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# Exploring the 'Marine Twilight Zone' in the Gulf of Eilat, Red Sea, Israel

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In 2003, the Marine Twilight Zone Research and Exploration (MTRX) program, a deep reef research and exploration program, was initiated at the Interuniversity Institute for Marine Sciences of Eilat (IUI). The IUI is the major marine sciences research facility in Israel and the IUI's diving center stands among the busiest research diving facilities in the world, with an average of about 3,500 dives annually. The idea of exploring the 'marine twilight zone' was born out of the fact that virtually no work had been done on the deep coral reef of the northern Red Sea. This was a particularly remarkable oversight given the unusual water clarity, and related deep light penetration in this area. We erected an infrastructure to support technical diving, as well as a training program, starting with open-circuit technical nitrox through OC trimix and finally mixed gas closed-circuit rebreathers. Hundreds of research dives have been conducted to depths of between 40 to 92 m, working on subjects as broad as deep seagrasses, coral and fish distribution and community structure, coral physiology, geological aspects of ancient reefs and bottom morphology. The MTRX program has become an important resource for researchers at the IUI.

Keywords: marine twilight zone, Red Sea, technical diving

## Introduction

Diving technology and marine sciences have long shared a pleasant symbiotic relationship. As advances in the accessibility and convenience of underwater breathing systems improved, so did marine researchers access to the submerged realm, and alternatively—as the desire of researchers to record, describe, study and understand the sea so too was diving technology further propelled. The Interuniversity Institute for Marine Sciences in Eilat (IUI) embraced the opportunities afforded via these advances by investing in and supporting a scientific technical diving operations center referred to as 'MTRX.' This center provides the training and equipment necessary to extend diving times and depths for a wide range of research activities, thereby improving access and the feasibility for cutting-edge research in the Red Sea.

IUI is a multi-disciplinary marine research center located on the Gulf of Eilat in the northern Red Sea (Figure 1). It supports research activities from seven research universities in Israel and is financially supported by the Israel Council for Higher Education (ICHU). In addition to the research activities of the resident scientists, the facility also hosts accredited science courses, visiting research expeditions, conferences, and graduate students. The dive center of the IUI is very active, logging a minimum of 3,000 scientific dives a year. The IUI recently became an organizational member of the AAUS as well as a member of the European Marine Board, titles held by no other diving facility or center in Israel.

Geographically, the IUI is fortuitously located on one of the northernmost reefs in the world, in a bathymetrically steep zone, with very high average visibility. In layman's terms, to travel from sea level to -100 m depths is a matter of a few kicks of the fins from shore, and it is usually possible to

see your destination. For researchers, these circumstances present an unusual opportunity to conduct comparative depth research and explore the less-visited twilight zone depths without requiring the aid of a research ship.

Figure 1. Aerial view of IUI.

The amount of research conducted in the deeper zones of the Gulf of Eilat has been limited. Observations from submersibles and remotely-operated vehicles (ROVs) demonstrated that the coral growth extended beyond the 30 m depth zone, and suggested continuation beyond 90 m water depth. Despite this, the last published study of coral in these depths was in 1983 (Fricke, 1983). This dearth of information is not only unfortunate, it is dangerous. The data used to inform scientific studies and conservation studies is primarily derived from the shallow (less than 30 m) zone without any consideration of the condition of deeper areas. Until recently, very little was known about the biological communities in the deep coral reef.

Researchers at the IUI aimed to change this state of affairs by studying firsthand the deeper reef. It also is possible to approach the deeper reef with the use of ROV or submersible technology. However, these means are costly, and while improvements and advances are made regularly, direct firsthand human observation, and the convenience and dexterity of human hands has yet to be matched with those tools. With this in mind, the Marine Twilight Research and eXploration (MTRX) center was established in 2003 at the IUI dive facility (Figure 2).

**Building the MTRX**

The MTRX was first established with a generous private contribution which supported the purchase of three complete open-circuit technical diving sets. The DSO of the facility was trained through trimix instructor and in turn began training a pair of the more experienced graduate student divers to create the seed of the MTRX diving group. trimix blending capabilities were installed at the dive center allowing the IUI to be completely self-sufficient and independent. Within a year, hundreds of dives were completed by members of the group collecting material for the graduate students own research as well as providing deeper water collection material for others. In 2006, the MTRX added four megadelon rebreather systems (one donated by Shahar Segal) to the facility and four IUI MTRX divers were trained by Leon Scamahorn. After completing about 200 hours of diving on the Megadalon rebreather the DSO began instructor training for the megadelon to teach more students. Today the MTRX is housed within the recently renovated dive center and a storage caravan on the campus, future development plans include a new 'hanger' to house MTRX equipment, plan dives, prepare and maintain gear.

Figure 2. IUI dive center.

**The Work**

A variety of techniques have been used by MTRX divers to conduct research in the Red Sea. In the deep reef, line transects and video transects were used for community studies of corals fish and invertebrates, macroalgae and seagrass. Many dives included collecting samples of various organisms, translocating corals between shallow and deep reefs and vice versa, light measurements, in situ photosynthesis measurements of corals, macroalgae and seagrass. Marine geological researchers have used the technology to expedite sediment coring, collecting rock samples, and surveys of deep reefs of the region. The work was done in depths between 39 to 92 msw, and in some

cases the technical diving gear was used to greatly extend diving time limits and safety margins during shallower work. Throughout this period, the MTRX also engaged in training new technical divers and making skill proficiency practice dives on a regular basis.

## Results

There are multiple ways to assess the success of the MTRX dive program at the IUI, and in every aspect it has reached its goals and will continue to set new ones. Quantified from a purely diving perspective in terms of training and dives, it has been a great success. Over 1,000 technical deep (>42 m) scientific research dives have been completed since its inception in 2003. More than 30 students have completed at least one level of technical training, and six have completed training through trimix diver or higher. From a scientific perspective the program has also exceeded expectations. The materials, collections, recorded observations and studies carried out by the MTRX has contributed to five master and doctoral theses, over 10 peer-reviewed scientific papers, book chapters, and conference papers and poster presentations. The technology was used for a resident researcher's sediment core collections and highlighted in the National Geographic special 'Herod's Lost Tomb.' Video footage of the deep reef and damage caused by anchors, traps, fishing nets, and other marine garbage is being used to lobby for greater protection and conservation of these areas.

## Conclusions

Today's deep-diving technology allows marine scientists to enter and carry out work safely in depths beyond recreational limits in a manner more cost-effective and accessible than ever before. The IUI has chosen to embrace these tools and add them into the overall dive training and capabilities of its dive center, making it the only such facility in Israel, and one of a handful of centers with the capability to research these depths worldwide. The awards reaped from this have been great in the form of better understanding the deeper environment, contributing to scientific knowledge, providing more information for environmental policy makers, and improving methodological approaches in underwater research.

## References


Alamaru A, Loya Y, Brokovich E, Yam R, Shemesh A. Carbon and nitrogen utilization in two species of red sea corals along a depth gradient; insights from stable isotope analysis of total organic material and lipids. Geochim Cosmochim Acta. 2009; 73: 5333-42.

Brokovich E, Einbinder S, Kark S, Shashar N, Kiflawi M. A deep nursery for juveniles of the zebra angelfish *Genicanthus caudovittatus*. Environ. Biol. Fish; 2007; 80: 1-6.

Brokovich E, Einbinder S, Shashar N, Kiflawi M, Kark S. Descending to the twilight-zone: changes in coral reef fish assemblages along a depth gradient down to 65 m. Mar Ecol Prog Ser. 2008; 371: 253-62.

Einbinder S, Mass T, Brokovich E, Dubinsky Z, Erez J, Tchernov D. Changes in morphology and diet of the coral *Stylophora pistillata* along a depth gradient. Marine Ecology-Progress Series. 2009; 381: 161-74.

Mass T, Einbinder S, Brokovich E, Shashar N, Vago R, Erez J, Dubinsky Z. Photoacclimation of *Stylophora pistillata* to light extremes: metabolism and calcification. Mar Ecol Prog Ser. 2007; 334

Mass T, Kline DI, Roopin M, Veal CJ, Cohen S, Iluz D, Levy O (2010) The spectral quality of light is a key driver of photosynthesis and photoadaptation in *Stylophora pistillata* colonies from different depths in the Red Sea. J Experim Biol. 213: 4084-91.