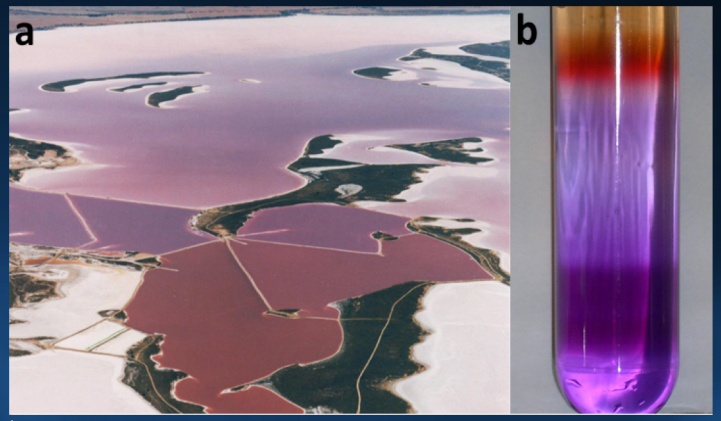
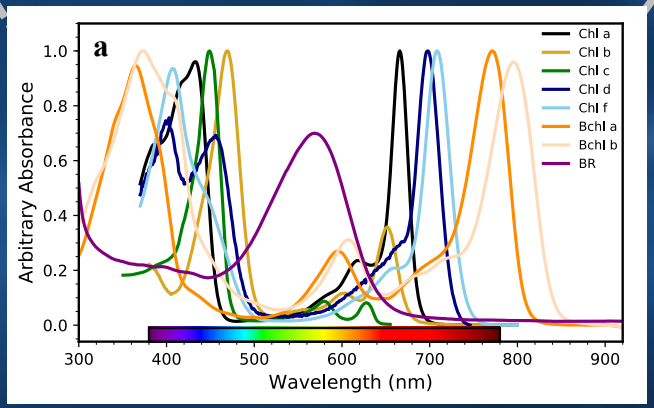
Early Evolution of Purple Retinal Pigments: Implications for Exoplanet Biosignatures





COMPLEMENTARY PIGMENTS IN PURPLE PONDS | The striking colors of hypersaline ponds are partially due to light—harvesting extremophilic Haloarchaea (top image). These microbes have a purple membrane that absorbs light in the green-yellow part of the spectrum compared to chlorophyll and bacteriochlorophyll pigments, which absorb most strongly in the blue and red (bottom plot).

Retinal pigments present in Haloarchaea illuminate the early evolutionary origins of light-harvesting for energy generation—and may be a signature of life on Earth-like exoplanets.

INNOVATION | Simple retinal-based light-harvesting systems like purple chromoprotein bacteriorhodopsin absorb at complementary wavelengths to the chlorophyll pigments used by photosynthesizers. This research suggests that these simpler light capture systems have an evolutionary origin that predated photosynthesis and examines their application as remote exoplanet biosignatures.

DISCOVERY | Purple retinal pigments absorb light at complementary wavelengths to chlorophyll pigments and power ATP (energy) synthesis by coupling to membrane potential. Their early origins may have influenced the evolution of more complex photosystems on Earth and may create unique spectral signatures on inhabited exoplanets, such as “green-edges” compared to the more familiar vegetation “red-edge.”

MISSION RELEVANCE | Remote life detection on exoplanets will encompass both atmospheric and surface characterization. This work expands the categories of surface signatures we might expect from light-powered organisms beyond those typically considered for photosynthetic organisms such as cyanobacteria and plants to other light-harvesting life.

S. DasSarma & EW Schwieterman, October 2018, *Int. J. Astrobiology* **1-10**
doi.org/10.1017/S1473550418000423