The first GAME project in Mexico: Of white sand, coral reefs and brittle stars

Five months ago GEOMAR gave us a really hard task: We had to do research in the Mexican Caribbean, a place where millions of tourists spent their long desired holidays every year. The name of our research station is nearly as long as the coastline of the Riviera Maya: Unidad Académica de Sistemas Arrecifales del Instituto de Ciencias del Mar y Limnología (ICML) de la Universidad Nacional Autónoma de México (UNAM). It is based at the north east coast of the Yucatán Peninsula, in Puerto Morelos, a small fishing village located between the worldwide known tourist centers Cancún and Playa del Carmen. The ICML is situated right at the coast, surrounded by beach bars, hotels and big resorts with names like "Desire" or "Dreams". The intentions of most people that spent their holidays here are: Siesta, Cerveza, Playa and Fiesta. However, when we arrived here, we did not had much time for these things, because our working group is new at the institute and it is the first time that a Mexican team takes part in a GAME project.



Angie enjoying the sun at the 25 km long hotel zone beach. In 1970, Isla Cancún had only three residents. Now, there are more than one million inhabitants plus over two million visitors every year.



The ICML. Behind the institute stretches a large mangrove forest.



The backdoor of the ICML. Possibly the best place for breaks we ever had.



Without the help of many friendly people our task would have been impossible.

In the beginning, our outdoor-lab consisted only of an empty table. One day after our arrival, we therefore went for a long shopping trip to Cancún. In the heat of the afternoon, still jetlagged, we crossed out one item on our checklist

after the other. Many times when we thought we got everything for starting our experiments, something was missing and we had to do even more shopping. Finally, after a lot of trials and errors, constructing and plumbing, our self-designed setup was ready and we could start the search for



It was a big relief when our setup was finally working.

suitable test organisms.

That was the time when things got really awesome for us. We spent most of our time with exploring the magnificent marine environment around Puerto Morelos. We were quite sure that the high biodiversity of the surrounding coral reefs, sea grass meadows and mangroves would make it easy for us to find a sediment feeding species that is able to ingest our microplastic beads. We snorkeled in shallow waters for polychaetes, dove in coral reefs for brittle stars and went on night walks to collect mangrove crabs.



Colorful gorgonians at the reef of Puerto Morelos. The whole area is protected and part of the second largest reef system in the world, the Meso American Barrier Reef.



The spiny brittlestar *Ophiocoma echinata* in its natural habitat.

After a lot of fieldwork fun, we could start the first experiments with

the animals that we collected. Amongst species we found, one consumed the plastic beads, was very abundant in the coral reef and easy to keep in the lab - the spiny brittle star *Ophiocoma echinata*. There was only one drawback: Spiny brittlestars are night active. But what is some nocturnal work when you therefore can get a boat ride to the coral reef in the morning to scuba dive and snorkel O. We just adapted, became night active too and conducted the upcoming feeding experiments armed with caffeinated drinks, mosquito repellent and head torches. The results were amazing: We found out that spiny brittlestars are capable of ingesting more than 500! microplastic particles (\emptyset 0.7 – 0.9 mm) in a single night. Besides from that we also found out that *Eupolymnia crassicornis*, a sediment feeding polychaete that has up to one meter long tentacles, is not able to consume the plastic beads – but builds awesome tubes with it.



Close up of the tentacles and the tube of *Eupolvmnia crassicornis*.

Brittlestars do not have a clearly structured digestive tract but the ingested plastic was easy to identify.

After the pilot studies with the brittle stars were running smoothly, we started looking for microplastic on the beaches around Puerto Morelos and other nearby areas to get an impression about the pollution at our study site. Soon it became clear that it would be harder to find a beach without microplastic than one with it. To our surprise, a totally different scenario awaited us underwater: we did not find a single piece of plastic in the sediments near the coral reef. Since the reef in front of our door step is part of the Meso American Barrier Reef (which is, by the way, the second biggest coral reef in the world), we speculated that heavy plastic particles sink somewhere on the ocean side of pollution.



One out of many examples for plastic pollution.

the reef and that lighter particles pass the reef top and accumulate on the beaches. Of course, hotel construction and millions of tourists also contribute to the local macroplastic pollution too...



There is nothing that makes Angie happier than the right oxygen values.

Taking sediment cores underwater is not as easy as one thinks but with the help of our supervisor Dr. Vivianne Solis Weiss and her husband Guy we managed it.

During our stay we experienced some tropical hurricanes. We were really lucky that our setup was protected from rain and wind.

Now, we are nearly at the end of our time in Mexico and right in the hot phase of our main experiment. Thanks to dozens of pilot studies, regular cleaning of tubes and frequent exhausting exchange of the sediment in our containers to avoid algae growth (carrying 160 kilos of sediment from the beach to the lab in the tropical heat is not really fun) nearly none of our test organisms died during the two month long feeding experiment. During the maintenance, we took the word 'team work' very serious and became something like a single roboter like unit: After some weeks every move and all workings steps were perfectly coordinated.

At the moment, we are carrying out oxygen depletion experiments to investigate if there are differences in the stress tolerance of the brittle stars between the different treatment groups. By this we want to test if the consumption of microplastic beads impairs the performance of the animals. Apart from this, we also did motility tests with our brittlestars (or how Angie calls them: brittlestar-olympics). Two things are for sure: We will bring a lot of data back to Kiel and we hope that our results will make the cold and dark German winter more bearable for us O.



But wait ... what do we do in our free time? Well, we save baby turtles, snorkel with whale sharks, explore tropical islands and Mayan ruins, work at the underwater museum of Cancun, dive in coral reefs and in cenotes, build awesome sand castles and simply enjoy the Caribbean life style!





The stunning Mayan ruins were once sacrificial or ceremonial places and were built around 2000 B.C. There are so many ruins in Yucatán that it is impossible to visit all of them. Left: Road of Tulum.

Left: Road of Tulum. Right: Nohoch Mul pyramid Koba.





During the summer months (June -September) hundreds of Whale Sharks (*Rhincodon typus*) gather just north of Isla Mujeres to take advantage of the plankton rich waters by the joining of the Gulf of Mexico and the Caribbean Sea. Whale sharks are the largest fish species.





Cenotes are natural pits, or sinkholes resulting from the collapse of limestone bedrock that exposes groundwater underneath. In the Yucatán Peninsula, cenotes were sometimes used by the ancient Maya for sacrificial offerings. The term derives from a word used by the Maya, "Ts'onot" to refer to any location with accessible groundwater.



Angie releasing baby green turtles at the beach. When the turtles hatch at the beaches around Puerto Morelos, students collect them at night. They are later on released at a safe location to lower predation pressure.



The Underwater Museum Cancún consists of over 400 permanent life-size sculptures and is one of the largest underwater artificial attractions in the world. Our supervisor monitors the epifauna/-flora of the statues and we had the opportunity to help her with it.



The international sand castle contest at Playa del Carmen.