# cross-resistance and collateral sensitivity between clinical antibiotics and natural antimicrobials: the case of Cornish seaweeds

Michiel Vos
University of Exeter
m.vos@exeter.ac.uk

with Abigail Colclough, Jukka Corander, Sam Sheppard and Sion Bayliss

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*Review*

**Medicinal and pharmaceutical uses of seaweed natural products: A review**

Albertus J. Smit
*Department of Botany, University of Cape Town, Rondebosch, 7700, South Africa: Current address: School of Biology, Faculty of Science, University of KwaZulu-Natal, Westville Campus, Private Bag X54001, Durban, 4000, South Africa*
**Author for correspondence (e-mail: ajsmit@science.uct.ac.za)*

**An assessment of the antioxidant and antimicrobial activity of six species of edible Irish seaweeds**

Cox, S., *Abu-Ghannam, N. and Gupta, S.

*SHORT COMMUNICATION*

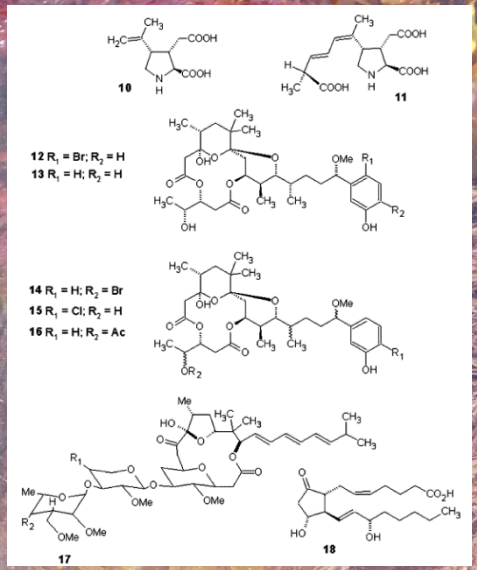
**Antiprotozoal, Antimycobacterial and Cytotoxic Potential of Twenty-Three British and Irish Red Algae**

**Seasonal antibacterial activity of two red seaweeds, *Palmaria palmata* and *Grateloupia turuturu*, on European abalone pathogen *Vibrio harveyi***

ORIGINAL PAPER

***Asparagopsis armata* and *Sphaerococcus coronopifolius* as a natural source of antimicrobial compounds**

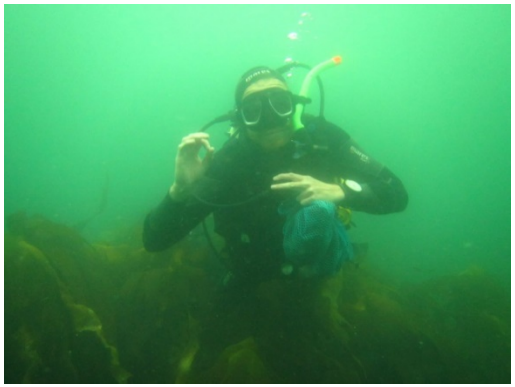
Susete Pinteus · Celso Alves · Hugo Monteiro · Ernesto Araújo · André Horta · Rui Pedrosa



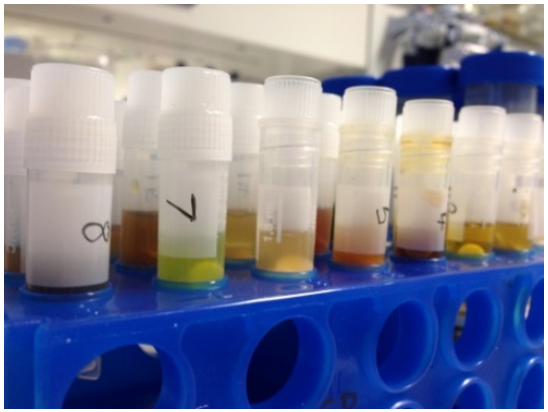

**Properties of Polysaccharides in Several Seaweeds from Atlantic Canada and Their Potential Anti-Influenza Viral Activities**

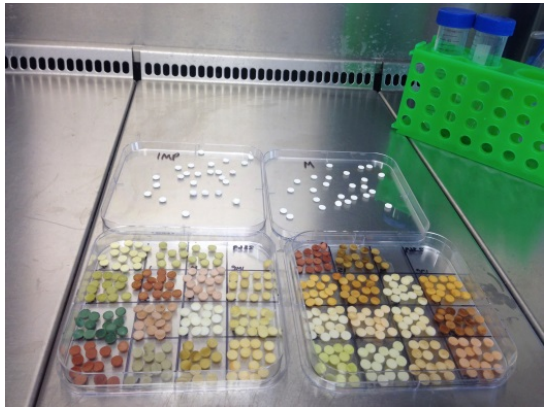
**Seaweed defence against bacteria: a poly-brominated 2-heptanone from the red alga *Bonnemaisonia hamifera* inhibits bacterial colonisation**

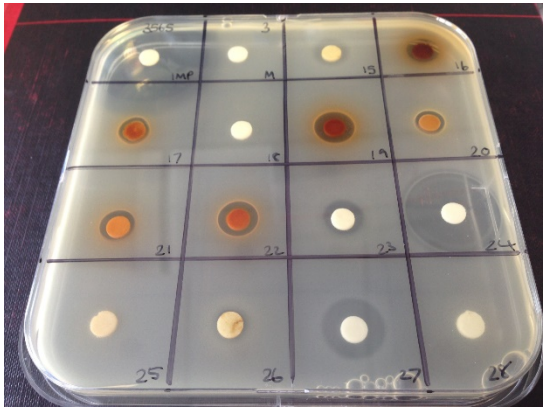
# Seaweeds to antimicrobial extracts



48 seaweed spp.





28 *S. aureus* isolates

# seaweeds are a promising source of antimicrobials

27/48 (56%) extracts showed anti-*S. aureus* activity

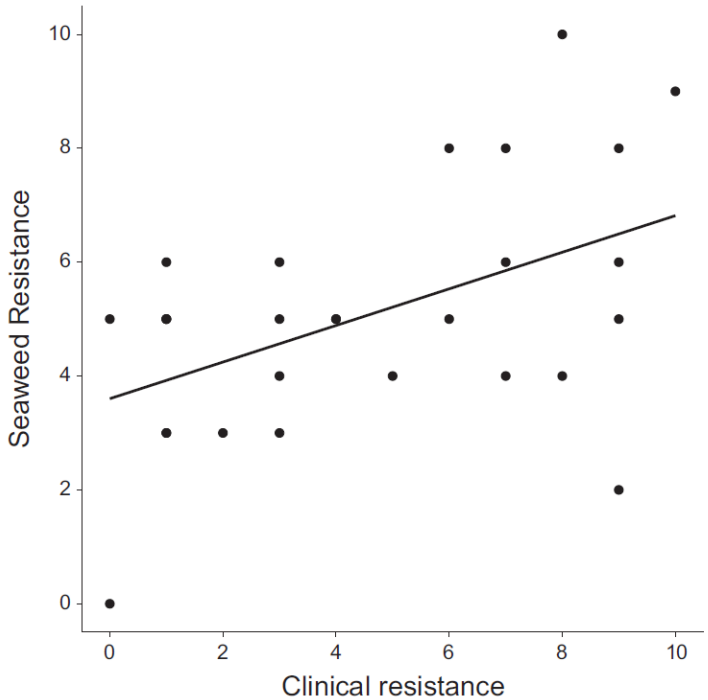
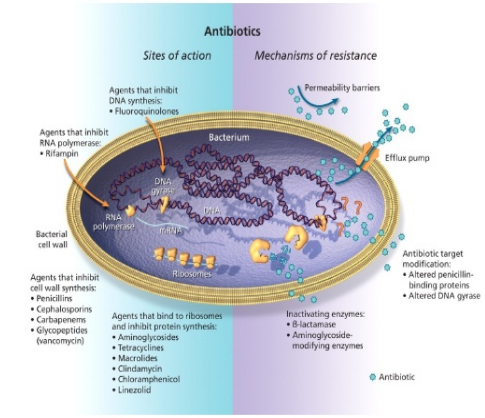



**FIGURE 1** Correlation between clinical resistance (sum of 22 antibiotics assayed using VITEK technology) and seaweed resistance (sum of 27 methanolic extracts) for 28 *S. aureus* isolates ($R^2 = 0.21$, $p < 0.01$).

but seaweed extract resistance correlates with clinical resistance

# Patterns of cross-resistance and collateral sensitivity

**Figure 1: Sites of action and potential mechanisms of bacterial resistance to antimicrobial agents.**




Mulvey M R , Simor A E CMAJ 2009;180:408-415

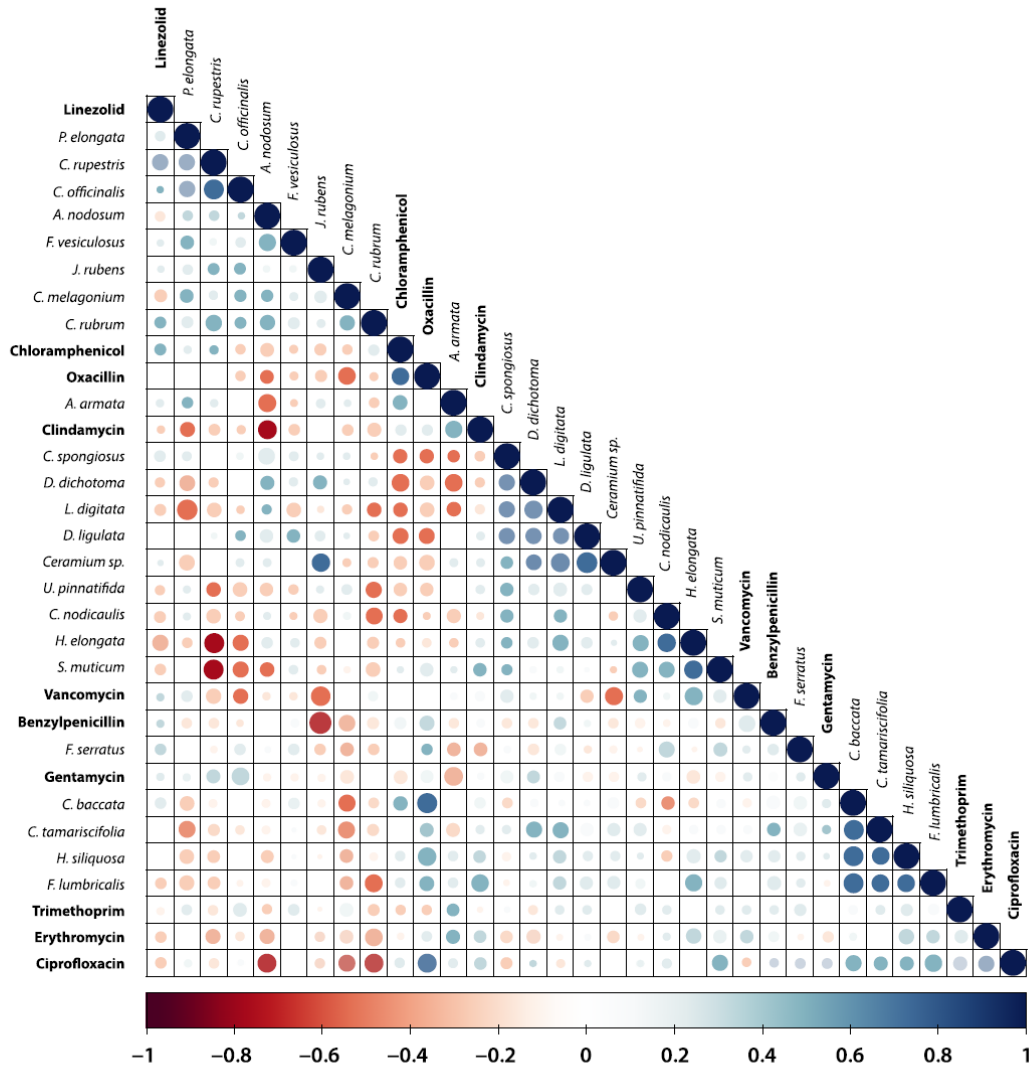
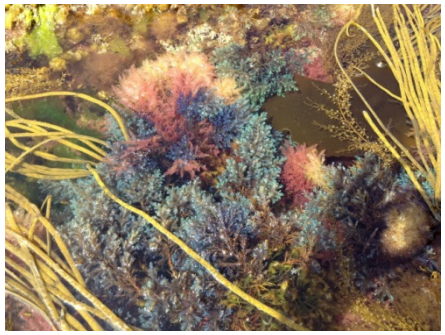



**FIGURE 5** Pearson correlation coefficients between seaweed extract inhibition zone sizes and clinical antibiotic MICs assayed using VITEK technology generated on a test panel of 28 *S. aureus* isolates. Colour-coded values range from −1 = perfect negative correlation (red) to 1 = perfect positive correlation (blue); the size of the data points co-varies with colour intensity

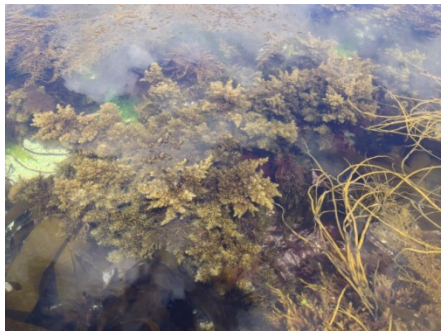
# Discovery strategies

- Do invasive species have more killing activity? No ($\chi 2$= 0.14, $p$=0.70)

- Do related species have related killing spectra? No:

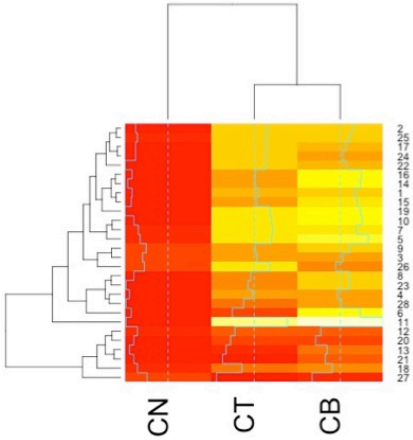


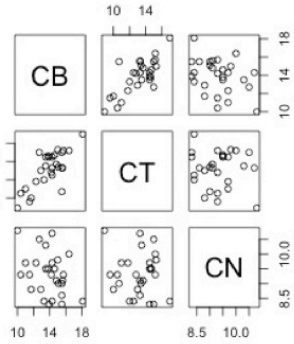
*Cystoseira tamariscifolia*



*Cystoseira baccata*

*Cystoseira nodicaulis*



# Conclusions Drug Discovery

- confirmation that antimicrobials are prevalent in nature
- even closely related species produce different compounds
- general cross-resistance antibiotics – natural antimicrobials
- BUT this is not always the case: collateral sensitivity
- evolutionary ecology-informed natural product discovery?
- can seaweeds select for antimicrobial resistance? (‘biotic selection’)

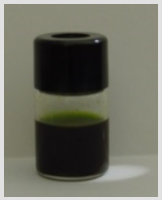
# Bottlenecks

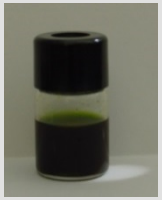
- Metabolomics…
- Industry contacts?
- Genomics (GWAS)….
- Lab experiments…

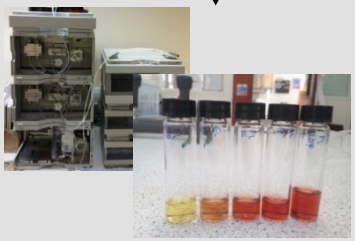
Ruth Airs

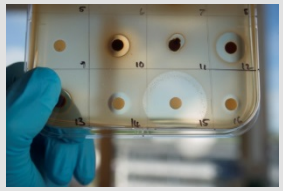
PML | Plymouth Marine Laboratory

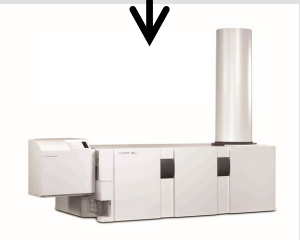
fractionation: degradation:



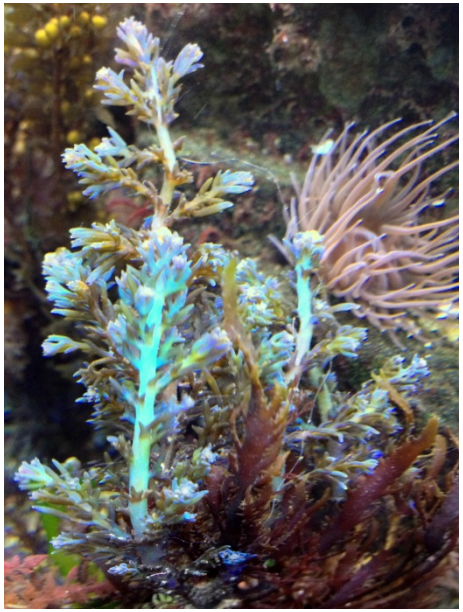








HPLC-QTOF-MS



*"Thus, it may be compared to some Christians, who are dull and profitless in prosperity, but whose graces shine out gloriously when they are plunged into the deep floods of affliction."*

*Philip Henry Gosse, 1854*