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OFFICE BEARERS OF THE PSSA



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FROM THE EDITOR

Our lives have drastically changed over the past few months, in response to the pandemic caused by the novel coronavirus, COVID-19. In South Africa, we have responded to this threat with a national lock-down, in an effort to limit the spread of the virus and save lives. This has undoubtedly impacted us all, with many now working from home. While this may be a challenge for some, it has given others much needed time to complete their research, or compile the next newsletter ;). I hope you are all doing well during these unprecedented times.

Fortunately, some of you were able to attend the last PSSA congress, which may prove to be one of the very few conferences to be held in 2020. This issue of the PSSA newsletter series largely serves as a record of the 32nd PSSA congress.

MAGGIE REDDY

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PHOTO CREDIT: GAVIN MANEVELDT

THE SEA WOMAN OF JEJU, SOUTH KOREA

GAVIN MANEVELDT

The 23rd International Seaweed Symposium (ISS2019) was held from 28 April to 3 May 2019 on the island of Jeju, a special self-governing province of South Korea. The scientific theme of ISS2019 was “Seaweeds: From Tradition to Innovation”. Included in the opening ceremony, in the mid conference tour programmes, as well as among the various exhibitions, the haenyeo tradition was richly portrayed.

HAENYEO

Haenyeo (pronounced ‘henyo’), quite literally meaning ‘women of the sea’, are female divers from Jeju, South Korea. In this semi-matriarchal family structure women have largely replaced men as the primary labourer. In communities where sea-diving became the sole source of income, this reversal of gender roles was taken to the extreme with husbands looking after the children and going shopping while their wives and daughters would bring in money for the family.

**HAENYEO FROM THE
HADO FISHING VILLAGE.**



PHOTO CREDIT: GAVIN MANEVELDT

Jeju is a volcanic island and so rich fertile farmland is scarce. Consequently, the Jeju people were forced to rely heavily on the sea and on diving. Jeju’s diving tradition dates back to around 434 A.D. Diving was originally an exclusively male profession and the first mention of female divers only appeared in the 17th century. According to the island’s Haenyeo Museum, haenyeo numbers peaked in the 1960s at around 23 000. Two possible reasons provided for this increase was suggested to result from the many foreign wars that drained Jeju’s men away from the island as well as the fact that women’s earnings were exempt from the heavy taxes imposed by the then Korean king.



Today, however, less than 4 300 haenyeo remain on the island. Reasons provided for this exodus from the profession include better education opportunities and more attractive positions in emerging industries that have deterred younger woman from becoming haenyeo.

Consequently the haenyeo way of life is aging with roughly 98% of haenyeo being over the age of 50 and a significant proportion being older than 70, but still among the hardest workers after more than half a century in a job they began as teenagers. Many haenyeo are in their 80s and the oldest active haenyeo is 93 years of age.



PHOTO CREDIT: GAVIN MANEVELDT (2)

What is remarkable about the haenyeo is that they use no breathing equipment, relying solely on breath-hold diving and their remarkable abilities to equalise with depth. Their diving equipment include: an old-fashioned, headlight-shaped scuba mask; lead weights strapped around their waists and back to help them sink; and a large round flotation device (called a *tewak*), with a collecting net hanging beneath it. Depending on what will be harvested a *bitchang* or *homaeng-i* (flat hand hoe for collecting abalone and other shelled molluscs), a *kkakkuri* (a hoe for collecting sea urchins and octopus), a *jaksal* or *sosal* (a harpooned stick for spearing fish) and/or a *jeonggehomi* (sickle for collecting seaweed) will be used. Traditional haenyeo garb called *mulot* was originally composed of only three pieces of cotton items: a *mulsojungi* or pants, a *muljeoksam* or jacket and a *muljugun* or hair piece. Since the 1970s though, rubber diving suits have replaced the traditional attire. These rubber suits have greatly increased haenyeo productivity through increased working time and deeper dives from 30-60 mins per day with the older garb, to 3-6 hrs per day in the rubber suits, but have also come at a cost of motion and decompression sicknesses.



PHOTO CREDIT: GAVIN MANEVELDT (2)

HAENYEO PREPARING TO DIVE FOR SEAFOOD ALONG GWANGCHIGI BEACH.

Depending on the weather conditions, Jeju haenyeo may harvest for up to six hours a day, 18 days a month, 90 days of the year. Haenyeo are categorised into three groups depending on their level of experience: hagun (beginners - diving independently at the age of about 15, but learning to swim and dive from as young as eight years old), junggun (intermediate divers - diving to 7 meters depth and holding her breath for between 40 seconds and a minute), and sanggun (experts - reaching depths in excess of 10 meters and holding her breath for around two to three minutes). Haenyeo make a peculiar, yet distinctive, breaching sound (sumbisori - meaning 'breath sound' is an ancient whistling breathing technique) when they resurface. Since the haenyeo have limited vision because of their masks, these aural sounds are acoustic location markers assisting fellow divers to track each other's position, acknowledge each other's presence, and to signal one another if something goes wrong.

Haenyeo harvests account for as much as 60% of Jeju's fisheries. Jeju is known for its rich seaweed diversity (with over 700 species recorded) and while most seafood harvesting is for subsistence, seaweed collection is far more lucrative. On a good day a haenyeo can make up to 650 US\$ (selling at 1US\$ per kg of seaweed) collecting seaweed.



A KELP (ECKLONIA CAVA) SNACK MARKETED BY THE GIMNYEONG HAENYEO VILLAGE.

Haenyeo collect seafood in a sustainable manner. They never collect juvenile fish and shellfish, and prohibit harvesting at certain times of the year (especially during spawning seasons) to preserve the region's ecology. For this very reason, and because of their rich cultural heritage, in 2016 UNESCO awarded the divers a Cultural Heritage of Humanity designation. The Korean government hopes that through this designation the haenyeo way of life might be maintained into perpetuity.



A SCENE FROM THE MUSICAL GALA AT THE ISS2019 OPENING CEREMONY DEPICTING A STORY AND THE CULTURE OF THE JEJU HAENYEO.

PHOTO CREDIT: GAVIN MANEVELDT 2

THE 23RD INTERNATIONAL SEAWEED SYMPOSIUM (ISS2019)

NEILL GOOSEN

So the world is talking about seaweeds. Very excitedly, sometimes vaguely in a hand-waving and uninformed manner (not that I necessarily count myself to be among the informed), using words like 'stuff' and 'as such and so forth', but at least they are talking. At long last the world (actually, more the Western world as the East seems to have woken up to this a long time ago) seems to be realising the potential that these organisms hold to advance discovery and innovation in a range of different scientific fields, and I cannot think of a time when there was more excitement within the seaweed community. And every once in a while the community gathers to talk about only and all things seaweed at, for instance, the International Seaweed Symposium (yes, there is such a conference!) that was recently held in South Korea.

What was obvious at the symposium was that 'seaweed people' come from all walks of life and all kinds of disciplines, ranging from the pure biological sciences to applied biology and aquaculture, to health professionals and engineers. In my mind, the reason for this is simple: seaweeds are endlessly interesting, extremely diverse and undoubtedly they still harbour some mysteries that we need to unlock.





PHOTO CREDIT: GAVIN MANEVELDT



For me, as an engineer interested in how we process seaweeds in the best manner to recover some of the high-value compounds from them, working with seaweeds as a feedstock has thrown up some interesting challenges yet also opened up some amazing commercial and scientific opportunities. Compared to processing well known terrestrial biomass, seaweeds can be odd at times. For instance, they don't contain lignin (which is great and could simplify processing), but they do contain polysaccharides which are unique in the sense that sulphate groups form part of the polysaccharide structure. However, if one would want to use environmentally friendly enzymatic processing methods, very few commercial enzymes are available for this simply because almost all commercial enzymes have been developed to process terrestrial feedstocks. Seaweeds also contain hydrocolloids (gel-forming polysaccharides like alginate and carrageenan) which can be a valuable product in themselves, or a nuisance when trying to recover other compounds beside these gelling agents. The list of peculiarities when processing seaweeds is almost endless, and in a world where the demand for novel and bio-based products is continually escalating, scientists and engineers will have to come up with increasingly innovative methods of supplying these. Discussion around the details of the detailed aspects of processing seaweeds abounded with a lot of different viewpoints being raised, but the general consensus was that whatever processing routes are viable, seaweeds are anticipated to play an important part in meeting future demand in biological products.

Being my first Seaweed Symposium and therefore almost 'coming in from the outside', it was heartening to see how the community embraced all disciplines and encouraged good and rigorous science. The few South Africans at the event also quickly found one another and talked all things seaweed and South African, and the enthusiasm around expanding the knowledge about our rich South African resources was contagious. And I won't be surprised if a braai recipe for kelp sees the light soon!

32ND PSSA CONGRESS



PHOTO CREDIT: GAVIN MANEVELDT (2)

The 32nd PSSA congress was held at the Wavecrest Hotel and Spa, situated along the scenic Eastern Cape coastline of South Africa. The conference took place from the 12th-16th of January 2020, and was attended by 25 delegates representing 8 South African institutions. Talks covered a broad range of topics from many facets of phycology. Field trips to a nearby mangrove, rocky shore exploration, and a boat trip along the Ngqusi Estuary allowed participants to unwind and enjoy the beauty the Eastern Cape has to offer.

CONFERENCE EXCURSIONS AND PRIZES

PSSA 2020 WAVECREST HOTEL AND SPA



WE EXTEND OUR CONGRATULATIONS TO THE PSSA 2020 CONFERENCE PRIZE WINNERS

Best Oral: Luca Stirnimann (PSSA)

Best Poster: Dhirren Vanmari (PSSA)

Seaweed Development and Innovation presented by Taurus LTD: Wendy Stirk

Klaus Rotmann Memorial Prize for commercial seaweed presented by Taurus LTD: Mariska van Tonder



PHOTO CREDIT: GAVIN MANEVELDT (2)

MESSAGE FROM THE PRESIDENT

MARK ROTHMAN

Thank you to Tommy Borneman and Paul-Pierre Durant for hosting us at this wonderful venue and putting together a great conference.

The Society wants to thank all the supervisors for bringing their students to the meeting. Students is the lifeblood of the society and once again it was great to have so many students here. We had 26 delegates of which 10 were students – almost 40%. I want to encourage supervisors to make every effort to get their students to conferences. These moments tend to stick in one’s mind and it serves as motivation to work harder and get done.

Students, make connections and ask for help, everyone here want to see you excel. PSSA is more than just a group of people; we are a community.

The industry’s participation is also invaluable, and we thank Taurus for always participating in our meetings and supporting what we do. It is appreciated.

I am looking forward to 2020. I want to see the Society grow, especially in establishing more international links.

It is an honour to serve as President Elect.



PHOTO CREDIT: GAVIN MANEVELDT (2)

SECRETARY- TREASURER'S REPORT

LEKRAJ ETWARYSING

The Society has a Money Market Account, that is held at First National Bank. Money Market Accounts have a basic monthly charge, a cash handling fee, and higher interest rates than conventional current accounts. There is a cheque book linked to the account for convenient handling of payments. There are two signatories (currently John Bolton and Mark Rothman), although withdrawals or cheques only require one signature. The Society has opening balance of R 117,070.64 as from 1 April 2020.



PHOTO CREDIT: GAVIN MANEVELDT

IMPORTANT NOTE: All income and expenses are not finalised and projected figures are being reported here. A full financial report will be published in our next newsletter.

The general election will take place at our next meeting in 2021. Call for nominations will be sent out via e-mail later this year, and voting will take place at our next meeting. The members of the council are very grateful to the Faculty of Science at Nelson Mandela University and Taurus Cape Kelp for their generous donation and sponsorship. Finally, we are thankful to the Organising Committee - Tommy Bornman, Paul-Pierre Steyn, and Debbie du Preez for making this year's PSSA possible.

It has been a pleasure serving as Secretary/Treasurer.



PHOTO CREDIT: GAVIN MANEVELDT

MEMBERSHIP REPORT

CHRIS BOOTHROYD

MEMBERSHIP	REGIONAL	INTERNATIONAL
LIFE	11	1
CORPERATE	3	0
ORDINARY	28	5
STUDENT	44	5
GRAND TOTAL		97

FROM THE NEWSLETTER EDITOR

MAGGIE REDDY

It has been an absolute pleasure serving as the editor for the PSSA newsletter series since July 2018. Thanks to all those who have contributed to the newsletter series during this time. Over the past 18 months, two issues (84 and 85 issues) have been compiled, edited and distributed to current members who are subscribed to the PSSA mailing list. These issues are also available online via the PSSA website for non-members to access. The 84th issue largely served as a record of the 2018 PSSA conference proceedings, while the 85th issue included contributions from international algal working groups, local researchers, and at least 2 students covering a broad range of algal-related topics. I hope such enthusiasm continues for the upcoming issues. My intention is to compile a new issue every 6-8 months, but the viability of this depends on your contributions.

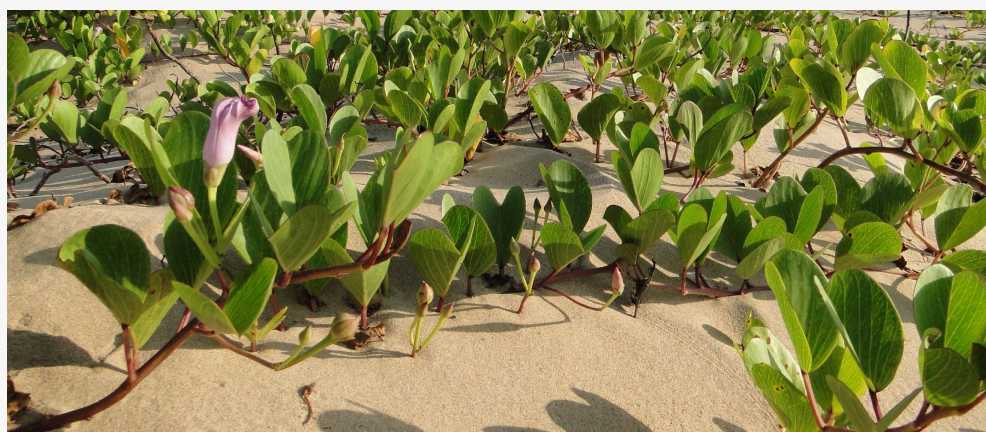


PHOTO CREDIT: GAVIN MANEVELDT

Science communication is fast becoming an integral part of research in the modern era. Popular articles are an effective way to communicate your research findings to a wider audience, and to ensure that our scientific recommendations become actionable. To this end, I encourage you all to submit a popular article for the upcoming PSSA newsletter. Articles need not be long. ½-2 A4 pages is recommended, and will facilitate the layout. We are interested in hearing from our members about their multidisciplinary collaborations, research visits, field trips, workshops and conference participation. Students, remember that you stand a chance of winning a prize for the best student article at the next PSSA conference.

FROM OUR STUDENT REPRESENTATIVE

KARABO MOKOENA

The 31st PSSA Congress led to the 'digitization' of the PSSA by moving the society onto social media. This was met with mixed emotions but resulted in a small committee, including myself to share all research on a platform that could allow students to engage with a range of people.



PHOTO CREDIT: GAVIN MANEVELDT (2)

We managed to share a few research projects from the newsletter and the 31st PSSA congress, however recent student research was lacking. I have tried to contact as many students as possible via email, however, none of them submitted any new research project they would like to share.

The social media platforms, especially Facebook, resulted in interaction with international psychologist and currently has 279 likes. We would love to increase our presence in 2020 by asking everyone to share their research with us as much as possible.



ORDER OF EVENTS

PSSA CONGRESS 2020



NELSON MANDELA
UNIVERSITY



Phycological Society of Southern Africa



32nd Congress, 12 – 16 January 2020

Programme

Sunday 12 January			
15:00	Arrival & Registration		
18:00	Ice-breaker & dinner		
Monday 13 January			
08:00	Breakfast		
09:00	Orientation		
09:10	Opening & welcome	PSSA President	
09:25	Plenary speaker	G. Rishworth	Life's greatest survivors that beat all past climate change crises.
Session 1		Aquaculture and Industry	Chair: Mark Rothman
09:10	Okkers, N	1	The effect of <i>Ulva</i> extracts on the growth of invertebrate pathogens: implications for integrated aquaculture.
09:30	Etwarising, L	2	Effects of nutrient variation on aquacultured <i>Ulva</i> : A lipidomic approach to investigate the lipid and fatty acid composition of <i>Ulva rigida</i> .
09:50	Rothman, M	3	Trends in seaweed resource use and aquaculture in South Africa and Namibia over the last 30 years.
10:10	Stirk, W	4	Effect of cell disruption methods on the extraction of bioactive metabolites from microalgal biomass.
10:30	Tea		
Session 2		Algal Blooms	Chair: Paul-Pierre Steyn
11:00	Campbell, EE	5	Diatom vs Dinoflagellate: The Sundays River Beach surf-zone during a red tide.
11:20	Human, L	6	Extent and impact of a macroalgal bloom in South Africa's most important estuary.
11:40	Lemley, D	7	Harmful algal blooms in South African estuaries: The "ins and outs" of an emerging issue.
12:00	Pitcher, G	8	Harmful Algal Blooms – their prevalence and impacts in the southern Benguela.
12:30	Lunch		
Session 3		Various	Chair: AJ Smit
14:00	Bornman, T	9	Phytoplankton of the Southern Ocean and its contribution to the biological carbon pump.
14:20	Abrahams, A	10	Variability in upwelling patterns across the Benguela.
14:40	Cotiyane, P	11	Austral winter marine epilithic diatoms along the coast of South Africa.
15:00	Vanmari, D	12	Mechanisms of interference and exploitation competition in a guild of encrusting algae along a South African rocky shore.
15:20	TEA		
16:00	Forest walk		
19:00	Dinner		
Tuesday 14 January			
08:00	Breakfast		
09:00	Housekeeping		
09:30	Excursions		Diving PAM demonstration, stromatolite walk, macroalgal collection, surf-zone diatom collection, mangrove walk/RSET
18:00	Poster Sessions		
19:00	Dinner		

Wednesday 15 January			
08:00	Breakfast		
09:00	Orientation		
Session 4	Microalgae		Chair: Eileen Campbell
09:10	Du Preez, D	13	More than <i>Anaulus</i> : South African surf diatoms and their beaches.
09:30	Mansfield, L	14	Phytoplankton biodiversity of the southern Benguela.
09:50	Seanego, K	15	Phytoplankton communities and the productivity of the Vanderkloof Dam.
10:10	Stirnimann, L	16	Phytoplankton productivity and distribution around Prince Edward Island Archipelago during the Autumn season (2017).
10:30	Tea		
Session 5	Macroalgae		Chair: Tommy Bornman
11:00	Mavombo, N	17	The influence of kelp species, age and part on associated epiphytic diatom assemblages.
11:20	van Tonder, M	18	The potential of native South African macroalgae species as feed ingredients for ruminants.
11:40	Smit, A	19	Kelp forests: Industry perceptions of challenges and opportunities.
12:00	Maneveldt, G	20	Resolving cryptic diversity in South African non-geniculate coralline algae (Corallinophycidae, Rhodophyta).
12:20	Steyn, P	21	Macroalgal communities as indicators of abalone habitat.
12:40	Mdhlalose, M	22	Hard substrate benthic community structure on the East London coast: baseline information for abalone ranching.
13:00			Lunch
Workshops / discussion groups			
14:00 – 14:45	East coast HAB workshop / discussion group		
14:45 – 15:30	East coast kelp workshop / discussion group		
15:30	TEA		
16:00	AGM		
19:00	Banquet		
Wednesday 15 January			
07:00	Breakfast		
08:00	Depart		

Abstracts of Orals

Listed in order of presentation

Plenary Speaker

Life's greatest survivors that beat all past climate change crises

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The history of Earth is riddled with dramatic change, extinction events and species resurgences. These phenomena are richly recorded as fossils or geological imprints and help us to understand past processes of change. A looming climate crisis is facing Earth today. Recently-discovered examples of ancient ecosystems forming on the coastal doorstep of Nelson Mandela University, offer glimpses into life's adaptations, changes and responses to past divergence and extinction events. These habitats (termed 'stromatolites', which are built by a range of microbial organisms and microalgae) have existed from as far back as 3.5 billion years ago and represent the most longstanding and uninterrupted record of ecosystem resilience on Earth. Some examples of these structures still exist today. Exactly what the societal relevance of these are and how they could help us to understand past climate change, coastal processes and species adaptation is being uncovered. The South African stromatolites represent a biodiversity refuge for many species, hosting some unknown and unusual taxa. This year the United Nation's IPBES dramatically published that "a million species are under threat of extinction". Understanding the role that life's diversity offers in responding to climate change is crucial towards knowing how resilient or adaptable our Earth is – this presentation will muse the role of stromatolites in this saga.

Session 1 – Aquaculture and Industry

The effect of *Ulva* extracts on the growth of invertebrate pathogens: implications for integrated aquaculture

Okkers, N¹, Braaf, E², Etwarysing, L³, Macey, BM^{3,4}, Maneveldt, GW¹ and
Beukes, DR²

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Integrated aquaculture is fairly well established in South Africa with at least five farms growing the green seaweed *Ulva rigida*. The *Ulva* is not sold but used as a protein-rich feed and a bioremediation tool. Disease outbreaks, caused by microbial pathogens may have devastating consequences to farms. This may require the use of expensive antibiotics which, in turn, may lead to environmental contamination. The development of a “natural” antibiotic may be useful. *Ulva* species are known to produce a wide array of natural products that act as a deterrent to the microbial community while in culture systems, some *Ulva* species have shown to be resistant against pathogenic infection. The main aim of this study was to evaluate the antimicrobial properties of *U. rigida* extracts (ethanolic, dichloromethane-methanol and water) against nine invertebrate pathogens (*Vibrio splendidus*, *V. anguillarum*, *Lactococcus lactis*, *L. garvieae*, *Aeromonas veronii*, *Roseobacter* sp., *Rhodobacter* sp., *Shewanella* sp. and *Pseudomonas* sp.). Extracts were tested using the disk diffusion methodology. Preliminary results indicate that *Lactococcus* and *Pseudomonas* species are susceptible to the DCM-MeOH and ethanolic extracts while the *Vibrio* species and *A. veronii* are not susceptible. All nine microorganisms were not susceptible to the aqueous extract. Further investigation needs to test the effects of different concentrations of *Ulva* extracts and to identify the compounds responsible for the antimicrobial properties.

Effects of nutrient variation on aquacultured *Ulva*:

A lipidomic approach to investigate the lipid and fatty acid composition of *Ulva rigida*.

Etwarising, L^{1*}, Bolton, J.J.¹, Beukes, D.R.², Macey, B.M.³, Cyrus, M.D.³, Vanmari, D.⁴ and Maneveldt, G.⁴

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Ulva is one of South Africa's most important aquaculture products with over 2000t produce annually, it constitutes a vital feed source for abalone, *H.midae* and is utilized as a bioremediation tool. Much interest has been given to this seaweed when it was reported that the supplementation of the diet of sea urchin, *T.gratilla* with *Ulva* could produce commercially acceptable gonads, where *Ulva* acted as a natural pigment (Beta-carotene) while also increasing feed attractability and consumption. Isolation of polar compounds belonging to the glycolipid group namely mono- and digalactosyldiacylglycerol (MGDG & DGDG) from local aquacultured *Ulva* could indeed act as feed stimulants for this urchin species. The current study was designed to investigate the effects of different nutrient regimes on the growth, total lipid (including major lipid classes) and fatty acid composition of aquacultured *U.rigida*. In total, five different nutrient regimes (25, 50, 75, 100 & 200%; 100% \approx 8.05N, 3.78P, 1.08K g.Kg⁻¹ *Ulva*) along with control (0 %) were tested at ambient condition. Preliminary study showed *Ulva* cultured at higher N had better specific growth rate (23.0 %·d⁻¹; SGR; 17.74 μ mol.L.d⁻¹ NH₄⁺) compare to lower N (13.2 %·d⁻¹; 2.96 μ mol.L.d⁻¹ NH₄⁺). Significant variations were also observed in the total lipid composition of aquacultured *Ulva* in between treatments.

Trends in seaweed resource use and aquaculture in South Africa and Namibia over the last 30 years.

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and Bolton, JJ²

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³ Department of Botany, Nelson Mandela University, Port Elizabeth 6031, South Africa

⁴ Department of Fisheries and Aquatic Sciences, Sam Nujoma Campus, University of Namibia, P.O. Box 462, Henties Bay, Namibia

The seaweed industry of temperate Southern Africa was last reviewed in 2003. Since then there have been considerable changes. There are three main uses of kelp (mostly *Ecklonia maxima*, with some *Laminaria pallida*) in South Africa. The collection of wash-up for drying and exporting for alginate extraction has drastically reduced to very small amounts in recent years. The boat harvest of fresh kelp for abalone feed in land-based farms has reached a plateau of around 4-5000t per annum. The diver harvest of *Ecklonia maxima* for agricultural liquid plant growth enhancer shows a constant increase over several years, is still growing, and is currently over 2000t per annum. The small intertidal collection of *Gelidium pristoides* as export for agar production has maintained a small, sustainable production of around 100t for many years. Former *Gracilaria* industries in sheltered bays in both South Africa and Namibia have collapsed, and there is currently no commercial collection. There was commercial raft aquaculture production of *Gracilaria* in Lüderitz Bay, Namibia for a number of years, but this is no longer practised. The only current commercial seaweed use in Namibia is the collection of ca. 150t per annum of fresh wash-up kelp (*Laminaria pallida*) in Lüderitz for feed land-based abalone aquaculture. There are a number of small start-up companies experimenting with seaweed products for cosmetics and nutritional products in both countries, some involved species of *Ulva* and *Porphyra*.

Effect of cell disruption methods on the extraction of bioactive metabolites from microalgal biomass

Stirk, WA¹, Bálint, P², Vambe, M¹, Lovász, C³, Molnár, Z², van Staden, J¹ and Ördög, V^{1,2}

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Microalgae synthesize potentially high-value compounds. Due to the robust cell wall, cell disruption is necessary to improve extraction of these compounds. While cell disruption methods have been optimized for lipid and protein extraction, there are limited studies for other bioactive compounds. The present study investigated the effect of freeze-drying combined with sonication and ball-milling on the extraction of antioxidant and plant biostimulating compounds from *Chlorella* sp., *Chlorella vulgaris* and *Scenedesmus acutus*. Both cell disruption methods resulted in higher yields from the biomass and increased antioxidant activity. The effectiveness of each treatment varied between strains. Sonication resulted in the highest antioxidant activity in *Chlorella* sp., ball-milling gave the best results for *C. vulgaris* and both cell disruption methods decreased antioxidant activity in *S. acutus*. Plant biostimulating activity of the microalgae samples were tested using the mung bean rooting assay. Damaging the membrane by freeze-drying was sufficient to release the active compounds using water extracts. Both cell disruption methods negatively affected the biological activity. These results indicate that the potentially valuable bioactive compounds in microalgae are sensitive to post-harvest processes and their biological activity can be negatively affected by cell disruption methods. Care must be taken when using a biorefinery approach to not only optimize yield of the target compounds but to also preserve their biological activity.

Session 2 – Algal Blooms

Diatom vs Dinoflagellate:

The Sundays River Beach surf-zone during a red tide.

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In the first half of 2014, Algoa Bay experienced a *Lingulodinium polyedra* (F.Stein) J.D. Dodge red tide. While the red tide waxed and waned in the Bay for half of the year (followed by sporadic appearances for several years), the Sundays River Beach surf-zone only had red water for one month. In this month, the usually overwhelmingly dominant surf diatom, *Anaulus australis* Drebes et Schulz, shared the surf-zone with the red tide dinoflagellate in a strange red patch-brown patch state. For years we have predicted that surf diatoms could outcompete red tide dinoflagellates due to their unique biology. The red tide of 2014 gave us an opportunity to consider this dynamic. The surf diatoms are able to access the terrestrially derived nutrients that discharge into the surf-zone through the beach swash zone. In so doing, they maintain the surf-zone waters at relatively low levels of free nutrients and limit access to nutrients for other taxa. As a result, they remained successful competitors in this environment.

Extent and impact of a macroalgal bloom in South Africa's most important estuary

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The Knysna Estuary is South Africa's top ranked estuary and remains permanently open to the sea. In 2015, a large bloom of opportunistic macroalgae (*Ulva* spp.) has covered the lower reaches of the estuary. The occurrence of an opportunistic species is globally considered as a sign of eutrophication. The aim of this study was to determine the impact the bloom had on the saltmarsh and *Zostera capensis* and why the bloom was persisting in the lower reaches of the estuary. Changes in saltmarsh cover were measured through seven permanent line transects that started in the supratidal zone and ended in the intertidal zone. Water column samples were collected for nutrient analysis and benthic chambers were deployed at four sites in the Ashmead channel to investigate the flux of nutrients from the benthos. The results showed that there was a significant decrease in both intertidal saltmarsh species which had been displaced by the algal bloom. Recycled nutrients specifically, NH_4 and SRP, from the benthos and input from a nearby WWTW were a source of nutrients that enabled the persistence of the bloom.

Harmful algal blooms in South African estuaries: The “ins and outs” of an emerging issue

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Over recent decades the frequency, magnitude and extent of harmful algal blooms (HABs) have increased globally in estuarine waters. Embedded in the definition of eutrophication, anthropogenic nutrient loading (e.g. agricultural, domestic and urban runoff) is the key culprit responsible for the increased incidence of HABs. The primary concern arising from such HAB events is founded in the array of possible consequences. Some of these include oxygen depletion related to bloom decay processes, direct toxic effects on higher trophic levels, mechanical interference and suffocation of faunal communities and habitat destruction through shading of submerged aquatic vegetation. The aim of this talk is to showcase multiple case studies documenting various HAB species in South African estuaries, and to delve into the drivers and ecophysiological adaptations associated with their occurrence. The dynamics of HAB species recorded in the Sundays (*Heterosigma akashiwo*, *Heterocapsa rotundata* and *Mesodinium rubrum*), Gamtoos (*Prorocentrum cordatum*), Hartenbos (*Nannochloropsis* sp., *H. akashiwo*, *Oxyrrhis marina* and *Cylindrotheca closterium*) and Zandvlei (*Prymnesium parvum*) estuaries will be highlighted. Finally, the lessons learnt from these case studies will be discussed and contextualised in terms of guiding research and management objectives into the future.

Harmful Algal Blooms – their prevalence and impacts in the southern Benguela

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The paper *Harmful Algal Blooms of the southern Benguela Current: a review and appraisal of monitoring from 1989 to 1997* was published by Pitcher and Calder in the *South African Journal of Marine Science* in 2000. The publication served to document the known incidence and consequences of harmful algal blooms (HABs) in the southern Benguela at that time and in so doing it provided an evaluation of the threat posed by HABs within the region. Two decades on we review progress in understanding these phenomena and we reassess their impacts within the southern Benguela. We review the toxin-producing species responsible for the shellfish poisoning syndromes of Paralytic, Diarrhetic and Amnesic Shellfish Poisoning, the impacts of yessotoxin-producing species, fish-killing species, ecosystem disruptive algal blooms and high biomass blooms linked to events of anoxia and mass mortalities. This presentation forms the basis of a regional contribution to a *Global HAB Status Report* to be published in a special issue of *Harmful Algae* in 2020.

Session 3 – Various

Phytoplankton of the Southern Ocean and its contribution to the biological carbon pump

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Summer Subantarctic surface waters are characterized by high concentrations of unconsumed nitrate (NO_3^-), likely due to combined iron, light and silica limitation of phytoplankton growth. The response of phytoplankton diversity and community structure to these nutrient limitations is not well understood despite the implications of such dynamics for organic carbon (C) export. The Antarctic Circumnavigation Expedition sampled all the bioregions of the Southern Ocean during a single summer cruise in 2016/2017. Results from 103 underway and 26 CTD stations indicate that surface NH_4^+ and silica concentrations were higher near and downstream of the islands and the Antarctic continent relative to open Subantarctic waters, indicating terrestrial inputs. Phytoplankton consumption of (new) nitrate is proportional to net C export, while growth fueled by recycled ammonium yields no net C flux. In terms of relative abundance (RA), the open Subantarctic is dominated by picoeukaryotes (64%), while nanoeukaryotes thrive (50%) near the islands and Polar Front. By contrast, microphytoplankton (largely chain-forming pennate diatoms) constitute >50% of the biomass despite their RA of ~1%. The dominant microphytoplankton species responsible for nitrate consumption and C export were *Fragilariopsis kerguelensis*, *Chaetoceros radicans*, *Eucampia antarctica* var *antarctica*, *Pseudonitzschia heimii*, *Odontella sinensis* and *Thalassiothrix antarctica*.

Variability in upwelling patterns across the Benguela

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The South African coastline is comprised of three distinct coastal regions, each varying in average temperature due to the presence of two distinct ocean currents: namely the Agulhas and the Benguela currents, the latter an eastern boundary upwelling system (EBUS). This study was designed to examine whether same upwelling patterns were discernible at varying distances from the coastline and if this was apparent from different datasets. Analyses of temperature time series data from 4 sites within the west coast of South Africa were conducted to examine the variation in intensity occurring in different upwelling events at different distances from the coastline. This study further made use of wind data to determine the upwelling index for each of the sites. By using ANOVA analyses, it was possible to determine the relationship between intensity for each of the sites at variable distances. Results showed high intensity of upwelling events in the OISST dataset but less high intensities in the CMC dataset. Similar upwelling patterns are present in the in situ and OISST dataset at a distance of 10km from the coastline. However, it should be noted that at distances of 50 km or more from the coastline, fewer upwelling events are detected in both remotely sensed datasets.

Austral winter marine epilithic diatoms along the coast of South Africa

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The knowledge on the composition and spatial distribution of marine benthic diatoms around the coast of South Africa remains limited. Epilithic diatom assemblages from natural intertidal rocky substrate and physico-chemical variables were investigated during July-August in 2016 and 2017 along the South African coastline. A total of 85 diatom taxa from 31 genera were observed at 15 sites along the coast. Taxa with the highest contribution included *Nitzschia* (9 species), *Cocconeis* (7 species) and *Achnanthes* (6 species) and the observed Shannon Index (H') during the study varied from 0.44 (Kraalbaai) to 2.09 (Bird Island). The non-metric multidimensional scaling ordination (nMDS) separated the diatom assemblages into three groups with 20% similarity among sites (grouped according to coastal sections) and the PERMANOVA analysis revealed a significant difference between the coastal sections. The observed diatom composition was shown to be influenced by both nutrient concentrations along the west coast and temperature along the east coast. This study provides insights on the abundance and distribution patterns of marine littoral diatoms along the coastline and the potential environmental drivers. The observed variations in diatom composition and distribution warrant further investigations if they are to be considered as potential indicator species of change.

Mechanisms of interference and exploitation competition in a guild of encrusting algae along a South African rocky shore

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Within the marine benthos, space is considered an absolute requirement that is often in limited supply. The often-low availability of this essential resource causes species to interact competitively through mechanisms of interference and exploitation. Species of encrusting algae, in particular, use overgrowth as a mechanism for interference competition, and variable growth rates have often been argued as a mechanism for exploitation competition. This study examined overgrowth interactions as a proxy for interference competition, and cover abundance as an indirect proxy for exploitation competition, to understand how encrusting algal species coexist. Cover abundance was shown to be tightly correlated with marginal growth rates ($r = 0.99, p < 0.023$). Results additionally indicated a strong competitive hierarchy for both overgrowth competition and for cover abundance, and an inverse relationship between the two proxies (overgrowth vs cover abundance) of competition (upper mid-eulittoral zone, $r = -0.81$; lower mid-eulittoral zone, $r = -1.00$). Although postulated, none of the species that are seemingly subordinate in terms of overgrowth are excluded from their respective habitats. The reason for the coexistence between subordinate and superior overgrowth competitors can be argued through the interplay between interference and exploitation competition mechanisms, in which species that are typically always overgrown (poor interference competitors), maintain their existence largely because they are better at exploiting the limited available space because their faster growth rates result in higher cover abundances.

Session 4 – Microalgae

More than *Anaulus*: South African surf diatoms and their beaches.

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Surf diatoms constitute a small group of species exclusively found in the surf zones of sandy beaches. These diatoms form dense accumulations which discolour the water. Four surf diatoms have been recorded in South Africa, and to date, all brown diatom accumulations in sandy beach surf zones have been considered to be caused by *Anaulus australis*. The other three species are *Aulacodiscus johnsonii*, *Aulacodiscus petersii* and *Asterionellopsis cf. lentisilicea* and they are generally considered to be distant sub-dominants. Based on distinctive features of the accumulations the beaches along the south coast can be classified into three groups: major accumulating beaches (where accumulations of *Anaulus australis* are near-permanent), accumulating beaches (where accumulations occur regularly, but the surf diatom responsible could be any of the four) and occasionally accumulating beaches (where accumulations occur irregularly, and the species dynamics remain to be investigated). The phenomenon of surf diatoms in South Africa appears to be more complex than previously thought.

Phytoplankton biodiversity of the southern Benguela

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The phytoplankton biodiversity of the coastal waters of South Africa is poorly described. This study undertakes an assessment of the diversity of the phytoplankton of St Helena Bay, a large, open and highly productive embayment located in the southern Benguela upwelling system. Samples from 3 m depth were collected from a single station during 28 field studies conducted between March 2015 and November 2018. Photographic records of all species present in all samples were established using light microscopy and samples were enumerated using the Utermöhl method. Phytoplankton composition was investigated in relation to bay hydrography as dictated by season and the upwelling-downwelling cycle as determined by wind events. The net plankton (>10µm) dominated phytoplankton biomass and a high degree of concordance between characteristics of water column stratification and groupings of phytoplankton demonstrated the importance of the upper mixed layer in determining species or life-form selection and development. The presence of dinoflagellates showed greater seasonality compared to the diatoms and peaked in late summer and autumn. The most dominant diatoms included species of *Skeletonema* and *Thalassiosira*, whereas the dominant dinoflagellate species belonged to the genera *Prorocentrum* and *Ceratium*. Other prominent phytoplankton included species of coccolithophorids and the photosynthetic ciliate *Mesodinium rubrum*.

Phytoplankton communities and the productivity of the Vanderkloof Dam

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Vanderkloof Dam is situated 130 km downstream of the Gariep Dam and is fed by the Orange River. It was built in 1976 and is the second largest storage reservoir in South Africa. Our study examined phytoplankton community composition and productivity in relation to a number of environmental parameters over a period extending from November 2014 to April 2016. Results indicate that the dam is oligotrophic and phosphorus is the macronutrient in shortest supply. Nutrients are depleted through the summer and re-introduced during winter mixing when the water column turns over and the impoundment is nearly isothermal. Although primary production is thought to be predominantly light limited, phosphorus may be limiting during the summer productive period. Thirty-five species of phytoplankton were recorded with green algae contributing 54%, diatoms 23%, euglenoids 8%, and with lesser contributions from the dinoflagellates, cryptophytes and other groups. Dominant green algae included *Closterium acutum*, *Tetraedron minimum* and *Desmosdesmus bicaudatus*, and important diatom species included *Fragilaria crotonensis* and *Aulacoseira granulata*. Classification analysis was used to group samples of similar phytoplankton composition. Community analyses were linked to physical and chemical water parameters to identify the drivers of phytoplankton communities.

Phytoplankton productivity and distribution around Prince Edward Island Archipelago during the Autumn season (2017).

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The effects of the Subantarctic Prince Edward Island (PEI) archipelago in the eastern Indian Ocean on the surrounding marine ecosystem are well-studied, but over the last two decades, decreasing attention has been paid to the activities of phytoplankton, including their role in carbon production and export. Here, we present rates of primary productivity and nitrogen uptake, along with phytoplankton abundance and biomass distributions, in the vicinity of the PEIs for samples collected during April-May 2017. Phytoplankton productivity and biomass were higher between the two islands than in the waters upstream or downstream of the archipelago (PP = 668,80; 143,53 and 222,86 mg C/ m²d respectively), although the rates were in general fairly low and nitrogen uptake was largely of recycled ammonium. In addition, the phytoplankton community throughout the region was dominated by nanoplankton and dinoflagellates, with very low abundances of larger cells such as diatoms. Collectively, our data suggest that late summer/autumn in the vicinity of the PEIs is a period of enhanced organic matter regeneration and low carbon export, with little evidence for an island mass effect. In this regard, the waters surrounding the PEIs are perhaps more similar to the open Subantarctic Ocean than to productive waters near Crozet and Kerguelen Islands.

Session 5 – Macroalgae

The influence of kelp species, age and part on associated epiphytic diatom assemblages

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Kelps form biogenic habitats harbouring diverse sessile fauna and flora, including diatoms, which are widely used for biomonitoring of various environmental conditions and paleoecological reconstruction. Diatom community structures on different parts of adult and juvenile South African kelps, *Ecklonia maxima* and *Laminaria pallida*, were investigated to determine the influence of host plants on epiphyton. A floristic study of all diatom cells in cleaned materials was also conducted based on morphological observations of the frustules using a light microscope (LM), and scanning electron microscope (SEM). While only 22 diatom genera were counted directly on the host surfaces under SEM, a total of 41 species belonging to 37 genera were identified by examining the cleaned materials. PERMANOVA revealed that all investigated main factors (kelp species, age and part), as well as their two- and three-way interactions, except the interaction host species-age, were significant. However, the high residual variance suggest that other unexplained factors contribute the largest components of variation in the community structure of kelp associated diatoms. We speculate that the low epiphytic diatom density observed on kelps is not only the result of the influence of the host, but also of environmental factors such as temperature, light, turbidity and wave energy.

The potential of native South African macroalgae species as feed ingredients for ruminants

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Globally, the identification of novel feedstuffs has become important to the livestock industry in order to improve production in a responsible and sustainable manner. Recent research has found that certain macroalgae species show potential to be used as either feedstuffs or supplements for ruminant production; however no such research has been conducted on South African macroalgae. In this study three South African macroalgae species were compared in terms of their nutritional composition, namely *Gelidium pristoides* (Gel), *Pyropis sp.* (Pyr) and *Ecklonia maxima* (Eck). The mineral concentration ranged from 18.05% to 36.88%. Pyr and Eck had the highest ($P < 0.05$) mineral concentrations indicating the potential to be used as mineral supplements. Gel and Pyr had higher ($P < 0.05$) crude protein (CP) concentrations compared to the Eck samples (17.7% and 14.6% compared to 7.48%, respectively). The neutral detergent fiber (NDF) and acid detergent fiber (ADF) concentrations ranged from 40.16% to 54.49% and 10.17% to 20.56% respectively. The dry matter digestibility (DMD) of the species ranged from 69.94% to 84.01%. These results indicate the potential for the inclusion of South African macroalgae as an ingredient in ruminant feeding systems.

Kelp forests: Industry perceptions of challenges and opportunities

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A workshop about South African kelp forest ecosystems was hosted as part of the SANOCEAN BlueConnect Project (a South Africa-Norway Bilateral) at the Department of Environment Forestry and Fisheries (DEFF) Research Aquarium in Cape Town on 20–21st November 2019. The objective of the workshop was to bring together stakeholders representing various kelp-associated sectors to discuss challenges and opportunities for kelp forest resources in South Africa. Brief question and answer sessions were held after each presentation, discussions were held at the end of each day, and a basic questionnaire survey completed by all participants. A wide range of topics was addressed in the presentations, including kelp harvesting in South Africa; aquaculture; kelp products; research on mapping of kelp forest distribution, kelp forest species diversity and ecology; the management of the impacts of kelp on the shoreline City of Cape Town metropole, as well as National seaweed policy and permit conditions in South Africa. Broad comparisons were made with kelp resource management and utilization in Norway. This paper discusses the outcomes of the workshop and survey, and delve into aspects of an analysis of Strengths, Weaknesses, Opportunities, and Threats faced by the diverse stakeholders whose livelihoods, businesses, research, and management influences are coupled with kelp forests. This analysis paves the way for a National assessment of the intangible (non-market) value of kelp, which will form part of an international effort with more comprehensive goals by the BlueConnect team.

Resolving cryptic diversity in South African non-geniculate coralline algae (Corallinophycidae, Rhodophyta)

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Using an integrated taxonomic approach, which utilises DNA sequencing and morpho-anatomical characters, we aim to undertake a re-assessment of all non-geniculate coralline algae currently reported for South Africa. Starting with the most ecologically important genera (*Spongites*, *Phymatolithon*), DNA sequences (COI-5P, *psbA*, *rbcl*) from type, 'topotype' and recently collected field specimens showed that South African specimens (except for species with type localities in South Africa) are not the species to which they were previously ascribed and notably that there is a high degree of cryptic diversity. South African species of *Spongites* (Neognoniolithoideae) all formed well-supported, monophyletic clades within the recently established Chamberlainoideae, all aligning closer to the generitype, *Chamberlainium tumidum* and not to the generitype of *Spongites*, *S. fruticosus*. Nine distinct species of Chamberlainoideae are now confirmed for South Africa, eight included in *Chamberlainium* and one in *Pneophyllum*. Similarly, all but one South African species of *Phymatolithon* do not belong in that genus and a new genus *Phymatolithopsis* is instead being proposed. Here we give an account of these findings. Additionally, we comment on the congruency between morpho-anatomical and DNA sequence data, and on cryptic diversity and biogeographic considerations. Based on the findings from this study it is doubtful that South Africa has any representative species from the genus *Spongites* and we suspect that this may be true for several other regions within the southern temperate latitudes.

Can seaweeds be used to predict abalone presence and abundance?

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Anecdotal evidence suggests that certain algal species serve as indicators for abalone presence. Along the Port Elizabeth coast *Plocamium corallorhiza* has been recognised as one such a group, while the presence of *Ecklonia radiata* has been used as a sign abalone habitat further north. A functional group approach was used to identify predictors for abalone habitat on shallow reefs in Port Elizabeth. Multivariate techniques showed poorly defined seaweed communities, with abalone associated with deeper benthic community types, very poor correlations between specific seaweed functional groups and abalone abundance were found using this approach. Seaweed groups are therefore considered poor predictors for abalone habitat, and it is likely that other physical habitat attribute would be more useful in recognising good abalone habitat.

Hard substrate benthic community structure on the East London coast: baseline information for abalone ranching.

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As the numbers of South African abalone (*H. midae*) continue to decline, ranching and stock enhancement have become eminent areas of research. For ranching and/or restocking initiatives to be successful and sustainable, detailed baseline data of the benthic community composition, particularly seaweed species, is important. The data provides a reference point for future impact monitoring, and could offer a greater understanding of the species ecology, and may reveal easily recognizable species that could be used as indicators for suitable abalone habitat. Photographic and scrape data was collected during surveys of the benthic community in Abalone Ranching Concession Zone 2, on the East London coast. The reef

community was described in terms of the abundance of macroalgal and macroinvertebrate species, as well as on the basis of functional type cover. Preliminary results show a great deal of variability in community structure both in terms of species and functional type composition. The data also suggests that the benthic community that represents abalone habitat on the East London coast, differs substantially from that on the Port Elizabeth coast.

POSTERS

The diatoms of shore-platform extant stromatolite ecosystems in South Africa

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Extant marine stromatolites act as partial analogues of their Achaean counterparts, but are rare due to depleted ocean calcium carbonate levels and suppression by eukaryotic organisms. Unique, peritidal tufa stromatolites at the interface between marine and coastal groundwater seepage were discovered in South Africa in the past decade. Our aim was to investigate the benthic diatom community of these stromatolites to assess species richness, dominance and environmental drivers of succession over a period of one year. The stromatolite barrage pools consists of an upper pool that is freshwater dominated, a middle pool that varies between fresh and marine conditions and a bottom pool that is predominantly marine. Results indicate a relatively stable microalgal stromatolite community consisting of only 5 dominant species. Species richness increased to ~25 species in winter associated with marine overwash during storm events. The extreme conditions in the middle pool significantly reduced the species richness compared to the upper and lower pools. The main environmental drivers influencing the benthic diatom community were salinity and ocean swell. These results have implications in terms of interpreting community succession and differential layering in modern and fossilized stromatolites respectively.

Influence of geology on mid-intertidal communities.

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Rock types differ in terms of weatherability, morphology and surface texture. It would therefore be expected that benthic communities that occur on these different rock types will also differ. This expectation was explored by investigating the mid-intertidal communities on rocky shores in Port Elizabeth. Data was collected at two localities where different geological types occur adjacent to one another. Site 1 had quartzite, aeolianite and sandstone boulders, while the other had phyllite and quartzite. Species/ functional group abundance cover and community metrics (richness, diversity and evenness) were measured to test for differences between communities that was portrayed through using a detrended correspondence analysis (DCA) and comparison of taxon groups. The results show that, at both localities, there was a substantial overlap between the communities on different geological types. However certain differences were noted, suggesting caution should be exercised when selecting sites for long term monitoring.

**The effects of fertilization on the nutritional biochemistry of *Ulva*:
implications for aquaculture production**

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Ulva rigida is currently the largest aquaculture crop in Southern Africa, and by weight more than 2000t are produced annually. Conservative estimates of production in outdoor paddle raceway systems are estimated at 20 – 26 g DW m⁻² d⁻¹. In aquaculture *Ulva* is used as an extractive bio-filter and may be used as a natural feed alternative or a supplemented ingredient in formulated feeds, as it contains high concentrations of proteins, vitamins and minerals, with these additions having shown an improved protein digestibility, feed palatability and feed attractiveness for cultivated marine organisms. This study aimed to investigate the potential for cultivating high quality protein-rich *Ulva*, improve understanding of how farms can adapt to cultivate high quality *Ulva* and its implications for Integrated Multi Trophic Aquaculture (IMTA) systems. We experimented on various growth parameters (stocking density, volume exchange rate and nutrient fertilization) to optimally grow *Ulva* in a tank cultivation system, by evaluating growth and nutritional contents of *Ulva*. We also use the approach of rapid tissue nitrogen assessment using methods of photometry. Results indicate that *Ulva* cultivated at higher concentrations of nutrients are of better quality in terms of nutrients (micro and macro) and energy with significant variations in colour amongst treatments.

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