The physiological response of predicted future levels of atmospheric carbon dioxide on respiratory gas exchange and acid-base balance in the gulf toadfish.

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The oceanic carbonate system is changing rapidly due to increased uptake of atmospheric anthropogenic CO_2. Current levels of 380ppm are expected to rise to 1000ppm by 2100 and over 1900ppm by 2300. The present study was undertaken to investigate the impacts these increases will have on a marine teleost, the gulf toadfish. Using a paired experimental design, evidence for a compensated blood acidosis after 24h of exposure to 750, 1000 and 1900ppm CO_2 was observed. A more detailed time course at 1000 and 1900ppm CO_2 revealed a significant respiratory acidosis after 15min of exposure with full compensation by 8h and 2h, respectively. Interestingly, environmental PCO_2 of 1000ppm represents an outward diffusion gradient. Addition of carbonic anhydrase to the plasma did not alleviate acidosis therefore diffusion limitations are not imposed by the red blood cell. Exposure to bicarbonate-free seawater and 1900ppm CO_2 revealed that compensation is achieved by bicarbonate uptake. Branchial gene expression analysis showed no transcriptional changes in acid-base machinery during exposure to 1900ppm CO_2, but both sodium potassium and V-type ATPase activity were transiently affected. These results indicate that fish acid-base and osmoregulatory processes will be affected under future environmental conditions.