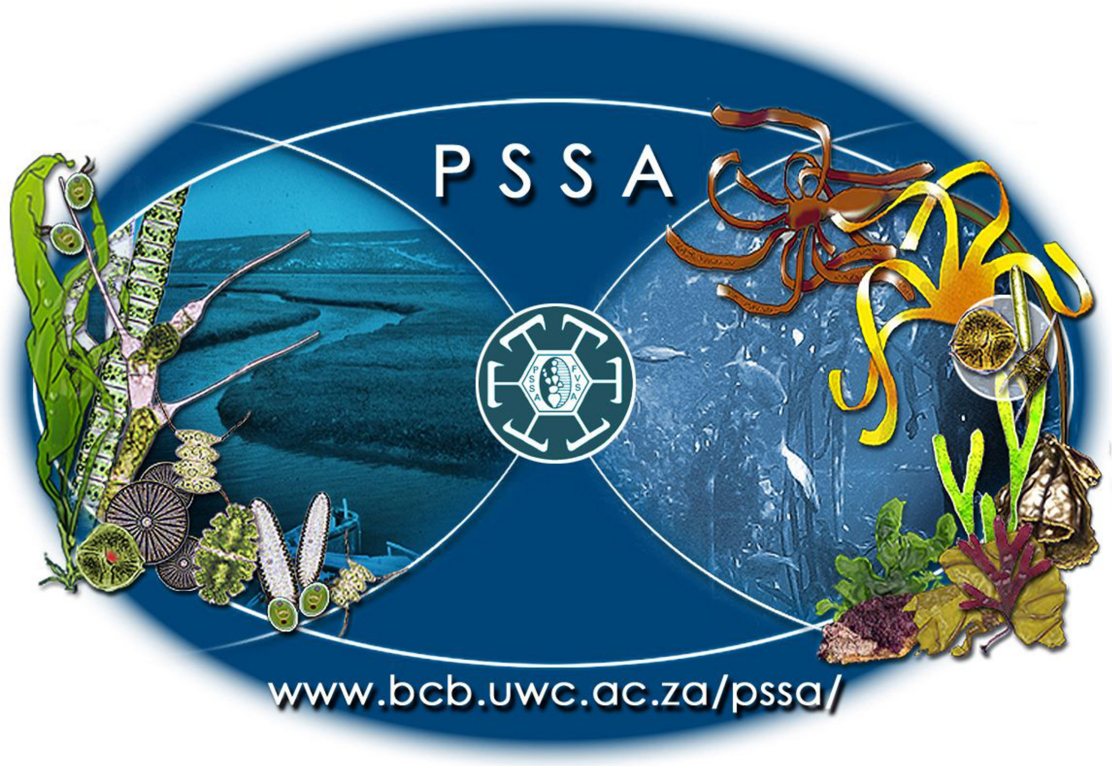
Forum Phycologicum



Newsletter of the Phycological Society of Southern Africa

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From the Editor

This PSSA newsletter is unique among the few I have edited in that no arm-twisting was required to elicit articles. Thanks very much to those who contributed!

I am particularly happy to be able to announce our new website – the first comprehensive, illustrated guide/flora on the seaweeds of the South African south coast (see page 14).

As usual the year is passing too fast, and leaving it its wake the detritus of many good intentions, including my idea of producing quarterly newsletters. Anyway, this one is only a month late, and I will certainly put out another later in the year, so please let us all know what you are up to, and students should remember that at each PSSA congress there is a cash prize for the best student article since the previous congress.

Yours in Phycological Endeavour,

Robert Anderson

Long-term monitoring of kelps

Robert Williamson (Post-doctoral fellow, University of the Western Cape, SAEON)

Data, we love them! We just can't seem to get enough of them. If you listen carefully it won't be too long before you hear "We don't have enough data!" echoing down some corridor near you. So when an opportunity arises to establish a near-continuous stream of data from a particular environment for eternity (or at least a very long time) there should be little wonder at the accompanying excitement, especially among the lovers of calculus.

Apart from the obvious enjoyment of being part of the *floppy – stiffy – hard – flash – solid state – e.coli – sand* (seriously) evolution of data storage and updating our hardware for the incoming volumes of data, there are numerous new things that can be done with these streams of data, scientifically speaking. In the past, and indeed currently, it is fairly common to resolve scientific hypotheses by analysing a snap-shot of the domain of interest, perhaps something like studying the complex social relationships of people from a snap-shot taken at a pulsating late-night party. The conclusions drawn from those caught in the frame would be less uncertain if we could take a short movie clip of the scene instead, as some participants in the picture may simply have bumped into each other accidentally and there would have to be some risky inferences for participants not fully included in the snap-shot. The results could be rendered more robust if the entire party could be filmed as relationships may change from the start to the end. Ultimately, the study should continue to observe everyone afterwards and update findings intermittently or as necessary. Applying this analogy to the environment may not seem novel and indeed it isn't. Long-term monitoring has been formally established among ecologists for many decades. What is novel is that in the near future, scientists are going to be able to ask all kinds of detailed questions regarding the long-term relationships within and among pulsating South African kelp beds.

These scientists will not be the first to be able to address long-standing questions on kelp ecosystem dynamics such as the battle among top-down, bottom-up and disturbance processes in controlling kelp biomass, the effect of slowly rising (or cooling?) temperatures and wave disturbance or the impact of changing landscapes in coastal watersheds. In April 2000 the University of California, Santa Barbara (UCSB) established their Long Term Ecological Research (LTER) site, which monitors giant kelp forests and they have focused much of their recent research on similar long-term dynamics. But that's not to say the local research will be doomed to be following the footsteps of others. There exists a great deal of information and knowledge that has developed over recent decades that is endemic to South African kelp systems and the long-term programme will both build on this research and hopefully add to the list of key research findings.

Kelp stipes flex under a large swell in False Bay

When the cameras roll, the long-term monitoring of South African kelps will officially join a number of other South African LTER sites under curatorship of the South African Environmental Observation Network (SAEON). SAEON, a member of the International LTER (ILTER) network of networks, has several LTER sites that fall into one of several environmental nodes. The kelp LTER will fall into the Elwandle Coastal Node and will be the second LTER in this node along with the Algoa Bay site. SAEON, however will not be alone. Scientists from the University of the Western Cape, University of Cape Town, Dept. of Agriculture, Forestry and Fisheries' Seaweed Unit, Santa Barbara Coastal LTER and representatives from South African National Parks have already met to discuss various aspects of the programme and will continue to participate along with new collaborators as the news spreads.

The kelp LTER site will initially include two primary sites; one on the False Bay side and the other on the Atlantic side of the Cape Peninsula. Monitoring methods will include permanently mounted sensors, periodic ecological surveys, remote sensing observations and physical model outputs, which will observe numerous parties and their participants for decades to come. These observations will provide insights into how climate variation affects kelp forest structure and function. More exciting for those who prefer the pulsating parties only, will be short-term studies that will aim to make the long-term studies more meaningful. For example, the impact of extreme wave disturbance on biomass variability or the fine-scale physical structures within a kelp bed. Because of the great love we have for data, every last bit of data will be made available to all who are interested and hopefully the programme will continue to expand. There can be little doubt as to the value of this endeavour, even among the most cynical phycologists. And best of all, you are all invited to participate!

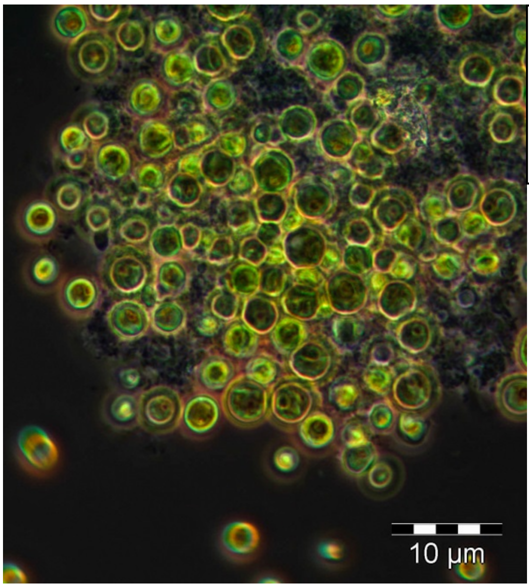
Microalgal Biomass – An Innovative Feedstock for South Africa's Growing Energy Requirements

Gordon Dodge (PhD candidate, Centre for Bioprocess Engineering Research, UCT)

Electricity Load Shedding in 2011 impacted businesses and consumers alike. While at the time it was considered Eskom's only option, it had serious impacts on the South African economy and society.

Although specifically related to electrical energy supply, Load Shedding highlighted a bigger issue within the South African energy sectors: electricity, transportation and heating. With the rise in the world's population, the number of power devices used per person has increased, and as a result the level of energy production needs to rise too (Voloshin, Rodionova, Zharmukhamedov, Veziroglu, & Allakhverdiev, 2016). However, with the ever-decreasing availability of fossil fuels, their associated environmental impacts, and the rising costs of fossil fuel derived energy sources, where can this energy be drawn from?

Traditionally, solar-, wind-, tidal/hydro-electric-, and nuclear power have epitomised environmentally friendly energy sources, and each one has been demonstrated to contribute to the National Grid on a large scale. However, an alternative which is growing in popularity is that of biofuels, with algae (in particular microalgae) having been shown to be a promising feedstock candidate for the production such fuels (Slade & Bauen, 2013).

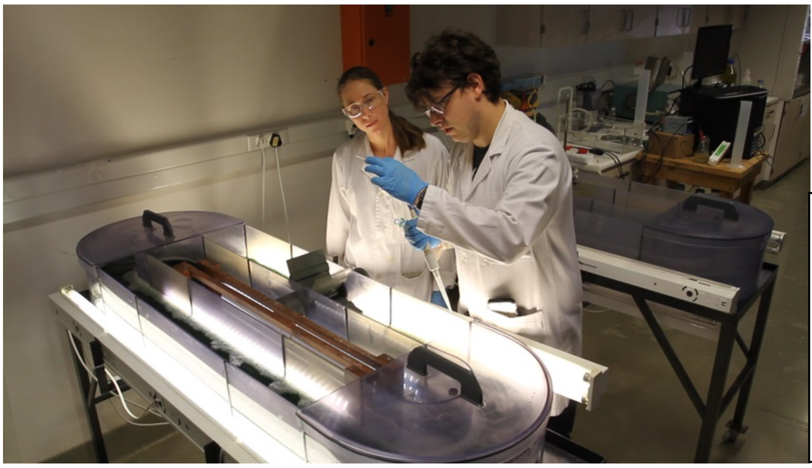


Where it all starts. Screening for algal species with sufficiently high productivity. Shown here, cells of *Parachlorella* (Photo: Sarah Jones)

Due to their environmental adaptability, favourable growth rates, high oil content and lack of competition with food crops and arable land, microalgae have received a lot of academic and commercial interest over the past decade as a possible sustainable biofuels feedstock (Xin, et al., 2016). The production of bio-gas, bio-diesel and bio-crude oil are just a few of the fuels which have been successfully produced from microalgal biomass.

Bio-gas is a fuel, composed primarily of methane, which is a clean heating source that has been used on both a small residential scale and much larger industrial scale. Bio-gas has been successfully produced from microalgal biomass by Anaerobic Digestion (AD) and Catalytic Hydrothermal Gasification (CHG). AD makes use of a consortium of microorganisms to convert the organic algal biomass via a step-by-step process to the final product, methane (Ward, Lewis, & Green, 2014). In comparison, CHG is a thermal aqueous process which reduces a wet organic feedstock, containing large amounts of carbon and nitrogen, into biogas and ammonia. This process occurs in the presence of a catalyst, at pressures and temperatures approaching the critical point of water and has been shown to obtain 99% efficiency for organic carbon (Richardson, Johnson, Lacey, Oyler, & Capareda, 2014).

A fuel that has received a lot of attention is bio-diesel, which is a mixture of fatty acid alkyl esters (FAAEs) which are obtained following the transesterification of fats and oils. In transesterification, fats and oils (triglycerides) react with an alcohol in the presence of a catalyst (typically a strong acid or base) to form FAAEs and glycerol (Kligerman & Bouwer, 2014). The use of microalgal biomass as a feedstock to produce biodiesel has been demonstrated numerous times and traditionally involves the extraction of lipids, specifically oil, from the microalgal cells. The oil then undergoes transesterification to produce biodiesel. Although the oil content of the microalgal species directly affects the biodiesel productivity, even at low oil content microalgae have a higher biodiesel productivity than other biodiesel feedstocks e.g. Soybean and Sunflower (Mata, Martins, & Caetano, 2010).



Inspecting *Spirulina* cultivated in a semi-batch 70 L raceway pond used for biogas production. (Photo Candice Mazzolini)

The use of microalgal biomass for the production of bio-crude oil has been a relatively new development. Bio-crude oil is produced through a process called hydrothermal liquefaction (HTL) – the use of water at high pressure and/or high temperature to break down the solid biomass into a liquid which contains short organic chained components (Valdez & Savage, 2013). Due to its high-water content, microalgal biomass is a challenging feedstock for many biofuel processes as it typically requires drying prior to its conversion. However, as HTL uses a mixture of biomass and water, the use of microalgae as a feedstock for this process has a marked advantage (Maddi, Panisko, Wietsma, & Lemmon, 2016).

Controlling 3 L airlift bioreactors for the comparison of growth and productivity of multiple microalgal species

Photo: Candice Mazzolini

Although there is a need for more energy production, and microalga-based biofuels present a viable alternative, the economic viability of producing the required biomass and converting it into a biofuel still needs to be worked on. The potential of microalgal biomass for the production of bioenergy may depend on the biomass first being used for the production of higher-value products, such as protein, with the remaining parts of the cells used in biofuel production.

The profitability of microalgae as a biofuel feedstock is still not at a level that can compete with fossil fuel, but it is clear that microalgae can contribute a viable and clear alternative for South Africa’s energy requirements.

CeBER pilot large scale (500 000 L) *Spirulina* cultivation at the BioDelta site in Franschoek (Photo: Candice Mazzolini)

The Centre for Biological Engineering Research (CeBER), based at the University of Cape Town, is extensively researching algae for its usage in industry and the bio-economy. For more information regarding CeBER's work and research areas, please contact Prof Sue Harrison (sue.harrison@uct.ac.za).

Bibliography

Kligerman, D. C., & Bouwer, E. J. (2014). Prospects for biodiesel production from algae-based wastewater treatment in Brazil: A review. *Renewable and Sustainable Energy Reviews, 52*, 1834-1846.

Maddi, B., Panisko, E., Wietsma, T., & Lemmon, T. S. (2016). Quantitative characterization of the aqueous fraction from hydrothermal liquefaction of algae. *Biomass and Bioenergy, 93*, 122-130.

Mata, T. M., Martins, A. A., & Caetano, N. S. (2010). Microalgae for biodiesel production and other applications: A review. *Renewable and Sustainable Energy Reviews, 14*, 217-232.

Richardson, J. W., Johnson, M. D., Lacey, R., Oyler, J., & Capareda, S. (2014). Harvesting and extraction technology contributions to algae biofuels economic viability. *Algal Research, 5,* 70-78.

Slade, R., & Bauen, A. (2013). Micro-algae cultivation for biofuels: Cost, energy balance, environmental impacts and future prospects. *Biomass and Bioenergy, 53,* 29-38.

Valdez, P. J., & Savage, P. E. (2013). A reaction network for the hydrothermal liquefaction of Nannochloropsis sp. *Algal Research, 2,* 416-425.

Voloshin, R. A., Rodionova, M. V., Zharmukhamedov, S. K., Veziroglu, T. N., & Allakhverdiev, S. I. (2016). Review: Biofuel production from plant and algal biomass. *International Journal of Hydrogen Energy, 41*, 17257-17273.
Ward, A. J., Lewis, B. M., & Green, F. B. (2014). Anaerobic digestion of algae biomass: A review. *Algal Research, 5*, 204-214.
Xin, C., Addy, M. M., Zh, J., Cheng, Y., Cheng, S., Mu, D., . Ruan, R. (2016). Comprehensive techno-economic analysis of wastewater-based algal biofuel production: A case study. *Bioresource Technology, 211*, 584-593.

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Uncovering cryptic coralline algal diversity

Gavin W. Maneveldt and Courtney Puckree-Padua
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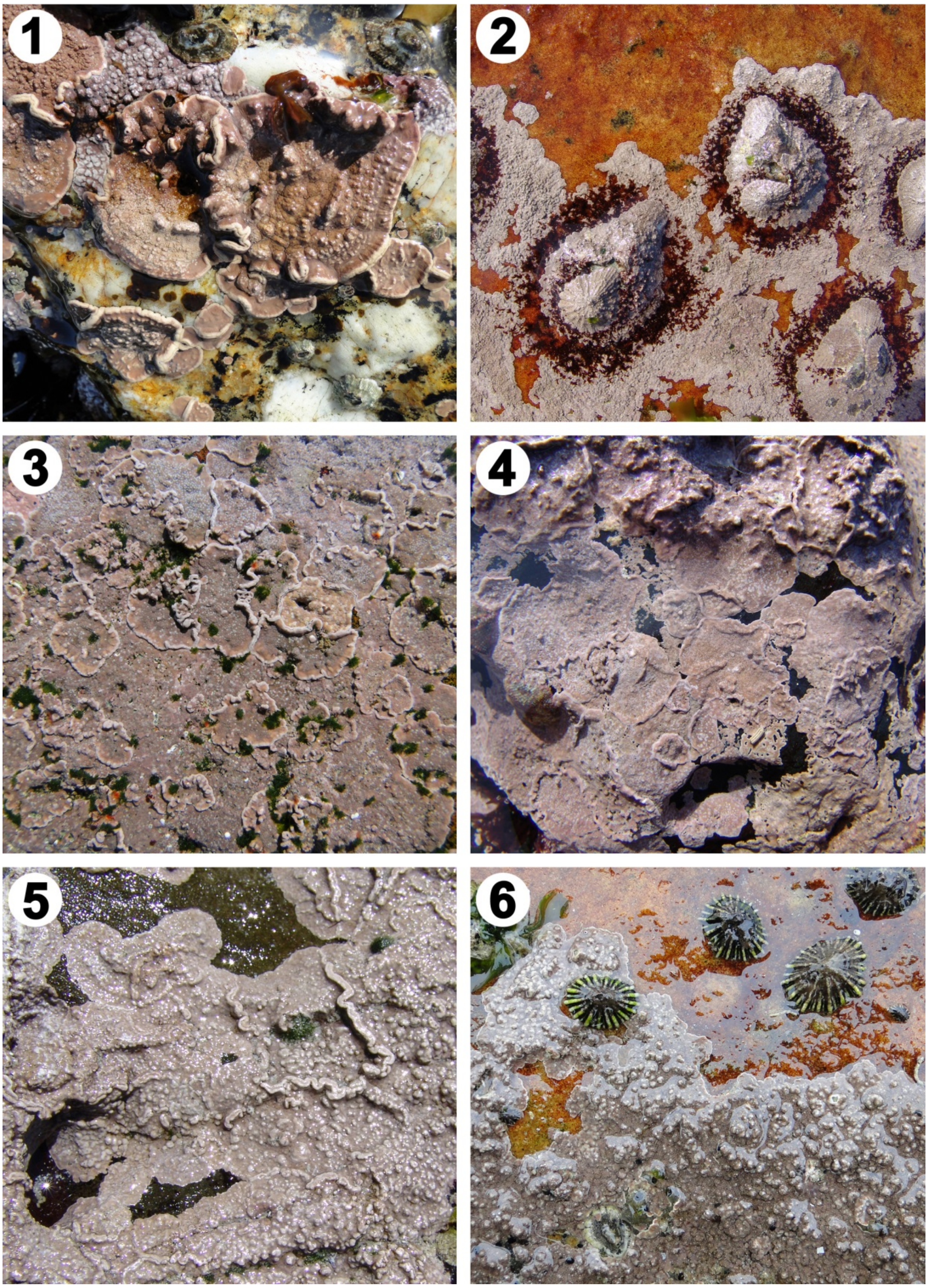
Non-geniculate (encrusting) coralline red algae (Corallinophycidae, Rhodophyta) are widespread in all of the world's oceans where they often form the dominant cover on primary rocky substrates. Despite their ecological importance and their ubiquity, and despite being amongst the best-studied algal groups in the last 10-15 years, the coralline algae still remain a largely poorly understood group of marine algae. This is evidenced by much ongoing debate on their systematics, and a taxonomy that has remained in flux.

Much of the lack of understanding of the non-geniculate coralline algae stems from a legacy of poor quality taxonomic work and it was not surprising that these algae were considered to constitute a ‘difficult’ taxonomic group. The fact that these algae are not collected by the vast majority of seaweed biologists, and thus are poorly represented in most collections, is due largely to the fact that they require specific collection (hammer and chisel) and special laboratory methods (dissolving away of the calcium carbonate structure). Until recently, descriptions of coralline algae were based solely on morphological and anatomical characters, and currently a large number of species are reported to be widely distributed. However, recent molecular-assisted alpha taxonomic studies have demonstrated that many widely distributed species are really different species passing under the same name. These studies are increasingly showing that species are generally NOT widely distributed across ocean basins suggesting that we have highly (possibly by as much as 2-4 times that which is currently recognised by morphological and anatomical features) underestimated the coralline algal diversity across the globe.

The South African rocky intertidal and subtidal habitats are particularly rich in diversity and abundance of coralline algae. Specimens/species (e.g. Figs 1-6) ascribed to the cosmopolitan genus *Spongites* are particularly widespread with *Spongites yendoi* (Foslie) Y.M.Chamberlain (Fig. 2) previously reported to be the most abundant intertidally, occurring along the entire South African coast. The species was said to be particularly abundant along the West and South coasts in association with the territorial, gardening limpet *Scutellastra cochlear*, and has been considered to perform an important ecological function (dietary supplement for the limpet) in that association. Although generally a thin featureless species, throughout its geographic range specimens of variable morphologies, ascribed to *S. yendoi*, were proposed to result from sand scour, wave action and/or grazing pressure.

Recent molecular data, however, have shown that South African specimens matching the current description of *S. yendoi* not only differ from the type specimen, but that several cryptic species are posing under this name in South Africa (Figs 3-6). The molecular data have confirmed that these species are strongly geographically distributed (Fig. 7) and that external morphology (discrete *vs.* fused thalli; smooth *vs.* warty [protuberant] thalli) can indeed be a useful character for their regional separation. In addition, even more recent molecular data are showing that many species (not only from South Africa) currently ascribed to the genus *Spongites* will have to be assigned to more than one genus, notably because the southern hemisphere taxa do not align with the generitype (which incidentally is from the Mediterranean). From these results, all South African specimens currently ascribed to the genus *Spongites* (including the many cryptic species) will need to be transferred to a new genus, which is currently being described.



Figures 1-6. Habit photographs of six different species that match the current anatomical characterisation of the genus *Spongites*. Fig. 1. *Spongites impar* (an SA type). Fig. 2. '*Spongites yendoi*'. Fig. 3. *Spongites* sp. synonymous with *Lithophyllum natalense* (an SA type). Fig. 4. *Spongites* sp.4. Fig. 5. *Spongites* sp.6. Fig. 6. *Spongites* sp.8.

Currently only four species (*S. agulhensis*, '*S. discoideus*'[1], *S. impar* [Fig. 1], *S. yendoi*) of non-geniculate coralline red algae are assigned to the genus *Spongites* in South Africa. Only two of these (*S. agulhensis*, *S. impar*) have type specimens from South Africa. Molecular data have shown that another South African type (*Lithophyllum natalense* Foslie), previously subsumed in *S. yendoi*, will have to be resurrected, and that specimens currently called '*S. yendoi*' are not that species, and comprise at least six different species new to science. In total then South Africa now has at least 10 species of non-geniculate coralline red algae that match the current anatomical characterisation of *Spongites*[2]. As a consequence of these recent findings, all species of South African non-geniculate corallines will have to be reassessed using DNA sequence data, especially those species that do not have type specimens from South Africa.

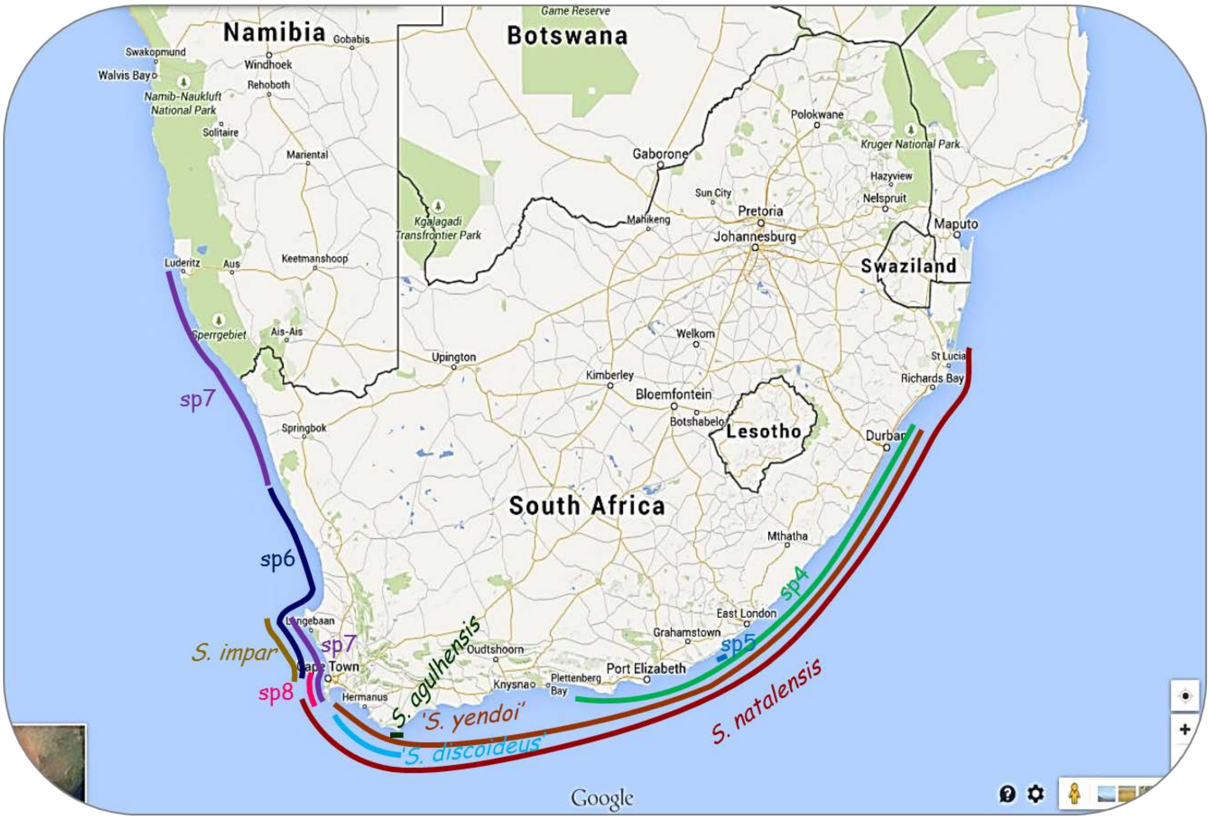


Figure 7. Geographic distributions, based on DNA sequence data, of all taxa currently recognised from South Africa to match the anatomical characterisation of the genus *Spongites*.

[1] Our molecular data are showing that specimens assigned to *S. discoideus* (type locality: Argentina) are not that species and so those specimens will need to be assigned a new name.
[2] Bearing in mind that these 10 species will all have to be assigned to a new genus.

South Africa has a high diversity of non-geniculate coralline red algae, having representatives from more than half (18 of 33) of the currently recognised extant genera. Currently nearly one in four species (10 of 45 ~22%) are endemic to the South African coastline and nearly one in three species (14 of 45 ~31%) are endemic to the Southern African region. Considering our recent findings these figures of endemism are bound to increase quite substantially as we begin to report on these findings.

In conclusion, we have come to realise that geographically overlapping species are generally genetically more similar than morpho-anatomical, nearly indistinguishable species whose distributions are widely disjunct. We now find that we have to question the practice of placing into synonymy geographically widely separated species based solely on morphological and anatomical features that likely may have resulted from convergent evolution.

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Announcement – New website!

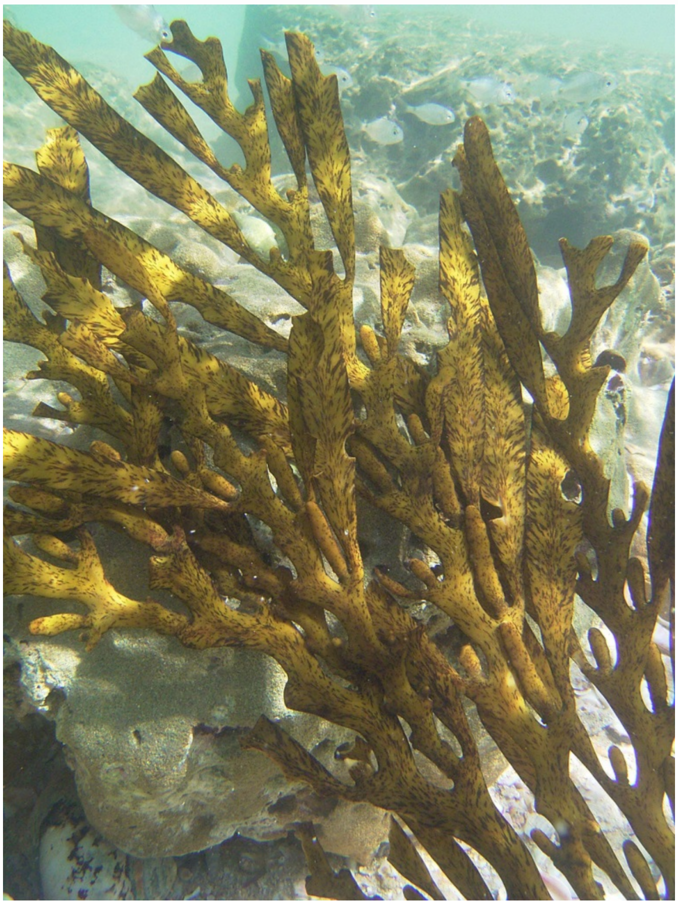
Seaweeds of the South African South Coast http://southafrseaweeds.uct.ac.za

Anderson RJ, Stegenga H, Bolton JJ. 2016. Seaweeds of the South African South Coast.
World Wide Web electronic publication, University of Cape Town, http://southafrseaweeds.uct.ac.za

Between Cape Agulhas and the KwaZUlu-Natal border lies the Agulhas Marine Province – a warm temperate marine environment along approximately 1000 km of coastline, with a distinctive flora (and fauna) that includes many endemic seaweeds.

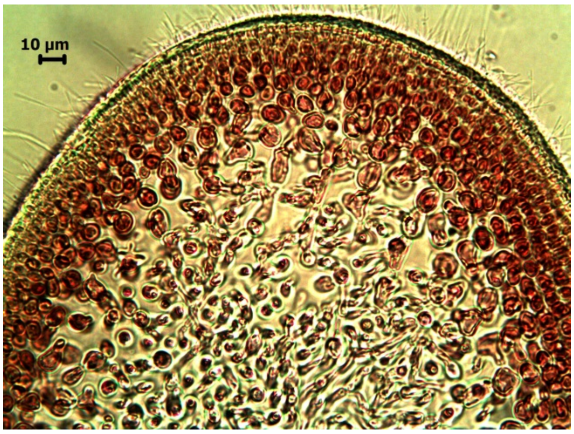
For several decades, the DAFF Seaweed Unit, John Bolton (UCT), Herre Stegenga, and our students collected seaweeds on this coast. We often struggled to identify some species, because descriptions were scattered in journals that span more than a century of research – and of course some species were undescribed. Over the years we built up collections of specimens and, thanks mainly to Herre Stegenga, a collection of almost 2000 microscope slides. We were also able to describe some of the new species: again, thanks mainly to Herre, but also to some of our post-graduates' taxonomic studies. However, a guide or flora was still sorely needed, because this remained the only part of the South African coast without a single, comprehensive publication for identifying the seaweeds (our west coast has the flora by Stegenga et al. (1997) and KwaZulu-Natal has the guide by De Clerck et al. (2005)).

Now, almost ten years after we started this project, the website is up and running. It has descriptions and illustrations of the approximately 500 species of south coast seaweeds, including those that also occur on the west and KwaZulu-Natal coasts. At the moment only two genera have yet to be added (*Laurencia* and *Porphyra*, which are still under study), but we expect them to go on by the end of this year. The crustose (non-geniculate) corallines are not on the website, but can be identified using the keys in Maneveldt et al. (2008).



Oerstedtia scalaris, a South African endemic, monospecific genus of the Sargassaceae. This large brown seaweed is recorded from just west of Cape Agulhas to Durban. In some places it is rare or absent, but in others it can be very common,

We tried to illustrate each species with habit photos, but this was not always possible, particularly for small or very rare species. In some cases habit illustrations had to rely on herbarium specimens.



Prionitis filiformis (Halymeniaceae). Cross section, showing medulla of dense filaments surrounded by cortical cells.

Illustrations of anatomical details are provided where they can assist in identifications.

Acrothamnion preissii (Ceramiaceae). Stained slide preparation showing structure and the terminal gland cells (dark).

Many smaller species are illustrated by photos of Herre's excellent microscope slides.

Besides the descriptions and illustrations of 500-odd species, the website has sections on the south coast inshore environment, seaweed ecology, biogeography, and commercial seaweeds. We sincerely hope that the website will enable further studies on these seaweeds and on south coast inshore ecology in general.

THANKS: We would not have attempted this work without Michael Guiry's incomparable AlgaeBase website! We also thank the students and colleagues with whom we have worked over the decades. For financial support for all those studies, we are grateful to the NRF, UCT, DAFF, SANPAD and the recent SeaKeys Programme. We thank Chris Boothroyd and Derek Kemp (DAFF Seaweed Unit) for cheerful and invaluable technical help.

References

De Clerck, O., J.J.Bolton, R. J. Anderson and E. Coppejans, 2005. Guide to the Seaweeds of Kwazulu-Natal. National Botanic Garden of Belgium, Brussels (Scripta Botanica Belgica), pp 40-93.

Maneveldt GW, Chamberlain YM, Keats DW (2008). A catalogue with keys to the non-geniculate red algae (Corallinales, Rhodophyta) of South Africa. South African Journal of Botany 74: 555-566.

Stegenga, H., Bolton, J.J. and R. J. Anderson. 1997. Seaweeds of the South African west coast. *Contributions from the Bolus Herbarium* 18: 655 pp.