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Flux of seawater and animals in a submarine cave

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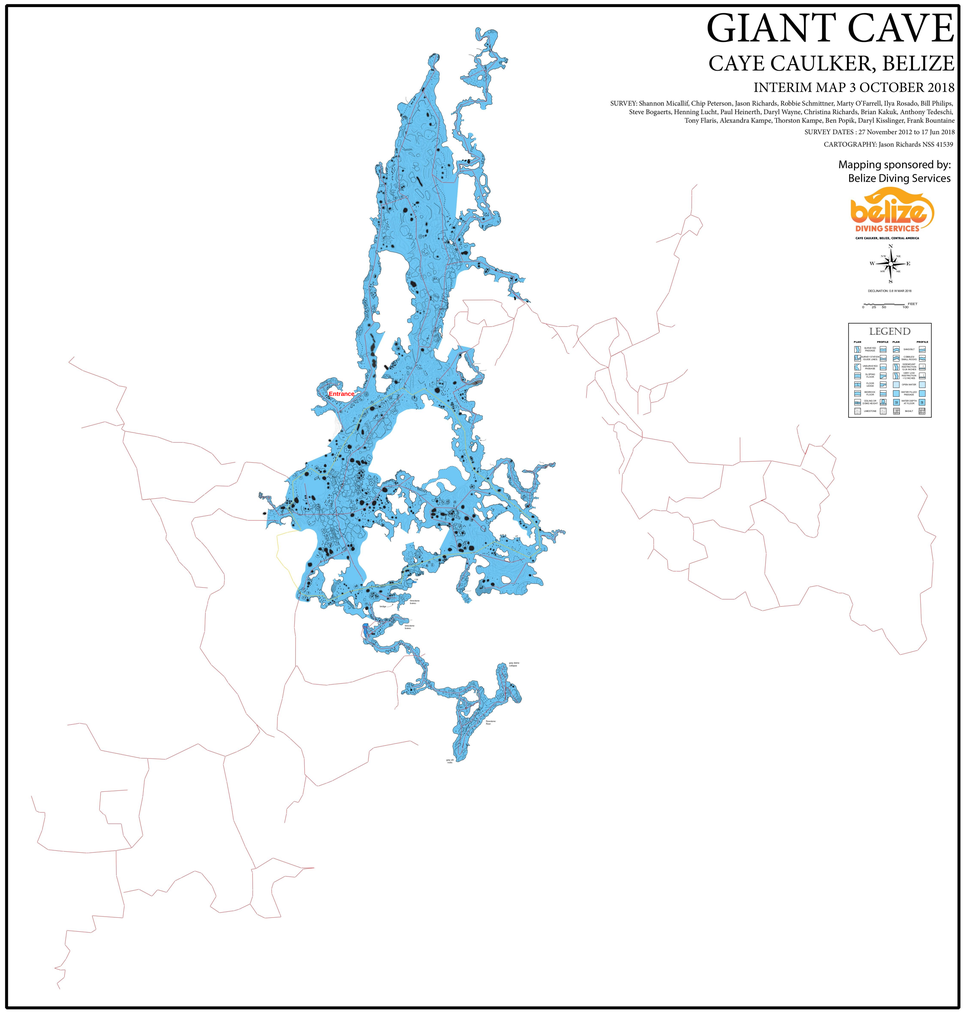
Giant Cave in Belize is a complex labyrinth of undersea passageways and vast chambers where exploration and mapping still continues. The single entrance to the cave lies just offshore from the island of Caye Caulker with the cave extending under the island and beneath the seafloor such that it is entirely submerged with no air spaces.



Tidal exchange of seawater from the ocean into submarine caves provides important sources of organic nutrients and dissolved oxygen to cave biota. Lacking photosynthetic production in lightless cave environments, external sources of nutrients and oxygen are fundamentally important to the maintenance of cave ecosystems. Undersea caves function as subterranean estuaries, where the velocity of periodically reversing tidal currents varies due to bathymetry, topography, morphology, and location of the cave conduits relative to the sea. We will use high-resolution water-current meters, electronic water quality analyzers and plankton sampling to examine the sustainability of cave ecosystems. In addition, microchemical analysis of scales from tarpon schooling in the mouth of the cave provides a non-lethal means of tracing their migration and habitat use. These will allow us to assess physical environmental parameters, and flux of water and organic nutrients between the sea and cave habitats.

Fig. 1: Tidal depth fluctuation inside (blue) and out (black) at Giant Cave, Belize; cave tides are nearly identical to ocean tides indicating good water exchange

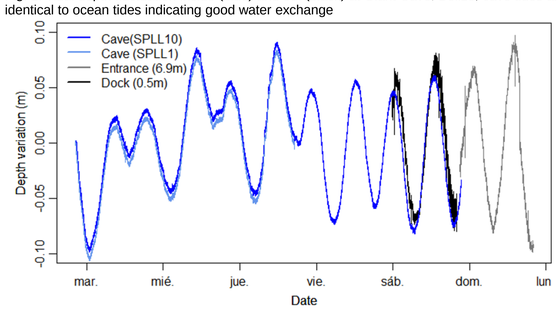


Fig. 2: Salinity (blue) and temperature (red) water column profiles at Giant Cave, Belize; salinity increases, while temperature decreases with water depth

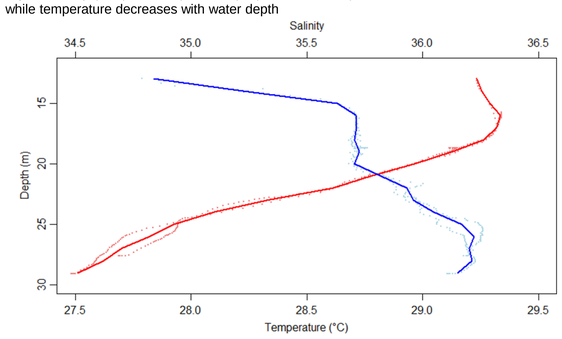


Fig. 3: Dissolved oxygen levels at Giant (red: shallow, black: deep) and Winter Wonderland (blue: shallow, green: deep) Caves, Belize; deeper water is well oxygenated, with water at cave ceilings is hypoxic

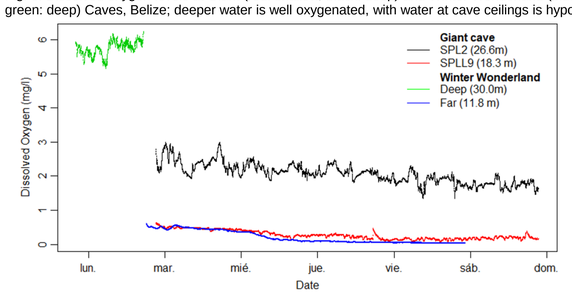
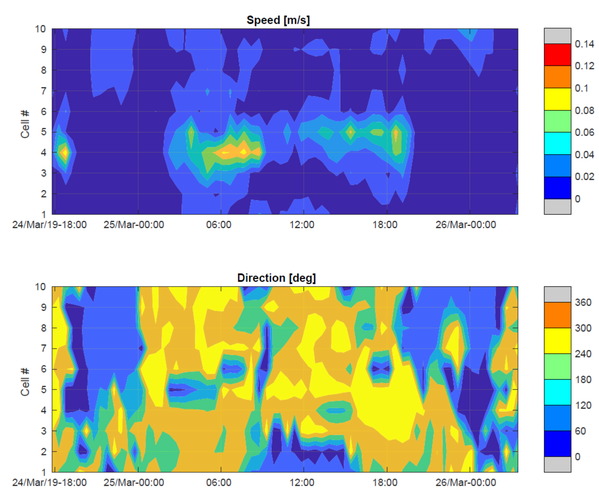
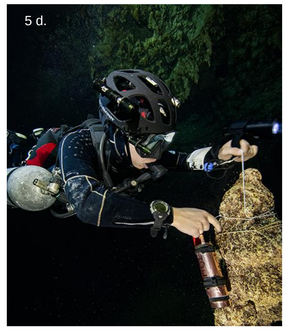
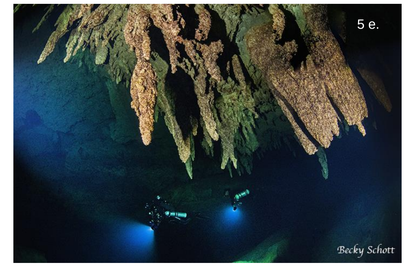
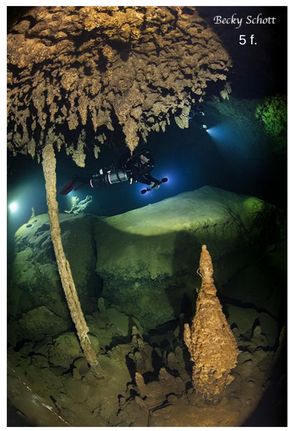


Fig. 4: Current speed (top) and direction (bottom) in Giant Cave, Belize. The vertical extent covers 2.5 m from near the bottom of the cave's entrance to the ceiling of the entrance. There appears a relatively more intense flow in the center of the entrance during the high tide period (maximum outflow), with speeds reaching up to about 0.1 m/s. Speeds above and beneath this flow core, as well as during the low tide periods, were much weaker (0.0-0.04 m/s).









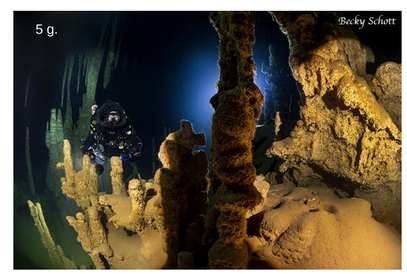


Fig. 5: Photographs from Giant Cave, Belize, courtesy of Becky Schott. a-c. Divers collecting specimens of a small, blind, albino shrimp *Typhlatya dzilamensis;* d. Placement of hydrological sensors for recording long-term variations of water parameters; e-g. Views of the largest room in Giant Cave, named the "Swimming Pool" after it's clear, warm water. The numerous stalactites and stalagmites seen in the photos could only form in air by dripping water offering proof that the cave was completely dry during the Ice Ages when sea level was as much as 120 m lower than today. The last peak of low sea level occurred about 18,000 years ago.