

Built for the Ocean: Lipid Organisation and Composition in Cetacean Skin

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AIM

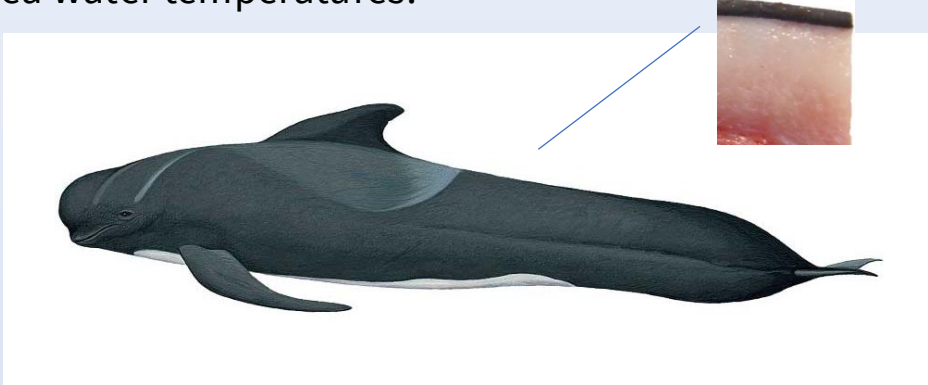
The biophysical organisation of mammalian skin is well studied, yet little is known about the biophysical properties in the skin of mammals that spend their whole lives in water, such as whales, dolphins, and porpoises (collectively known as cetaceans). Yet, characterising these adaptations are key to understanding the role of external stressors, such as chemical waste, increased sea water temperatures, and changes in pH, all of which can have a detrimental effect on cetacean health.

PURPOSE

To characterise the fatty acid composition in cetacean outer epidermis (stratum externum, SE), and to measure the thermotropic behaviour of SE lipids at varying sea water temperatures.

METHOD

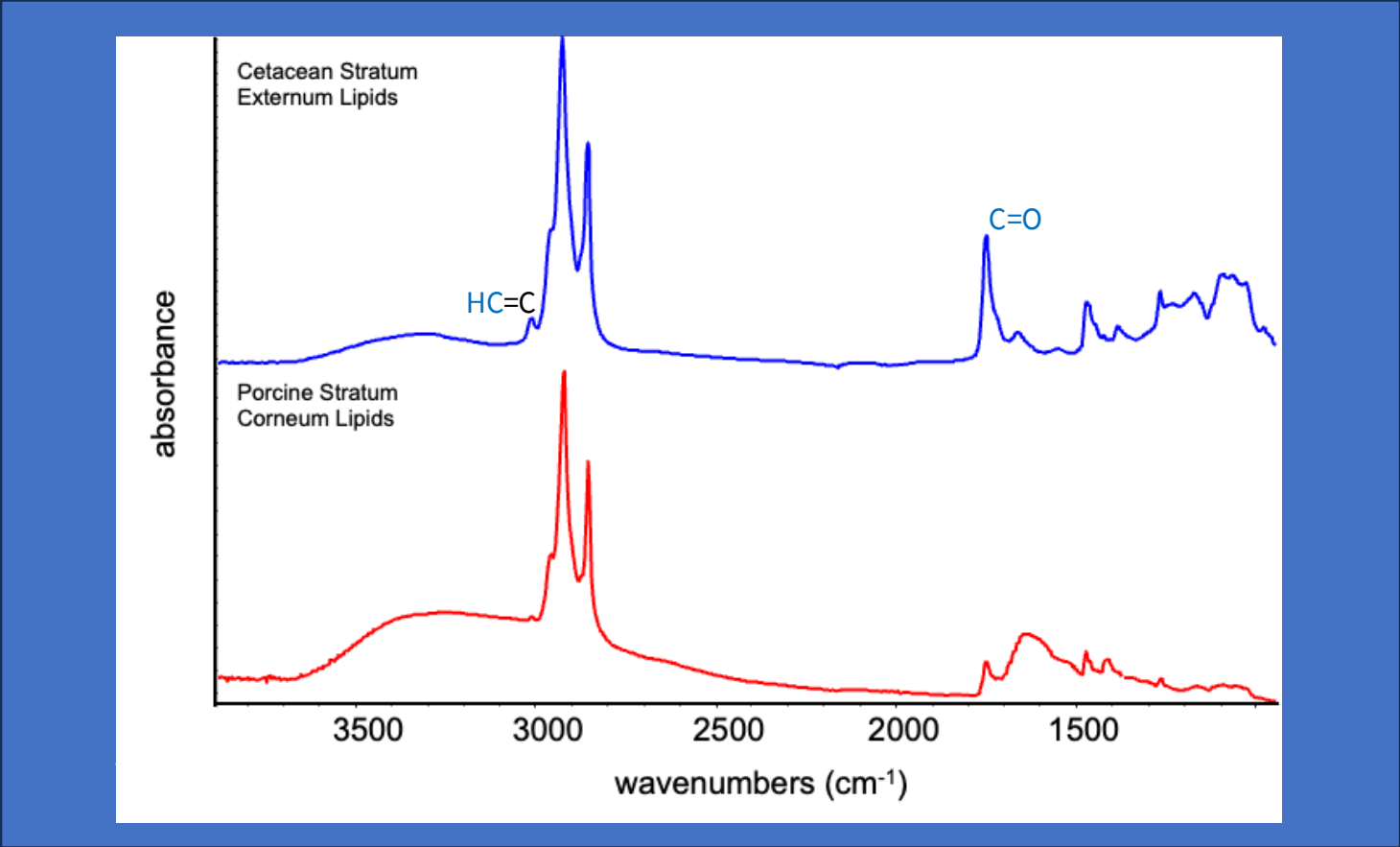
Using samples from stranded long-finned pilot whales (*Globicephala melas*), we characterised the total lipid and fatty acid composition in the cetacean outer epidermis (stratum externum, SE) using **GC-MS**. We also used ATR and transmission biophysical **FTIR spectroscopy** techniques to measure the molecular organisation and thermotropic behaviour of SE lipids at sea water temperatures.



BIOPHYSICAL FTIR SPECTROSCOPY MEASUREMENTS COMPARING CETACEAN AND PORCINE EPIDERMAL LIPID ORGANISATION INDICATE LARGE DIFFERENCES IN MOLECULAR ORGANIZATION AT APPROPRIATE ENVIRONMENTAL TEMPERATURES

Attenuated total reflectance (ATR) Fourier transform infrared (FTIR) spectroscopy of extracted epidermal lipids demonstrate the similarities and some key differences in cetacean and terrestrial mammalian outer epidermal lipids. Cetacean lipids have more unsaturated chains and carbonyl groups (esters and fatty acids).

At ambient temperatures cetacean SE lipids are more conformationally disordered (fluid) than SC porcine (a model for human SC).

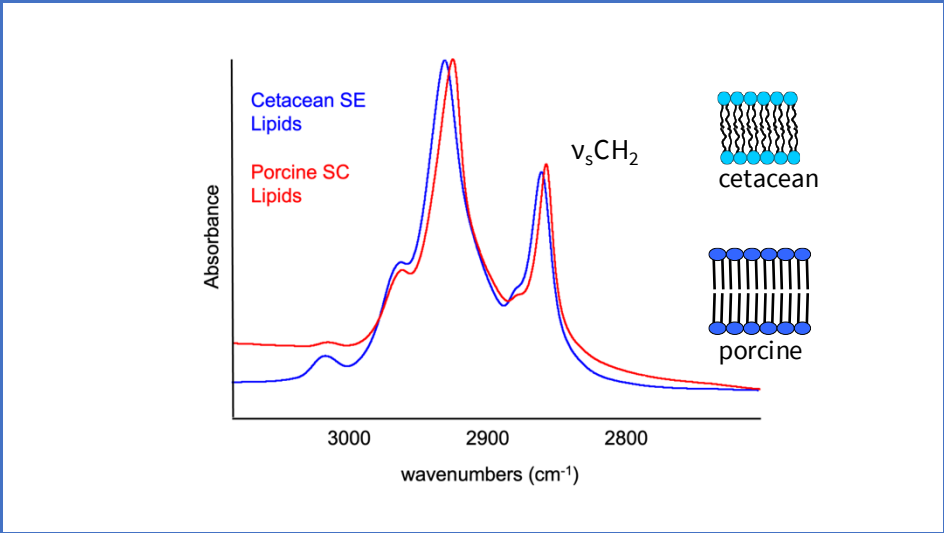


LIPID CONFORMATIONAL ORDER IN CETACEAN SE IS MORE “FLUID” THAN IN THE SC OF TERRESTRIAL MAMMALS AT NORMAL OCEAN AND LAND ENVIRONMENTAL TEMPERATURES

Initial results from several cetacean samples indicate SE lipid lamellae are “fluid” at all relevant ocean temperatures (+2 to +18°C).

In contrast, porcine and human SC lipids form highly ordered lamellae ($\nu_s\text{CH}_2 < 2849.5$). These ordered lipid lamellae are essential to barrier function in terrestrial mammals by maintaining water homeostasis and preventing desiccation and death.

°C	$\nu_s\text{CH}_2$
3	2851.4
8	2851.6
10	2851.6
13	2851.7
16	2851.8



THREE MAJOR LIPID CLASSES IN THE STRATUM EXTERNUM: FREE FATTY ACIDS, WAX AND STERYL ESTERS, TRIACYLGLYCEROLS

NEXT STEPS

Additional cetacean samples will be analyzed using biophysical FTIR spectroscopy methods to monitor SE inter- and intra-molecular lipid organisation across relevant ocean temperatures. These data will be correlated with GC-MS analyses.

Comparison with terrestrial mammalian SC lipid organization data will allow us to build an understanding of the role of SE lipid organization in healthy cetacean skin barrier function as a foundation to investigate the impact of health and environmental challenges of cetacean skin (and systemic) health.

