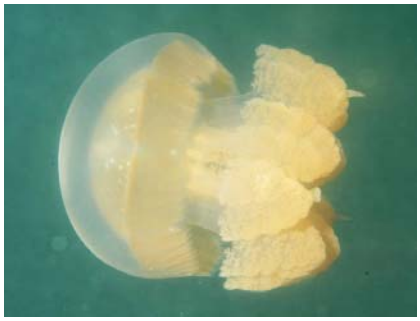
Coral Reef Research Foundation

❖ Jellyfish Lake Information Sheet ❖

Ongeim'l Tketau (OTM), also known as Jellyfish Lake, is a 30 m deep basin filled with seawater indirectly connected by cracks and crevices to the lagoon. Typically the lake hosts ~13 million golden jellyfish. While this is the only lake open to visitors, there are over 50 marine lakes in Palau, at least five of which contain golden jellyfish.

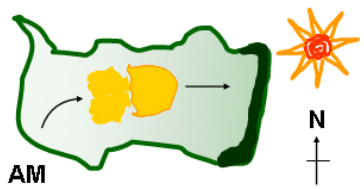
What are marine lakes? Marine lakes are isolated bodies of seawater, surrounded by land. All marine lakes retain connections to the ocean via channels through the encircling limestone rock. The number, size, and length of channels determine the degree to which water and organisms exchange between the lakes and the ocean. Each marine lake is unique in characteristics such as depth, size, shape and volume of the lake, number and positions of tunnels and vertical profiles of salinity, temperature, and dissolved oxygen. These factors affect the types and amount of habitat, and therefore the numbers and kinds of marine species each lake supports. In fact, each lake is distinguished by a unique suite of habitats and species.

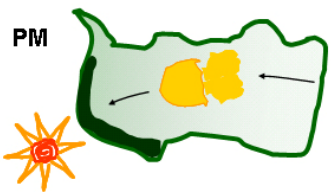
Marine lakes occur in two main types: mixed and stratified. In mixed lakes, temperature, salinity, and the amount of dissolved oxygen do not change significantly with depth. The opposite is true in stratified lakes, and the deeper regions of these lakes lack oxygen and have high concentrations of hydrogen sulfide. Like most jellyfish lakes, OTM is stratified with the anoxic (oxygen-less) lower layer beginning at ~12-14 m (40-45 ft). This transition is marked by a pink bacterial layer ~ 1 meter thick.



Why call it Jellyfish Lake? Two species of jellyfish inhabit OTM: the golden jelly, *Mastigias papua etpisoni*, and the less common moon jelly, *Aurelia* sp. 4. Fragile, transparent moon jellies are graceful swimmers that often hang suspended, unmoving in the water. These animals generally spend daylight hours ~ 5m (15 ft) below the surface feeding on plankton. Golden jellies, in contrast, are a mutualistic union of jellyfish and microscopic algae. As in corals, the algae provide energy for themselves and the jellyfish by converting sunlight into sugars, some of which they share with their host. Golden jellies also acquire energy by capturing zooplankton with stinging cells located on their frilly oral arms. Like their ancestors in the lagoon (*Mastigias papua*), the sting of OTM's *Mastigias* is mild and often undetectable. This has given rise to the myth that the jellies have lost their ability to sting due to isolation in a predator-free lake. However, you may feel their tingly sting if an oral arm comes in contact with sensitive skin like that around your mouth.

Is the lake really predator-free? The myth that the golden jellies lack predators is also discredited by the presence of the endemic white sea anemone *Entacmea medusivora* (medusa-eating). Although immobile, these animals are capable of capturing and ingesting a passing jellyfish larger than themselves and can often be seen doing so on the rocky point ~ 50 m from the dock. In fact, these anemones are likely responsible for the evolution of the remarkable, daily migration of the golden jellies.

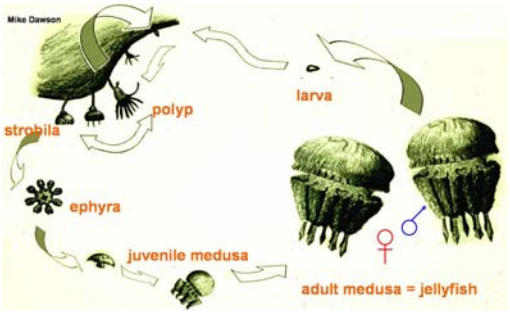




How and why do the golden jellies migrate? The golden jellies of OTM make a 1 km long, daily migration the direction of which helps them avoid capture by the predatory sea anemone *Entacmaea medusivora*. Swimming east in the morning and west in the afternoon ensures the jellies always encounter a shadow before the actual side of the lake. Staying out of the shadows keeps them away from the edge where this major predator lurks. The jellies' avoidance of shadows also causes them to form spectacularly

dense aggregations at the illuminated edge of the shadow. Make a point to visit the densest area of jellies - you won't regret it!

How do the jellyfish reproduce? Like most jellyfish, golden jellies have two separate life stages, the free-swimming medusa and the bottom-dwelling solitary polyp, a dinky sea anemone-like animal only a few millimeters tall. The fertilized eggs of a female medusa develop into free-swimming larvae that eventually attach to the bottom and grow into polyps. Polyps are generally found between 7-12 m (20-40 ft) in the lake. It is the polyp that buds off a new young medusa (an ephyra) to complete the life cycle. Over a period of months, the ephryae grows and matures into the organism we commonly recognize as a jellyfish.



How many subspecies of *Mastigias papua* exist? Five separate subspecies of *Mastigias* inhabit each of five different marine lakes in Palau. Today's jellyfish lakes formed as sea level rose after the last glacial maximum and flooded dry land to create both the Rock Islands and the lakes within. The individual populations of jellies have been isolated from their ancestor, the lagoon golden jelly, and from one another for anywhere from 5,000 - 15,000 years depending on the depth and, thus, age of the lake (deeper lakes formed earlier and are thus older). Each subspecies is distinguished by a lake-specific suite of genetic, physical and behavioral characteristics. The five subspecies have been named in honor of the five elected Presidents of Palau.

Is Jellyfish Lake a threatened ecosystem? Unfortunately, OTM is vulnerable to the same threats as other ecosystems including climate change and non-native species. For example, the same warm ocean temperatures that caused dramatic coral bleaching in Palau during the 1998 La Niña also interfered with reproduction and survival of the *Mastigias* medusae. Completely absent from the lake for ~ 1 year, the medusae population eventually recovered once the lake cooled. Recovery was possible because jellyfish polyps were able to tolerate the elevated temperatures. The warm water apparently did not affect the moon jellies, which thrived in the absence of the *Mastigias*.

More recently, a non-native sea anemone (a species of *Aiptasia*) has successfully established in OTM. Discovered in late 2003, this anemone along with its mutualistic algae was probably introduced on a shell or other material carried in by a visitor. Unfortunately the anemone, which is a known aquarium pest, is rapidly taking over the shallow water habitats of the lake. It can be distinguished from the bright white, native anemone by its relatively small size and golden color. Currently, no quantitative data exist to describe its impact on the ecosystem. However, mangrove root and shallow water communities that were once dominated by algae or diverse assemblages of invertebrates are now dominated by invasive anemones.

How should I behave in Jellyfish Lake? To avoid mechanically damaging the fragile jellyfish, we recommend that you wear fins to maintain greater control. If you do not wear fins, do not kick among the jellies with your feet as this rips and tears them. Always remain in a *prone* position on the *surface* and propel yourself with *slow, gentle* strokes. Please also make sure to carry in only *clean* snorkel gear (check your pockets for any organic materials including dead shells) and do *not* apply sunscreen directly before entering the water. These actions will help preserve the wonder that is Jellyfish Lake for generations to come.

For more information on marine lakes of Palau contact the Coral Reef Research Foundation at crrf@palaunet.com.

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