contained in the CSIR algal culture collection, previously isolated from these provinces, were screened for high CO_2 assimilating species using a high-throughput screening (HTS) method. The HTS method, developed during this study, allows for the simultaneous screening of 28 algal isolates in 2 ml culture volumes over four days. Use of this HTS method has generated kinetic growth data for 80 previously uncharacterised algal species under enriched CO_2 conditions. The nine algal isolates with the highest growth rates compared to a *Scenedesmus* sp., characterised as a high CO_2 assimilating species, were selected for further characterisation. Eight of the isolates were identified at the species level using 18S rRNA gene sequences, and the sequence of one species showed very low similarity to previously submitted sequences in the GenBank® database. The biomass compositions were determined and used to select isolates for further large scale studies based on the potential value of the resulting algal biomass. The value of this research is highlighted by the fact that algal production for CO_2

biomitigation may also result in the production of potential high value algal products, job creation and the offset of operational costs if the most appropriate species is selected for this purpose.

Screening for Bioenergy Indicators in Indigenous Microalgal Isolates

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Microalgal bioenergy has been identified as a critical medium-term intervention to address energy challenges both locally and globally. Microalgae can produce high amounts of carbohydrates and fatty acids, termed "bioenergy indicators" that can be used to generate bioenergy. In an attempt to address this global challenge, the CSIR initiated a project to isolate microalgae from South African environments that could have application in the bioenergy sector. The project yielded a database of approximately 500 isolates from the 9 South African provinces. The database is currently stored on solid medium and housed at the CSIR Biosciences in Pretoria. The objective of the present study is to characterise a select few indigenous isolates regarding growth rate, carbohydrate and fatty acid production. Profiling of selected isolates will allow for the identification of candidate species for further process and commercial development. Isolates were grown in triplicate at 2 L scale in round bottom glass flasks under 60 µmol photon s^{-1} m^{-2} fluorescent lighting and stirring at 350 RPM and 22°C ± 1°C. Samples were analysed daily for optical density (685 nm), dry cell weights, carbohydrate production (Dubois method), fatty acid production (gas chromatography), and total lipid production (fluorescent spectrometry). Results from growth experiments indicate linear growth rates of 0.103 – 0.177 d^{-1} and biomass yields of up to 1.3 $g.L^{-1}$ dry cell weight. Further observations include carbohydrate accumulations of up to 0.160 $g.L^{-1}$ equating to 12% of the total dry biomass during the linear phase. The fatty acid profiling demonstrated that cultures produced the majority of fatty acids in the C12 to the C18 range. These fatty acids have been widely reported as suitable for biodiesel production.

The study demonstrates that selected isolates are capable of producing carbohydrates and fatty acids that can be converted into biodiesel or bioethanol for the transport fuel sector.

Investigation of carbon dioxide capture using microalgae in different CO_2/HCO_3^- ratios

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Worldwide concern about global warming caused by greenhouse gas emissions, mainly carbon dioxide (CO_2), has led to the development of CO_2 capture, storage and cycling methods. This research is on the usage of microalgae in the capturing and cycling of CO_2 from flue gas produced by burning fossil fuels such as coal. Productivity of microalgae in open pond systems prevalent in large-scale operations is typically limited by mass transfer of CO_2. Mass transfer of CO_2 to support algal growth can be divided into gas-liquid transfer and the subsequent CO_2 uptake by algae cells. Carbon dioxide is known to speciate into three inorganic carbon species, namely CO_2, bicarbonate (HCO_3^-) and carbonate (CO_3^{2-}), based on the pH of the media. The mechanism of CO_2 uptake by algae cells depends on the carbon species present in the media. Algae can take up CO_2 and HCO_3^- whilst CO_3^{2-} is not utilised. This research investigates the effect of CO_2 and HCO_3^- on algae growth rates.

Furthermore, the research includes the development of methodology for measuring CO_2 uptake by microalgae in both CO_2-rich and HCO_3^--rich solutions.

Phycoremediation of industrially generated heavy metal contaminated water streams

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The discharge of waste water streams containing heavy metals such as aluminium, iron, cadmium, lead and mercury by the textile, plastic and mining industries has significant short- and long term implications on the environment and society. The toxicity of heavy metals to plant and animal life has provided impetus for research into the remediation of these waste water streams before their discharge into environmental water sources. Biological remediation has been identified as a means of effectively removing heavy metal contaminants and is favoured over its physical and chemical counterparts due to its economic viability and process simplicity. In particular, algae have been proven to be a successful form of biological remediation (phycoremediation) with over 75 species being shown to have the ability to take up heavy metals through a variety of mechanisms.

This research assesses the ability of individual algal species to grow and bio-remediate heavy metal contaminated water streams and to select the most appropriate microalgae species based on their ability to successfully remediate metals from solutions according to uptake rates and biomass production. Following this, the research will investigate the effects of individual heavy metals on the degree of anaerobic digestion and methane production of *Spirulina*.

Chemical and biological diversity of halogenated monoterpenes from *Plocamium* spp

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Seaweeds have evolved unique and highly specialized biochemical pathways to survive in the marine environment. One such adaption, in seaweeds of the genus *Plocamium*, is the biosynthesis of natural products containing bromine and chlorine atoms. A larger number of unusual halogenated monoterpenes have been reported from *Plocamium* spp. Interest in these molecules was mainly due to their reported biomedical potential such as anticancer, antimalarial and antibacterial activities. However, fascinating data have become available establishing the ecological relevance of these molecules.

In this presentation, the chemical diversity and biological significance of halogenated *Plocamium* natural products is briefly reviewed.

Session 6 – Microalgal Applications

Effect of two drying methods on the phytochemical and auxin content in *Chlorella* biomass produced in a semi-continuous mass culture system

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Microalgae produce many secondary metabolites which have commercial value. These include phenolic compounds with therapeutic potential (especially antioxidants) and phytohormones which serve as natural biostimulants in agriculture. Cultivation of microalgae provides opportunity to manipulate growth conditions to enhance the phytochemical composition. In the present study, *Chlorella vulgaris* MACC 755 was grown in a 300 L semi-continuous culture system and harvest over a period of 24 days (day 10, 17 and 24). Two post-harvest drying methods (lyophilization vs. thermal drying at 40°C and 90°C) were also investigated. Phenolic acids, flavonoids, condensed tannins, iridoids and indole-3-acetic acid (IAA) content were quantified. Growth rates in the culture system declined over time with positive growth in week 1, stationary growth during week 2 and negative growth during week 3. The highest phenolic acid, flavonoid, condensed tannin and iridoid contents were recorded in the sample harvested on Day 17 and then lyophilized. Post-harvest exposure to elevated temperatures used for drying the samples increased the phenolic compound content but had little effect on the iridoid content. IAA levels increased with culture age and with post-harvest drying at 40°C. While growth conditions and harvest time are important considerations to optimize both the yield and biochemical profiles of microalgal biomass, post-harvest methods also have a large effect on the biochemical composition. The results suggest that a mild thermal drying regime (40°C) could initially be used to induce stress and so further improve the yield of high value compounds with therapeutic potential and biostimulants applicable in agriculture.

Dinoflagellate diversity along a subtropical Permanently Open Estuary: emphasis on potential harmful species

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Dinoflagellates are one of the most economically and ecologically important phytoplankton groups in aquatic systems as they are primary producers, heterotrophs and well known as causative agents of red tides and harmful algae blooms. It is therefore imperative that in aquatic systems with human interactions and/or shell fish harvesting, potential harmful species are known, monitored and their driving factors understood. Dinoflagellate abundance, species composition and diversity was investigated in a subtropical permanently open estuary (Mlalazi, South Africa) to understand the variation of species with emphasis on harmful species. The Utermöhl method and inverted microscope were used to settle and enumerate cells. Scanning electron micrographs and relevant literature were used for identification. Forty-two dinoflagellate species, nine of which are harmful, were recorded for a year. Species composition and abundance differed between the three sites

[*p*=0.001, F=2.98] along the length of the estuary and four seasons [*p*=0.001, F=2.55]. Total abundance ranged from $4.00x10^1$ - $6.03x10^5$ Cells/L with highest and lowest values in the middle and upper reaches respectively. The harmful *Prorocentrum cordatum* was most dominant and present in all sites and seasons. Amongst the sites, species richness and diversity ranged from 26 - 35 and 0.39 - 0.48 respectively. Richness was highest at the lower reach while diversity was highest in the middle reach. Some dominant species (accounting for >10% abundance) recorded were *Prorocentrum cordatum, P. micans, P. redfieldii, Scrippsiella trochoidea, S. spinifera, Protoperidinium steinii, P. bispinum, Oxyrrhis marina, Gyrodinium estuariale, Diplopsalis lenticulata, Durinskia capensis, Gonyaulax spinifera* and *Peridinium quinquecorne*. Dinoflagellate composition and abundance in this subtropical permanently open estuary was influenced by temperature, turbidity and dissolved inorganic phosphorus and nitrogen. This study reveals the presence of harmful dinoflagellate species which have the potential to bloom with increase in dissolved inorganic nutrients, a common occurrence in our degrading estuaries.

The development of the Wilderness Embayment during the Holocene based on micropaleontological evidence

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A fossil-rich record from a 30.47m sedimentary core extracted from the coastal lake, Eilandvlei in the Wilderness Embayment on the southern Cape coast revealed the Holocene development of the system. Biostratigraphical sequences of diatom, ostracods and foraminifera, grouped by salinity preferences, show a strong marine signal from the onset of the record at 8900 cal. BP in response to post-glacial sea level rise. Coincident with dilute diatoms suggesting freshwater influxes, which briefly shifts the system to a brackish environment at 7300 until ~7000 cal. BP. A mid-Holocene transgression submerged the embayment and returned marine conditions until 4700 cal. BP. During this stage, increases in the marine diatom *Paralia sulcata* suggest frequent coastal upwelling between 6800-6000 cal. BP brought about by the prolonged exposure to easterly winds along the coast emanating from a strong the ridging South Atlantic High Pressure cell. Subsequently, the southern westerly winds expanded equatorward promoting the advection of surface plumes off the current onto the Agulhas Bank from 6000-5000 cal. BP, favoring a community tolerant of warmer waters. After 4700 cal. BP, marine influences begin to recede transitioning the embayment into a lagoon-like state. Brackish-marine taxa flourished during this period but began to wane and give way to a brackish to fresh community as sea incursions declined. This lead to water level fluctuations and ultimately bringing about the modern state, that of a coastal lake by 1400 cal. BP. The record provides a detailed and high-resolution account of environmental changes indicated through the fluctuations in the biological assemblages, which are comparable on a regional and global basis.

Problematic cyanobacterial blooms in water abstracted from the Vaal Dam.

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Several studies have indicated that many South African water bodies suffer from eutrophication and an increase in cyanobacterial blooms. *Microcystis* blooms in particular are of critical concern for water quality and ecosystem health due to the potential of this cyanobacterium to produce hepatotoxic microcystin. South Africa's largest bulk water treatment facility abstracts water from the Vaal Dam via a canal, to produce approximately 3800 ML of drinking water a day. A survey of different physical and chemical parameters indicated very little temporal changes during the study period (from 2000-2013). *Microcystis* cell densities and microcystin concentrations at the Vaal Dam wall showed relatively low average concentrations for both *Microcystis* cells and microcystin. Results indicated that during the 13 years of sample collection there were only sporadic incidences of high *Microcystis* cell counts together with high microcystin concentrations. The percentage composition of phytoplankton groups in the Vaal Dam showed a succession where Cyanophyceae are dominant during the warmer months and, Bacillariophyceae and the Chlorophyceae are dominant during the cooler and winter months. The cyanobacteria consisted mostly out of *Microcystis* (69%) and *Anabaena* (31%) while the diatoms consisted mostly out of the filamentous *Aulacoseira* (53%) and the centric diatom *Cyclotella* (38%). The Chlorophyceae was mostly comprised of *Chlamydomonas* and other Chlorophyceae that occurred were *Actinastrum*, *Oocystis* and *Micractinium*. Dinophyceae and Euglenophyceae occurred to a lesser extent. During the study period between 2009 and 2011 six sampling occasions showed phytoplankton counts below the detection limit. However despite the relatively low cell count, sporadic event of extreme high cell counts makes it difficult to anticipate water purification problems associated with cyanobacteria in the Vaal Dam.

Pulsed Electric Field Application to Algaculture: Predator Control and Product Extraction

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This research focused on the application of Pulsed Electric Field (PEF) processing on the growth and biochemical component extraction of microalgae and microalgae products. PEF processing uses short, high voltage electrical pulses to disrupt cell membranes. The two distinct objectives for this effort were: 1. Assess the use of PEF as a pretreatment for extraction of algal compounds, and 2. Investigate the application of PEF processing as a low-cost, chemical-free method of microalgae crop protection via mitigation of destructive predator organisms. Fourteen different strains were assessed under varying PEF conditions. We confirmed the ability of PEF processing to disrupt cell membranes or lyse multiple strains at reasonable field strengths and at costs lower than drying the algae for extraction. PEF treatment killed rotifers, ciliates, and *Poteriochromonas*, a very difficult flagellated

algal predator, at field strengths that were non-lethal to *Chlorella vulgaris*. We are the first researchers to demonstrate PEF lethality of *Poteriochromonas*. In addition, there appears to be a sub-lethal stress effect on some algal strains, making them less permeable to Sytox® staining and potentially enhancing algal growth. The implications of this remain to be assessed. Our results indicate that PEF treatment is a viable method of low energy extraction of algal components, with varying levels of efficacy against different species. The cost of PEF ranges from much lower than drying for freshwater extraction to comparable for brackish strains. Treating pre-concentrated algae requires no more energy than treating typical growth cultures, significantly reducing the energy required on a dry-weight basis. PEF treatment of algal predators appears to be a cost effective, chemical-free approach, which can be applied without damage to the alga itself.

Algal assemblages of the Mooi River System and the correlation with the anthropogenic activities in the surrounding area

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The Mooi River System is influenced by a number of anthropogenic factors such as agricultural and mining activities in and around the Potchefstroom area which may influence the water quality of the river. The city of Potchefstroom obtains its potable water from surface- and groundwater in the Mooi River catchment. Klerkskraal Dam is the most pristine site of the system but the water quality deteriorates after the confluence with the polluted Wonderfonteinspruit upstream from Boskop Dam. Potchefstroom Dam is downstream from both the Wonderfonteinspruit and Boskop Dam and acts as an accumulation point for the mining and agricultural pollutants gathered in the system. The aim of this study was to survey algal assemblages from the headwaters to the confluence with the Vaal River. Surface water samples were collected from January 2014 until April 2015 from 7 sites along the Mooi River System. Samples were used for chemical analysis as well as the enumeration of algae and cyano-prokaryotes. A species list of the algae and cyano-prokaryotes compiled for each site showed a significant difference between the reservoir and stream locations. Chlorophyceae was the dominant class at the reservoir locations and the river locations had more Bacillariophyceae species. The Mooi River System was classified as an oligotrophic to mesotrophic river system during the study of Venter *et al*., 2013. This study illustrated elevated levels of nitrite/nitrate as well as a concerning increase of phosphate concentrations in the system. The entire system can no longer be classified as an oligotrophic to a mesotrophic system, the sampling sites closest to the confluence with the Vaal River did indeed fall in the eutrophic category and also showed potential to reach hypertrophic ranges putting this system at risk and emphasising the importance of future monitoring.

Microalgal dynamics associated with living stromatolites along the Eastern Cape coastline of South Africa

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Living stromatolites are rare in modern ecosystems but previously dominated shallow oceans during the Precambrian, from 0.5-3.7 bya. These structures form through the layered trapping of sediment and cellular deposition of calcium carbonate by microalgae, principally cyanobacteria and diatoms. An extensive network of actively accreting stromatolites has been discovered within the past decade along the South African coastline. These coastal stromatolites form at the interface of groundwater seepage and the ocean high water mark, constructing rimstone dam-like pools at an accretion rate of ~2-5 mm per year. The aim of the current study was to characterise the biological community from representative stromatolite sites near Port Elizabeth, South Africa, in terms of microalgae and macroinvertebrates, as well as to describe some of the functional drivers of community change. Key physico-chemical attributes of the stromatolite pools are related to the frequent, complete states shifts between freshwater and marine conditions, driven by tidal and ocean swell variability. Salinity, as well as temperature and macronutrient concentrations (dissolved inorganic nitrogen and phosphorus), are the primary drivers of biological community change within the microalgal assemblage. These results are discussed in light of stromatolite persistence in modern ecosystems, especially in terms of the factors which preclude stromatolite formation in other habitats, such as metazoan bioturbation or grazing.

ABSTRACTS OF POSTERS

(Listed alphabetically, by presenting author)

Analysis of land use and its influence on the water quality of the Sabie River catchment

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River health is closely associated with surrounding land use practices and is of the utmost importance to water quality for both domestic uses and sustainable ecological flow. The Sabie River Catchment represents an X3 secondary catchment and forms part of the Inkomati System that originates in the Drakensberg and extends into Swaziland and Mozambique. The three main tenure classes within the catchment is commercial (west), communal (centre) and conservational (east). Land use in this catchment is strongly linked to topographical changes when moving from west (head waters) to east. Land use and land cover play very important roles in general river ecosystem health. During this study these influences where assessed through the use of river water properties at different study sites within the Sabie River Catchment. Although there are 56 broad land use types in the catchment contributing to changes in water parameters, future urbanization and especially in rural settlement developments (such as the Bushbuckridge community) is causing the most concern. Non-Metric Multidimensional Scaling (NMDS) analysis could clearly distinguish between the sites within

conservation areas, rural settlements and sites close to agricultural areas. Land use practices could then be related to water quality parameters. Rural settlements could be correlated to high counts of *E.coli*, nutrient levels, and TOC concentrations. While the conservation areas also related to these parameters but with lower average values this was most probably due to the low water levels experienced during 2016. At the sampling site in the Sand River within the Kruger National Park high levels of calcium and other metals was observed.

The effects of kelp forests on the inshore physical environment

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Within South African kelp forests of *Ecklonia maxima* it is unknown how water movement and temperature are influenced by the presence of kelp. The aim of this project is to understand the physical environment created in kelp forests. It is hypothesized that the presence of kelp forests will break wave energy and water flow as well as change the albedo within the kelp forest, aiding in the temperature stratification of the water column. In order to investigate the temperature profile and flow dynamics within kelp forests a number of kelps are being fitted with accelerometers, and lines of temperature and light sensors are being installed (HOBOUA-002-64 and HOBOUA-004-64). Kelps chosen to be equipped with sensors are in three different positions within the kelp forest: freestanding past the outer edge, in sparse stands on the edge, and in the dense kelp stands in the center. These sensors allow physical data to be collected in three dimensions in the kelp forest, enabling questions to be answered on the kelp forest's ability to attenuate wave energy and detailing the temperature stratification and light environment along the depth profile within the forests. Data will be presented from a sampling site at Buffels Bay, in False Bay, showing the effects of the presence of kelp through a five day sampling period. The Buffels Bay data set shows water temperature change during night day cycles, disruption of this pattern by increased wave action during the sampling period, turbulence created by the kelp and its influence in altering temperature stratification and the light regime. These studies will provide detailed information on the physical environment experienced by individual kelps growing in different kelp forest positions, as well as the impact of this ecological engineer species on the environment experienced by other members of the kelp forest ecosystem.

Shell morphology and reproduction of *Scutellastra longicosta* along the Wild Coast, South Africa

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Limpets are heavily exploited as an alternative food source along the Wild Coast. However, more pressure is exerted on the larger individuals due to their meat to shell volume. This threaten *Scutellastra longicosta* since body size, together with sea surface temperature, is main trigger of reproduction in this limpet. Reproduction in South African limpets has been understudied and this

study thus aimed to relate gonadal development and sex differentiation to the shell morphometry of *S. longicosta* limpet. Individuals of *S. longicosta* were collected in Dwesa marine protected area and shell dimensions such as shell length, shell width and shell height were measured. Wet weight, somatic mass, visceral mass and gonad weight were then weighed. To determine the shape of *S. longicosta* shell coneicity and shell ellipticity were calculated, while gonad somatic index (GSI) was calculated for reproductive output. Results showed that this species was protandrous with females having a gonad weight and GSI than males. All the limpets below 30 mm were neuters. The shell morphometry directly influenced the GSI, with conical limpets having a bigger GSI than the flat and spherical limpets. Results from this study have an implication in the conservation and management of *S. longicosta* in South Africa.

Mapping the zonation pattern of both limpets and seaweeds in Hluleka Marine Protected Area

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The Wild Coast is a transition between the warm subtropical East Coast and the cold temperate West Coast of South Africa. As such, this area comprises some species with both cold temperate and subtropical affinities. Therefore, changes in sea surface temperatures will lead to a dominance of either cold species or subtropical species. Research has shown that global warming will lead to increased sea temperatures, which will result in dominance of subtropical species in areas formally occupied by temperate species. The purpose of this study was therefore to locate, identify and map the distribution of limpets and seaweeds in Hluleka MPA. The study also aimed to quantify the effects of habitat heterogeneity on limpet and seaweed diversity. Vertical line transacts were laid from high shore to low shore and species were identified. Species diversity and density were recorded. All data were mapped and analysed using QGIS. Rhodophytes such as *Jania verrucosa, Hypnea spicifera* and *Arnthrocadia carinata* were found co-existing in mixed habitats from mid to low shore. Brown crustose algae such as *Ralfsia verrucosa* and *R. expansa* occupied emergent rocks on the low show but preferring mixed habitats in the mid shore. *Fissulera natalensis* and *Cellana capensis* were the most abundant limpet species in rock pools and mixed habitats. Overall, the zonation pattern and species diversity of Hluleka MPA was determined mostly by habitat types.

Common terrestrial algae and cyanobacteria of Southern Africa

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Surveys of different terrestrial environments show that algae and cyanobacteria can colonize a wide spectrum of non-aqueous substrates such as mafic and ultramafic soils, sandy soils of the Kalahari, rock faces, buildings and even heavy metal-rich mine tailings. Moisture and surface temperatures are

key factors in the establishment of these organisms and higher plants can create windbreaks and shade, influencing the moisture content and light intensity and creating suitable habitats for these microorganisms. Bacillariophyceae and Cyanophyceae are usually more characteristic of alkaline environments while Chlorophyceae can colonize more acidic soils. Cyanoprokaryotes such as *Leptolyngbya foveolarum, Microcoleus vaginatus, Phormidium ambiquum, Calothrix, Syctonema* and different species of *Nostoc* were found in most of the surveyed sites, including on mafic, ultramafic, and dolomite substrates. These filamentous cyanoprokaryotes can colonize the uppermost soil layers, forming a net-like structure that binds together soil particles. This forms soil aggregates that create pathways for water infiltration and surfaces for nutrient transformations, while also increasing the soil's resistance to wind and water erosion. Cyanobacteria are usually the dominant photosynthetic microorganisms on rocks and buildings. Other common terrestrial algae include the Chlorophyceae, represented by mainly coccoid genera such as *Chlamydomonas, Bracteacoccus* and *Chlorococcum*, and Bacillariophyceae represented by *Hantzchia amphioxys, Pinnularia borealis, Luticola goeppertiana* and *Luticola nivalis.*

Cultivating *Macrocystis pyrifera* (Laminariales) 'angustifolia' ecomorph for abalone feed, through holdfast fragmentation and vegetative propagation

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Macrocystis pyrifera is a large brown alga, found along rocky shorelines, throughout much of the temperate oceans. Global *Macrocystis* populations display variations in holdfast and blade morphology, and as such can be split into four forms or 'ecomorphs'- 'pyrifera', 'integrifolia', 'angustifolia' and 'laevis'. Little work has been done on South African *M. pyrifera* and little is known about these populations. The purpose of this study was (1) to document the population structure and basic morphology of the *M. pyrifera* 'angustifolia' along the southwest coast of South Africa, and (2) to determine if South African *M. pyrifera* can be cultivated through holdfast fragmentation and vegetative propagation for abalone feed. Morphometric data were obtained from *M. pyrifera* collected from Oudekraal, Kommetjie and Melkbosstrand. *Macrocystis pyrifera* was collected from Jacobsbaai and split into three treatments: Juvenile- holdfast fragments with one upright around 50 cm long, Simulated Harvesting- holdfast fragments with one upright cut to 1 m, and Holdfast- holdfast fragments with no uprights. These were then attached to a rope raft system in Saldanha Bay and measured over the course of three months. In natural populations, upright length ranged from 170 - 275 cm and occurred in densities of 30 - 40 uprights.625 cm^{-2}. Sporophyll fertility varied from 42 - 54 %.625 cm^{-2} and holdfast weight ranged from 865 - 3900 g.625 cm^{-2}. Samples in the Simulated Harvesting treatment survived, but stipe elongation stopped. The complete removal of uprights in the Holdfast treatment caused *M. pyrifera* holdfasts to die. *Macrocystis* in the Juvenile treatment grew well, nearly doubling in upright length over three months. Upright relative growth ranged from 0.99 – 1.22 %.day^{-1}, and samples developed new uprights and larger holdfasts within the growing period. Therefore, South African *M. pyrifera* 'angustifolia' does have the potential to be cultivated through holdfast propagation, for abalone feed.

Environmental Control of Distribution in South African Kelps

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Responses to climate change are particularly rapid and strong in marine ecosystems and climate-change induced range shifts are more predictable for marine than for terrestrial species. Kelps in particular are dominant organisms on rocky shores around the world and any changes to these kelp beds which may occur due to climate change and interactions with other human pressures could immediately and critically affect the coastal ecological balance and human livelihoods (Wernberg et al 2011). The loss of this dominant habitat-forming foundation species can set off a cascade of indirect changes within an ecosystem (Johnson et al. 2011). Climate change could thus have its strongest effects where temperature alters recovery of foundation species from local pulsed disturbances, linked to climate systems. Moreover, ecosystems that are common globally and defined by foundation species that are taxonomically closely related provide a unique opportunity to understand the generality of the effects of climate change. To address the possibility of kelp shifts, this project assesses the evidence and potential for change in these ecologically and socio-economically important systems, based on the environmental tolerances and biogeography of the kelps. The current South African and global distributions of South African kelp species, *Laminaria pallida, Ecklonia radiata* and *Ecklonia maxima,* will be studied via both biological niche modelling as well as laboratory experiments. The study utilises Maximum Entropy (MAXENT) modelling using the global environmental dataset BioOracle (Tyberghein et al. 2011) to predict potential future range shifts of Southern African kelps. Heat-shock experiments, using temperatures denoting warm events and extreme conditions, assess temperature tolerance levels of *Laminaria pallida,* and are aligned with results of similar experiments on *Laminaria ochroleuca.* This research contributes to studies on the impacts of environmental change on kelp systems. It also provides a critical body of research into potential effects of climate change on kelp forest niches, placing South African kelp climate change studies in a Southern Hemisphere and global context.

Growth and reproductive seasonality of *Helcion concolor* along the Wild Coast of South Africa

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Helcion concolor (Krauss 1848) is found in Indian Ocean of Mozambique and the East Coast of South Africa where it is regarded as the variable limpet due to its colour variation. The growth and reproduction of the variable limpet *Helcion concolor* was measured in Nqabara along the Wild Coast. This study thus aimed to measure the seasonal growth rate of *Helcion concolor* in Nqabara along the Wild Coast. It also aimed to establish the annual reproductive cycle and the frequency and duration of the spawning cycle for this species. Shell dimensions such as shell length (SL), shell width (SW), shell height (SH) were measured monthly. Body weight (BW), somatic mass (SM), visceral mass (VM) and gonad weight (GW) were also weighed monthly. Shell conicity (SC), shell ellipticity (SE) and gonad somatic index (GSI) were then calculated to determine seasonal variability. Strong correlations were detected between SL, SW, BW, SM, VM and GM. SH correlated with SC, whereas

SW only correlated with SE. Gonad Somatic index showed that spawning started in late spring and peaked in summer, then ended in early autumn. The females (SL=4.475±0.28cm, BW=6.686±0.79g) were always bigger than the males (SL=4.12±0.16cm, BW=4.658±0.41g) suggesting that *H. concolor* is a protandrous hermaphrodite. Gonad size of females (0.884±0.18 g) was also bigger than that of males (0.727±0.09 g). Overall, the results showed that seasonal variations were more pronounced in reproduction than in the growth of *H. concolor*.

Habitat preference of intertidal organisms on rocky shores of the Wild Coast, South Africa

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Habitat heterogeneity increases the surface area of rocky shores and results in higher diversity along the rocky shore. Hence substrate for attachment is limited along the rocky shores. This study investigated the effects of habitats heterogeneity on species distribution and diversity. The habitats and biota from Dwesa and Silaka reserves were therefore quantified. Various habitats were identified and grouped into six categories which are: the rock pools, grooves, emergent rock outcrops, boulders, mixed habitats and secondary habitats. Biota was grouped into invertebrates, limpets and seaweeds. The results showed that mixed habitat was the most dominant, while fissures were least common. Species such as *Afrolittorina africana* and *Tetraclita serrata* were the most abundant invertebrate species on emergent rock outcrops. *Cellana capensis* was the dominant limpet on the outcrops and mixed habitats. Rock pools were characterized by the encrusting coralline algae such as *Ralfsia verrucosa* and *Phymatolithon foveatum* seaweeds. *Oxystele tabularis* and *Perna perna* were abundant in grooves while G*elidium pristoides* was the dominant species on secondary habitats. Overall, the habitat type was found to be important in determining the diversity and distribution of organisms along the rocky shores of this reserve.

Macroalgal distribution in peritidal seeps on the Port Elizabeth coast

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Coastal peritidal seeps on the Port Elizabeth coast have received increased attention due to the recently discovered association between these wetlands and stromatolite forming microbes. These small (< 25m^2) systems rely on freshwater inflow from coastal freshwater seeps, as well as seawater input from overtopping during spring tides, resulting in estuary-like conditions. Macroalgal distribution within these systems appears to vary spatially in response to small scale differences in physical conditions, most notably salinity. However, the algal communities in these systems, as well as the factors that drive their distribution and abundance, have not been well described. An attempt was made to determine the main drivers for the distribution of the dominant macroalgal species in

these systems. The physiological responses to light and salinity were determined for the dominant macroalgae in these wetlands. These responses were related to light intensity and salinity conditions in various portions of these waterbodies. *Polysiphonia* sp. and *Cladophora* sp. showed broad salinity tolerance ranges, while *Cladophora* exhibited a preference for high light intensities, suggesting that light intensity rather than salinity is the main factor determining the distribution of these species in the system.

The effects of different algal substrates on larval settlement, and the effects of algal feeds and temperature on the growth and survival of post-settled *Tripneustes gratilla* (Linnaeus, 1758) sea urchins

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The gonads of the tropical sea urchin *Tripneustes gratilla* are highly sought after in the seafood industry, especially in Japan. Echinoculture could be of great economic and social benefit to South Africa if an aquaculture industry for commercial exports were to be established. Natural populations have been fully exploited in many countries and due to an increasing global demand for urchin roe, establishing an echinoculture industry would reduce fishing pressure contributing towards the conservation of these species. For the successful cultivation of this species, larval settlement and post-settled growth and survival needs to be improved. This project aims to determine the effects of different algal substrates on larval settlement and algal feeds on the growth and survival of post-settled juvenile urchins at two temperatures (20˚C and room temperature: average of 26.09˚C). The six feeds/substrates included four diatom monocultures (*Amphora* sp., *Nitzschia constricta, Navicula jeffreyae* and *Cocconeis* sp.), a locally-occurring mixed diatom community and a green crustose macroalga *Ulvella lens.*, with five replicate plates per temperature treatment. Direct transesterifications were performed on the diatoms to analyse whether the algae differed significantly in fatty acid (FA) composition and amount. Test diameter (µm) data was collected every 7 days for 22 days. No significant difference in growth and survival was found between the temperature treatments. The mixed diatom community induced significantly higher levels of settlement than the single strains of diatoms and contained significantly more % FA than the other diatoms. The *U. lens* feed resulted in significantly higher growth and survival rates than the other feeds, confirming the use of *U. lens* as a suitable feed for post-settled juvenile *T. gratilla*. This research has contributed towards identifying optimal settlement substrates and algal feeds of *T. gratilla*, confirming the potential to establish an echinoculture industry in South Africa.

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