Black Holes of South Andros, The Bahamas : What they are and why they are Black.

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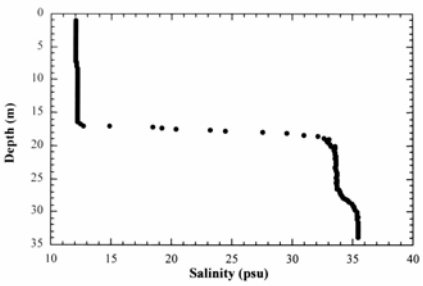
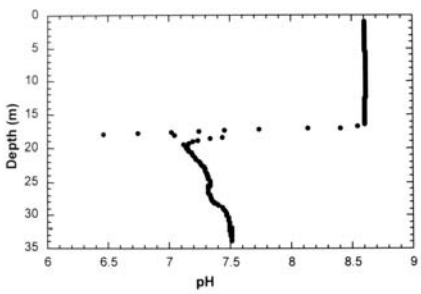
Introduction. Black Holes are vertical cave systems which form in the limestone interior of the larger Bahamian islands. The South Andros Black Hole is the most spectacular of these vertical limestone caves with an entrance 300m in diameter and a depth of 47m (see Fig.1). The water column is thermally stratified with an upper brackish water mass (12 ppt salinity) overlying a lower saline layer (35 ppt salinity). At the boundary between the two water masses is a 1m thick layer of phototrophic purple sulfur bacteria. The population density is ~10^7 viable cells/ml and conservative estimates indicate a total biomass of ~ 5 tonnes.

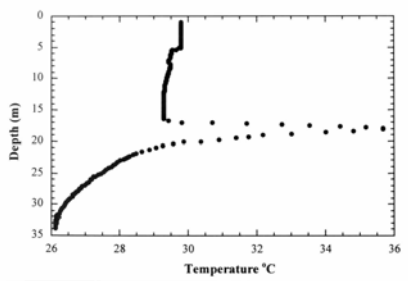
In this study we have investigated the distribution of the populations of purple sulfur bacteria in relation to the prevailing physico-chemical gradients.

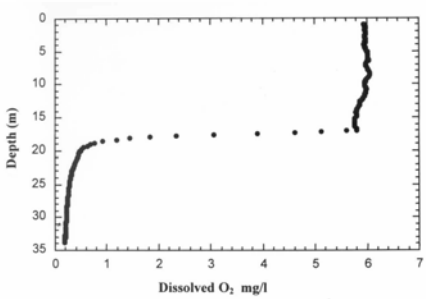
Methods. Depth profiles of salinity, pH, temperature, sulfide, oxygen were measured using a Hydrolab 3 multi-probe logger at 20 cm depth increments. Water samples were collected at selected depths by Scuba diver in sterile N_2 filled 500ml Duran bottles. The dominant purple sulfur bacteria were isolated in pure culture according to the methods of Pfennig & Trüper(1992). The isolates were identified to genus and species level according to the taxonomic schemes of Pfennig & Trüper (!989;1992) and Imhoff *et al*., (1998).

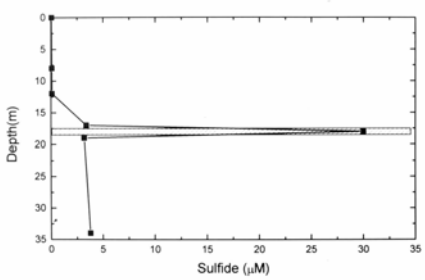
Results. Data presented in Figs 2-6 show the prevailing physico-chemical gradients in the South Andros Black Hole. The most noteable feature is the sharp increase in temperature at the thermocline from 29^{0}C to 36^{0}C and pH decrease from pH 8.6 to 6.45. Dissolved O_2 decreased from 6 to <1mg/l and sulfide is present.











Figs. 2-6. Prevailing physico-chemical gradients in South Andros Black Hole. Hatched area shows position of microbial layer.

Fig.1. Aerial view of South Andros Black Hole

From the microbial layer two purple sulfur bacteria were isolated. Isolate BH-1 was identified as a strain of *Thiocapsa roseopersicina (Fig.7)* and Isolate BH-2 a small celled *Chromatium sp. (Fig.8). In vivo* absorption spectra showed absorption maxima of Bchl*a and carotenoids* indicative of the normal spirilloxanthin series (Fig.9). The presence of significant amounts of spirilloxanthin in isolate BH-2 is unusual. Both isolates grow optimally at 20 ppt salinity but also grow in the absence of salt

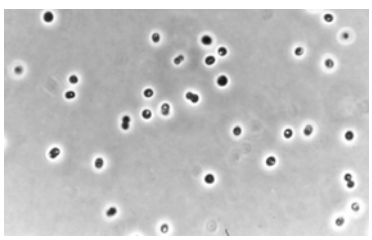


Fig.7 Photomicrograph of *Thiocapsa roseopersicina BH-1*

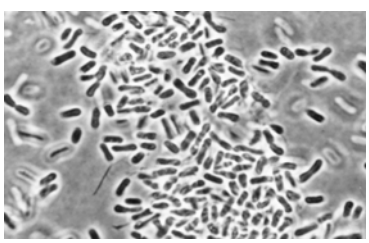


Fig. 8. Photomicrograph of *Chromatium sp.* BH-2

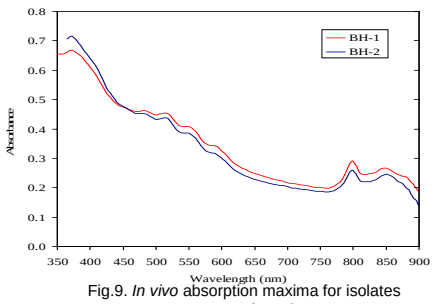


Fig.9. *In vivo* absorption maxima for isolates BH-1 and BH-2.

Discussion. Data presented in this poster show that the dominant anoxygenic phototrophic bacteria present in the microbial layer are members of the genera *Thiocapsa* and Chromatium. Both have carotenoids of the normal spirilloxanthin series which strongly absorb light between 480 and 550nm; the visible light wavelengths that penetrate deepest into the water column. Both isolates are therefore well adapted to growth at this depth. Coincident with the presence of the 1m thick microbial layer the temperature rises sharply from 29^{0}C to 36^{0}C. Spirilloxanthin has a relatively low efficiency (~30%) in channelling captured light energy to the photosynthetic reaction centres in purple sulfur bacteria (Cogdell & Frank, 1987). The remaining captured light energy is therefore potentially available for dissipation as heat. It is not inconceivable that captured light energy as heat by such a large biomass could lead to the recorded temperature maxima recorded at 17.8m. The presence of dense populations of purple sulfur bacteria also explains why the South Andros Black Hole appears black and not blue. Strong light absorption by the carotenoid rich cells prevents light scattering and hence viewed from the air the water surface appears black. A more detailed taxonomic study has shown that *Chromatium isolate BH-2 is a* new species related to but different from *Allochromatium vinosum (* Imhoff et al.,1998) and has been accorded the name *Allochromatium palmeri.*

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