CORAL REEFS *of* KUWAIT

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Kuwait Foreign Petroleum Exploration Company (KUFPEC) was established in 1981 as a subsidiary of parent company Kuwait Petroleum Corporation (KPC), to conduct Exploration and Production world-wide. KUFPEC has just celebrated its 30th anniversary and at the end of 2014 was active in 13 countries spread over five continents. International activities are directed from the Head Office in Kuwait and Regional Offices in 6 countries. A program of growth is underway to achieve a production target of 200,000 barrels of oil equivalent per day (boepd) by the year 2020.

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Coral Reefs of Kuwait

by
Nancy Papathanasopoulou & Stamatis Zogaris

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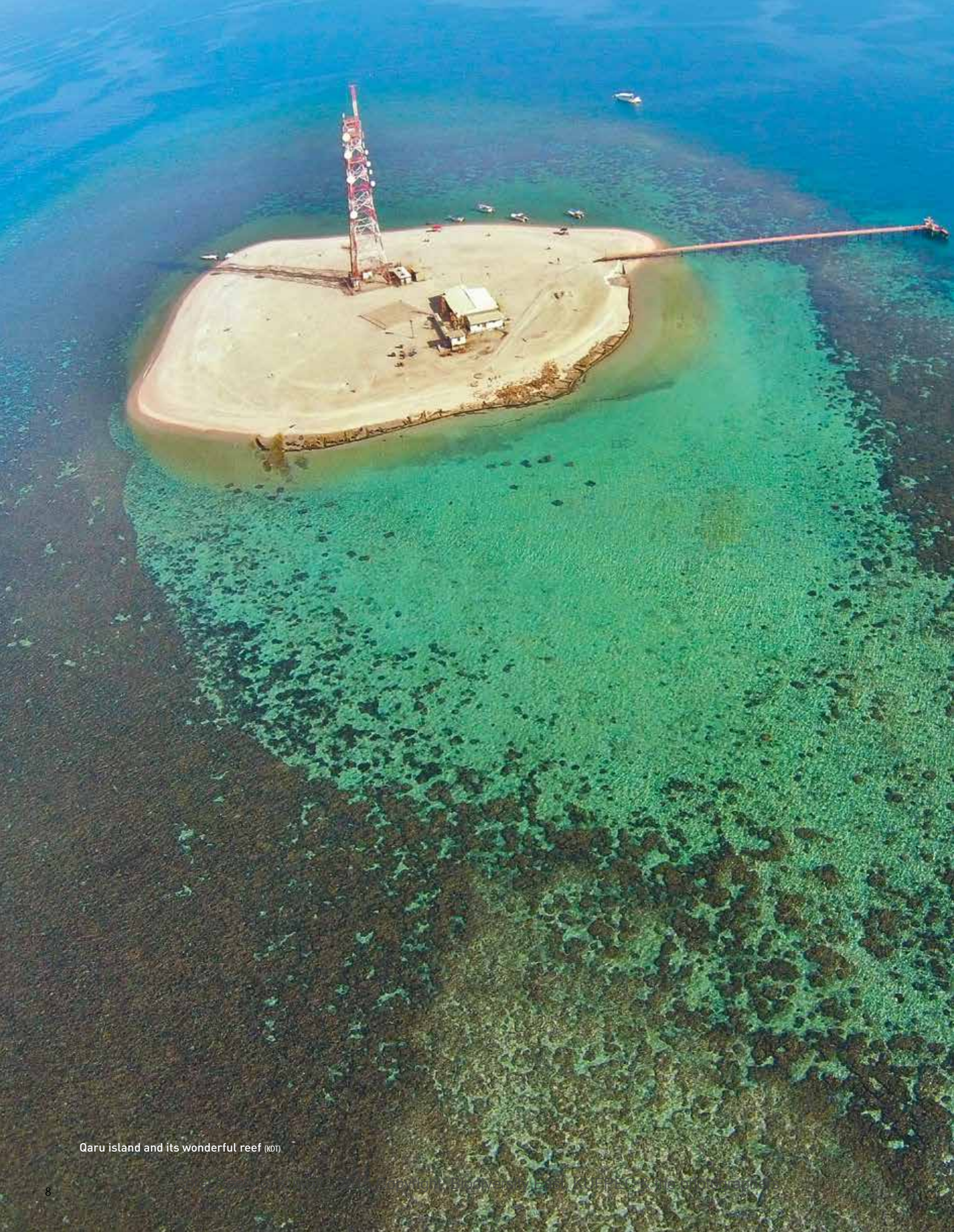

Qaru island and its wonderful reef (KOT)

Our Environment ... Our Commitment

Ever since its inception, KUFPEC has increasingly focused on producing hydrocarbons in an environmentally sustainable manner. We work to protect the environments in which we operate and deliver results to Kuwait's precious ecosystems for the benefit of our future generations.

In 2012, we published The Birds of Kuwait, the first comprehensive catalogue of the rich diversity of birds that migrate through Kuwait. A joint project with Biodiversity East, The Birds of Kuwait was a significant corporate social responsibility milestone for KUFPEC. The hardcover book and its electronic version are recognized and highly sought after by the most prestigious institutes worldwide, including the Museum for Natural History in Paris.

Building on the success of The Birds of Kuwait, we have once again collaborated with Biodiversity East, this time to catalogue Kuwait's original resource, its marine life.

The Coral Reefs of Kuwait is the product of over seven years spent in research and underwater photography by dedicated and highly skilled scientists, environmentalists and volunteers from academic and research institutions worldwide. Like its ornithological companion, this new book is yet another milestone in KUFPEC's contributions to helping protect and showcase our vital environmental endowment.

KUFPEC
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Sheikh Nawaf S. Al-Sabah
Chief Executive Officer
of Kuwait Foreign Petroleum
Exploration Company

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Yellowbar angelfish at Qaru waters • VID

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Biodiversity East

This book was created out of deep love for the coral reefs of Kuwait. We are sure that most Kuwaitis love the sea. Few know, however, of the riches and specifically the spectacular living treasures of coral reefs in the southern part of this country. In this book we showcase Kuwait's major coral reefs and their wildlife, primarily through photos we have taken ourselves and with the help of volunteer efforts of friends and visiting acquaintances. These photographs are not all from professional photographers, they are from people who love taking pictures in order to learn from and document the natural world. This is, therefore, not the book that will show the "most beautiful underwater photos". This book is an interpretative guide, it uses photography to showcase what scientists know about coral reefs; what we have seen and where, and how these unique ecosystems are truly worth preserving. And although most people know that the seas are threatened and suffering, perhaps through this book they may learn to understand specifically about Kuwait's coral reefs; and this kind of understanding will bring deeper appreciation and love. And it is all about love.

Biodiversity East is an environmental, non-governmental organization, linking a network of naturalists and scientists who care about nature in the Middle East. It promotes conservation through scientific research, education and ecotourism. Our members and associates have been working for conservation in several Eastern Mediterranean countries and in Arabia for over two decades. And often it is not just pretty pictures, its hard work and long-term commitment that leads to protecting nature. We strive to assist local initiatives towards protecting natural places and that is what we aspire to demonstrate in this book.

This book combines an initiative undertaken by a major industrial corporation that is supported by volunteer efforts of local naturalists and visitors to Kuwait. We at Biodiversity East are eternally thankful to all who have helped and will continue to support future initiatives towards nature conservation. It is up to those of us who respect and enjoy marine life to take an active role in its study, interpretation and protection. It is our sincere belief that through this book more people will become deeply interested in coral reefs in Kuwait.

Nancy Papathanasopoulou, Stamatis Zogaris, Vassiliki Vlami, Aris Vidalis
Founding Members of Biodiversity East

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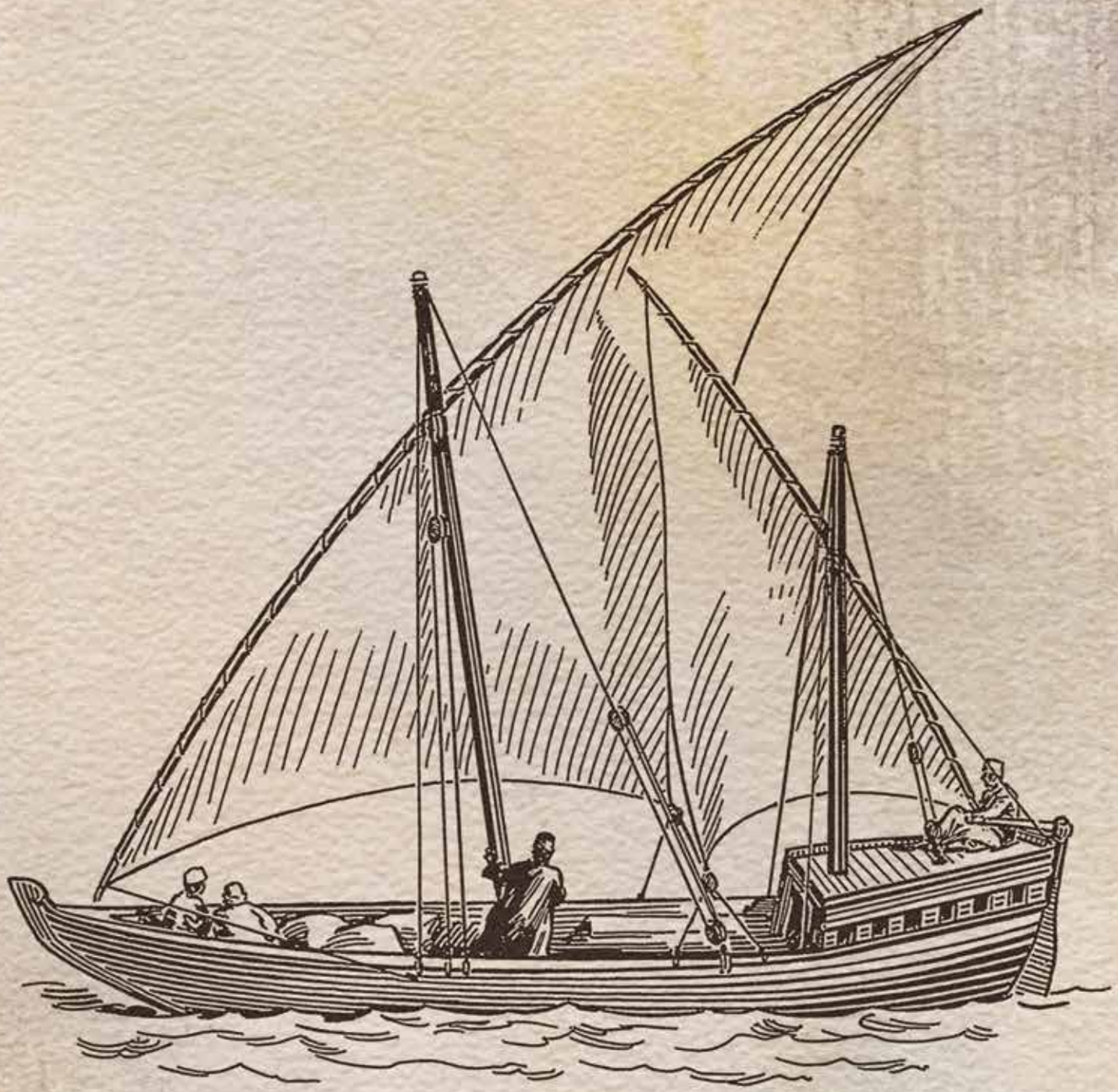

PART ONE

Kuwaitis and the Sea

A long history, a bond for life

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The *Boom*, the iconic Kuwaiti Dhow, featuring a front and and a hind sail, made history through the years in and all around the Arabian Gulf, marking the most important trade routes in the wider region with its dynamic presence.

As children, Kuwaitis often camped near the southern shores of the country, where the water was clear and swimming was pleasant. In contrast with the north of the country, the offshore islets Qaru, Kubbar and Umm Al-Maradim as well as the coasts south of Ahmadi provided sandy shores and clear views of the seabed: a living aquarium of exotic sealife available for enjoyment and relief from the scorching heat; ideal for the sport of spearfishing. Barbecues were set ablaze at night and families enjoyed the fragrant pleasures of food and sang old songs. Inspired by the crackling fire and the magic of the nocturnal reflections of the sea under the stars, stories were told and eventually sleep overcame every party, and everyone was later awakened by the sweet light of dawn.

Living an existence defined by the desert but also the sea, the people of old Kuwait had to look beyond the sea's horizon in order to meet their needs. They built ships and sailed them to resource richer countries such as India, Iraq and what today is Iran. Kuwait became a small maritime nation of traders and sailors and soon was well known to the whole region for its capable mariners. Every year the sailing *booms* left the City port bound for southern Arabia, the west coast of India and the east coast of Africa. They carried cargoes of dates and returned with cargoes of rice, timber and spices. Many Kuwaitis went pearling in the Gulf waters during the harsh summer months, enduring hardship and maintained local trade among the ports of Arabia, Persia and beyond.

This strong bond with the sea characterized the people of Kuwait and filled them with hope and courage.

In 1951, when some of these fringing coral reefs of Kuwait were cleared by dynamite to build a navigable seaway to the port of the city everyone knew it was for a good cause and

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Al Saif port, the ultimate source of trade, hustle and bustle and social life in old Kuwait, where the country's economy bloomed and nourished its people for many decades.

to bring development to the country. What may have been a barrier to navigation for some is seen today as a unique subtropical marine oasis: Kuwait's coral reefs. Today we know that Kuwait's coral reefs, present, but no longer abundant in the mid and southern seas of the country contain hundreds of marine species; they are some of the country's richest and most attractive ecosystems. So many resident and migrant sea animals depend on these reefs. A close relationship has been forming for years in those seas, the life of corals and their communities intertwined with those of other creatures such as sponges, crabs, shrimp, fish, sea turtles and jellyfish, in palaces which have inspired so much wonder from humans: Coral reefs.

These coral reefs and associated reef islets are becoming increasingly popular for recreation, snorkelling and scuba diving and are strategically important for Kuwait. In fact, Kuwait's coral reefs are of international importance since they are one of the northernmost coral formations in the Arabian Gulf. Beyond their outstanding value on a scientific basis and as educational living laboratories, Kuwait's reefs are also of deep spiritual and inherent value. The coral islet of Qaru especially holds a particular place in the heart of Kuwaitis, as it was the first piece of land freed from the Iraqi occupation in the war of independence. And most of all, these places are sanctuaries for the Kuwaiti spirit, Kuwaitis will always love and cherish these underwater oases.

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As the dhows from neighbouring countries arrived with precious drinking water in their hulls, a quest of obtaining it began. Ladies, donkeys with leather pouches and all interested parties flocked towards the source of life arriving from beyond the borders.

In the times before drones, boys played with model sailing ships which they often built themselves, out of discarded kerosene tins. These first ship building skills prepared the boys for a later life defined by ship building or sailing.

Al Saif port, in full bloom, in the mid 1950s.

In times when water was scarce and expensive, laundry was done by the seaside.
In this photo from the 1940s, ladies wash all kinds of clothes on the shores of the city.

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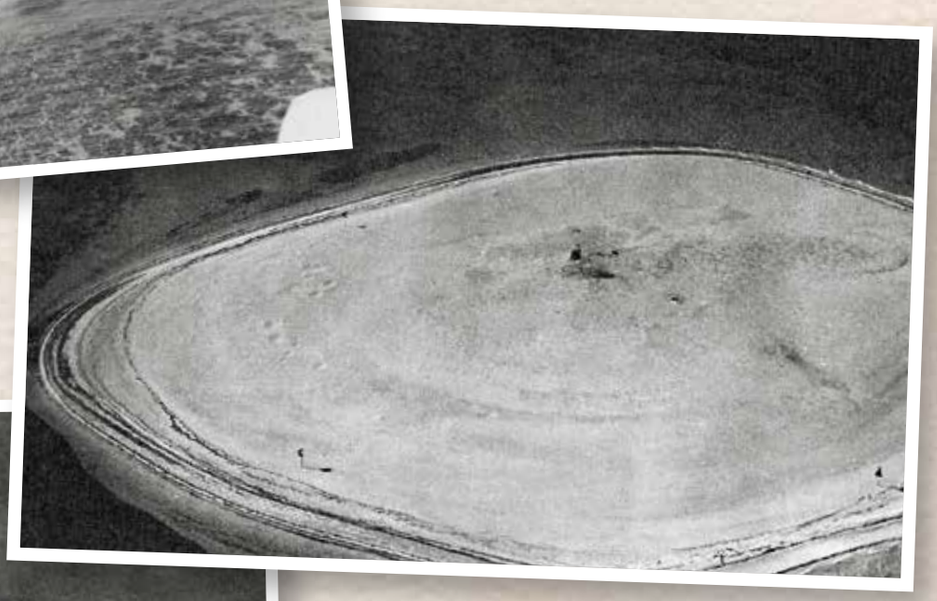
Basic in its construction, the *warjiya*, was often used by Kuwaiti fishermen for personal use. Made of palm leaves, it was not water tight in order for the water to keep the fish caught alive for a number of hours until reaching the shore. Two oars were fitted but when the wind allowed it, a small and graceful lateen sail was raised to steer her home faster.

Umm Al-Maradim Island (above and left), in rare aerial photos dating from the 1950s.



Qaru Island (above) and Kubbar Island (left), as they were captured in aerial photos a few decades ago. On Qaru we can even see the sea turtle nesting traces on the sand.

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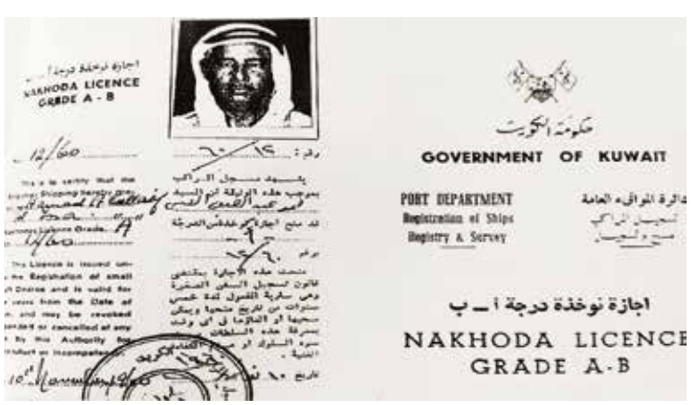
Marine History of Kuwait

How shipmasters shaped Kuwait

The *nowakhtha*, as merchant shipmasters in Kuwait were called in the end of the 19th century, held positions of high status in society. After the royal family, the social class with the most influence were wealthy businessmen *nowakhtha*, who were organizing the Kuwaiti economy by developing business relationships with the international maritime industry, including sea freight transporters as well as pearl divers and traders. There was undoubtable trust between the government and the *nowakhtha*, who were paying taxes calculating the amount appropriate on their own and paying them to the government without any prompting to do so.



The government maintained accurate records of boats sailing in Kuwaiti territorial waters, along with the details of their owners, the merchandise carried and the times it was loaded, as well as details of all the import-export activities undertaken. Taxes paid by shipmaster traders served as the most important source of income for the country.

Kuwaitis exported their ships and dhows and imported sugar, coffee, spices, rice and other goods from India and Yemen. They were then re-exporting the merchandise to Saudi Arabia, Baghdad, Syria and other Middle Eastern countries. This put Kuwait in an enviable position to participate and take the lead in the shipping trade in the region.

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To each their own port

Before petroleum, the sea was an economic fountain of wealth for Kuwait. Some Kuwaiti families owned dhow jetties or small ports in front of their residences. Such a jetty was called *nig'ah*. Others would occupy space by the seaside to repair their boats or build others. In these privately-owned jetties shipping was given the chance to flourish in Kuwait, as the boats were protected from strong winds and rough seas. Before the beginning of the 20th century, very important hardware stores at junctions of boat jetties were built to cater to the needs of the sea merchants. These shops were the *amayer* and they were crucial to the maritime economy as they provided ships with everything needed. Many *nig'ahs* existed until the end of the 1960s. Today, only one *nig'ah* exists, *Shamlan's Nig'ah*, located on Seif street and some dhows can still be seen in it.

Aerial views of private ports and jetties taken by Royal Air Force planes in the 1940s.

Common trade routes of Kuwaiti dhows

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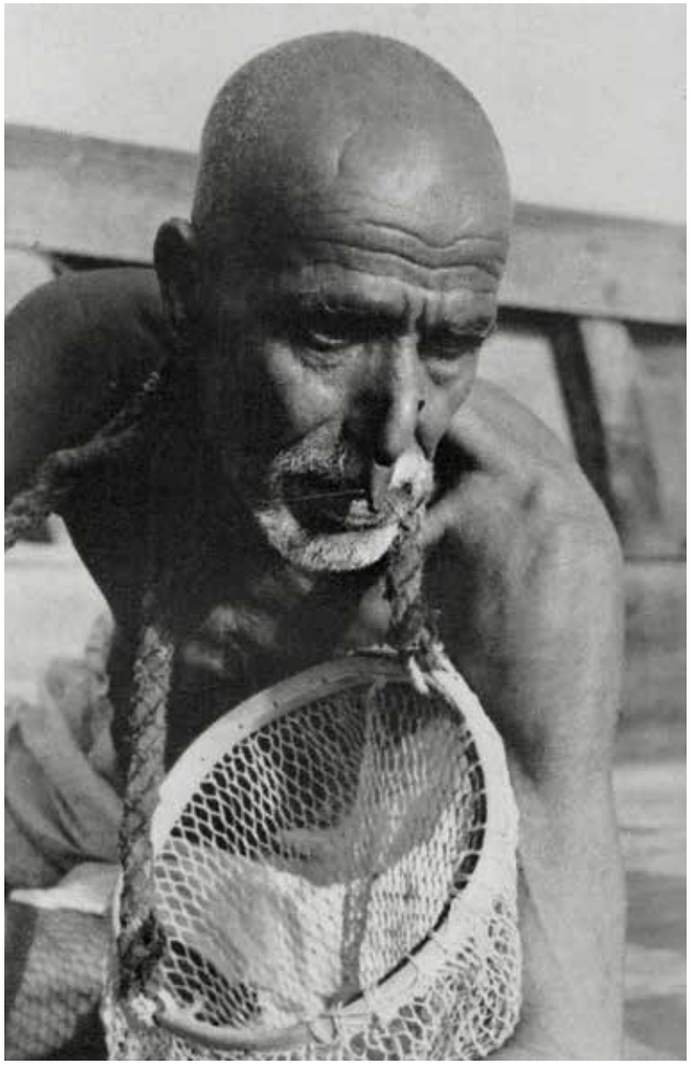
Dhow made to celebrate Kuwait's 50th National Day

Kuwait dhows sailing the region

The ancient overseas merchandise dhow, clearly distinguished from dhows made for pearl diving was referred to as the *Boom Saffar* by Kuwaitis. The *boom* was meant for traveling in the open sea beyond territorial waters. Their shape was distinct and it influenced other countries in the region as well, such as Iran and Oman. In India, the *boom's* unique shape came to be known as "the Kuwaiti style". The sails were usually very large, reaching from the front part of the boat up to the tail end. Unlike other boats, the *boom* had two sails as opposed to the one-sail dhows used by other sailing nations in the region, and this characteristic made them clearly recognizable in provenance even from a great distance.

Al Seif port, the main trading port in Kuwait for many decades. This photo is from the 1950s.



Kuwait pearl diving: core revenue source

Pearl diving rapidly became an area of special expertise for Kuwaitis who developed advanced diving techniques over the years. Gradually, pearl diving activities increased along with relevant shipmasters and divers. According to the notes in Saif Al-Shamlan's books, the number of pearl diving dhows increased to 1200 boats at the peak of the activity, in the year 1912.

That year is referred to as *Sanat Al-Tafha*, a popular expression used locally to refer to that golden period. One meaning of Tafha is maximum high tide.

After the major pearl diving trips, the amount paid by the shipmaster as a tax to the government was equal to the total fee paid to the divers. These fees were called *Glattah*. The divers were young men, skilled and trained for this specialized job. They were proud of their work, which involved free-diving to the bottom of the sea, recognizing and extracting pearl oysters in highly turbid waters, facing their own physical limits, and later shelling-out the pearls from the oysters on the ship.

The divers tied a rope around their waists, while another person, referred to as *Al-Saib*, held the other end of the rope on the ship. He would loosen or tighten his grip on the rope according to the diver's varying needs. Different ways of shaking the rope indicated different signals of communication and a sort of a "language" by itself, understood only by a diver or a *Saib*. The life of the diver literally lay in the hands of the *Saib*, who also took care of divers when they emerged from the sea, serving them tea, coffee and food.

The organizational hierarchy aboard the ship was understood and respected by all crew members and ran as follows:

The *shipmaster* was the ship owner and a wealthy trader, had to have good navigational skills, be over 50 years of age, and more than anything else, he had to be respected by all crew members. Shipmasters often spoke several languages, such as –apart from Arabic– Hindi, Farsi, Swahili and some English, in order to be able to communicate with often non-Arab speaking crewmembers. The *Ji'edy* was the deputy shipmaster, while the *Sekkouny* was the captain and main navigator of the dhow, understanding water currents, winds and exact underwater locations of pearl oysters and treacherous formations to the safety of the ship. The *Mojadimee*

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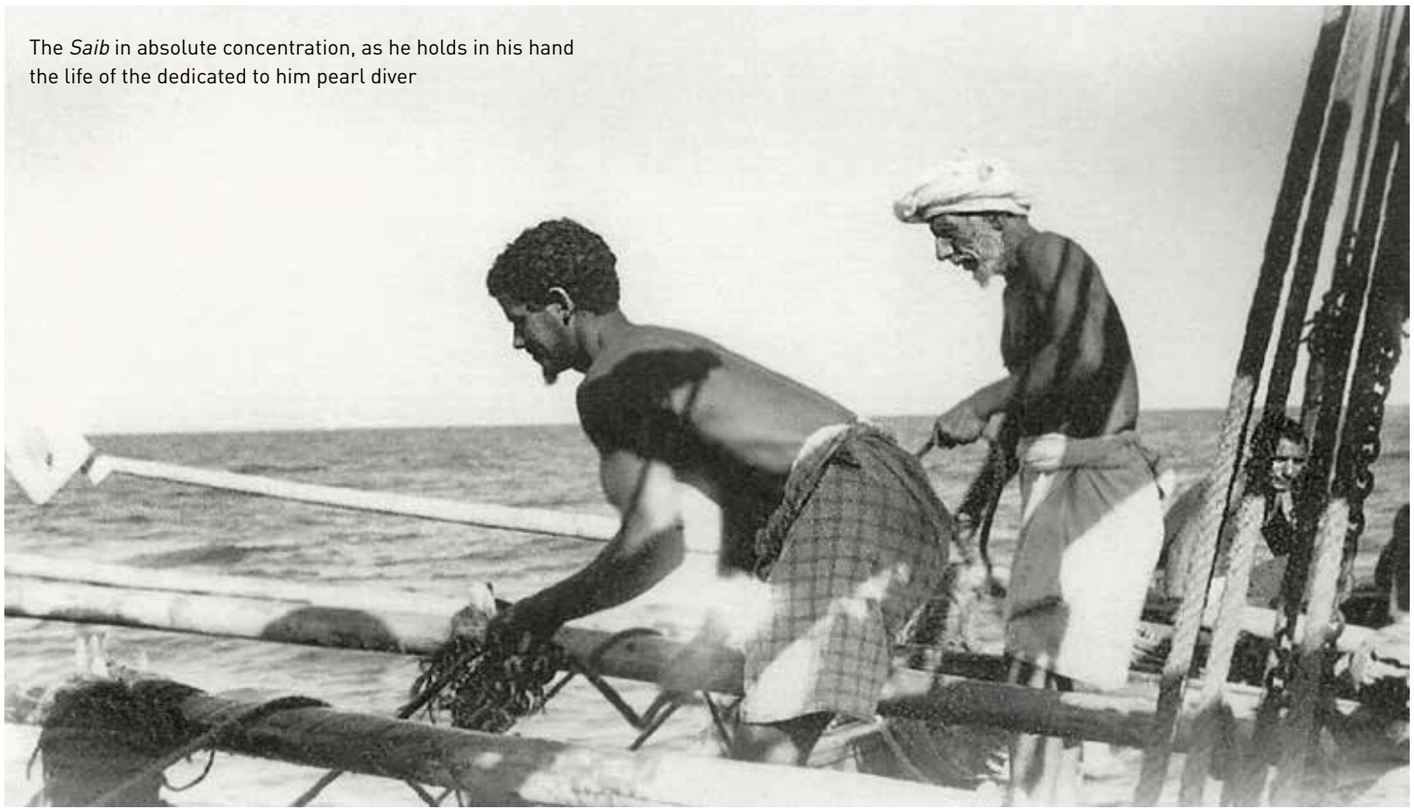
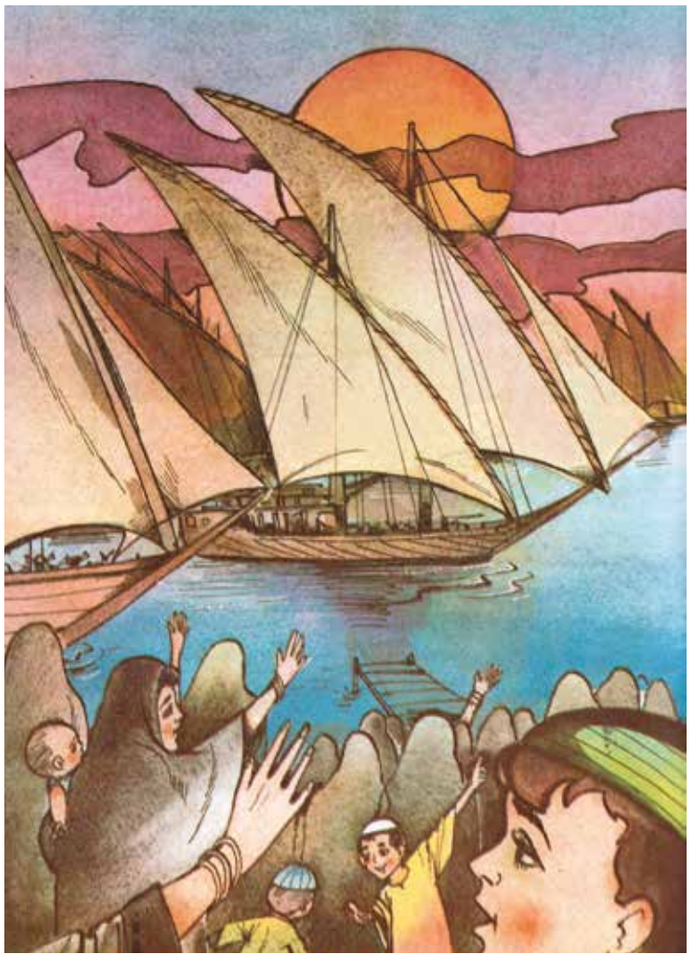


The *Saib* in absolute concentration, as he holds in his hand the life of the dedicated to him pearl diver

Pearl divers were receiving great honors from Kuwaiti society throughout the first decades of the 20th century. Their work was supporting the local economy and providing financial independence as well as the much-needed stimulation of trade. Nevertheless, the life of a pearl diver was harsh and physically demanding, as depicted in these photographs from the 1930s and 1940s.

The pearl oyster *Pinctada margaritifera*, most important species sought by pearl divers in Kuwait and the Arabian Gulf.



Saying goodbye to pearling dhows in the old days is deeply rooted in the cultural conscience of Kuwaitis and many fairytales speak of this painful moment.

was the crew supervisor, responsible for food, proper daily services, maintenance, equipment and spare parts, and the coordinator between the shipmaster and other crewmembers. The *Ghais* was the diver who could dive the deepest to collect pearl oysters, and his title made him very prestigious in society. The *Saib* was the rope holder, as stated above. The *Ridtheef* was the general helper on the dhow, the *Tabab* were service boys and sailing apprentices from 12 to 16 years of age, the *Naham* was the singer aboard the ship, a significant role as he was the unique source of entertainment during the long months of pearling hardship. The *Tabbakh* was the cook and finally, special mention must be made to the *Gallaf* who was the ship's carpenter and builder and his crucial main function was to maintain the vessel in its optimum condition all the time.

Pearling season began every year in April and ended in mid-September, but other periods of the year also were suitable for pearl diving as follows:

- Last week of September and throughout October: In this season, quick sailing trips in smaller dhows were conducted and trips were known as *Al-Riddah*. Even though the water was colder, the advantage for divers was that whatever they caught they kept to themselves and did not have to hand it over to the shipmaster, as was the rule in the previous season.
- The *Irdaidah*, the smallest pearl trip which lasted three weeks in November, with the same terms as *Al-Riddah*.
- *Al-Khanjiyah* was taking place for 3-4 weeks in the month of April on smaller dhows and with the same terms as the previous two.

The end of the pearling season in mid September, marked by the change of weather, was known as *Gouffal*, an expression to indicate packing and locking up all pearl diving tools and equipment for the next season.

The deadly *dardour*

Apart from sharks and sea snakes that a pearl diver dreaded and feared, the greatest danger to him was the fury of the sea, especially as it presented itself in the form of the *Dardour*. The *dardour* is tidal water pulling the diver away and downwards. *Dardours* were encountered anywhere in Kuwaiti seas, even as close as Kuwait City, and many lives were lost upon encounters of them by swimmers or divers. Today we know that these rapid tidal currents are still present, but modern scuba divers are well informed and always prepared using tide-tables and modern technology.

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The *Al-Ahaimer* star

It is common knowledge, until this day, that the state of Kuwaiti seas may change very suddenly, even in the midst of summer. As a result, crew members on dhows attempted to understand astronomy for the sake of predicting the changing nature of the sea. In due time, every sailor became an expert in the study of stars and their positions and even coined interesting names for the stars they regularly sighted.

Standing out from others, the *Al-Ahaimer* star was important to the sailors, as when they sighted it a sudden change of the weather was certain to occur. Huge ocean waves hit the coastal areas of India, causing tremendous damage to the cities and villages, often claiming human lives and properties. Such weather also hit the southern coast of the Arabian Gulf region and ultimately damage dhows and ships, injuring or even killing sailors.

The *Tab'aahs* that haunt forever

When dhows were wrecked at sea, killing their crew, the tragedy was referred to as *Tab'aah*. Many Kuwaiti sailors were lost during the pearl diving and seafaring days and some major incidents can never be erased from the memories of the Kuwaiti people.

One such tragic occurrence was the Bahman family's *boom Tab'aah*, in 1940, on which nine men from that family sailed to India carrying a cargo of dates from Iraq. Their *boom* went under in strong winds and rough seas, along with 25 crew members. Other such renowned incidents involved the Abo Taiban family *boom Tab'aah*, the Ghaith *boom Tab'aah* and Abdulwahab Abdulaziz Al-Othman *boom Tab'aah*.

Legendary *Tab'aahs* were recorded on film, such as the 1971 Kuwaiti film "Cruel Sea", which became one of the best-selling films in the country.

Sailors on trading boats and pearling dhows needed to be of optimum skill and bravery in order to properly face rough seas and stormy weather during trips, thus ensuring the safe return of the crew to their home after many painful weeks of absence.

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Kuwaitis and their Fisheries

Fishing has historic and cultural roots in Kuwait. From ancient times until the discovery of oil, fishing was a major activity in the country, stimulating the economy and ensuring the survival of the population in the harsh living conditions of the time. In recent years, unsustainable fishing practices and environmental degradation threaten fish populations and the natural food webs that depend on them. Despite solid efforts of the government to achieve better fisheries control, illegal fishing is still practiced and recreational fisheries are not regulated by law. Sadly even recreational fishing when not regulated can have a serious negative impact. On coral reefs for example, many of the larger fishes are scarce primarily due to unchecked spearfishing.

Today, Kuwait's major professional fisheries consist of two main sectors: a limited industrial-scale shrimp fishery and substantial artisanal small-scale fish and shrimp fisheries. The main gears used are bottom-trawling nets, primarily for shrimp, and gill nets, the *gargoor* wire traps and, to a much lesser extent, intertidal *hadra* traps for all other species. About two dozen fish and invertebrate species are exploited; these are precious culinary commodities. Local fish landings meet only 30% of Kuwait's requirements for fresh fish.

The shrimp fishery is especially important for Kuwait; its management has had both positive and negative consequences. Results of implemented scientific recommendations applying enforcement of specific regulations led to record yields in the late 1980s; however, after the Gulf War, trawling fisheries intensified to the point that the fish stock size was dramatically reduced. Considerable illegal shrimp fishing occurs during the closed season and poor monitoring and enforcement is a serious problem. Today, only a fraction of the shrimp stock size remains, compared to what was there four decades ago. Along with the trawled shrimp many more animals are sacrificed as bycatch (i.e., species that are unintentionally retained and sacrificed by the fishing gear). Each trawl kills thousands of young and non-commercial fish and invertebrates that are simply discarded overboard. Bycatch is a major component of shrimp fisheries raising concerns of ecological and economic impacts. Sometimes even soft coral and other sessile key-stone assemblages are killed as the sea bottom is scraped beyond recognition by the trawled nets.

Scientists warn that important fish stocks of very popular fish species are also threatened. The *Zobaidy*, Silver Pomfret, is an example of a transboundary fish shared between Kuwait, Iraq, and Iran. Although the main spawning grounds are in Iran, the fish are exploited in all three countries. The serious reduction of the *Zobaidy* stock is due to overfishing. The *Suboor*, Hilsa Shad, travels to the Tigris, Euphrates and

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Karun River systems to spawn but its populations have been impacted by the drainage of the marshes and decreased river flow. *Hamoor*, the groupers, are long-lived species and therefore, highly susceptible to overfishing. KISR scientists propose that the *Hamoor* exploitation rate is too high and requires at least a 50% reduction in fishing effort for biomass recovery.

Wider environmental degradation threatens Kuwait's fishes. The construction of dams on the Tigris, Euphrates, and Karun Rivers in Turkey and Iran has reduced riverine discharge to the northern Gulf. The absence of flood events and salinity changes have reduced the availability of nutrients, resulting in a shift in the dominant plankton communities, which in turn impacts food webs. Harmful algal blooms have increased and massive fish kills have occurred.

An urgent action plan is recommended for fisheries management and this should include: intensive scientific monitoring, more and better-enforced fisheries regulations, modified fishing gears to reduce bycatch and efforts to stop illegal fishing. Finally, the establishment of marine protected areas with no-take zones where no fishing is allowed is critically important. In some cases, such as local spearfishing impacts on coral reefs, protected areas could quickly help fish populations rebound. An ecosystem-based fisheries management should be implemented based on scientific understanding of the sea and a serious investment in the enforcement of regulations.

VID

ZOG

VID

From traditional fishing nets pulled from the shore in the old days (upper photo, preceeding page) to the modern fishing boats and fishmarkets of today, Kuwaitis are defined by fishing and a palate for fresh, exquisite sea food.

The central fishmarket at Sharq • VID

Hadra fish traps mostly remain active in Failaka island • NPA

The unique case of the *hadra*

Many of the fish that used coral reefs move about and forage in the tidal shallows of the coast as well. Here they have been traditionally harvested by a unique fishing technique, the *hadra*.

The *hadra* is a traditional, semi-permanent fish trap erected in the intertidal and shallow sub-tidal zones. During high tide fish and other marine animals move inshore and as the tide recedes the marine animals are directed along a wall, placed perpendicular to the shore, into an approximately circular enclosure with a funnelled mouth. The entrapped animals remain alive within the enclosure until fishermen collect them at low tide.

Because of their position in the intertidal zone, *hadra* fish traps have a particularly significant impact on young populations of both commercial and non-commercial marine species, as well as birds, turtles, and marine mammals, such as young finless porpoises and dolphins.

Fifteen years ago, *hadras* were common all along the coastline of Kuwait. They were in many ways connected to a family like symbols of prosperity and, to a certain degree, of status. They were inherited like any other piece of real estate and sold with a contract document signed by a judge. Men of a family were introduced to the stake trap from very early days and the suspense of what the sea brought every day was such that several songs were written about individual *hadras*. Most also carried a male name, such as Suleiman, Mahmood or others.

As fish stocks progressively dwindled and the marine area in the region suffered from pollution, war and overfishing, acknowledging the severe damage on marine wildlife the government banned them, judging their kind of fishing unsustainable. Nowadays, the population has been discouraged from using *hadras*, which can only be operated in certain areas with special permits. Very few are now used on the mainland, and most are encountered in Failaka Island and nearby Miskan Island.

With the marine environment under such stress in the Gulf and around Kuwait, it is hoped that the use of *hadra* or any other unsustainable fishing practice shall soon be completely abandoned, giving wildlife the chance it deserves to regenerate and survive.

Modern day *hadra* in Failaka • NPA

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity Section, KOC & NPA photographers

Contracts of *hadra* sales transferred ownership
in the legal and appropriate way
with the official signature of a judge.

Low tide at a *hadra* • SRA

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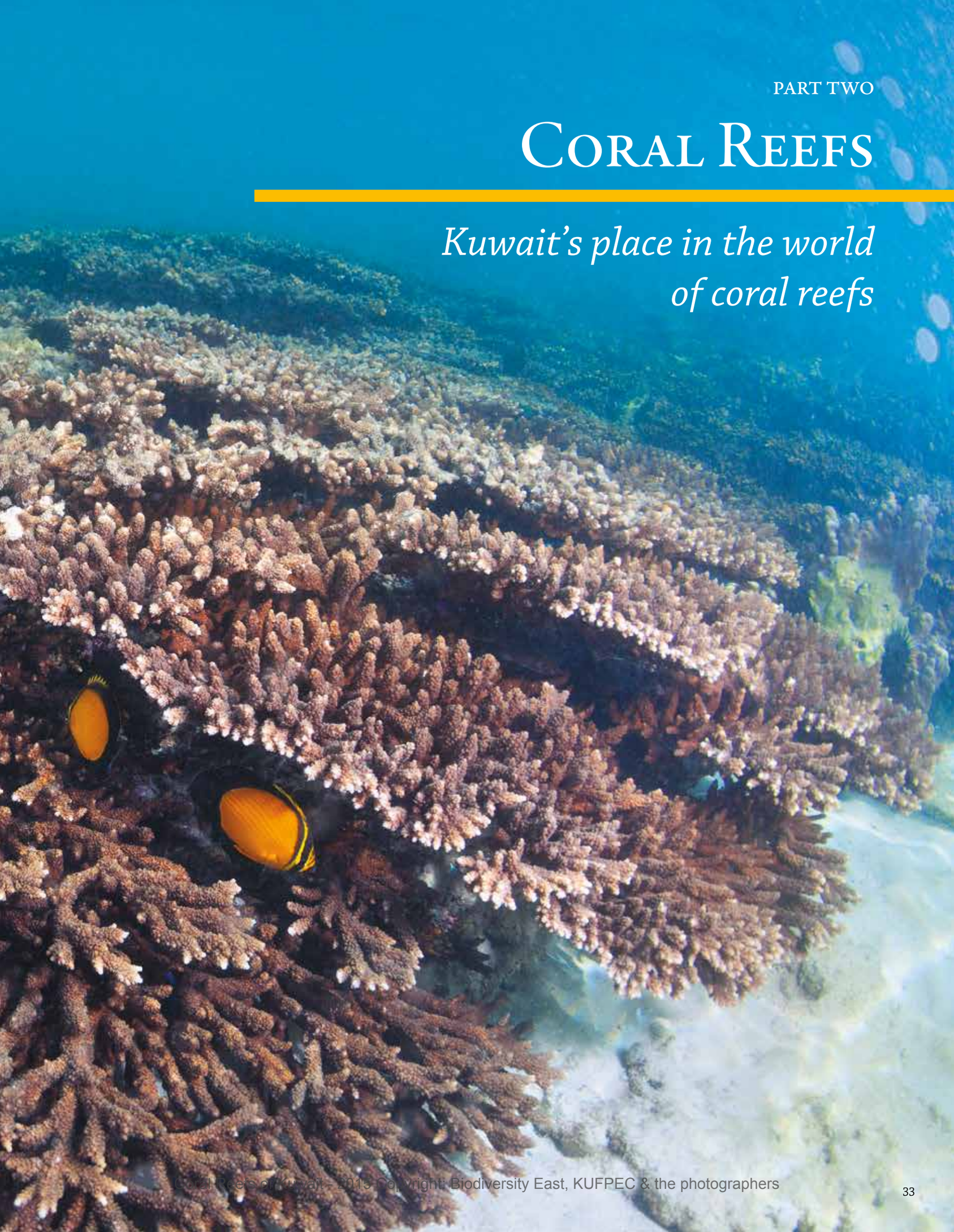
Acropora corals and butterfly fishes on Qaru reef • ALH

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photog

PART TWO

Coral Reefs

Kuwait's place in the world of coral reefs



Coral Reefs of Kuwait – 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Snorkelling Kuwait's Qaru Reef • VID

Coral Reefs of Kuwait - 2015 Copyright Biodiversity East, KUFPEC & the photographers

Coral reefs are crucial for marine biodiversity

The importance of coral reef ecosystems may be seen in their numerous ecological, aesthetic, economic, and cultural functions. Atoll and barrier reef islanders recognize that healthy reefs are essential for the support, creation, and repair of the coral islands on which they live all or part of their lives.

Coral reefs also protect coastlines from shoreline erosion and serve as a living pantry for the subsistence harvest of many reef organisms. The cycle of reef growth and erosion maintains beaches and provides habitat for seagrasses and mangroves. Coral reefs are important recreational resources for most of the world's people having the privilege of living near them. Nowadays, in some countries, coral reefs' channels provide safe navigation for boats, and harbours are often sighted on reefs because they provide natural protection from heavy wave action.

Coral reefs are fast becoming the main attraction for visitors to many tropical coastal destinations. Modern uses, though, are not beneficial to reefs, and scientists and other reef users are beginning to realize that these "rainforests of the sea" are fragile and are now threatened in many areas in the world from chronic disturbance by human activity.

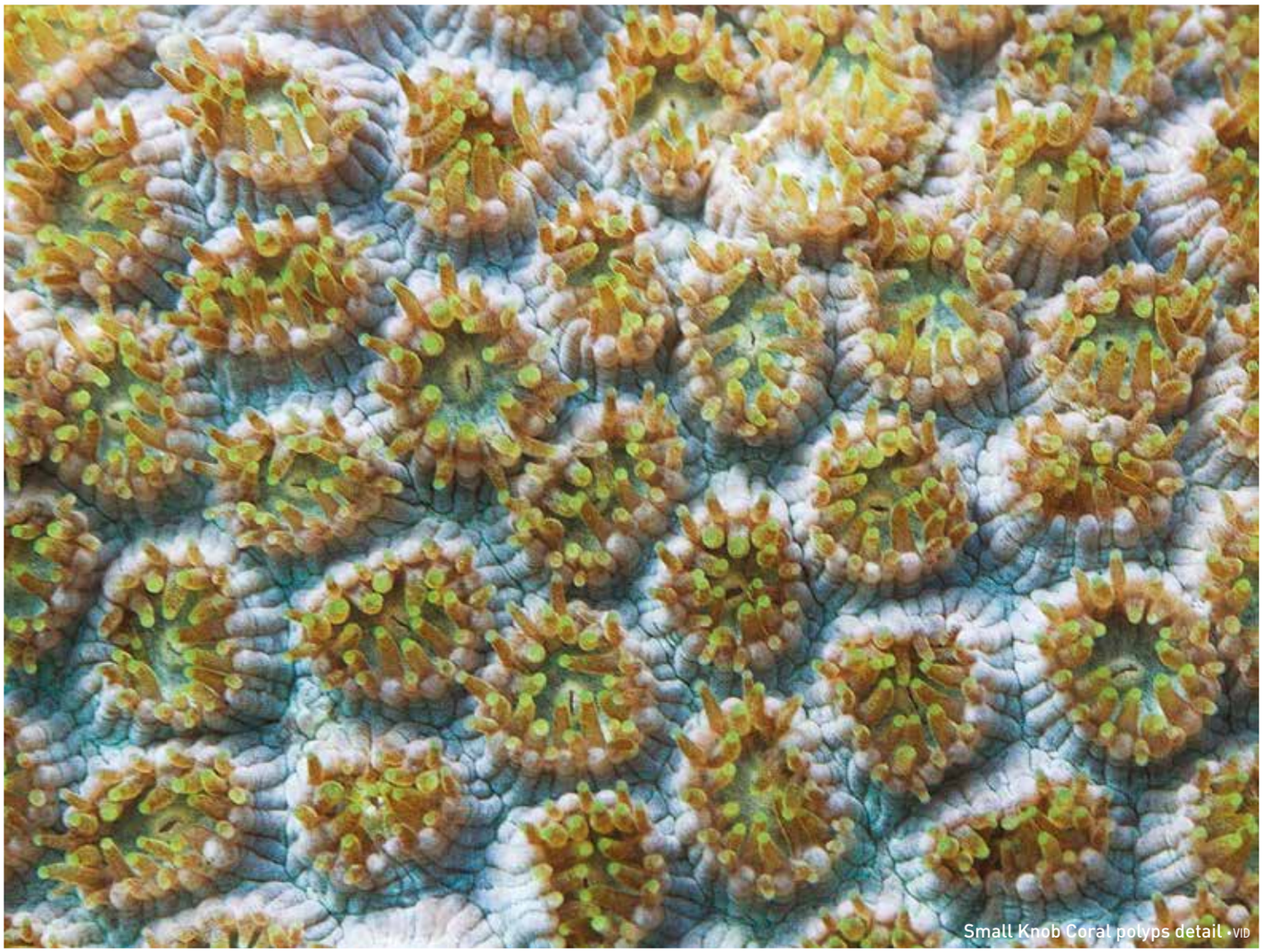
The ability of reef ecosystems to exist in balanced harmony with other naturally occurring competing/limiting physicochemical and biological agents has been severely challenged in the last several decades by the dramatically increased negative impacts from poorly managed human activities. Globally, scientists are now working together and with all concerned groups of stakeholders to promote assessment, monitoring, protection and restoration of coral reefs.

Establishment of coral reef management initiatives at the local community, national, and regional levels are essential for long-term sustainable use and conservation of these critically important habitats. The focus of these initiatives should be on assisting culturally, economically, and politically diverse peoples around the world in their development of integrated coastal zone management with emphasis on local community involvement and leadership.

Female Bluetail Trunkfish at Qaru • ALH

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

What is a coral reef?



Small Knob Coral polyps detail • VID

Most of what we have learned about coral reefs has been gathered by scientists during the past 150 years, beginning with Charles Darwin and James D. Dana in the mid-19th century. Darwin first postulated that the subsidence of volcanic islands can result in the evolution of fringing reefs to barrier reefs and atolls. Dana, as geologist aboard the U.S. Exploring Expedition (1838-1842) which circumnavigated the globe, was able to publish the first definitive global distribution of coral reefs. He also addressed some of the major factors -the need for warm seawater temperatures (generally higher than 21°C) and light- that contribute to vigorous coral reef growth and described more species of corals than any other scientist beforehand or afterward. Research has evolved since with the use of constantly improving technology in many parts of the world. Nevertheless, through the years, and especially in the last few decades,ecological processes of coral reefs have been increasingly perturbed by human-related activities.

Not only is the coral reef structure itself composed of and built by a diversity of organisms, but the reef structure serves as the basis for one of the richest ecosystems in the world.

Coral reefs are accumulations of the biogenous remains of carbonate secreting reef organisms-both plants and animals that formed in warm tropical (and in some cases, subtropical) seas. The principal reef builders are referred to as "'hermatypic" corals. These corals, all marine invertebrates in the class Anthozoa (Phylum Cnidaria), exist in a symbiotic relationship with microscopic unicellular algae known as "zooxanthellae." The coral-algal symbiotic association aids the formation of massive reefs because of the unique advantages of the association. The symbiotic algae are protected in the tissues of the coral animals that are themselves protected by highly specialized stinging cells, the nematocysts. These animals can also depend on the algae for most or all of their food supply, whereas the algae can depend on the animals for

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

nutrients and carbon dioxide for photosynthesis. This symbiotic relationship is widely believed to greatly increase calcification and improve energy and nutrient fluxes between the animals and the plants, allowing more rapid coral growth and the corresponding opportunity for more rapid reef growth.

The growing coral reef structure itself is a thin veneer of living reef organisms that overlays the remains of generations of progressively older reef organisms. In fact, most of the major coral reefs observed today are living veneers that have covered previously existing substrates only within the last 10,000 years. The accumulations are cemented together to form wave-resistant structures, capable of continued growth in the face of heavy and prevailing wave action and currents.

Not all tropical coasts are able to support coral reefs. Active volcanic islands or continental soft-sand coasts may be too inhospitable or unstable for corals and other reef organisms to settle and grow. If the shorelines of islands and other coasts are either sinking or emerging too quickly, then it is not possible for large reef structures and wide reef flats to form. Coastlines subjected to heavy sedimentation, freshwater flooding, or excessive storm and wave action often do not support structural coral reefs. Isolated reef communities may be capable of forming in these areas, especially offshore of islands and continental coastlines where they sometimes occur only as submerged patch reefs.

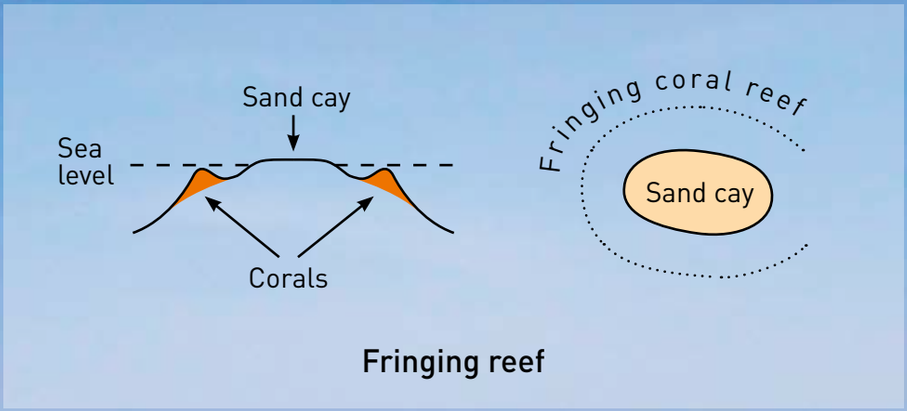
Living healthy coral reefs generally grow upward and outward (or seaward) from the submerged slopes of islands, continents, or older reefs, and are able to thrive in nutrient- poor transparent oceanic waters. If reef growth reaches sea level, then only outward growth is possible because the marine organisms forming coral reefs cannot normally live above mean low tidal levels. Continuous periods of outward reef growth create reef flats. The inner portions of progressively wider reef flats begin to accumulate sand and other sediments that eventually may be transported to shore to form the white sand beaches that characterize many coral reef coasts.

However, the seaward slope and edge of the reef flat usually supports the principal populations of diverse reef-building organisms such as corals. The diversity of reef-building organisms contributing calcium carbonate materials to coral reefs also includes echinoderms (such as sea urchins and starfish), sand producing crustose coralline algae as well as worm tubes, barnacles, and others.

Coral reef formation just off the shore of Umm Al-Maradim • ALH

Corals at Qaru • VID

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity Trust of Kuwait and the photographers



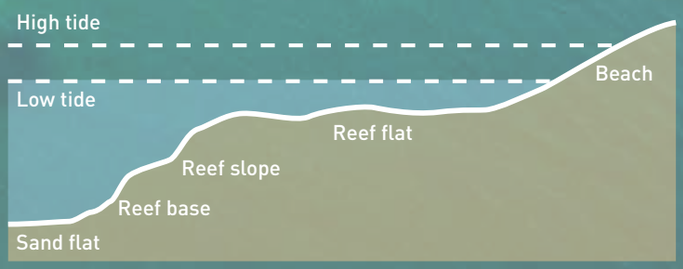
Umm Al-Maradim island and its fringing reef showing a typical reef zonation pattern • KDT

Coral Reefs of Kuwait - 2015 Copyright, Biodiversity East, KUFPEC & the photographers

Reef zonation

A special kind of zonation, similar to altitudinal zonation in terrestrial vegetation, helps define major coral reef habitats. Different coral species –with their symbiotic algae– have different light requirements, a coral reef with many kinds of corals growing on it exhibits "zonation" with depth. The corals requiring bright-light grow near the surface and corals that need less light gather further down toward the base of the reef. This zonation pattern produces distinct habitats: the reef beach and coral rubble is found near the shallows of the reef flat; below the reef flat is the reef slope – an area very rich in coral species. At the reef base which is usually rather dimly lit due to Kuwait's turbid waters, a different assemblage of corals grow.

All the various creatures associated with the coral are also "depth zoned", they are found mainly where their associated or preferred coral species and microhabitats are. Species of fish, snails, crabs, worms and so on are thus spread along this zonation down the reef, which permits more and different species to survive in the same general area at the same time, and contributes to the enormous diversity of coral reef life.



Principle reef zones on Kuwaiti reefs

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

MIP

SIM

ROB

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NPA

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YIS

ROB

ROB

Coral reef biodiversity and importance

Not only is the coral reef structure itself composed of and built by a diversity of organisms, but the reef structure serves as the basis for one of the highest diversity of ecosystems in the world. Coral reef ecosystems generally have remarkably high species richness, although in areas such as Kuwait, where sedimentation is high and climatic conditions are adverse for corals, this diversity can be lower than in most oceanic reefs. Reefs have far greater productivity than other marine systems, as they include a multitude of living organisms such as reef fish, sea urchins, coralline algae, and many interrelated assemblages of plants and animals.

Diversity of reef-building corals and other reef organisms tends to diminish in an east to west direction across the tropical latitudes of the Indian Ocean; however, the Red Sea supports especially high levels of species diversity in the Western Indian Ocean region.

Although surprisingly little is known about the numbers and precise distribution of most coral reef species, existing information indicates that Southeast Asia tends to have perhaps four to six times as many species in a given taxonomic group (fish, corals, gastropods, bivalves) than the Caribbean and peripheral areas of the Pacific. The diversity difference with East Africa and the Red Sea tends to be much less with Southeast Asia having only perhaps two to four times more species in a given group.

The incredible diversity of organisms found associated with coral reefs also holds great promise for improving the quality of life for the human species. In the ever-evolving field

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Typical northen Arabian Gulf coral reef life. From left to right (Left page): Bridled Tern; Whale Shark; Tiny crab in Acropora coral; Angelfishes feeding on sponges; Red coral crab; Salps; Smallscale Sandpearch; Tiny crab in Acropora; Jawfish. (Right page): Humback dolphins; Picasso Triggerfish; Gorgonian soft coral; Brittle stars on soft coral; Hawksbill Turtle; White-cheeked tern; Arabian Gulf Blenny; Labyrinthine Brain Coral; Longfin Bannerfish.

of biotechnology, chemical extracts derived from coral reef associated sponges and tunicates have potent anti-viral activity. In addition, several sponge and nudibranch species found in coral reef ecosystems are capable of producing terpenes, a broad class of aromatic compounds used in solvents and perfumes and known to deter feeding by fish. Extracts derived from these same species have also demonstrated powerful insecticidal activity. Porites and other species of reef coral have been used as bone grafts for people requiring maxillofacial and cranial surgery, and pieces of Gorgonian corals have also been used successfully in clinical applications.

Not only are coral reef ecosystems an important resource in terms of their biological richness and productivity, they are also the foundations of coastal protection, tourism, recreation and subsistence economies and in many areas serve as focal points for cultural and community heritage. On the Great Barrier Reef, the visitor and resort industries annually gross over one billion australian dollars a year in revenues.

Also coral reefs are a great example of how "connected" the sea world is and brings many countries in closer proximity since coral and other reef animal and plant populations communicate through sea currents. The transboundary influences both to and from coral reef ecosystems are not limited by political boundaries. Just as ocean currents are potential carriers of pollutants from one country to another, larval and adult life stages of coral reef organisms may travel from reef to reef across national borders. Hence a global perspective is important for all nations to take when addressing threats to coral reefs.

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

A map of the world's coral reef areas (Yushin Kato and Univ. of South Florida Institute for Marine Remote Sensing)

Coral reefs in the world

Coral reefs are estimated to cover 284,300 km^2 of the oceans' surface area. The Indo-Pacific region (including the Red Sea, Indian Ocean, Southeast Asia and the Pacific) accounts for 91.9% of this total. Southeast Asia accounts for 32.3% of that figure, while the Pacific including Australia accounts for 40.8%. Atlantic and Caribbean coral reefs account for 7.6%.

Although corals exist both in temperate and tropical waters, shallow-water reefs form almost exclusively in a zone extending from 30° N to 30° S of the equator. Tropical corals do not grow at depths of over 50 meters. The optimum temperature for most coral reefs is 26–27 °C, and few tropical reefs exist in waters below 18 °C. However, reefs in the Arabian Gulf have adapted to extreme temperature ranges of 13 °C in winter and 38 °C in summer.

Deep-water coral can exist at greater depths and colder temperatures at much higher latitudes, as far north as Norway. Although deep-water corals can form reefs, they are very different from typical tropical reefs.

Coral reefs are rare along the west coasts of the Americas and western Africa, due primarily to cold-water upwelling and currents that reduce water temperatures in these areas. Corals are seldom found along the coastlines of Southern Asia as well as along the coasts of northeastern South America, due to the freshwater and sediment releases from great rivers such as the Ganges and Amazon.

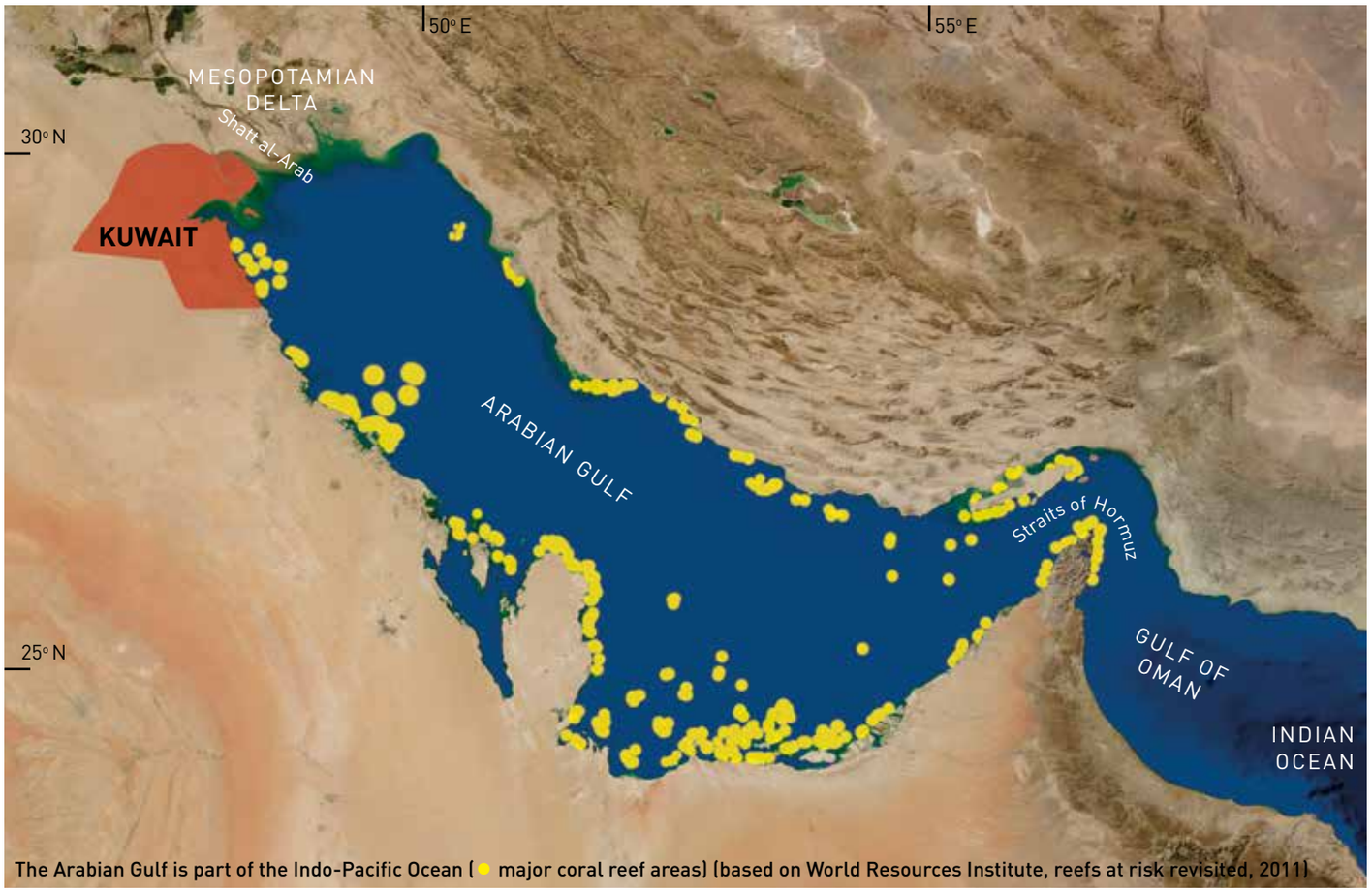
Some of the most important coral reef systems on the planet are:

- The **Great Barrier Reef** – largest, comprising over 2,900 individual reefs and 900 islands stretching for over 2,600 kilometres off Queensland, Australia
- The **Mesoamerican Barrier Reef System** – second largest barrier reef, stretching 1,000 kilometres from Isla Contoy at the tip of the Yucatán Peninsula down to the Bay Islands of Honduras
- The **New Caledonia Barrier Reef** – second longest double barrier reef, covering 1,500 kilometres
- The **Bahamas Barrier Reef** – third largest, following the east coast of Andros Island, Bahamas, between Andros and Nassau
- The **Red Sea** – includes 6000-year-old fringing reefs located around a 2,000 km coastline
- Numerous reefs scattered over the **Maldives**
- Numerous reefs in the **Polynesian and Micronesian South Pacific**
- The **Philippines** coral reef area, the second largest in Southeast Asia, is estimated at 26,000 square kilometres and holds an extraordinary diversity of species.
- The **Indonesian archipelagos** which sustain some of the richest known marine diversity hotspots.

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Rich reef structure populated by Indo-Pacific Seargents and lots of other fish species at Kuwait's Qaru island • VID

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers



The Arabian Gulf is part of the Indo-Pacific Ocean (● major coral reef areas) (based on World Resources Institute, reefs at risk revisited, 2011)

Coral reefs in the Arabian Gulf

The Arabian Gulf is a small body of water communicating with the Indian Ocean through the narrow Straits of Hormuz. It seems to be one of the areas that have been severely affected by extreme weather conditions in the last few decades. Some scientists have estimated that up to 35% of its coral reefs may have been lost. Extreme temperatures are believed to be the single most important cause of coral reef decline and loss in the region. Research suggests that the extremely high sea water temperatures observed during 1996 and 1998 were primarily responsible for the coral bleaching and subsequent mass mortality of coral in the area.

Other threats to coral reefs in the area include attacks by disease and human-induced pressures including oil pollution, poor land use practices and impacts from commercial and recreational fishing. Indeed, it has been suggested that with the population explosion and the resulting expected increase in development and fisheries in the area, threats to the coral reefs and associated habitats will become more serious in the future.

According to previous research in the region, five major factors probably restrict the distribution and abundance of coral reef organisms in the Arabian Gulf:

- The distance from the world centre of diversity
- The narrow Strait of Hormuz allows limited flow of seawater into and out of the Gulf, lowering the chance of larvae entering the Gulf
- Extreme environmental conditions only a few months apart may not allow certain species entering the Gulf to survive
- There are only few remaining large reef areas in the Gulf, which limits the area where reef organisms may be able to colonize
- The Arabian Gulf is a relatively young body of water, having dried out 20,000 years ago and then reestablishing as sea levels rose. So in many ways, it is not as developed yet as other marine areas on earth.

Sea temperature, sedimentation and salinity have important effects on reef development; coral reefs usually grow best where the mean minimum sea temperature is above 18-20 °C, the mean maximum temperature is below 30 °C and sedimentation rates are low. Salinity is a measure of the total amount of salts and other material dissolved in seawater, and coral reefs are usually best developed where the aver-

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

age salinity of seawater is about 35 parts per thousand (‰).

The fact that the Red Sea is farther from the Western Pacific biodiversity center than the Gulf, and yet has infinitely higher diversity, may indicate that local environmental extremes combined with reduced availability of reef habitat are particularly important in limiting diversity in the Gulf. In fact, within the Gulf itself, local environmental factors are important. Near the Gulf entrance there is higher diversity in species, and this diversity decreases towards the northwestern region of the Gulf, where Kuwait is situated.

The northern Gulf's oceanographic conditions are especially harsh. Winds vary, with northwestern winds, the *Shamal*, lashing over land and sea. When the wind turns to southeast, the *Kaus*, boats stop sailing and life awaits to resume once they are over.

Gulf tides are complex and regionally variable. Tidal ranges are large, exceeding 1m everywhere and at the Shatt al-Arab surpassing 3m (the Shatt al-Arab or "Stream of the Arabs", is the river of some 200 km in length, formed by the confluence of the Euphrates and the Tigris rivers in southern Iraq). Off Kuwait, spring tides range about 2 m in the south and up to 4m in the north.

The current regime is a complex and variable combination of tidal, wind- and marine water-driven components. Strong tidal currents, commonly exceed 1-2 m/s past islands and through constrictions. Tides are mostly influenced by the *Shamal*, although some are density-driven because of the high evaporation rate.

Salinity of Arabian Gulf waters is of about 36.5% depending on the location. Depending on the influx of Indian Ocean water, less entering the Gulf in winter and more in the summer, salinity levels fluctuate.

"I have already had occasion to speak, in the course of my travels, of the astonishing mats of works formed by marine insects; namely the immense banks of coral bordering, and almost filling up, the Arabic Gulf... The reader may therefore conceive with himself what a variety of madrepores and millepores are to be met with in these seas"

Karsten Niebuhr (17 March 1733 Lüdingworth – 26 April 1815 Meldorf, Dithmarschen) a German mathematician, cartographer, and explorer in the service of Denmark, renowned for his participation in the 1761 Danish Arabia Expedition that mapped and described parts of the northern Arabian Gulf.

The Qaru reef at an exceptionally low spring tide (photo by Jane Lloyd)

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Discarded *gargoor* fish traps are lethal to unsuspected marine wildlife. ALH

Threats to the coral reefs

Coral reefs first formed along the original continent of Pangaea 300 million years ago, even before the continents themselves began to drift apart and move to their present configurations. The resilience of modern coral reefs is manifested by their continuous survival and expansion during the Pleistocene, a period of several major fluctuations of sea level. In fact, virtually all of the major coral reefs observed today grew 100 m during the past 10,000 years, as sea level began to rise at the end of the last glacial age. Thus for over millions of years, coral reefs have shown remarkable power of resiliency and adaptations to environmental changes. However, the ability of coral reef ecosystems to exist in harmony with other naturally occurring competing/limiting physicochemical and biological agents has been severely challenged in the last several decades by the dramatically increased negative impact of human activities.

Not only are coral reef ecosystems an important resource in terms of their biological diversity and productivity, they are also the foundations of coastal protection, tourism, and subsistence economies and in many areas serve as focal points for cultural and community heritage.

Reefs with organisms such as we know them at present appeared during the Eocene. Through changing sea levels, drifting continents and shifting climates, these organisms have migrated, adapted and evolved. But humans have upset the natural harmony on an almost catastrophic scale. Human induced-pressures in combination with natural agents and events affect reef survival all over the world.

Coral bleaching is probably the greatest threat facing coral reefs today. Bleaching is the loss of the symbiotic algae zooxanthellae that give reef-building corals their colour. Zooxanthellae live within coral tissues and through photosynthesis, they produce nutrients that help corals grow and survive. Unnaturally high temperatures cause corals to expel these algae. The white skeleton that we see through the clear coral tissue gives them a bleached appearance. In some cases, the coral regain the algae after the stressful condition subsides and survives, but if high temperatures persist, corals will often die. The spread of various diseases also affect corals creating symptoms similar to coral bleaching. Another unnatural cause of bleaching is pollution.

Pollution due to chemicals, particularly hydrocarbons,

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

gather at the surface of the sea and often kill coral spawn if the two events coincide. Surface pollution at the time when corals spawn can exterminate an entire year's reproduction, because spawning takes place simultaneously by all corals of a reef. Like other invertebrates, corals are sensitive to heavy metals. Marine water eutrophication due to higher than natural concentrations of nutrients such as ammonia and phosphates is a phenomenon triggering excessive algae growth, which may overgrow newly settled corals.

Destructive fishing practices, such as the use of explosives and cyanide, have destroyed vast areas of reef throughout much of the planet. Both methods have been –and unfortunately in some cases still are– an easy way to get a lot of fish quickly. The corals close to a blast are totally exterminated. In the case of cyanide, everything alive in the range of injection of the substance dies, corals included.

With overfishing, even by non-destructive practices, fish stocks are exploited beyond their sustainable yield thus affecting the natural sustainability of the coral reef. Submerged reefs in deeper waters –the least understood of all major reef types– are undoubtedly being severely degraded by bottom trawling activities.

Many dangers affect coral in seas beyond the Arabian Gulf. Crown-of-thorns Starfish (*Acanthaster planci*) infestations are a major cause of damage to many tropical reefs. With a special appetite for *Acropora* corals, this starfish is capable of advancing across a reef 24 hours a day, usually in groups of many, leaving behind it nothing but a devastated seabed and bleached coral skeletons. One of the reasons for the increasing invasions of these starfish in some coral reef areas of the world is the fact that its predators, its natural enemies, now only exist in reduced populations. Another reason for the explosion of the starfish can also be nutrient benefiting its larvae at run-offs of agricultural installations. Fortunately this strafish species has not been recorded in Kuwait waters and only isolated occurences exist in the extreme south of the Gulf.

Non-sustainable tourism development in reef areas also results in abusing coral reef habitats. Famous for their beauty, coral reef ecosystems are often used as an attraction of mass tourism, and where this is done preceded by careful environmental planning and management, it can be a mutually profitable economic activity, as business can flourish and knowledge and admiration of the reef can be successfully spread. Nevertheless, in many cases planning has not existed or has been incapable of protecting the reef from being overly used for pleasure. Crowds of humans touching corals and massive numbers of recreational vessels releasing raw waste in the waters, as well as pollution and overexploitation of beachside areas adjacent to reefs have seriously impacted these pristine ecosystems and brought many to the verge of disappearance.

Old anchor in Umm Al-Maradim North Marker • VID

On a global scale the most significant threats to reefs are associated with high-density human populations living near coral reefs. Human migration and population increase is one of the most significant causes of reef degradation worldwide and is the basic cause for most of the impacts to coral reefs near urban centres.

In recent years many actions have been taken to address the protection of coral reefs, and the international community is beginning to understand the need for their conservation.

Fishing nets smothering living coral at Mudayra • ZOG

Dying corals in Kuwaiti waters • ZOG

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity Fast Action Team and Photographers

Kuwait's south coast with Khiran Khor before extensive development in the late 1990s • KDT

Environmental change on Kuwait's coasts and reefs

In Kuwait, construction along the coast has resulted in deterioration of the natural landscape. The increasing demand by humans for coastal resources is likely to lead to further decline of environmental quality, so it is critically important to plan for conservation, rehabilitation and protected areas.

Kuwait is a very small industrial county whose marine and coastal environment is connected to several other states in the northern Gulf. Human-induced pressures have stressed Kuwaiti coasts and waters, especially during the last decades. The coral reefs of Kuwait were impacted by the world's most extensive oil spill during the 1991 Gulf War. Oil spillage took place at gigantic proportions and fires with heavy smoke burned more than 730 oil wells; this covered the region and blocked out sunlight for several months. However, because the coral reef ecosystems are adapted to extremely harsh local conditions, there was a remarkable resilience and regeneration. Other less dramatically apparent trans-boundary environmental changes may have had more lasting effects. This concerns anthropogenic changes to the mighty Tigris-Euphrates river system that feeds Kuwaiti's seas with freshwaters and nutrients. Huge hydroelectric dams, primarily in Turkey, along the course of the Mesopotamian rivers, and massive wetland drainage have caused many imbalances in the marine ecosystem. Increases in sedimentation, nitrate concentrations and a decrease in salinity have been documented in Kuwait's waters due to the upstream manipulations and canalization of Mesopotamian river waters. Some say marine turbidity may have increased. Kuwait's marine fisheries may have declined at least partly because of the dramatic ecosystem changes in the Mesopotamian Delta.

As human populations increase, human-induced change is rapidly altering the coastal zone in Kuwait. The middle and southern parts of Kuwait's coasts have seen an explosion of industrial, residential and recreational developments. The most significant activities affecting the intertidal environment are the filling and dredging processes of land reclamation along the coast. Major recreational development is seen along the Kuwait City waterfront on the coast of Kuwait Bay, Fahaheel waterfront project and Al-Khiran recreational project on the southern coast. The geomorphology of the coast is changing and great quantities of sediments are released into the shallow seas. There are proposals for new residential ar-

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

eas, townships, holiday villages, multiple purpose harbours and infrastructure projects. There are six existing and two proposed power stations along Kuwait's Coast, four of them are located along the coastline of Kuwait Bay. Moreover, there are six operating industrial complexes along the coast whose effluents (chemical and thermal) are released into the coastal zones.

Unfortunately it is difficult to monitor the health of coastal ecosystems since we poorly know the historic baselines before these explosive developments and there is little long-term coordinated ecosystem study. There is no sufficient information about the corals in Kuwait in the past; especially the many small inshore reefs and coral patches from Kuwait city to the Saudi Arabian border. The older Kuwaiti generation recalls many coral areas in the old stories of pearl divers. But today we do not know what has been really lost or is degraded; this is in itself a whole research topic.

Scientists know that coral reefs are among the richest and most diverse ecosystems in Kuwait but a lot of the damage that is taking place in the sea is unseen and therefore the public is unaware. Coral reefs are directly damaged by various human activities. Overfishing, lost fishing gear, solid waste disposal, increased sedimentation and extensive anchoring are prevalent. Most of the reefs are close to the shore and are major recreational and fishing areas. Anchors have destroyed large areas of the reefs and unregulated spearfishing by amateurs has impoverished larger-sized fish populations.

Protecting the coastal zone and saving the marine treasures such as the coral reefs is an important cultural initiative. People must support conservation action, they must understand what proper planning and law-enforcement of protected areas mean. Education campaigns are carried out by various non-profit organizations, industry and government agencies in order to increase awareness of the importance of coral reefs and their sensitivity. More needs to be done to inspire appreciation and respect for the coasts and the reefs.

Finally, there is an urgent need to improve and expand conservation-relevant scientific research. Coral reefs must be better inventoried and monitored. There are serious gaps in scientific knowledge and lack of quantitative studies on many human-induced pressures and how they affect our ecosystems. Better scientific knowledge will also help us adapt to global climate change in the future. Furthermore, conservation science initiatives must also include the preparation of practical management plans to actively protect reef resources. The more we understand and work for conservation, the greater the chance of keeping the reefs healthy for future generations.

by ***Jenan Bahzad***
Environmental Scientist

Al-Khiran Khor after dredging and present-day developments • SRA

Detail of Al-Khiran resort, early 2010s • SRA

Beach housing near a lagoon south of Al-Khiran • SRA

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

International action for protecting coral reefs

Coral reefs ecosystems exist in more than 100 countries around the world. An overview of the status of these ecosystems reveals that many are under threat or are being degraded as a result of chronic human-derived activities, especially where coral reefs are near population centres. Negative impacts also occur at many remote reefs, and natural disturbances may be exacerbating damage to coral reefs when superimposed over continual human degradation of these fragile ecosystems. The impacts of widespread degradation of coral reefs are difficult to predict exactly and accurately because of a lack of specific information and monitoring.

Biodiversity associated with coral reefs is difficult to assess because of a scarcity of reliable taxonomic information. Much of the biodiversity cannot easily be identified to species level as keys and taxonomic reviews of many of the invertebrate animals and plants on reefs are still incomplete for many of these areas. For species that are better known, such as those that are frequently harvested, there is a need for more information on life history cycles so that their populations can be studied holistically rather than piecemeal on individual reefs. Applying this information to questions such as where to develop and implement marine and coastal protected areas requires more information on the distribution and status of coral reef communities. Some efforts are recently being made by governments throughout the world, where marine protected areas are proclaimed, many of which containing coral reef habitats and aiming to preserve them.

Many of the world's coastlines where coral reefs exist have high human population density. The rapid human population growth rates of many regions tend to call for a very tight coordination of governmental and population-level management planning and implementation.

Only two decades ago, it was not possible to speculate on the global status of coral reefs. However, much has happened recently to improve global awareness of the urgency to address threats to coral reef ecosystems.

The United Nations Conference on Environment and Development (UNCED) in Rio Di Janeiro in 1992 and Agenda 21 brought worldwide attention to the need for protection and monitoring of coral reef ecosystems. Since then, multiple efforts of attempted international awareness and coordination campaigns have been launched and followed up by governments, and non-governmental organizations.

The Regional Seas Program of UNEP has also focused considerable attention to coral reef protection during the past twenty years with the establishment of regional approaches to control pollution and management of marine and coastal resources. At the same time, additional emphasis is being placed on community level management of coral reefs. This last strategy has proven to be effective in enlisting the cooperation and support for effective management of marine protected areas by affected or nearby communities. These management initiatives are now progressing at community, national, and regional levels for coral reef management.

Coordinated action and international cooperation is required and there are already some exemplars of good steps forward. The International Coral Reef Initiative (ICRI) is a partnership among nations and organizations seeking to implement chapter 17 of Agenda 21 of UNCED and other international conventions and agreements, for the benefit of coral reefs and related ecosystems. The ICRI was founded by eight governments Australia, France, Jamaica, Japan, Philippines, Sweden, United Kingdom and United States) and was announced in December 1994. The eight original members later drafted a "'Call to Action" to draft broad principles for further action. Since then, the ICRI has attracted the support of additional governments, UN organizations, multilateral development banks, environmental and development non-government organizations, the private sector, and the research community.

The Framework for Action is guided by several principles:

- full participation, and commitment by all parties
- support actions with tangible positive effects on coral reefs and related ecosystems and human communities
- managing human activities that degrade coral reefs
- recognition of the diversity of cultures, traditions, and governance within nations and regions
- integrated coastal management with emphasis on community participation
- developing national capacity to conserve and sustainably use coral reefs
- strategic research and monitoring programs; and taking advantage of the extensive body of international agreement and organizations that address issues related to coral reefs and associated ecosystems.

The Framework for Action identifies activities in the following areas that address the need for conservation and sustainable use of coral reefs and related ecosystems-integrated coastal management:

- public awareness, education, and training

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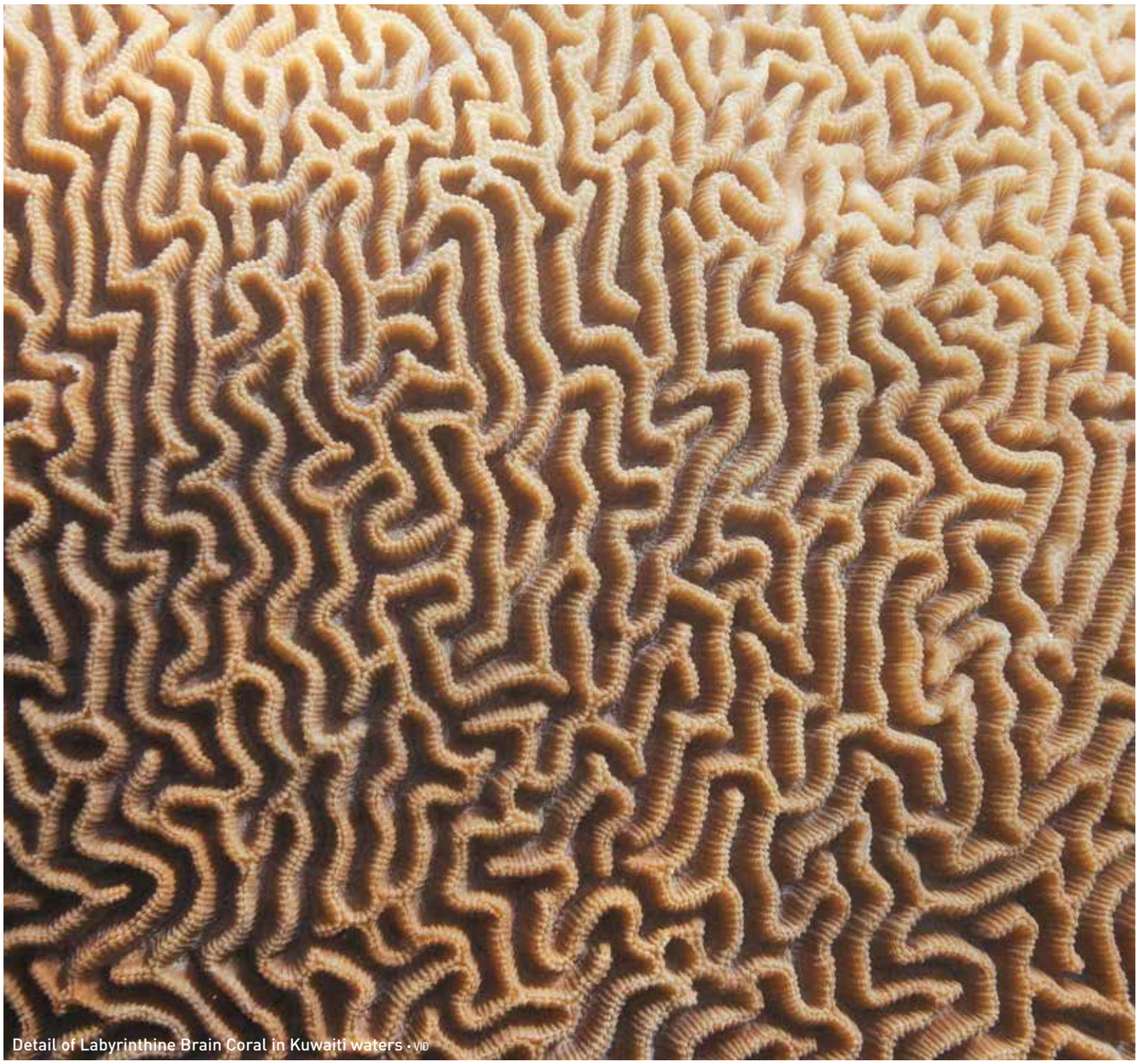

Detail of Labyrinthine Brain Coral in Kuwaiti waters • VID

- ratification of or accession to relevant international instruments
- stakeholder participation at all levels
- training policy makers and private sector decision makers in coral reef management
- marine science and technology
- environmental law, especially environmental impact assessment regulations
- assessing potential for micro-enterprise development and facilitating associated financing of it.

The Framework for Action also emphasizes four substantive directions: Management, Capacity Building, Research and Monitoring, and Review. Specific actions are specified within each of these four areas of emphasis.

Notwithstanding the style of the development of the ICRI to date, it has the best hope to provide the needed international framework and guidance to help direct management of coral reefs more effectively at the International and Regional levels while giving more support to the need for National and Community level management.

Many government research organizations are spearheading conservation science actions. NOAA in the USA contributes significantly to researching and conserving coral reefs worldwide. The primary objective of NOAA's involvement in the U.S. CRI is to foster innovative cross-disciplinary approaches to sustainable management and conservation of coral reef biodiversity and ecosystems through the development of cooperative relationships among the various stake holders. Perhaps the most important element is support

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for community involvement in developing and implementing local and regional conservation programs suited to those community needs and situations. For the U.S. and International CRIs to succeed in effectively conserving and managing coral reef ecosystems for long-term sustainable use, programs should essentially be based on local community involvement. To this end, the U.S. CRI sponsored regional workshops for U.S. states, territories, and commonwealths to assist the regions in working more closely together in promoting stewardship of U.S. coral reef ecosystems and in developing local CRIs. Scientists, government managers, non-governmental organizations, and other interested residents have been actively planning local coral reef initiatives throughout the U.S. tropical and subtropical waters. Most of these entities have developed local CRIs that are now well under way and promise to serve as models for development of local or community-based initiatives elsewhere in the United States and in other countries. As an example, Guam's local CRI activities were the focus of special sessions at the ICRI workshop in the Philippines, and much of the ICRI "Call to Action" and "Framework for Action"' can be traced to these earlier U.S. regional workshop efforts.

The greatest coral reef sanctuary in the world, that of the Great Barrier Reef, has been created in Australia. Both the British and the U.S. governments announced in 2014 their intentions of extending coral reef sanctuary areas by several hundreds of thousands of square miles.

Many non-governmental groups, some also operating in Kuwait, have been at the forefront in local implementation of various coral reef monitoring efforts, such as Projects AWARE, REEF, Reefkeeper and WWF's Coral Reef Initiative. Other less illustrious grass-roots approaches often involve protection of specific reefs, sometimes by small non-governmental organization or government organizations such as the military or coast guard initiatives. These grassroots efforts should be applauded and encouraged. However, long-term nationally and globally coordinated coral reef monitoring programs are essential to manage, archive, interpret, and transfer data among scientists, managers, and other interest groups. What we do not understand, we generally fail to appreciate and cannot effectively protect.

The next few years hold great promise in refining conservation goals and initiatives for better protection of all coral reefs. Without doubt these ecosystems are a top priority for global marine conservation in the current millennium.

Several dive teams organize reef cleanups in Kuwait at regular intervals in locations such as Kubbar island. KDT

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Teira Batfish in Qaru waters • ALH

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Qaru island and its reef • KDT

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PART THREE

Coral Reefs of Kuwait

At the northern edge of the Gulf

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Inshore Kuwaiti reef at Bnaider, degraded but still full of life • VID

Coral reefs in Kuwait

Kuwait has a coastline of approximately 170 km and its climate is one of extreme seasonal changes: hot and arid; cool and unstable. The average yearly rainfall is 100 mm and most of the rain falls in the months between November and March. Summer land temperatures often rise above 50 °C and fall close to zero in the winter, occasionally falling below freezing point in desert areas. At sea this means that water temperatures dip down to 13 °C in most winters. Strong winds are common throughout the year, creating rough seas most of the time. Sedimentation and marine turbidity is high, mostly as a result of the proximity of the country to the Mesopotamian delta. In the north of Kuwait, high sediment loads create vast mudflats and prevent the formation of coral reefs. Extensive coral reefs begin to form in the southern areas of Kuwait, where direct influence of sedimentation decreases.

Despite the proximity of the large delta plume, reefs in southern Kuwait form a range of offshore platform and smaller patch reefs, as well as near shore patch reefs and fringing coral assemblages along the coastline. All reefs are situated in shallow waters, less than 15m deep with the best coral growth found down to 10m.

Sea temperatures in reef areas rise up to 34 °C in the summer and down to 13 °C in winter, sometimes getting as cold as 11 °C in the shallows. It is therefore evident that sea temperatures in the summer rise above survival temperatures for corals and winter temperatures below. These extremes may explain low diversity in coral species found on Kuwait's reefs.

Sediment and water turbidity are also important factors regulating coral development. Corals struggle to shed sedi-

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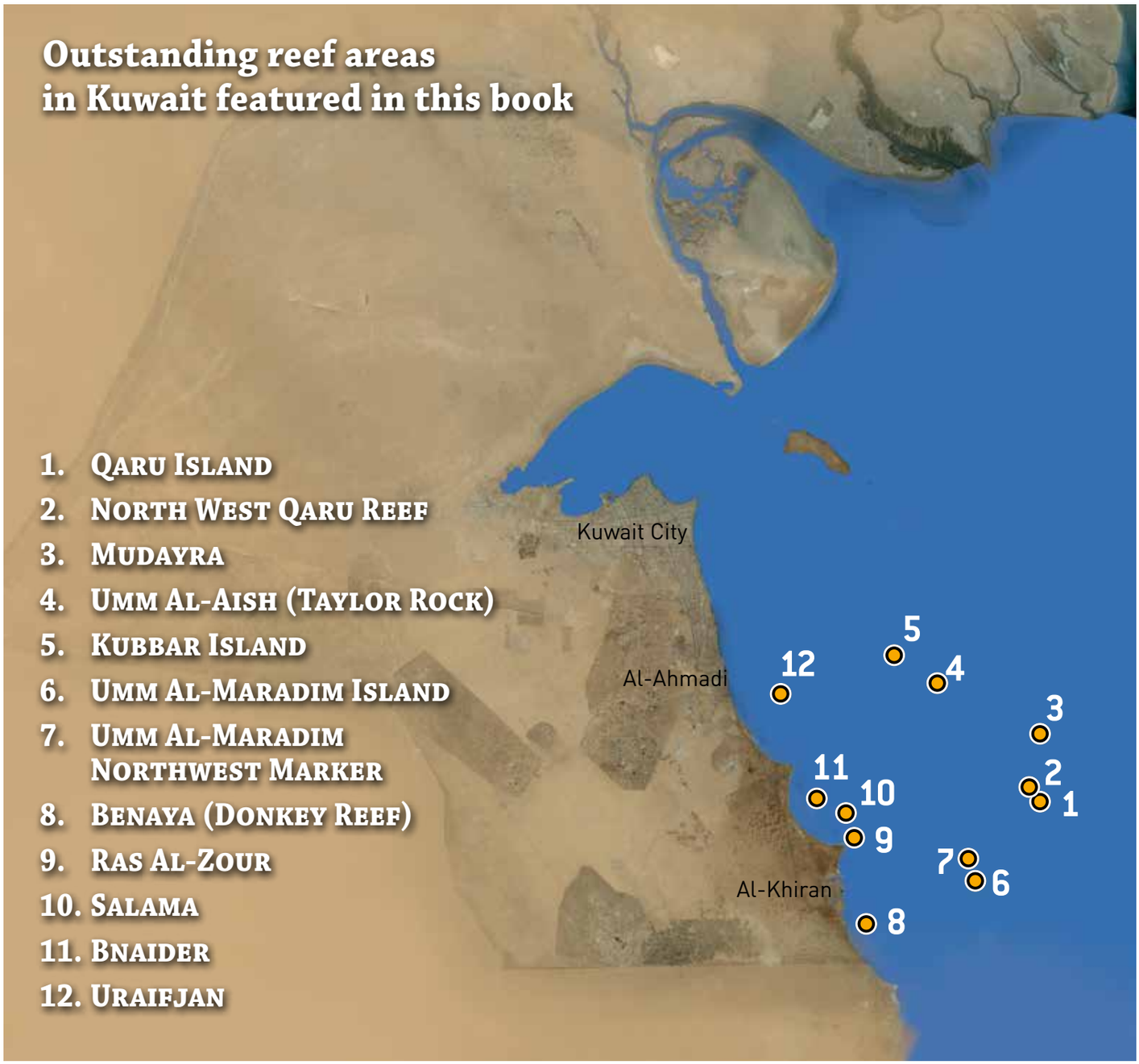

ment from their growing tissues so they do not have enough remaining energy to dedicate to their growth. High turbidity creates unfavourable conditions for the sun to penetrate the waters and help zooxanthellae of corals photosynthesize, and this is another impediment to growth. Kuwait's shallow waters also encourage strong plankton blooms, encouraged by nutrient-rich runoff, and these conditions further increase water turbidity.

Salinity is a natural limiting factor to the development of coral reefs in this country. It is elevated despite the high effluence of low salinity waters from the Shatt Al-Arab. Evaporation rates are high and as a result, salinity ranges from 38.6 to 42.4 ‰, which causes extreme stress in some corals and other reef organisms and may also limit the number of species present on Kuwait's reefs.

Other important limiting factors include intense grazing pressure by sea urchins and other bio-eroders as well as disturbance by storms and extreme waves, which can physically damage corals.

Last but not least, and like with most reef ecosystems in the world, anthropogenic pressure such as dense weekend boat traffic and human activities resulting from this can exercise extreme negative pressure to the reef ecosystems and prevent growth. Oil spills from vessels of all calibers in the region add to the stress and prevent development as well.

Despite all these stresses, coral communities do flourish in the southern waters of Kuwait. In the following pages we describe 12 of Kuwait's richest reef sites. These reefs sites are of outstanding conservation importance.

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Aerial view of the islet with the pier jutting out over the clear-water coral reef • SRA

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Qaru Island

One of Kuwait's richest reefs

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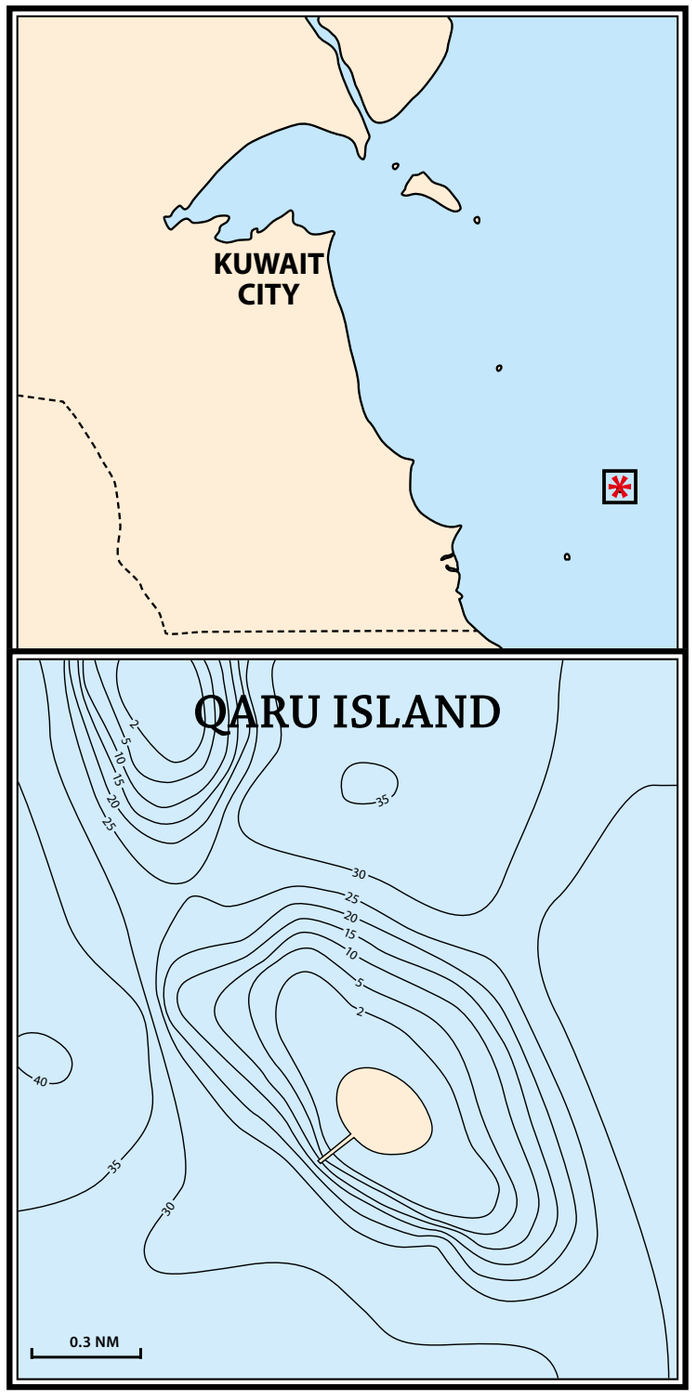
View from the pier: school of needlefish on the reef • VID



This island is both the smallest coral island and the farthest offshore. It is an oval-shaped sandy islet only about 200 m in diameter and it lies 37 km from the Kuwaiti coast. Out here you cannot see any land – the island stands like a beacon in the open sea. Qaru island has a permanently staffed coast guard station and a tall telecommunications tower; it is a very strategic outpost for the State of Kuwait.

Although it is the smallest of Kuwait's coral reef islets, Qaru has one of the largest and most biodiverse reefs in the extreme northernmost part of the Arabian Gulf. The reef begins immediately off the sandy beach. Qaru's reef extends up to 550 m offshore. The fringing reef formation is about 1.3 km long and 600 m wide in total.

Coral Reefs of Kuwait – 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Fish watching at night from the pier • VID

Coral white sand beaches encircle the islet – this sand is actually product of the eroding coral reef that completely encircles the islet.

The island's beaches are famous as one of the most important nesting grounds for two species of endangered sea turtles. They come out to nest on the sands of the island at night between May and August every year. Night time is very special not just for the turtles. The island's pier, lit by floodlights, is a wonderful place to sit and observe the waters of the reef below. Nocturnal predators stress the shoals of thousands of fishes. At night the corals' true colours reveal themselves in the glare of artificial light.

Hawksbill Sea Turtle returning to the water after nesting on Qaru island • VID

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Qaru's reef features a varied topography and sometimes amazingly clear waters – with visibility of up to 15 meters across. This is remarkable for the usually very turbid conditions of Kuwait's waters. VID

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Coral Reefs of Kuwait - 2010 Copyright: Bird Life International, KFAEC & the photographers

A maze of *Porites* coral heads • VID

The amazing aspect of Qaru is the remarkably high percentage of living coral cover that dominates the entire reef. Unfortunately, in most reefs in the Arabian Gulf, much of the reef is really composed of dead coral. Carpenter and colleagues (1997) recorded that at Qaru coral cover is over 80% living coral and these same conditions persist today. These live coral percentage "cover values" are comparable to those in pristine tropical reefs such as in parts of the Great Barrier Reef in Australia.

Yellowbar Angelfish • YIS

Massive *Porites lutea* colonies at Qaru are several meters in diameter; they resemble pyramids or small houses sometimes. Porites coral heads are likely to be hundreds of years old. These coral mounds dominate the reef flat close to the beaches. Often they are fringed by sandy areas all around and on calm days the brilliant visibility brings to mind an awesome aquarium scene.

Beyond the compact maze of Porites, usually beyond 100 meters from the beach line are very large branching *Acropora* table corals. Some of which are huge; more than 4 meters in diameter! These extensive expanses of large table-like branching formations are highly vulnerable to anchor damage and scarce in Kuwaiti waters. They are like delicate natural sculptures. The reef's slope and reef base has a high-relief environment with micro-caverns and low drops. These areas have a rich assemblage of different coral species and other benthic invertebrates.

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Scientists studying the species-rich reef slope • VID

Healthy *Porites* coral mounds • VID

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Massive and healthy *Acropora* patches • VID

Qaru's *Acropora* table coral habitats are the most extensive in Kuwait. Although this coral species grows fast in rather shallow waters it needs undisturbed areas; it is very susceptible to anchor damage.

Coral Reefs of Kuwait - 2015 © copyright: Burger & Bayfield - KUFPEC & the photographers

Immediately below the tip of Qaru's pier • VID

SPECIAL FEATURES

Exploring the reef from the pier: Qaru should be famous for its wood-and-steel pier. A beautiful bridge-like structure that does not damage the reef, spans across the leeward side of the islet. Here the waters are often very clear, sometimes crystal-clear! Many fish gather among the pilings – they may also feel protected by the increased structure of the pier's foundations. This 200 meter-long pier allows young and introductory divers and snorkellers to swim among a profusion of fishes and study them up-close with a feeling of total safety.

Gulf Parrotfish • YIS

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DIVING NOTES

Qaru is a reef that must be savoured, cherished and studied. It should be revisited as a study-site for fringing reef natural history. No reef is so much like a true "marine classroom" in Kuwait. It is definitely one of the best places to see an incredible variety of fish. In fact, several of the species of fish spotted at Qaru are scarce or uncommon on Kuwait's inshore reefs. This includes the rays, the Sohal Surgeonfish, boxfishes, sweetlips, triggerfishes, some species of wrasses, gobies and blennies.

Tropical reef fishes are everywhere on Qaru's reef. An interesting way to keep track is to count the number of species one can identify within a set period of diving or snorkelling, say 30 or 60 minutes. This is good way to appreciate the frequency of occurrence and abundance of the most prominent inhabitants of the reef. Also, honing one's identification skills takes lots of time and patience; and usually the use of a digital camera for recording and later reviewing identification field marks is useful. One of the reef's most abundant fishes are the tiny damselfishes and some of the small brown ones are not immediately easy to identify. With patience all five or six resident species of damsels will become "familiar faces" to snorkellers and divers.

Yellowfin Chromis and sea bream shoals • YIS

The scarce Bluetail Trunkfish • VID

The rare Thorn-back Trunkfish • VID

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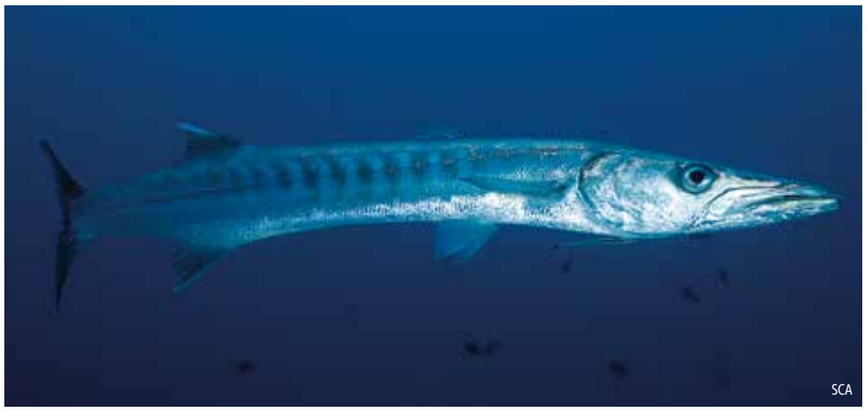
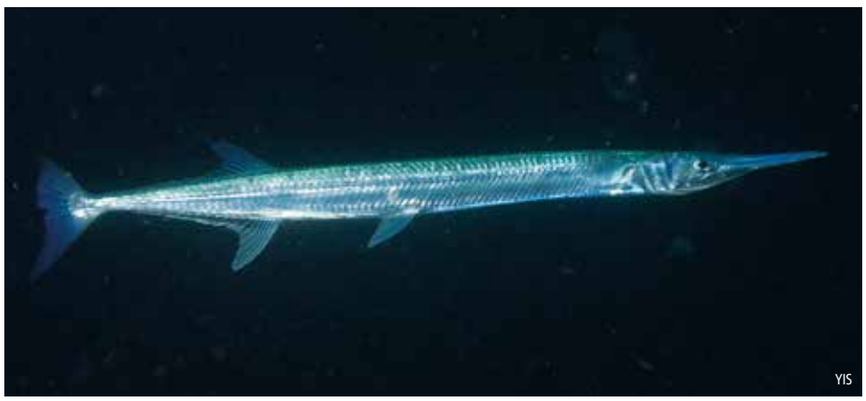
Sohal Surgeonfish • VID

Variablelined Fusilier • VID



Large barracuda species (in Sudan)

Talang Queenfish



Hound Needlefish (upper and lower image)

Qaru pier acts as sheltering area for huge shoals of fish at night, profuse with schooling Sind Halfbeaks and great densities of breams, snappers and other small fishes. The shoals moving as a single entity in ever-changing shapes and forms are frequently interrupted by predators that near the shallows. Halfbeaks are constantly chased by Hound Needlefish. The Hound Needelfish is in turn chased by jacks, trevallies and Talang Queenfish. And in turn some of the larger predators are food for barracuda and sharks! Predatory fish can also be observed from the flood-lit pier at night. Its fascinating to see them closing in on an attack. Their moves are strategic: surrounding, herding, and then rushing in for the kill. Fish often jump out

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Sind Halfbeaks • YIS

into the air to avoid being captured.

It may sound unusual, but very few divers or snorkellers have ever seen a shark in the water in Kuwait. Although most sharks are very fearful of humans, they used to be abundant here. One of the members of our team had a fleeting glimpse and a chance to photograph a Blacktip Reef Shark (*Carcharhinus melanopterus*) on two occasions at Qaru in June 2011. This is a fairly small shark species (1.6 m long), widespread on tropical reefs but in Kuwait it is a rarity.

Blacktip Reef Shark at Qaru • VID

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After sunset at the pier • VID

Songbird migrants such as redstarts and warblers seek refuge after a storm • ZOG

Qaru is also a 'bird sanctuary' of sorts. In fact it is a tiny desert islet that has little to provide for birds –apart as being a permanent "life-raft" in the middle of the sea– and many thousands of birds fly over the northern Gulf during their long-distance migration passages. On some days in spring and autumn hundreds of birds that you would never expect to see on a tiny desert islet land on Qaru! Especially during adverse weather birds are forced to land; a phenomenon known as a migration "fall". Located so far out at sea Qaru is a life saviour for these migrant birds. They use the industrial telecommunications tower as if it was a brightly-coloured tree; others rest amongst the steel pilings of the pier; some find a leaky tap and take a few sips of water; others glean every fly and aphid that may exist in the garbage cans and tiny flower pots of the Coast Guard station. And many exhausted migrants just rest on the sand. If it wasn't for Qaru many of these migrants would be just feathers in the ocean.

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Blue-cheeked Bee-eater • VID

Masked Shrike • VID

Little Crake, an uncommon passage migrant on Qaru • VID

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Soft corals (Octacoralia of the genus *Paraplexaura*) in the deeper parts of the sandy fringes below the reef • ZOG

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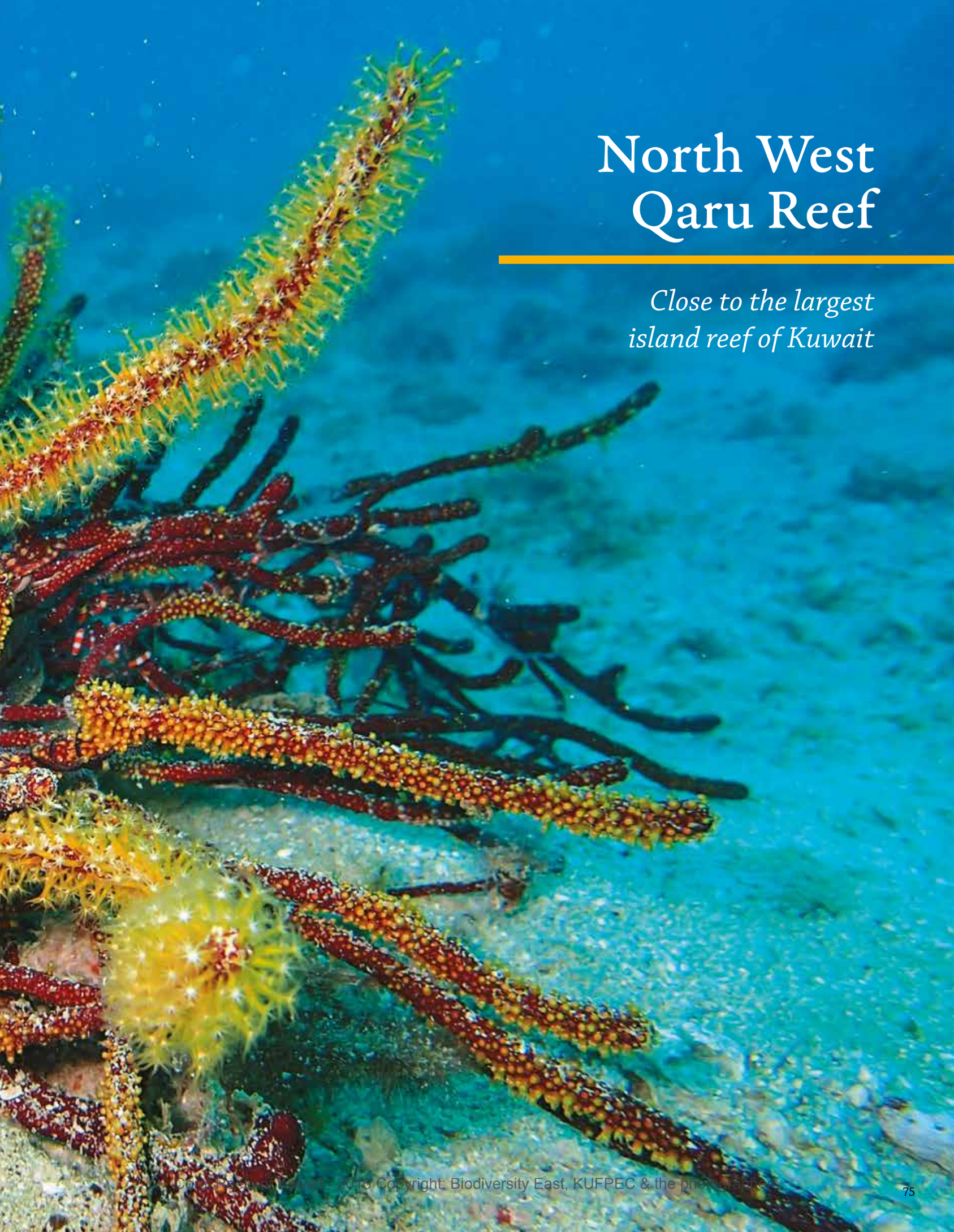


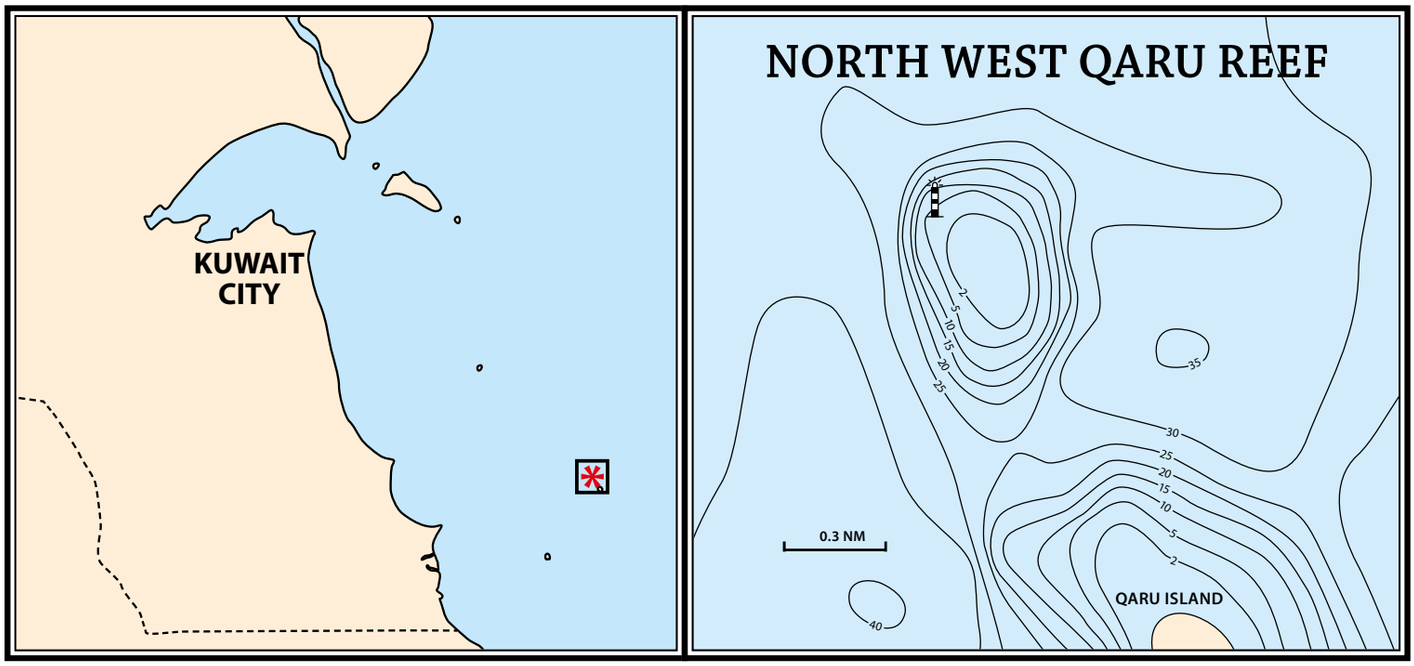
North West Qaru Reef

Close to the largest island reef of Kuwait

Coral Reefs of Kuwait - 2010 Copyright: Biodiversity East, KUFPEC & the photographers

Qaru Northwest Marker with Qaru island in the distance (at Left) • ZOG

This reef is a roughly oval-shaped patch located about 2 km to the northwest of Qaru. The sandy flat shallows of this small reef is crowned by a small light-house marker that is noticeable from far away. The shallow parts of the reef flat have extensive sandy areas but relatively low coral cover; some *Acropora* and *Porites* mounds mostly. It seems that much of the coral here has died or perhaps may be severely damaged by anchor damage and siltation. The site is also in the windward side of Qaru and has very strong silt-laden currents. However, parts of the reef slope have good reef communities, reminiscent of other outer offshore reefs slopes.



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The reef flat with scattered living and dead coral mounds • ZOG

Blackstreaked Monocle Bream (*Scolopsis taeniatus*) is a common fish with a distinctive broad dark brown stripe on the upper sides of its silverish body. This 15-30cm long sea bream is a relative of the Arabian Monocle Bream, both species in the Nemipteridae family of tropical breams. They share the sandy areas near reefs with a suite of light-coloured fishes including several other silvery breams, the Blacktip Mojarra (*Gerres oyena*), dartfishes, gobies and flatfishes.

Blackstreaked Monocle Bream • ZOG

Octocorals of the genus *Paraplexaura* with yellow polyps • VID

Tunicates thrive in the silty waters • VID

The deeper sandy slopes beyond the reef base have places with extensive beds of soft corals (*Octacoralia*). These are very distinctive communities that have been poorly studied by scientists. The soft coral clumps have some interesting invertebrates that cling on to the frail soft coral branches – these communities are reminiscent of dwarf shrubs in a sandy desert. Among the root-like clasps of the corals are tunicates, sponges and many echinoderms. Next to the "shrubs" may lurk a perfectly camouflaged scorpionfish or a giant sting ray! And other fishes may come in to investigate.

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Soft coral of the genus *Junceella* (Ellisellidae) with white polyps • VID

DIVING NOTES

This reef usually has strong tidal currents; extreme care must be exercised by novices. This exciting dive is usually experienced as a drift dive. However since the good dense coral areas are restricted to the sloping margins of the reef it is easy to "miss" them completely during a drift dive.

Scorpionfish • VID

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A school of Herring Scad (*Alepes vari*) over the reef • VID

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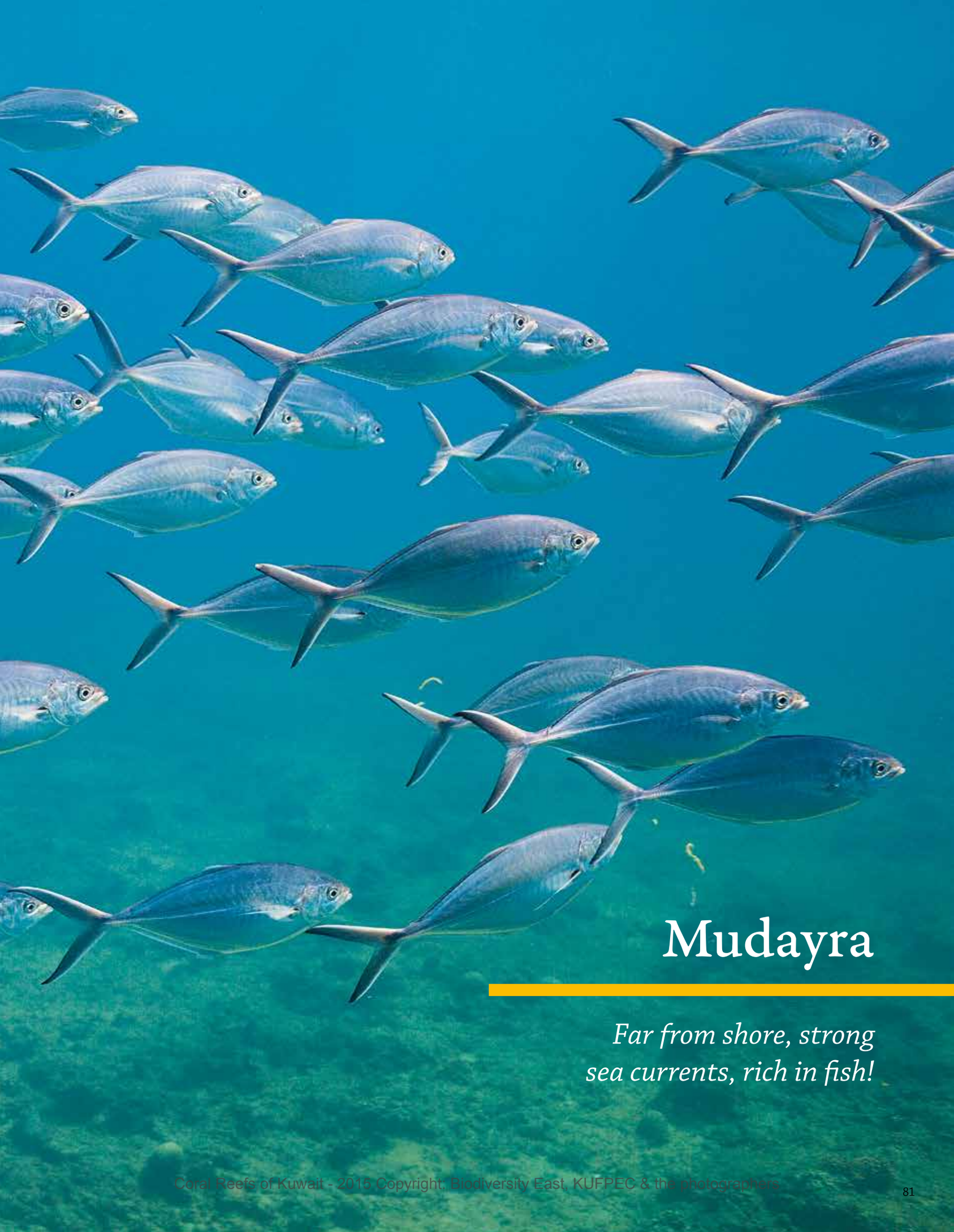

Mudayra

Far from shore, strong sea currents, rich in fish!

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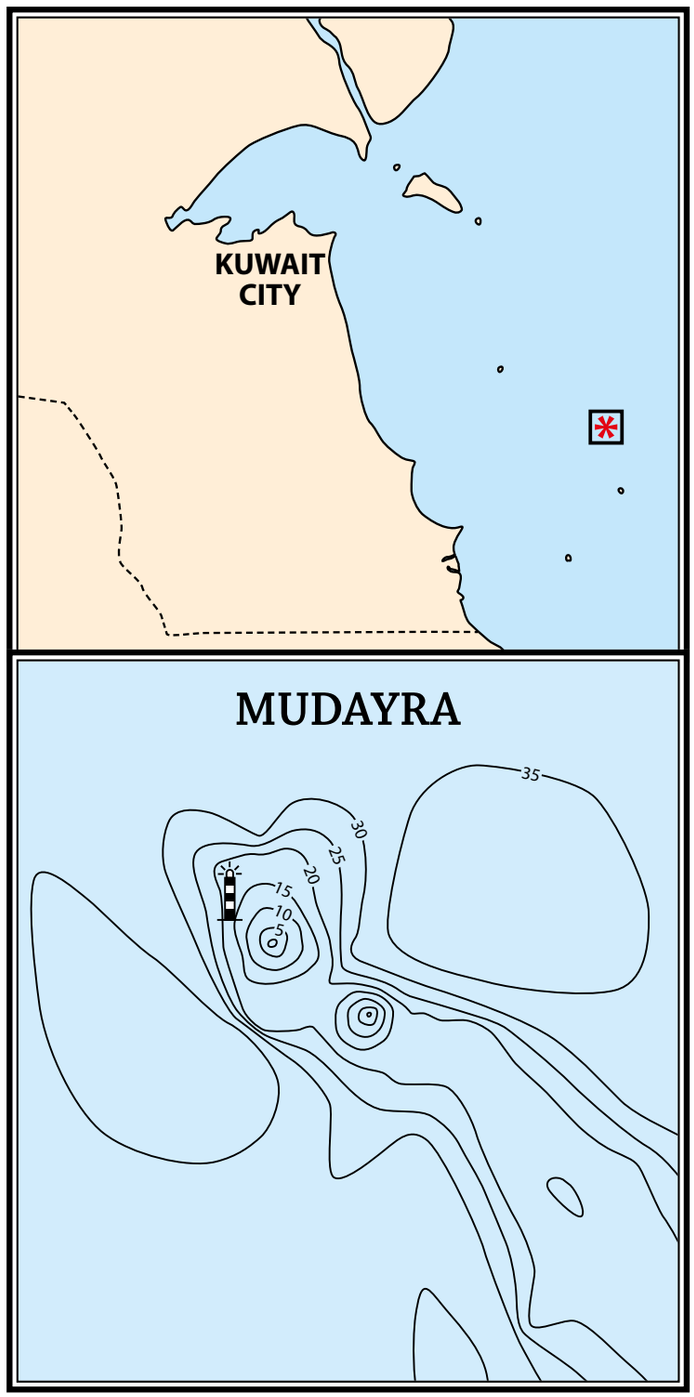


A group of reef patches on a rocky spur, far offshore near some of Kuwait's deepest waters. This is considered Kuwait's most distant reef. It lies near the entrance of a main deep water shipping departure channel; the sea's depths reach down to over thirty-five meters here. Although there are strong currents, water clarity is often very good in comparison with that of nearshore reefs. During calm weather on an incoming tide and the short span of slack tide, the waters can be almost brilliant. Due to the rich variety of reef life, the steep sloping reef margins, and exhilarating current–swept conditions, this is one of our favourite reefs for exploratory diving in Kuwait.

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

A rich coral assemblage • VID

The reef communities here are diverse but there are also large expanses with a lot of dead coral and rubble. Although numbers of branching corals may have declined, there are some corners of the reef that are pure magic! These wonderful sloping reef gardens have some gigantic Porites corals among a diverse jumble of coral formations, both dead coral lumps and fragmented coral forms. At some areas huge Porites Finger Corals (*Porites compressa*) and Downing's Table Corals (*Acropora downingi*) create outlandish compositions including overhangs and tiny caverns. It is these 'high-structure' reef habitats that usually have the highest fish and invertebrate population densities.

SPECIAL FEATURES

Despite the problem of overfishing in the region, this outermost open-sea reef attracts larger-sized fishes. You can immediately tell from the big angelfish and groupers that this site is not spearfished so intensively. Some of the larger pelagic fishes are especially wary of divers, so one must be very patient and observant. Schools of swarming small fish can attract predators. With luck, a large jack, trevally, queenfish, or maybe a barracuda may show up.

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Bubble anemones on dead coral mounds • ZOG

Pharaoh cuttlefish • ZOG

Despite the untidy character of this rocky reef, a variety of life exists even on the many dead coral outcrops. This is a place to see the beautiful Bubble Anemone (*Entacmaea quadricolor*), varieties of colourful crustose coralline algae and the ubiquitous Long-spined Sea Urchins (*Diadema setosum*).

The current sometime is so strong here; you may be forced to hang on to a dead coral. NEVER touch living coral. Sometimes huge Pharaoh Cuttlefish, nearly 40 cm in length, appear from the coral outcrops.

Small animals are always fascinating to search for. A tiny exotic-looking coral crab hides in the intricate *Acropora* table coral branches. In fact, a variety of invertebrates and even tiny gobiid fishes are specially adapted for living exclusively in this special micro-habitat! This is one reason *Acropora* corals are really important for reefs, without

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Tetraliid crab (*Tetralia cavimana*) among *Acropora* polyps • ZOG

DIVING NOTES

This place is notorious for its strong tidal currents; extreme care must be exercised when diving here. Mudayra must be dived during a slack in the tides and in calm weather only. In any case it is usually treated as a drift dive requiring professional guidance by experienced dive instructors. With very careful timing this reef is a fascinating challenge.

them many species are missing.

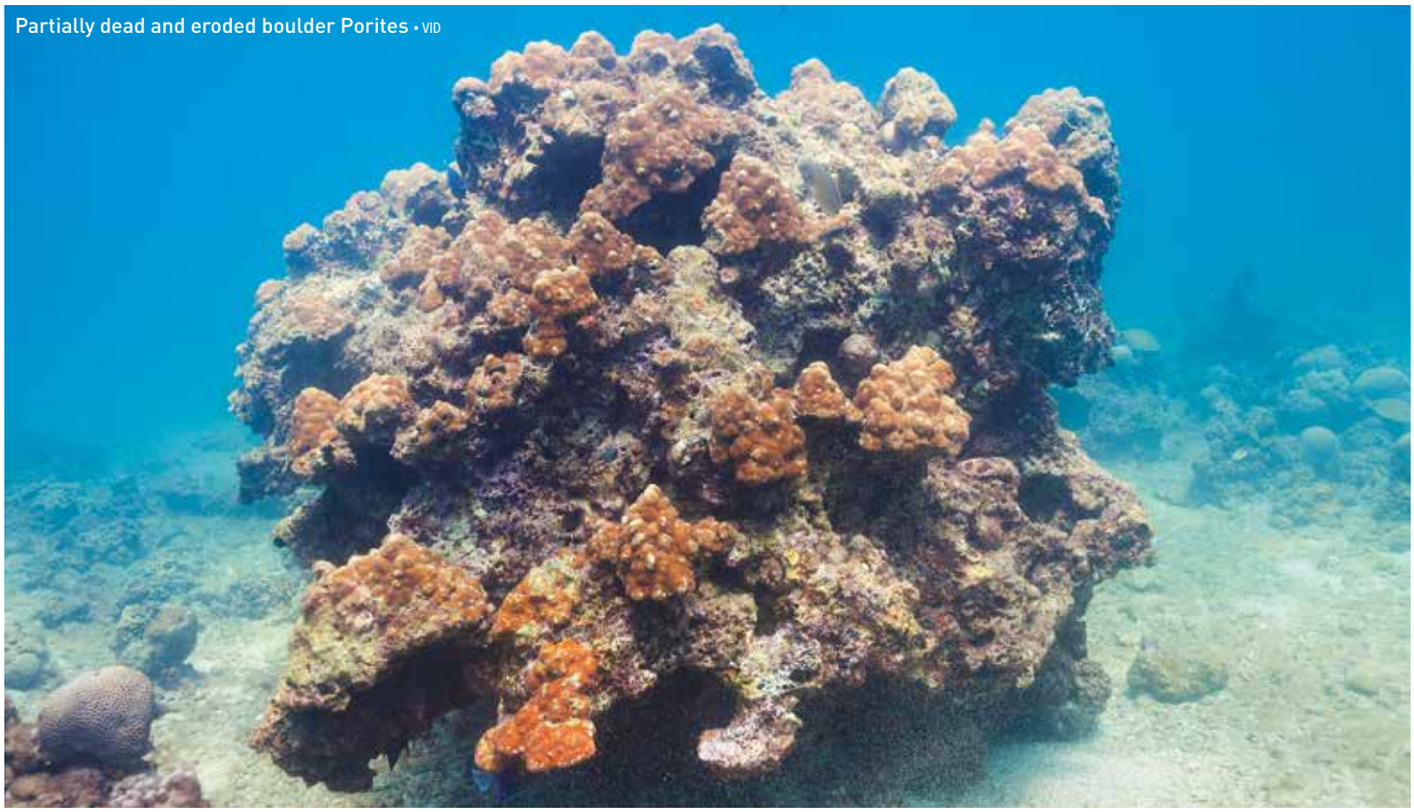
Mudayra has many colourful fishes, including many huge parrotfishes. These are grazers, roving around the reef and feeding on the algae that inhabits dead corals. Few people know that most parrotfishes are vegetarians!

Gulf parrotfish • VID

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Healthy *porites* • VID

Boulder Porites are seen in various massive forms, such as the huge all-healthy helmet-shaped mound (above) and eroded crumbling coral-head (below). Porites corals live for hundreds of years and when they die they may slowly erode creating a huge number of holes and fissures. These holes in the eroding coral become important habitats for marine life. The cycles of die-back and rejuvenation are prevalent in a dynamic reef environment such as Mudayra. Many young corals naturally colonize the older dead coral structures.



Partially dead and eroded boulder Porites • VID

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A dynamic jumble of reef corals • VID

Young coral growing on a dead Porites coral head • VID

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Exploring older navigational marker wreckage on the reef flat • VID

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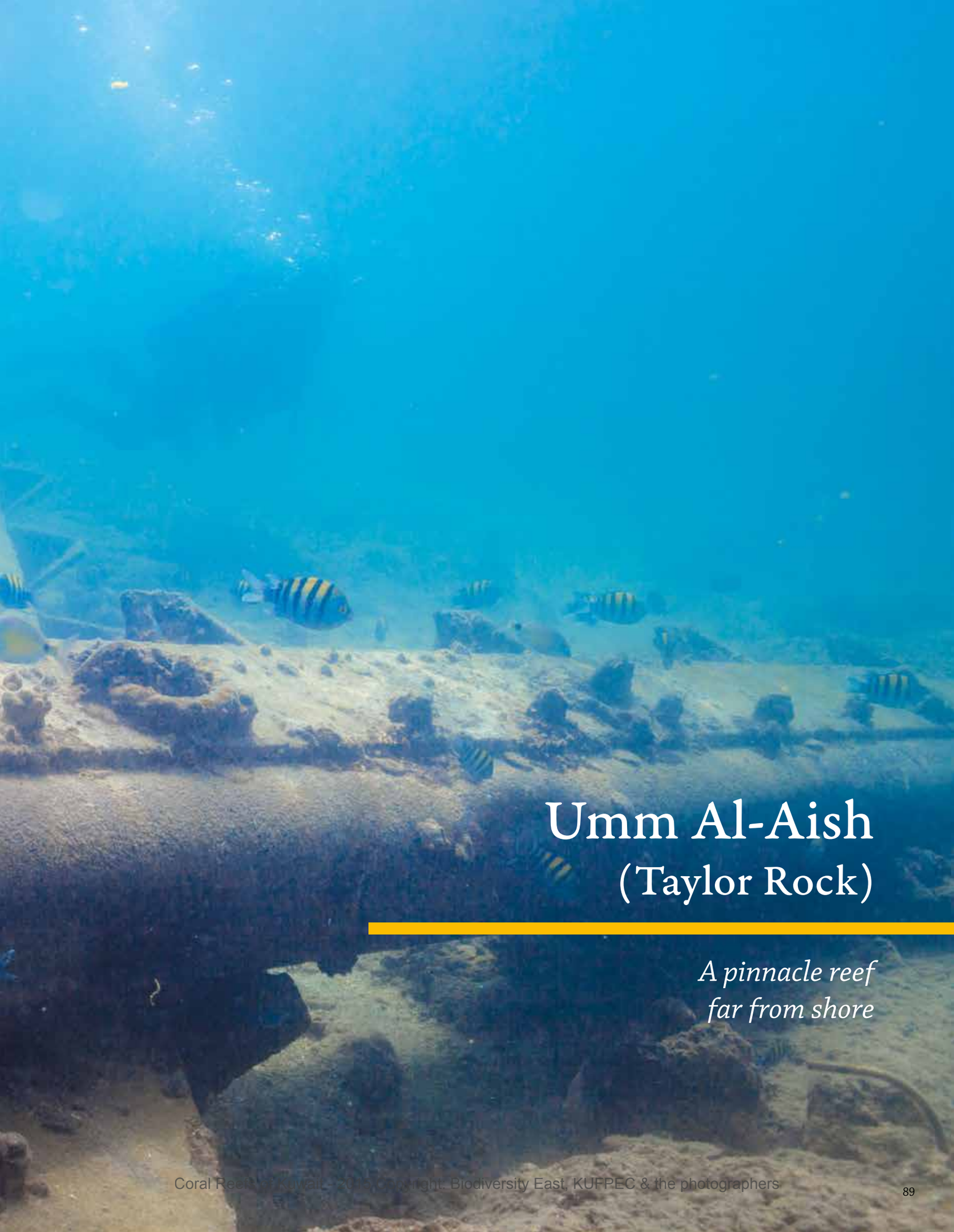

Umm Al-Aish
(Taylor Rock)

A pinnacle reef far from shore

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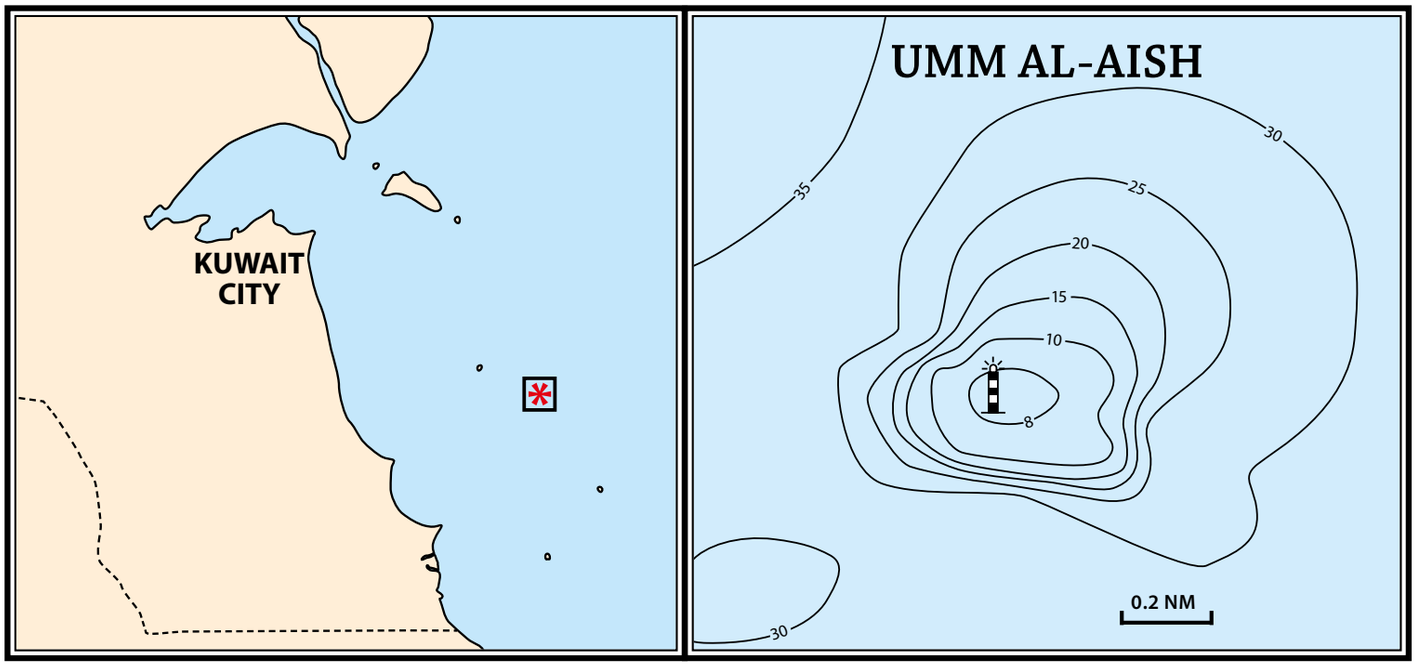
Slack tide at the navigational marker • ZOG

SPECIAL FEATURES

Umm Al-Aish feels very different from other Kuwaiti reefs. Notice what differences from nearshore reefs you can detect. Some species from the nearshore reefs may be missing, other species may be present. Take careful photographs to record different life forms – soft corals, sea urchins etc.

Umm Al-Aish shares with Mudayra a large column-like navigation marker. Like a miniature lighthouse it looms in the middle of the sea, located about 10 km south-east of Kubbar Island. Umm Al-Aish has been called a 'pinnacle reef'; it is a very small reef far away from shore, rising abruptly from the depths. The reef looms over some of the deepest waters in Kuwait, the surrounding waters being about 30 m. This reef is rather famous for its big fishes. However, the problem of overfishing is evident here, too. Although the reef is seemingly far from frequent recreational fishing access, it is a landmark location where a lot of fishing takes place. However, many pelagic fishes are still attracted to the current-swept pinnacle. So, seeing a really big trevally or barracuda or a reef-dwelling predator such as a large grouper, is still very likely here.



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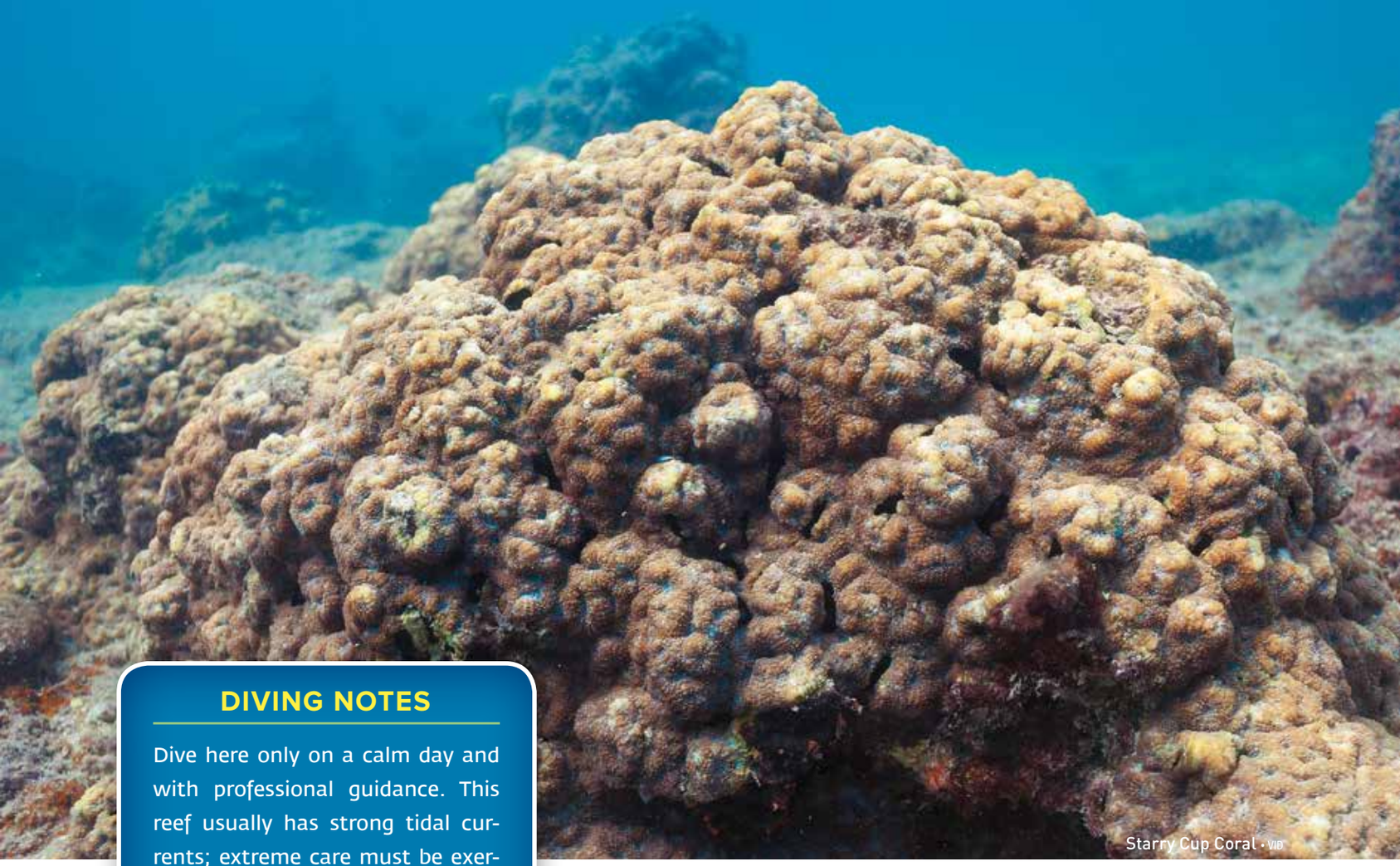


Starry Cup Coral • VID

DIVING NOTES

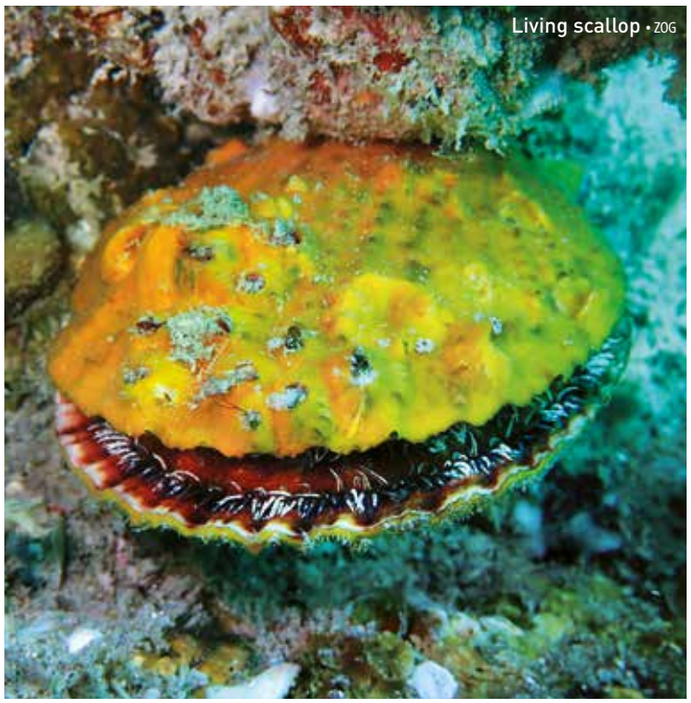
Dive here only on a calm day and with professional guidance. This reef usually has strong tidal currents; extreme care must be exercised by novices. It is usually experienced as a drift dive. And it is especially exciting at the steeper sloping areas where the experienced diver can descend to greater depths than is usual on most Kuwaiti reefs.

A massive mound of Starry Cup Coral, (*Acanthastrea echinata,* above) and the perfectly camouflaged Orange-spotted Grouper (*Epinephelus coioides*, below). Hiding is an art and a necessity to escape detection by the grouper's prey and its predators.

Orange-spotted Grouper • VID

Coral Reefs of Kuwait - 2015 Copyright Bloomsbury East, KUFPEC & the Photographers

Pencil urchins on rocky substrates • ZOG



Living scallop • ZOG

Scallop shell • ZOG

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A black coral in the genus *Antipatharia* at 15 m depth • ZOG

For experienced divers this is a good reef to explore deeper waters. Research in the 1990s showed that below 15 m depth, the substratum is bedrock and despite a relatively steep slope of about 30°, the rock is devoid of reef-building corals. The deeper rocky slope is covered with a layer of fine sediment. Clinging on the sediment-rich rock are a few small ahermatypic soft corals – these do not form reefs. The observations at this deep site show that, in Kuwait, the limit of reef-building corals is about 15 meters. This rather shallow depth limit for reef-forming corals may be a result of a combination of lack of light from a high load of suspended sediment and apparently high sediment deposition rates. Most reef-building corals do not settle on fine sediment.

Detail of the black coral's tiny white polyps • VID

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Kubbar is surprisingly green and colourful in early spring! • HAB

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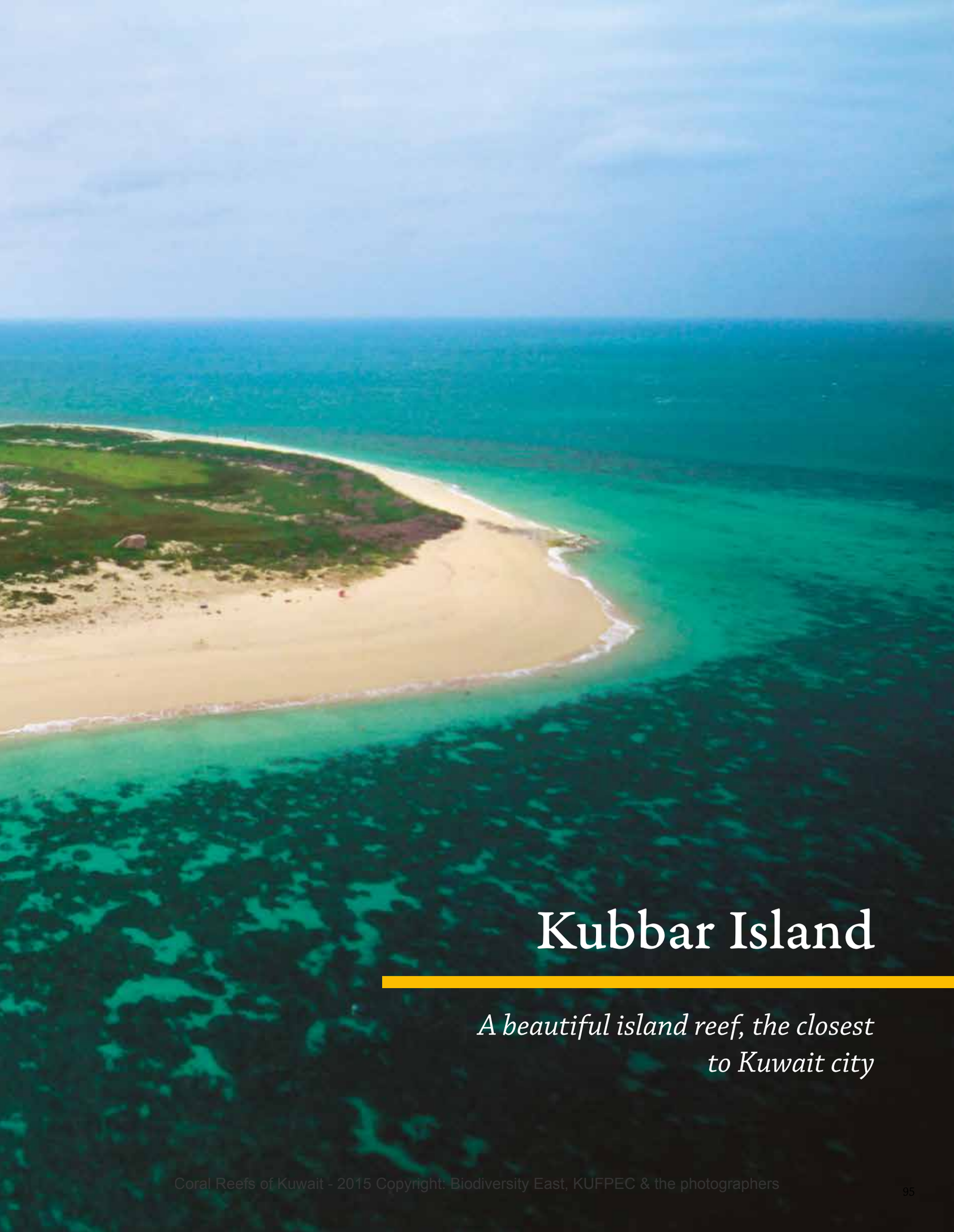


Kubbar Island

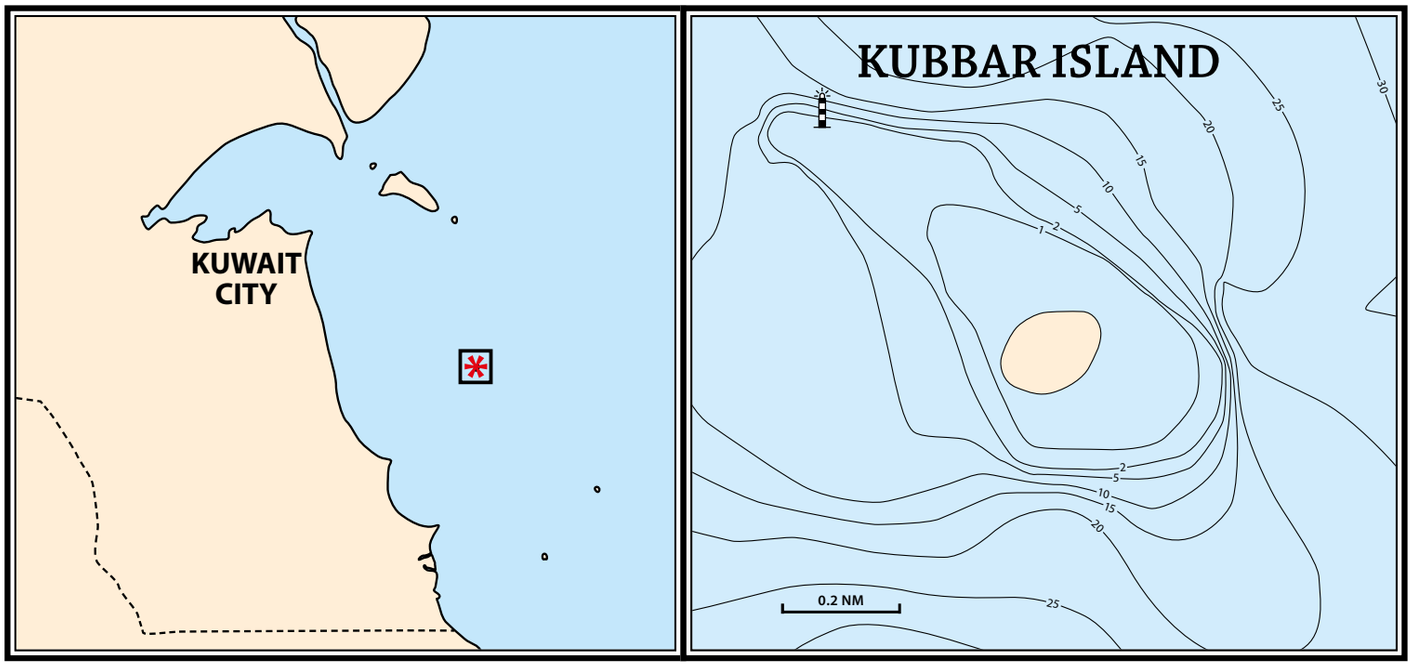
A beautiful island reef, the closest to Kuwait city

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Buoys help boats and protect the reef. • VID

Kubbar is definitely Kuwait's most famous reef island. It supports one of the Gulf's northernmost and largest fringing coral reefs. The island is a sandy low oval-shaped cay surrounded by a fringing coral reef; it almost looks like a sea-mount in its underwater topography. The island itself is about 500 meters long and completely fringed by coral-white sand beaches.

Unfortunately Kubbar's popularity is also its greatest curse. Since it is only 50 km from the city centre of Kuwait City and only 33 Km from the coast of Ahmadi it receives many boats and recreationists. The coral formations have suffered from repeated anchor damage. In fact it is remarkable that this subtropical coral beach is only a short boat-ride from an industrial heartland and major port capital city. It should be better protected.



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Kubbar is an internationality recognized bird sanctuary! • VID

Kubbar's distinctive reef flat and beach zones • VID

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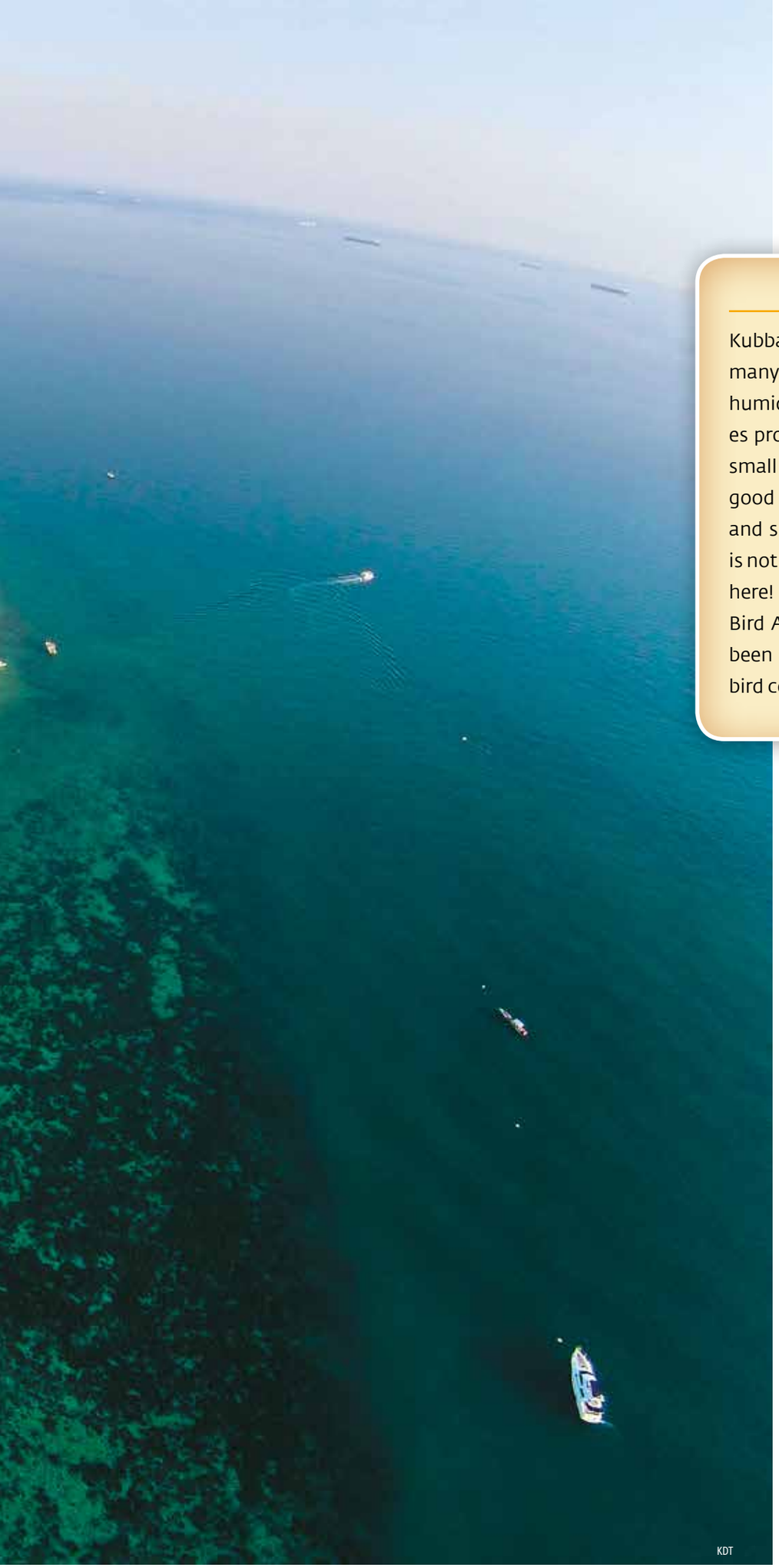

SPECIAL FEATURES

Kubbar is a bird paradise. Unlike Qaru there are many resources for birds here. In early spring the humid green flower meadows and Sueda bushes provide food and cover. It almost feels like a small island in the Mediterranean – receiving good numbers of migrant birds. In late spring and summer four species of tern breed here; it is not uncommon to count 6 or 7 thousand terns here! This tiny islet is a designated Important Bird Area and proposals for conservation have been forwarded. Sadly the protection of these bird colonies is poorly enforced.

Kubbar's coral reef is about 1.3 km long and 900 meters wide. Despite being the northernmost major Kuwaiti reef, its waters are usually quite clear; however, they are influenced directly by silt-laden currents from the Mesopotamian Delta plume. These "nutritious" currents feed the island's productive reef. Much of the reef is quite silty and sandy. Chutes of sand cover parts of the inshore reef flats and even deeper parts of the reef system. The massive *Porites* coral heads, known locally as "the cows" make huge boulder-like formations on the reef flat close to shore. These wonderful maze-like formations are easy to see in this air photo taken during summer-time. Note that about 20 small recreational boats are present in this early morning photograph; on weekends many more encircle the island.

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Typical scenes from Kuwait's most spectacular seabird nesting colonies, featuring: White-cheeked Terns (*Sterna repressa*) (above), Lesser Crested Terns (*Sterna bengalensis*), and the scarce Swift Terns (*Sterna bergii*) (below). Every effort must be made not to disturb nesting birds while taking photographs.

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Tern colonies are easily disturbed! • HAB

Lesser Crested Terns with their young • HAB

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Kubbar's beach rock habitat • VID

The variety of micro-habitats on Kubbar is really quite remarkable despite the intense recreation pressure. On the sandy beaches there are sections in the southern part with fossilized beaches – these are known as beach rock formations. In the reef flat just beyond the beaches brain corals and *Porites* corals are abundant.

Rich mix of *Favia* honeycomb corals, brain corals and *Porites* corals. • VID

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Diverse habitat structure at the reef's margin • VID

Massive brain corals • VID

Copyright Blue Image Photographers

Abundant fishlife • VID

Pearlspotted Rabbitfish • VID

Deeper parts of the reef near the reef slope and reef base are much richer in coral and fish species. However extensive patches of *Acropora* are not common. Among the coral reef fishes seen here are the rabbit fishes (*Siganus* spp.) that can change colour almost like chameleons. A rarity here is the Picasso Triggerfish – always an exciting scarce tropical fish to observe.

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Kubbar's reef fish community • VID

Picasso Triggerfish • VID

Brittle stars on soft corals • ZOG

Cavern full of cup corals • ZOG

Fascinating "special habitats" found on Kubbar reef are the rather low drop-offs and micro caverns of the reef slope. These are not really very extensive here, but where they exist an inquisitive naturalist should always take time to inspect them. Soft corals with their associated brittle stars and bright yellow Dendrophylid Cup Corals are usually present in these dark overhangs. Shoals of fishes take refuge in the eroded undercuts of the coral mounds.

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Damselfishes and angelfish add tropical colours • VID

Acropora is uncommon on Kubbar • VID

DIVING NOTES

The numbers of boats visiting has been increasing and this may be a disturbing place to dive when it is overcrowded. It is however, a huge reef and has many hidden corners! Try to arrive very early during the day and avoid weekends, in order to find this wonderful place in peace.

In early spring the island is green! • HAB

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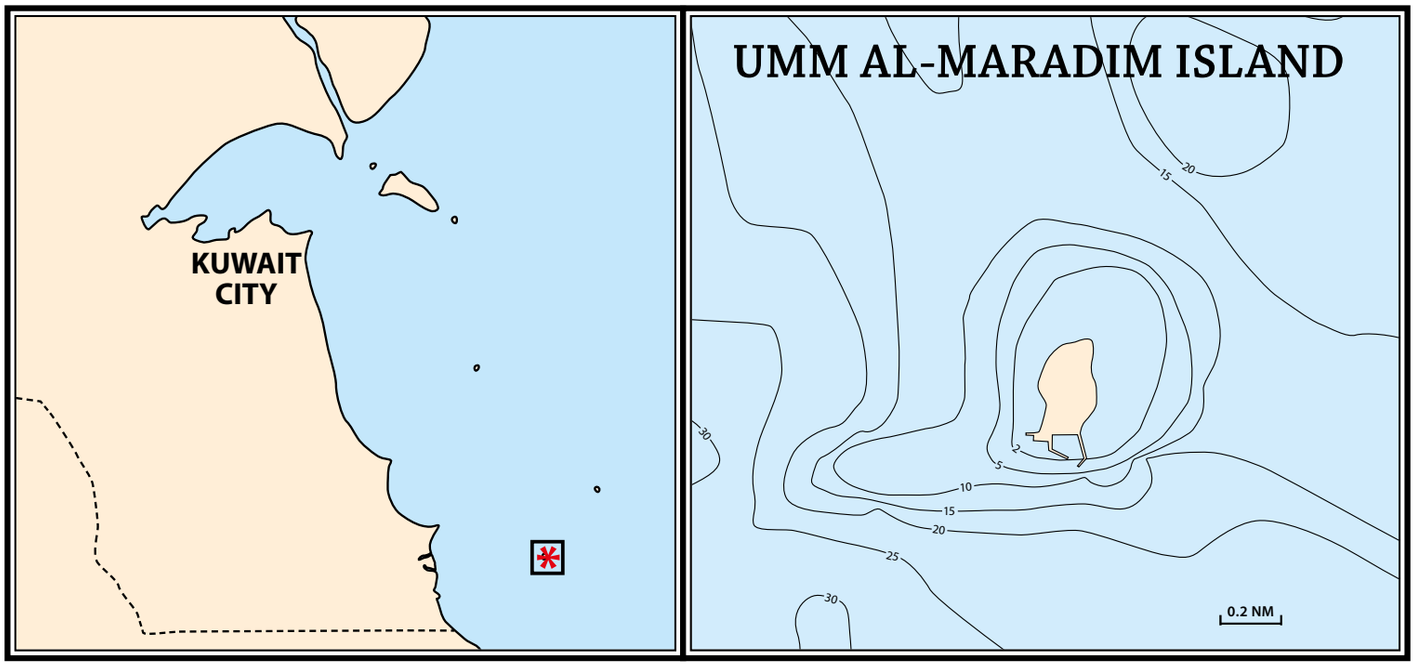
Umm Al-Maradim Island

Southernmost coral island in Kuwait

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Umm Al-Maradim • VID

An extensive reef surrounds Kuwait's southernmost island. This island is marginally larger than Kubbar, being about 550 m long and fringed by coral-white sand beaches and natural beach-rock pavements. On the southern side is the Umm Al-Maradim Coast Guard Station and its new harbour, inaugurated by HH the Emir of Kuwait in 2007. The island's reef is one of the largest in the country; it is about 1.4 km long and 1.1 km wide. The coral extends up to 400 m away from the beaches, beginning immediately from the beach shores. The extensive reef flat is dominated by massive Porites corals and a rich variety of other coral colonies. More diverse assemblages of corals are found in the reef slope areas around the outer margin of the island's reef.



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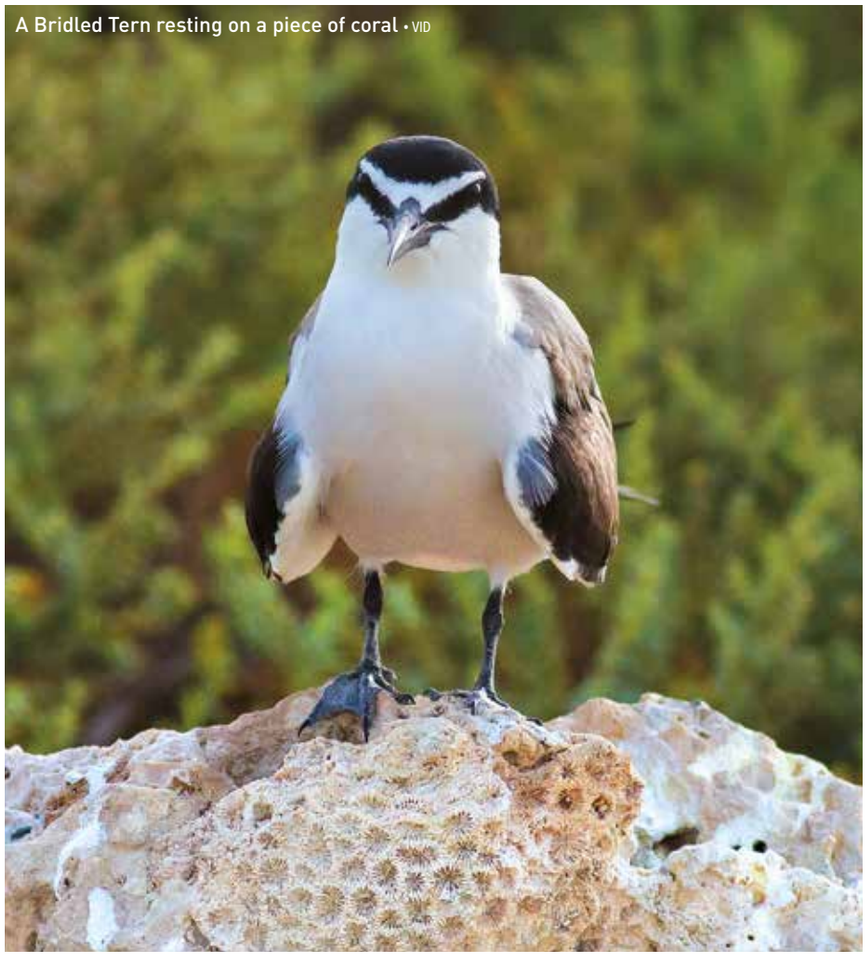
Seabirds sharing a crowded beach • VID

One of the most vulnerable elements of the island's biodiversity is a breeding colony of Bridled Terns (*Onychoprion anaethetus*). These elegant seabirds come to the island to lay their eggs on the ground behind the beaches. They have no natural predators here. A more serious problem, far worse than predation, is disturbance caused by people intruding on the nesting colony. People visiting the nesting areas during the late spring/summer breeding season often displace the birds from their nests and leave the eggs exposed to the scorching desert sun. Unprotected eggs heat up incredibly fast. Only a few minutes are necessary to result in thermal death of the chick embryos. During the day, the parents fly back and forth to shore in order to plunge in the water to soak their feathers so they can keep the eggs and young moist and cool. Human visitors should be aware not to disturb the nesting colony.


A Bridled Tern resting on a piece of coral • VID

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Umm Al-Maradim in 2014 • KDT

Umm Al-Maradim is both a resilient coast guard fortress and a fragile coral island. It must be carefully managed to maintain all its unique values for Kuwait. Changes have taken place due to the island's outstanding strategic importance to humans; this includes the building of the coast guard harbour where until recently there was merely a tiny pier. This harbour project was carefully executed not to destroy the surrounding reef. However, human disturbance on the reef by visiting recreational boats has increased. The result of a lot of recreational disturbance on the surrounding reef is that many of the fragile branching corals have been severely damaged.

In the 1990s Umm Al-Maradim was more natural-looking, but back then there was still a lot of disturbance by

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

amateur fishermen coming for spearfishing and anchoring haphazardly nearly everywhere on the reef. People have only recently begun to appreciate this island as a natural sanctuary. Today a series of carefully-placed permanent buoys helps recreationists resist anchoring on the coral. Also, due to the position of the island within a coast guard and military zone, camping is prohibited, so the nights are left to the sea turtles that come to nest on the island's coral-white beaches.

Umm Al-Maradim in the 1990s • KDT

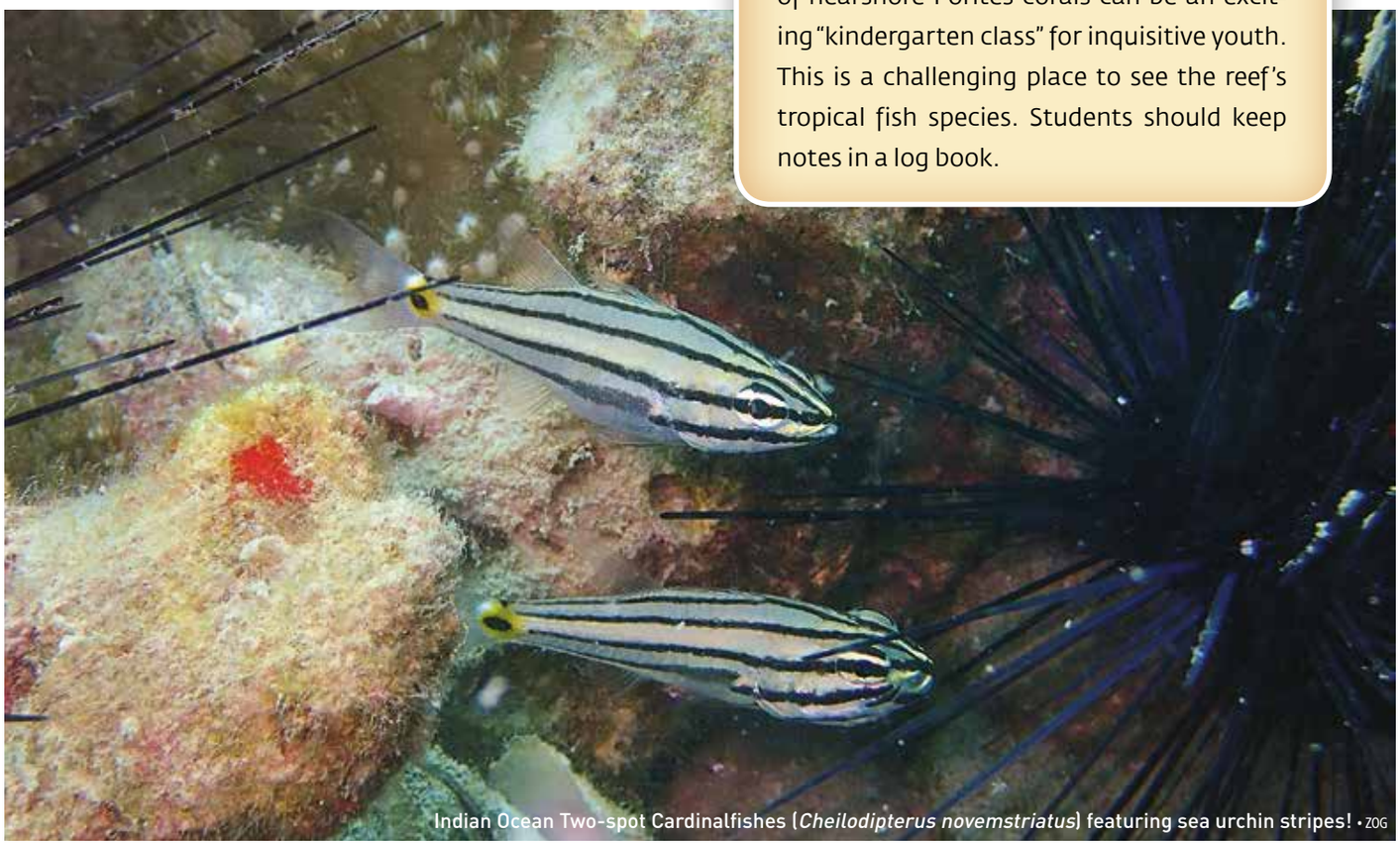
The south side of the island in the 1990s • KDT

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Spangled Emperors near damaged *Acropora* coral • VID

SPECIAL FEATURES

Umm Al-Maradim is a varied and easy reef to snorkel from the beach. We highly recommend snorkelling for families here. The maze of nearshore Porites corals can be an exciting "kindergarten class" for inquisitive youth. This is a challenging place to see the reef's tropical fish species. Students should keep notes in a log book.



Indian Ocean Two-spot Cardinalfishes (*Cheilodipterus novemstriatus*) featuring sea urchin stripes! • ZOG

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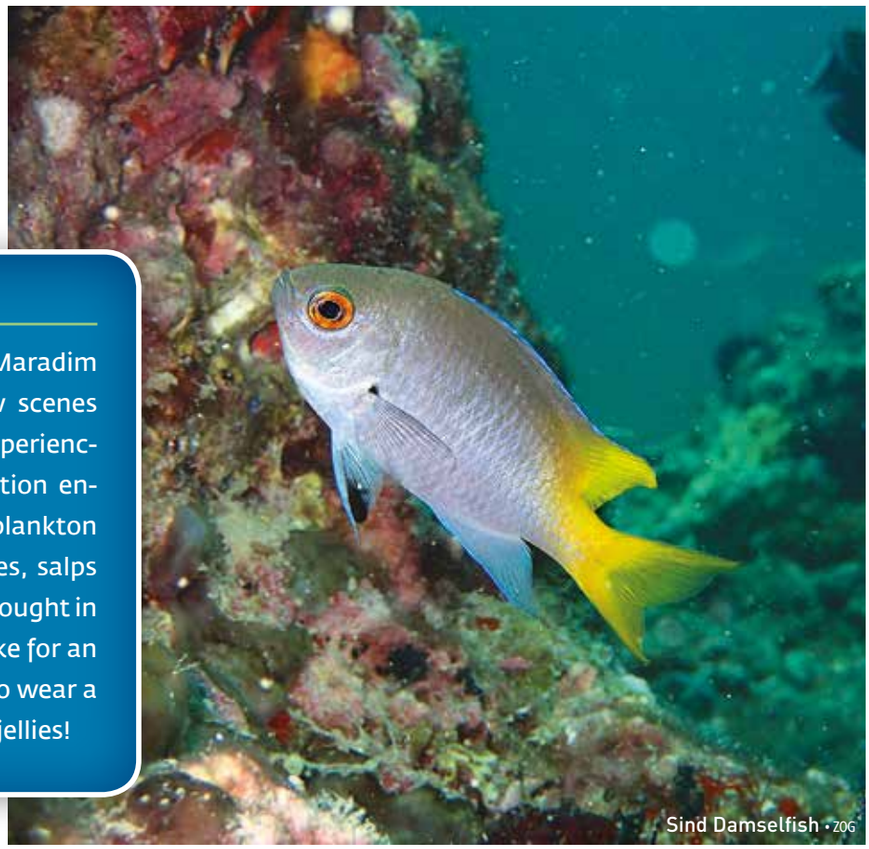
Sohal Surgeonfish • VID

Umm Al-Maradim is a great place to see a variety of reef fishes. Common fishes include: emperors (upper left previous page), cardinal fishes (lower left previous page), Sohal Surgeonfish (upper right) and Sind Damselfish (lower right).

DIVING NOTES

As at Kubbar and Qaru, diving at Umm Al-Maradim provides many new challenges and new scenes each time. One of the most spectacular experiences here is the amazing "soup-like" condition encountered during the frequent summer plankton blooms. Millions of sea jellies, comb jellies, salps and other planktonic organisms may be brought in by the tidal current. These conditions make for an unforgettable dive. Just take precaution to wear a full-body wetsuit and don't touch the sea jellies!



Sind Damselfish • ZOG

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Persian Cardinalfishes • ZOG

A unique type of habitat • ZOG

Near the deeper part of the reef margin • ZOG

Flowerpot coral garden!

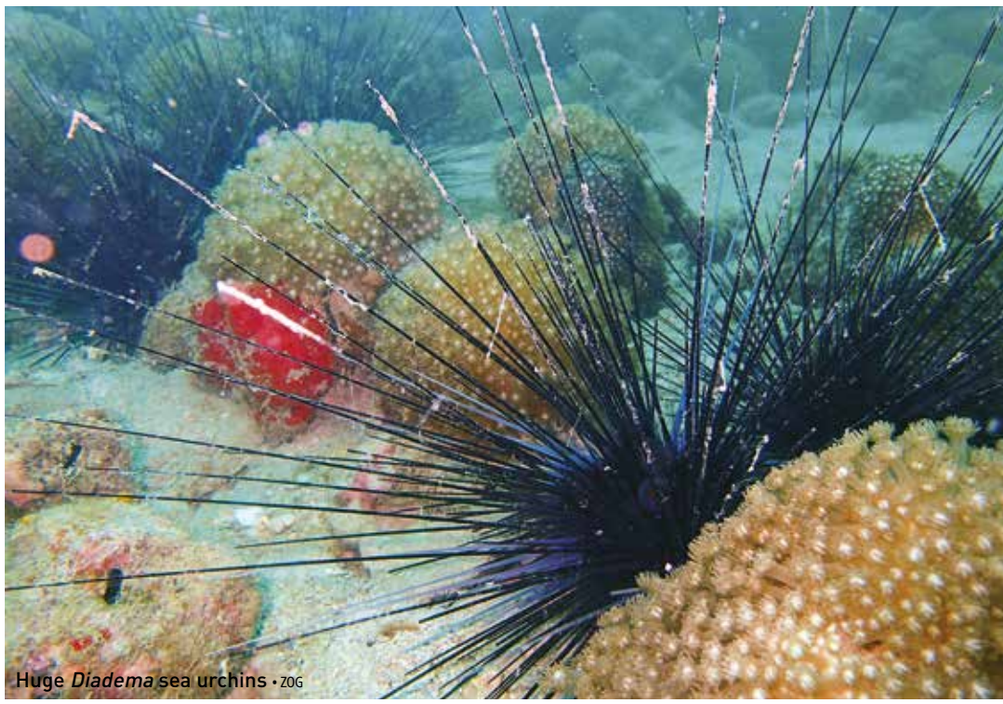
Flowerpot corals (*Goniopora columna*) flourish in some of the reef margins of Umm Al-Maradim. This is a fascinating reef microcosm to study; these corals form a distinct habitat type. Although dominated by one coral species, it vividly resembles a beautiful garden in the misty turbid waters. Among the flowerpot corals are huge pin-cushion-like *Deadema* sea urchins, sponges and other encrusting life forms. An intimate relationship exists between *Deadema* sea urchins and Persian Cardinalfish. These tiny fish, as do others, use sea urchins as protective nursery grounds; when young, cardinalfish are perfectly patterned with long black lines to resemble the urchin's spines. Look out for amazingly camouflaged greenish Scorpionfish among the coral bouquets.

Flowerpot corals look like no other corals. Some people mistakenly call them soft corals but they are true reef-forming scleractinian corals. Their most distinctive character are the huge coral polyps, the anemone-like polyps secrete the rock-coral skeleton. These polyps form colonies which join together at the base, where they secrete rock-coral in the form of dome-shaped "flower pot" mounds. Each polyp has a couple of dozen long and fleshy tentacles that are normally extended day and night; these can retract to reveal the "flower-pot" base beneath. The large polyps can use their tentacles to capture huge quantities of plankton and thus are not as reliant on sunlight, which is required for photosynthesis by their symbiotic zooxanthellae algae. So this coral species easily lives in very turbid waters. These corals have separate male and female colonies which release sperm and eggs into the water for external fertilisation. The fertilised egg develops into a free-swimming larva that will eventually settle on the substrate and develop into new colonies. In this way, isolated flowerpot corals can be found in both quite shallow and deeper waters; usually, however, they seem to prefer intermediate waters along reef margins in Kuwait.

Coral Reefs of Kuwait ©2015 Copyright: Biodiversity East, KUFPEC & the photographers

Flowerpot coral polyps • VID

Most coral polyps are open during the day • ZOG



Huge *Diadema* sea urchins • ZOG

Despite their delicate looks, flowerpot corals are generally aggressive against other corals! They are capable of developing elongated 'sweeper' polyps the tentacles of which can inflict tissue damage on a coral within their reach. It is therefore unusual to see other coral species growing immediately beside them. This adaptation gives the flowerpot a competitive advantage. For this reason we can see single-species stands of flowerpots dominating part of Umm Al-Maradim's reef base. Finding a flowerpot garden like this is, in the southern part of the island's reef, a real treat.

Flowerpots are, in fact, so distinctive that they are very popular in saltwater aquaria. But it is much more interesting to see a living colony in the wild than one in captivity! Although *Goniopora columna* is a widespread coral species in the wider Indo-Pacific, it is assessed as "Near Threatened" by IUCN and is protected as an Appendix II species in the Convention on International Trade in Endangered Species (CITES).

A scorpionfish, probably *Scorpaenopsis barbatus* with flowerpot coral camouflage • ZOG

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Rich coral life under the navigational marker • VID

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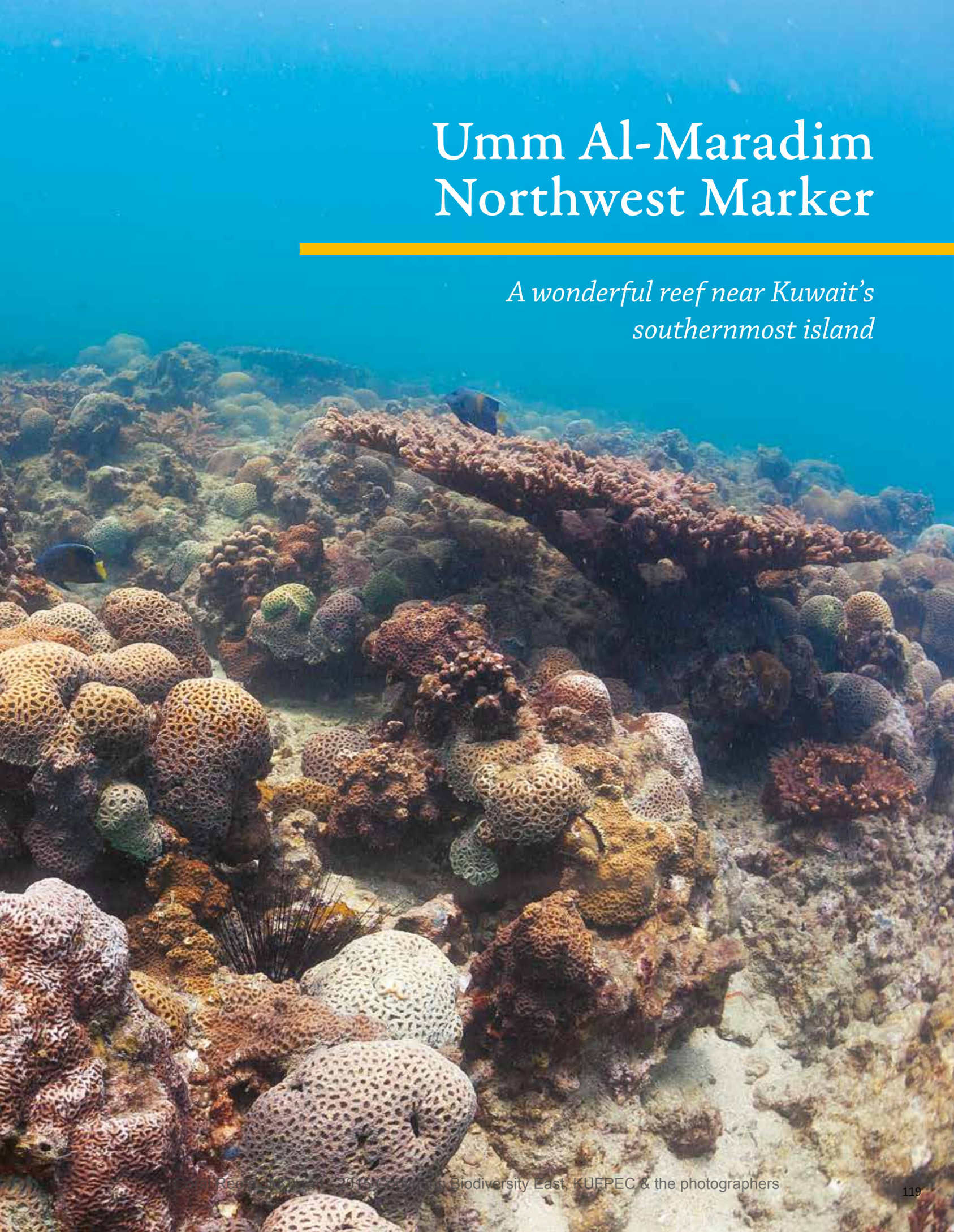
Umm Al-Maradim Northwest Marker

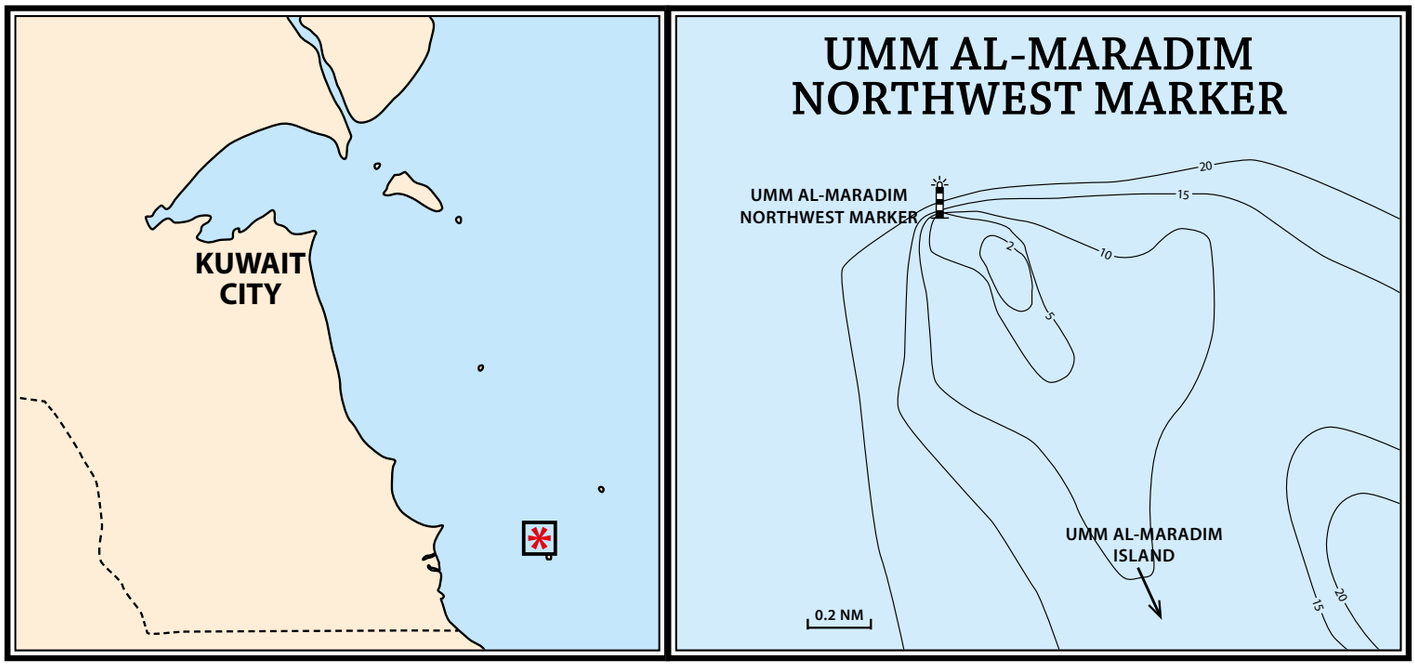
A wonderful reef near Kuwait's southernmost island



Coral Reef Survey 2009 © Biodiversity East, KUFPEC & the photographers

Navigation marker with Umm Al-Maradim in the distance • VID

About three kilometres northwest of Umm Al-Maradim island are a group of small patch reefs that make an excellent exploratory dive. These rough ridges under a simple navigational marker are open to fairly strong tidal currents that sweep nutrient-rich waters over the reef. They have a high coral cover and diversity, especially at the reef's steeper sloping sections, the reef margins. These reef slopes are full of Favia honeycomb corals, punctuated by single table corals, looming Porites corals and many brain corals. This reef gives the impression that it is totally alive and flourishing. It receives fewer visitors than Umm Al-Maradim's other much-frequented sites.

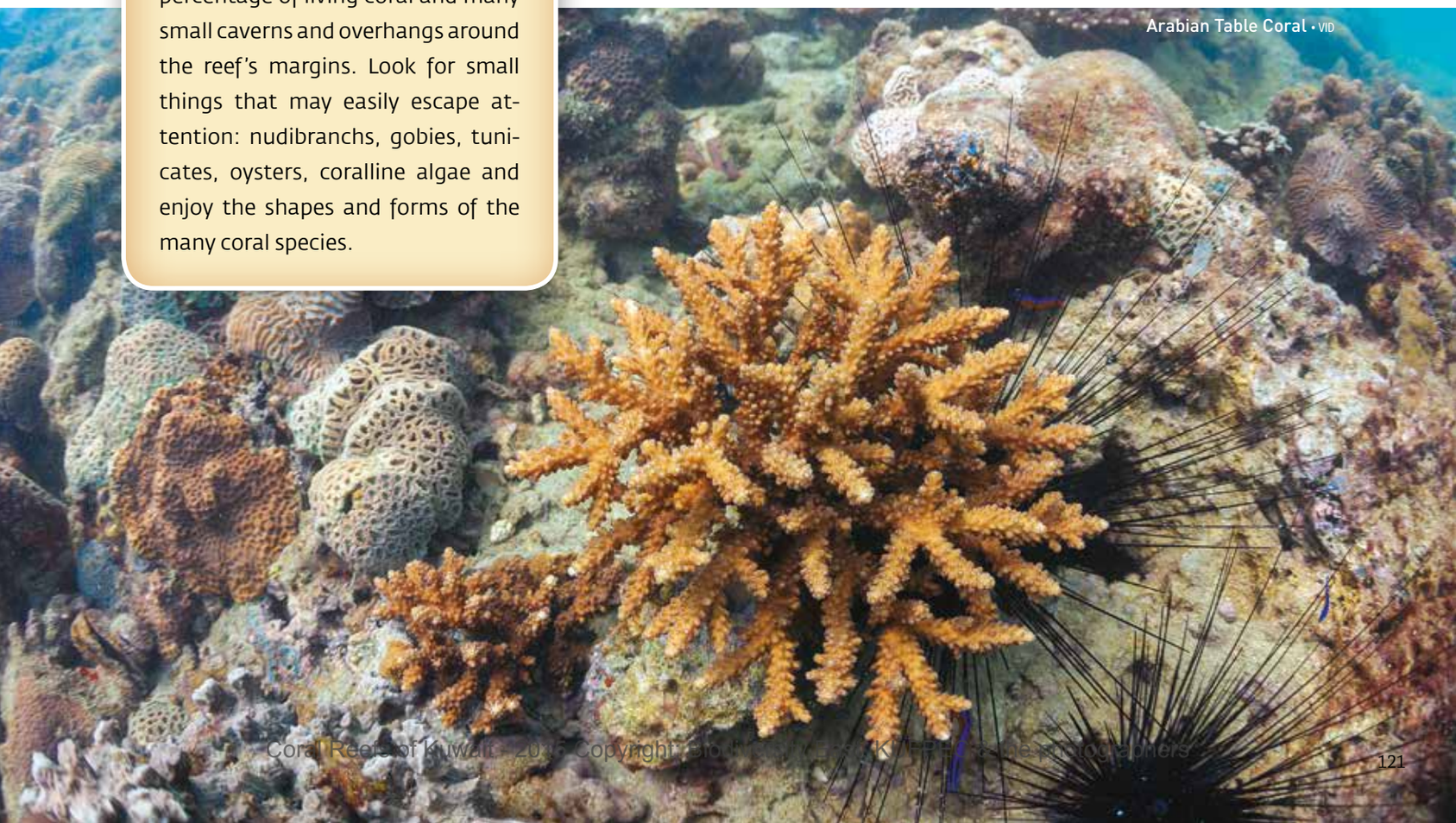


Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

A rich mix of coral species • VID

SPECIAL FEATURES

Pay attention to the "nooks and crannies" at this site. This is a wonderful reef complex to study in detail since it has a remarkably high percentage of living coral and many small caverns and overhangs around the reef's margins. Look for small things that may easily escape attention: nudibranchs, gobies, tunicates, oysters, coralline algae and enjoy the shapes and forms of the many coral species.



Arabian Table Coral • VID

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A large Kidney Yellow Scroll Coral, a threatened species • VID

DIVING NOTES

This site is prone to strong currents and care must be given when timing the dive. Visibility is variable; but some summer days are remarkably clear depending on the tidal flows and how windy conditions have been.

Nudibranch *Goniobranchus annulatus*, an ornament of the reef • ZOG

The NW Marker Umm Al-Maradim reef is a great place to study corals. Both on the ridge slope and in deeper parts there are many uniquely shaped Turbinaria disc corals. See if you can find both taxa of these globally threatened coral species. One of the most beautiful and uniquely "Arabian" coral species is the Arabian Table Coral (*Acropora arabensis*). These are easy to distinguish among the many Favia honeycomb corals. Generally the impression given is that of a coral 'rock garden'; diving here is also a very enjoyable exploration even in turbid conditions!

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Damselfishes among diverse coral structures • ZOG

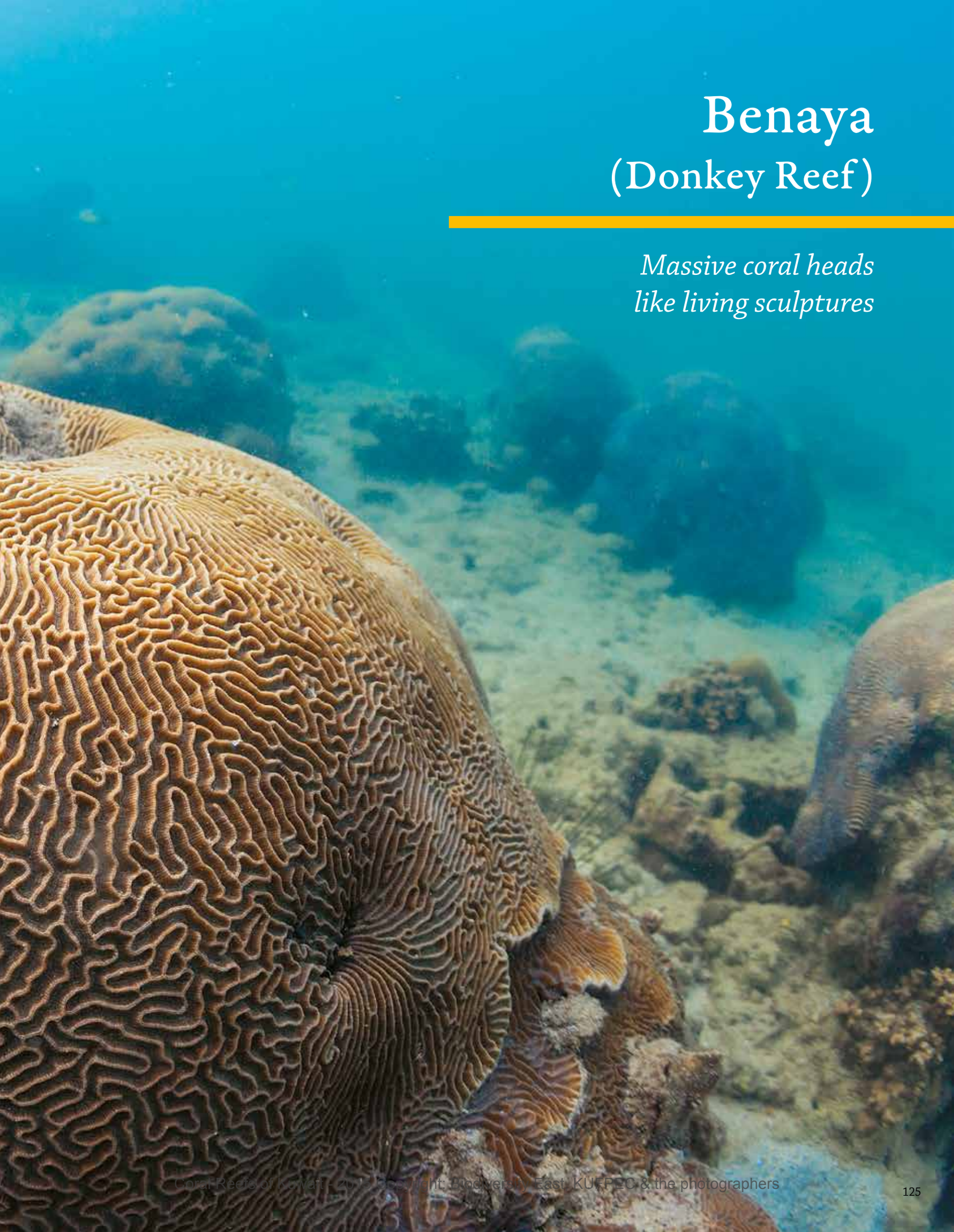
Cowtail Stingray (*Pastinachus sephen*) in deeper waters at the reef's edge • ZOG

Brain corals (*Platygyra daedalaea*) dominate the reef flat • VID

Page 124 of Kuwait 2018 Copyright: Biodiversity Research Institute & the photo/artwork

Benaya
(Donkey Reef)

Massive coral heads like living sculptures

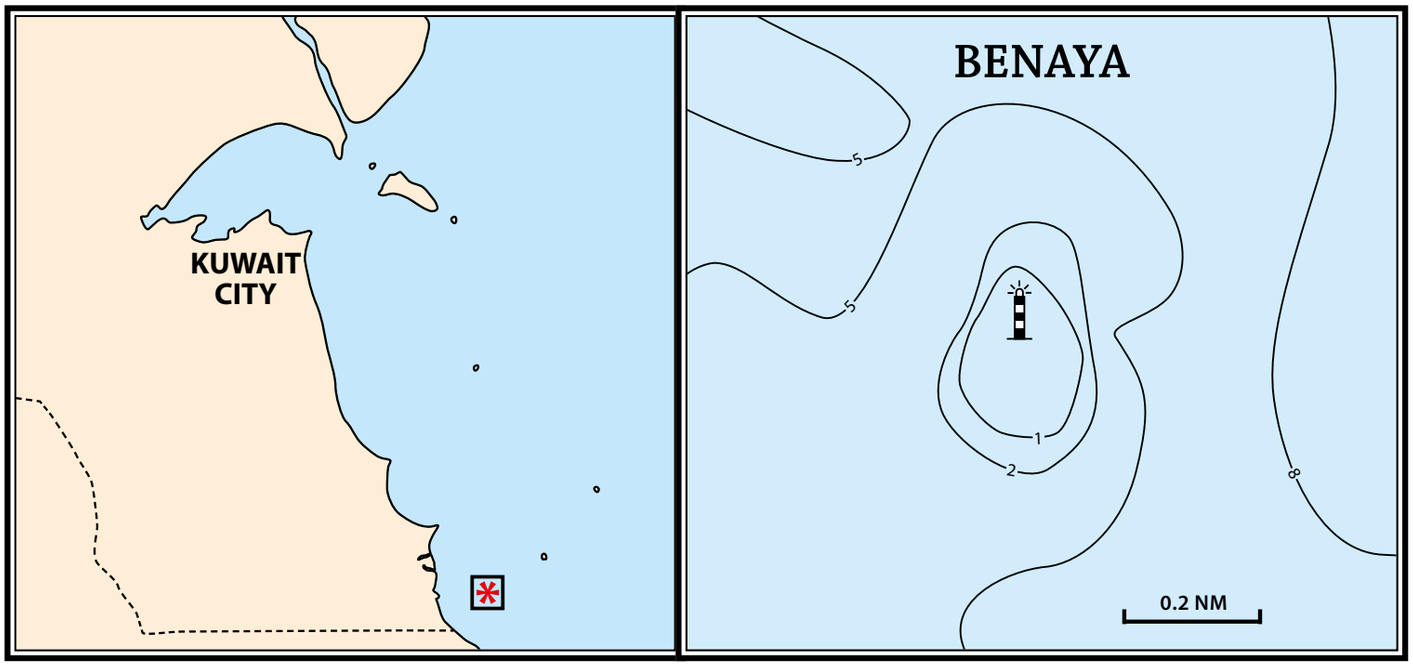


Coral Reefs of Kuwait 2011 Copyright Biodiversity East, KUFPEC & the photographers

Sunset by the navigation marker • ZOG

We suspect that both the Arabic and English names for this reef refer to the naturally sculpted massive coral heads that bring to mind animal and human-like figures. These *Porites* coral boulders may have given pearl divers much to dream about.

This could be called a typical inshore reef, and it is the southernmost accessible reef in Kuwait, just outside the port of Al Khairan. It is a silty reef with a lot of sediment; much of it a jumble of dead coral mounds, but literally crawling with life. There are sponges; both bluish and greenish and encrusting reddish forms. Big holes and caverns in the Porites pinnacles shelter a variety of fishes. Traditionally these were hideouts of grouper which are now extremely scarce here, unfortunately due to unchecked spearfishing pressure. Generally, like most inshore reefs, its waters are typically quite turbid but the reef attracts many fishes. The reef is famous for its schools of small barracuda!



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Bluish and greenish sponge colonies • VID

A school of small barracuda, probably *Sphyraena jello* • VID

SPECIAL FEATURES

Much of the reef has been damaged and has suffered from coral die-back since there are very few branching Acropora corals, but many dead mounds. However the Porites boulder corals present a wondrous maze with many tiny caverns full of life. Around the reef are sandy areas that are also very interesting, including homes for Pina shells and oyster beds.

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Freckled Goatfish • VID

On the sandy areas around the reef you can see a hidden array of animals such as Freckled Goatfish. They use their barbels as feelers to find tiny invertebrates in the sediments.

Soft sandy bottoms are not at all dull and lifeless as they may first appear. Many organisms are well adapted to hide, wearing elaborate camouflaged colouring. If one pays close attention, tiny gobies such as the one hereunder, may be found in the sands, along with many more signs of life.

Sometimes even small patches of isolated coral in the sand attract lots of life. The hermit crab uses a gastropod's shell for protection and as a home. The filter-feeding barnacles are crustaceans (relatives of the shrimps) that are totally encased in protective armouring and fastened for life to the dead coral.

Blackthroat Goby (*Papillogobius melanobranchus*), perfectly camouflaged • ZOG

Sand dollar (*Clypeaster humilis*)

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

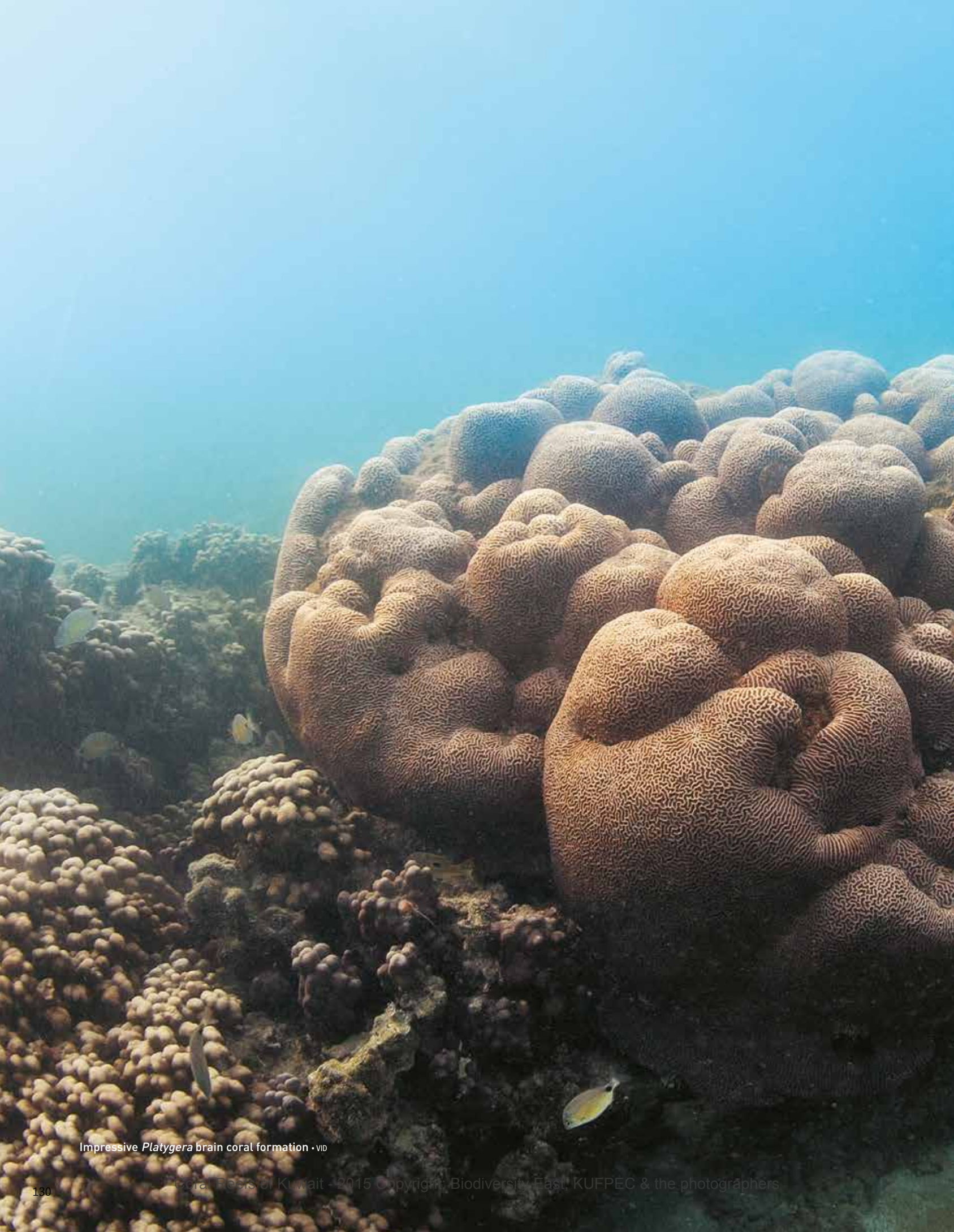
Hermit crab • ZOG

DIVING NOTES

This is a great "study reef", easily accessible by small sea craft from Khairan harbour. Due to the turbid and maze-like conditions. It seems to be totally different on each visit.

Cheekspot Blenny

Titan barnacle species • ZOG



Impressive *Platygera* brain coral formation • VID

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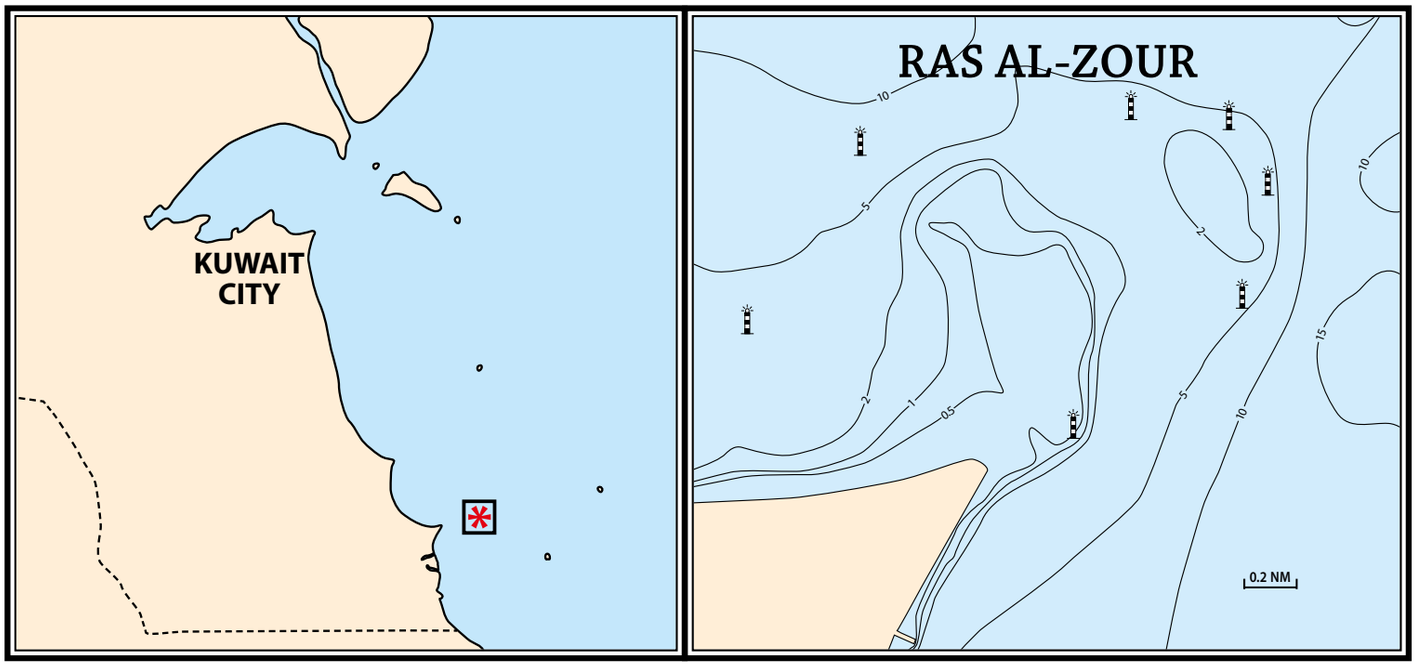
Ras Al-Zour

Shallow waters, massive corals

Reefs of Kuwait © 2015 Copyright Bournemouth University, East Kuwait Reef & Marine Photographers

Azure waters off Ras Al-Zour • VID

An extensive fringing reef in shallow azure waters among extensive sandy flats. The coral cover in many areas is well developed, dominated by a maze-like expanse of Porites boulder corals. Spectacular massive brain corals punctuate this rather simple reef flat expanse. The diversity of coral species is limited; *Acropora* is scarce here. Not too many fishes are found in these shallows but there are some special ones, such as Arabian Butterflyfish. A great number of corals are alive and since they are in very shallow water they are not extensively damaged by boat traffic.



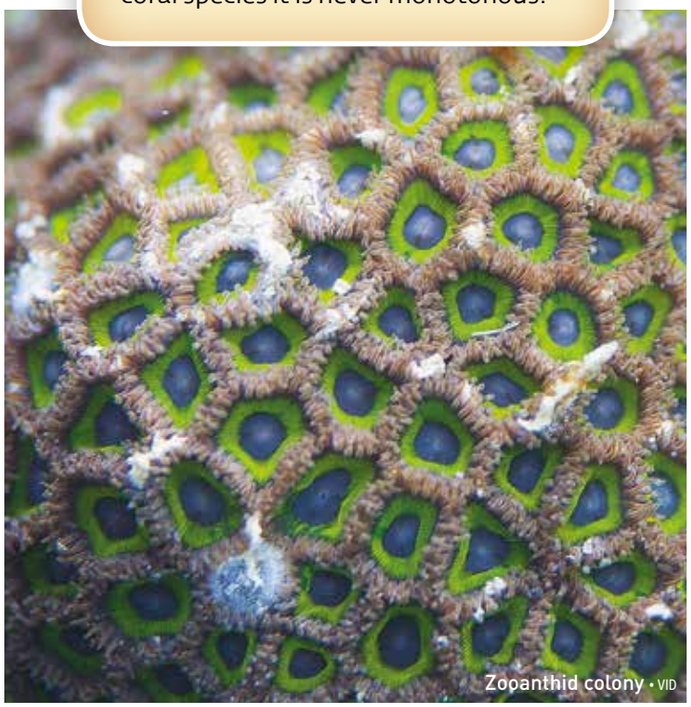
Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Healthy Porites coral heads • VID

SPECIAL FEATURES

The beauty of this reef is the fact that many of the massive coral heads are largely undamaged by human disturbance. Despite the limited number of coral species it is never monotonous.

The dominant coral here are Porites Finger Coral (*Porites compressa*); few other species are present. Little living wonders take refuge and find homes in the coral hollows and caverns; among them, nudibranchs and coral-like zooanthids.



Zooanthid colony • VID

Nudibranch • VID

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Ras Al-Zour industry and intertidal wonderland • KDT

Ras Al-Zour is a unique coastal sandy cape formation in southern Kuwait. It is a long tidal spit that is exposed at low tide. Its azure waters shelter an extensive coral flat. A living maze full of life. Most of the corals are several hundred meters from the beach since the waters are very shallow here.

Persian Dottyback • VID

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Sand bar and reef flats as the tide lowers • KDT

School of Shrimp Scad (*Alepes djedaba*)

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Dead and regenerating Porites corals • VID

Another big brain coral formation • VID

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Arabian Table Coral: a rarity among the Porites corals at Ras Al-Zour • VID

DIVING NOTES

Although much of the reef is in very shallow waters, divers can delight in weaving their way among the massive *Porites* corals, observing underneath in the eroded undercut hollows, spending time with small fishes and observing encrusting life-forms and coral patterns. Due to shallow conditions, diving time is extended and this is conducive to careful study and close-up photography.

Detail of Arabian Table Coral • ZOG

The die-back and constant regeneration of *Porites* Finger Coral creates complex patterns and many micro-habitats for many reef creatures. *Echinometra* sea urchins primarily graze on green algae that grows as a fuzzy film on the dead coral patches.

A unique range-restricted coral to this part of the world is Arabian Table Coral *Acropora arabensis*. It is rather scarce on the inshore reefs, yet this wonderful colony was found at Ras Al-Zour.

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Salama is a damaged and degraded reef with many *Echinometra* sea urchins • VID

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Salama

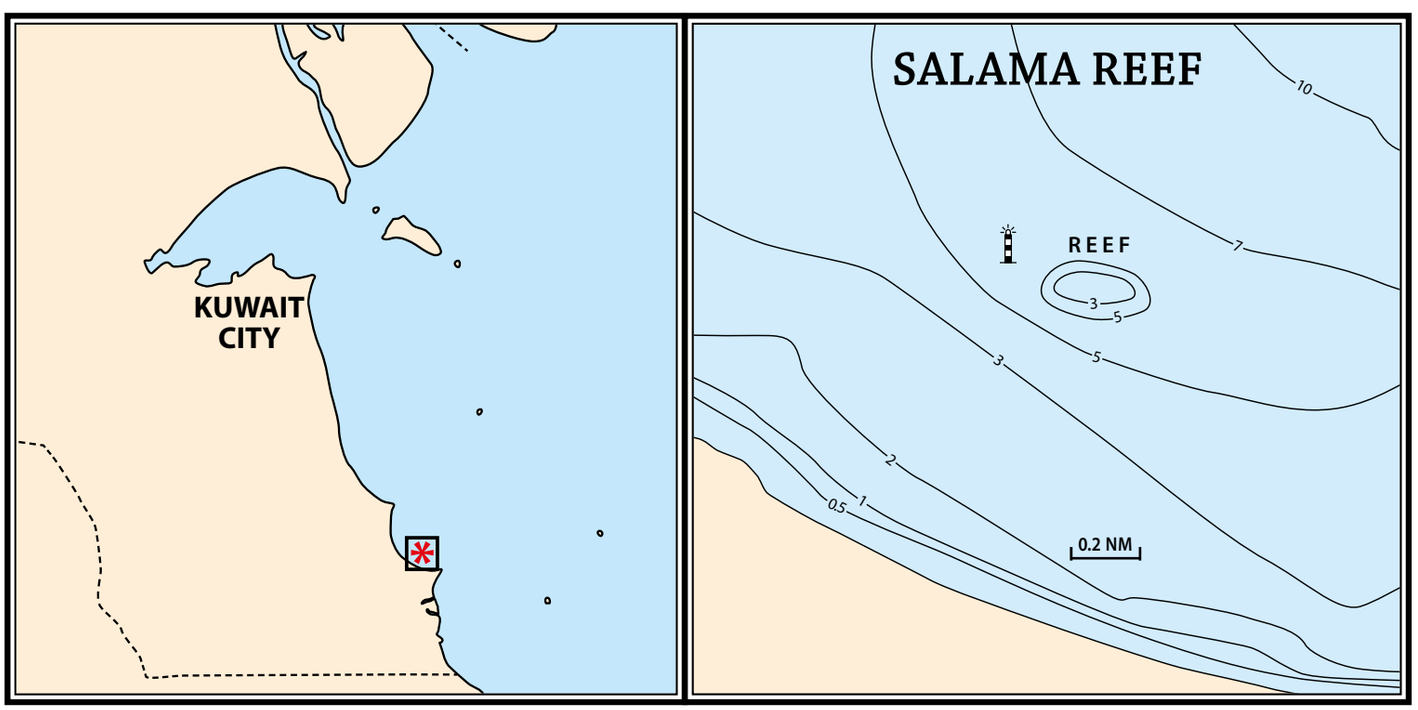
Nearshore next to the artificial reefs

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

A buoy marking the nearby artificial reef • VID

Salama is one of several patch reefs off the coast of Bnaider. The reef is located near the artificial reefs set in this area to protect and enhance marine life. However, much of this natural reef is actually quite degraded. The reef has an untidy appearance because many of the corals have died. Coral death may be the result of past bleaching events, but there are parts that are broken-up by anchor damage also. The more fragile coral species are scarce, there are very few *Acropora* branching corals. In the sandy reef fringes very few *Turbinaria* corals are found. However, the reef is struggling to recover; parts of it seem to be growing back!

This is a good study reef. Divers are often greeted by beautiful Teira Batfish (*Platax teira*) with their unique discus-like body shapes. These unmistakable fish occur in small groups and are often associated with the floating buoys. If you want to see them just look under the anchor buoys! Beneath the buoys, this reef has some interesting distinctions. Extensive colonies of beautiful yellow and red tunicates encrust on the dead coral heads. Sandy chutes around the reef are interesting habitats with many little patches of corals that attract life.



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Teira Batfish • VID

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Two-bar Seabreams and a Minstrel Sweetlips • VID

DIVING NOTES

A shallow and easy educational reef location. Conditions are often very turbid as in other nearshore reefs. This is not necessary a problem as it can heighten the adrenalin rush. Try to focus on small things, small themes in the corals, the rubble, the sand banks – there is always so much to study!

Gulf Goby • VID

Yellow tunicates • ZOG

This reef is a low-lying mix of some living and many dead corals. Dead corals are important because many fishes hide in their fissures and caverns!

In the coral rubble, shrimp gobies are common. One of the most interesting is Luther's Shrimpgoby (*Cryptocentrus lutheri* – its shrimp symbiont, *Alpheid* sp., is a smartly-patterned creature as well).

In the coral rubble and sands around the reef, Gulf Gobies are also common. This species does not live with shrimp but excavates its sand-holes with its mate.

Look for reef life growing on the dead corals. Note the extensive colonies of tunicates growing on dead corals. There are many species, some tiny colonies are yellow, others red; others are very much larger.

Coral Reefs of Kuwait © 2015 Copyright: Biodiversity East, KUFPEC & the photographers

SPECIAL FEATURES

This reef unfortunately has been degraded and its shows. A remarkable aspect in recent years on this reef is the huge numbers of sea urchins.

Yellow and red tunicates with Burrowing Sea Urchins • VID

Kidney Yellow Scroll Coral in the sandflat • VID

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Porites and brain corals surrounded by one-spot breams • VID

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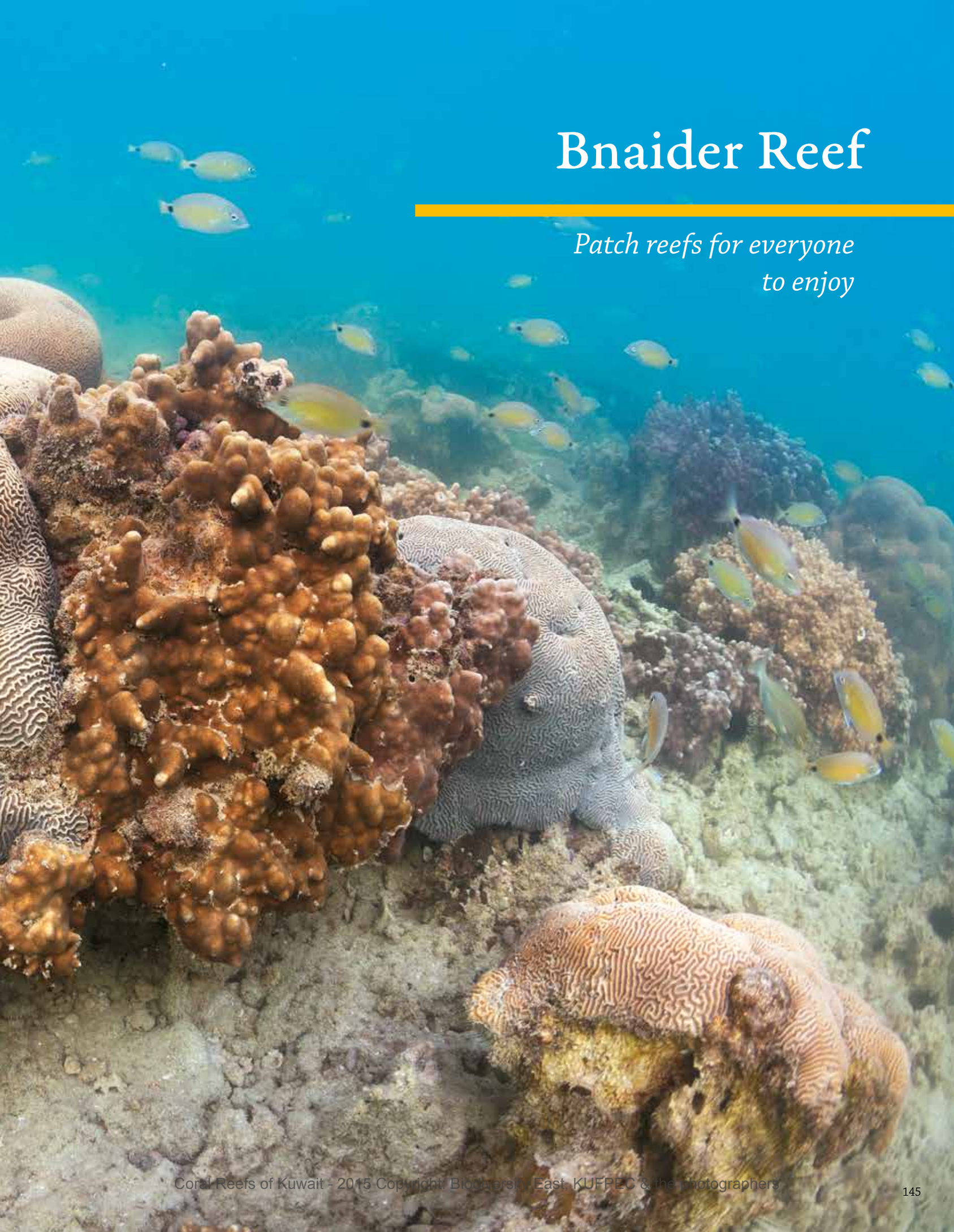
Bnaider Reef

Patch reefs for everyone to enjoy



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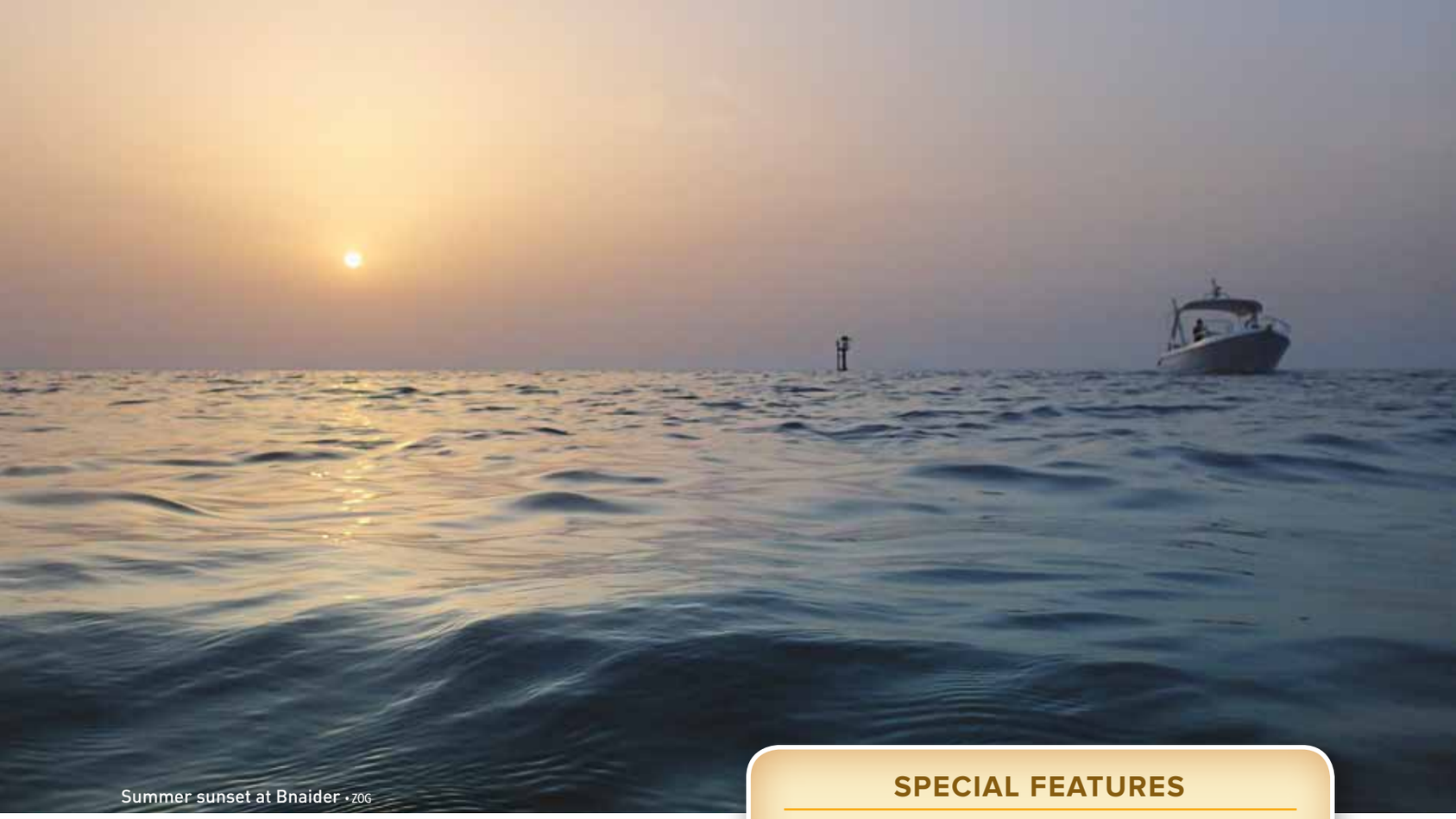


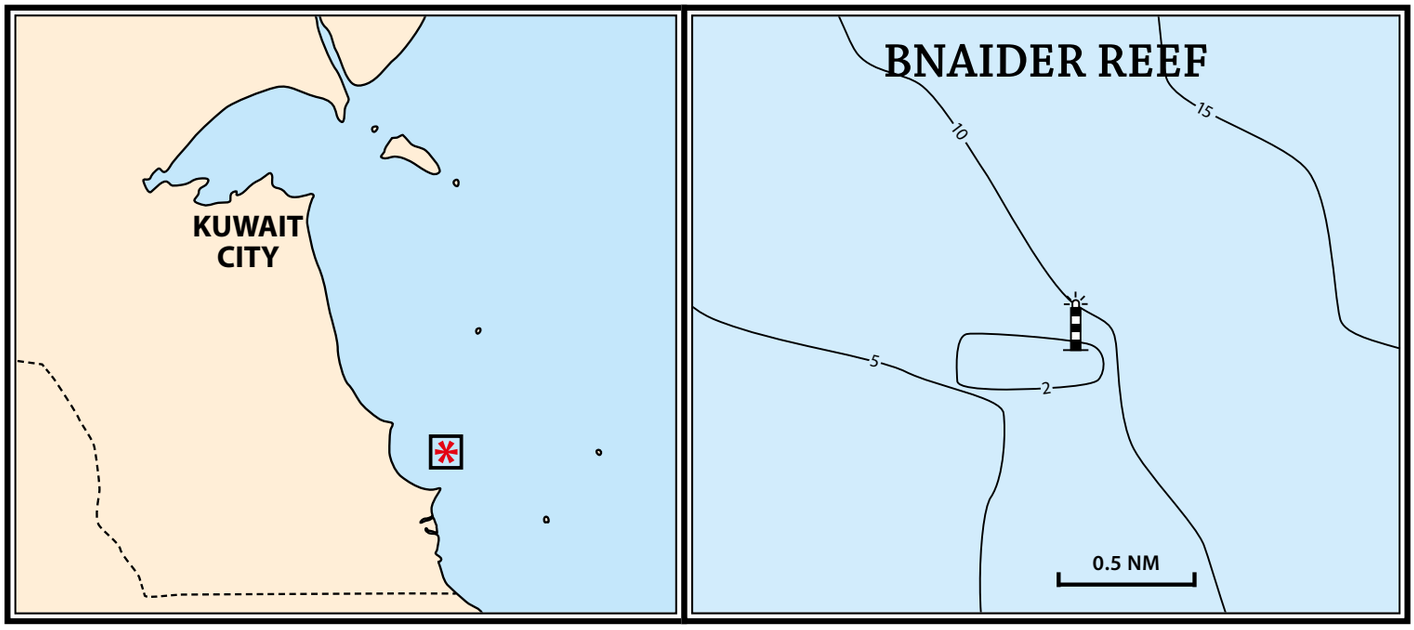
Summer sunset at Bnaider • ZOG

SPECIAL FEATURES

Inshore reefs such as Bnaider's are top candidates for inclusion in an organized network of Marine Protected Areas for Kuwait. Of course, conservation of "sea parks" is not as easy as on land. It is definitely worth supporting this initiative!

Along the coast of Bnaider there are actually several reefs. These patch reefs range down the coast from off Ras Qulai'ah to Ras al-Zour; some of them quite extensive and in good condition. These reefs have traditionally been known as important fishing grounds for Kuwaitis. In the past, fishing was done using very small boats and hand-lines; and the yield was sustainable. Spearfishing and overfishing changed this. The intensity of fishing pressure during the last 30 years has definitely impacted fish stocks, most of the larger fishes are now scarce. Yet the biological productivity of these warm nutrient-rich waters still provide for remarkable shoals of fish.

Bnaider's reefs are varied despite the fact that they do not have a high relief, nor really steep slopes or drop-offs. Swathes of corals act like a rock-gardens in the sandy flats and many fishes are attracted here.



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Whirling shoals of sea breams • VID

DIVING NOTES

Local divers will guide you to the best spots to explore these inshore reefs. Diving is easy here. But it is important to be guided by instructors who have professional training and deep knowledge of the marine world, in order to get the best possible experience.

At dusk you may encounter large shoals of sparid breams, whirling around the reef as they are chased by predatory jacks and trevallies. Large sea breams may come in the hundreds to Bnaider's reef, seeking shelter among the corals.

Sea breams (*Rhabdosargus sarba*) hiding in coral crevasses • ZOG

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Table coral colonies create rich high-structure habitats • VID

Porcelain crab in the genus *Pisidia* on coral • ZOG

A few patch reefs off Bnaider have some wonderful expanses of *Acropora* table corals. These extensive formations are actually scarce on Kuwait's inshore reefs. Branching corals are keystone biodiversity hotspots since they shelter many species. Look for tiny crabs, molluscs and rare fishes among their branches. Since the coral branches are especially fragile, divers and boaters must be aware – a single anchor drop can do unimaginable damage.

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Downing's Table Coral • VID

Striped Cardinalfish *Apogon taeniatus* • VID

Scallops in the coral fissures • ZOG

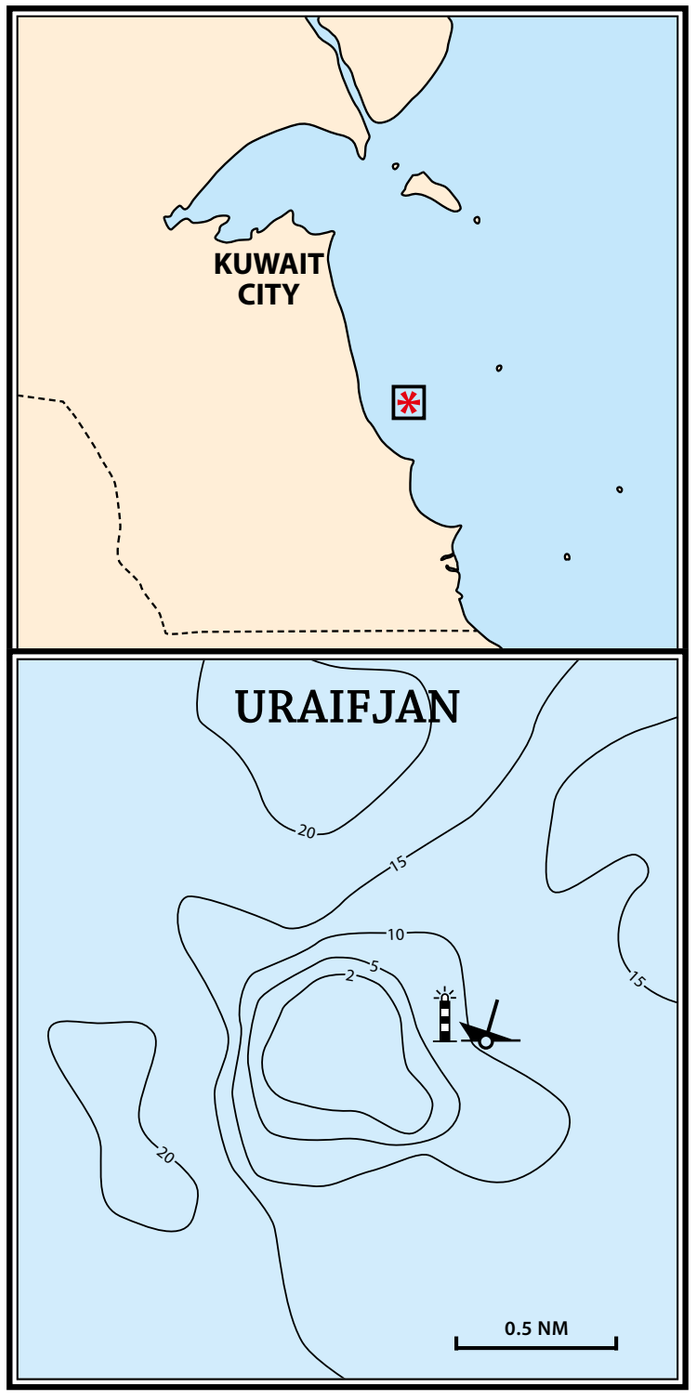
A school of Sind Damselfish (*Neopomacentrus sindensis*) • VID

Coral Reefs of Kuwait © 2015 Copyright. Biodiversity Fund, KUFPEC & the photographer

Uraifjan

Mysterious turbid waters and a shipwreck!

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers



SPECIAL FEATURES

A remarkable shipwreck of a steel ship rests immediately below the navigation marker. The wreck sits at 12 meters depth and usually very turbid conditions make the wreck dive exploration eerie and exciting. Note how many reef animals are encrusting on the steel walls of the wreck ship: soft corals, cup corals, pillow corals, sponges and more!

A small reef with varied structure. Unlike other Kuwaiti inshore reefs in shallow waters, this is a reef mount that slopes rather steeply creating a wonderful composition of different reef habitats. Although many corals are dead and sand/silt-covered they create exquisite foundations– including regenerating young corals, sponges, tunicates, soft corals and oysters. Hermit crabs and various molluscs are common here. Cuttlefishes are usually common here. The shallower reef flat on top of the reef has many beautiful brain corals among sparkling coral white-sand chutes. An added plus is the shipwreck, which is immediately next to the navigational marker piling; this is the most easily accessible wreck dive in Kuwait.

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Platygyra brain corals on the shallow reef flat • VID

Coral patches and chutes of sand in very shallow waters • VID

Coral Reefs of Kosrae © 2015 Copyright: Biodiversity East, KIUC & the photographers

The eerie reef margin with a variety of silt-covered coral formations • VID

DIVING NOTES

This is definitely one of Kuwait's most interesting dives; it is easily accessible from Fahaheel and other suburbs south of Kuwait City. Since this is one of Kuwait's northernmost inshore reefs, in close proximity to the Mesopotamian Delta plume, marine waters are usually very turbid. Visibility is sometimes less than five meters! Depending on currents, in some cases deeper parts may be even more turbid and upper water layers quite clear!

Octocorals with brittle stars grow on the wreck • VID

This reef is really full of silt and sediment, unlike most of the reefs further offshore. Primarily because of this, it feels different. There seems to be many sandy chutes, areas of dead coral rubble, dead coral heads, and many eroded corals creating small nooks, arches and mini-caverns.

Shipwreck diving is like stepping in another world. Much of the wreck is laden with a thin film of silt and waters are nearly always almost murky. Notice the colourful brittle stars around the soft corals and how many species of fish actually make the wreck their home.

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The ship wreck in murky water at 12 meter depth • VID

Yellowbar angelfish • VID

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KOC Artificial Reef Project

Where oil and water make friends

Some historical facts

The construction of artificial reefs is thousands of years old. Ancient Persians blocked the mouth of the Tigris River to thwart Indian pirates by building an artificial reef, and during the First Punic War the Romans built a reef across the mouth of the Carthaginian harbour in Sicily to trap the enemy ships within and assist in driving the Carthaginians from the island.

What is an artificial reef?

An artificial reef is a human-made underwater structure, typically built to promote marine life in areas with a generally featureless bottom, to mitigate previous coral reef destruction, control erosion or sometimes even block ship passage.

Many reefs are built using objects that were initially made for other purposes, for example by sinking oilrigs, scuttling ships, or by deploying rubble or construction debris. Other artificial reefs are purpose built (e.g. the reef balls) from PVC or concrete. Shipwrecks may become artificial reefs when preserved on the sea floor. Regardless of construction method, artificial reefs generally provide hard surfaces where algae and invertebrates such as barnacles, corals, and oysters attach; the accumulation of attached marine life in turn provides intricate structure and food for assemblages of fish.

In order for this structure to be successful in its reef building and creation, it needs sunlight - because coral photosynthesize like plants. It also needs relatively moderate temperature conditions and low sediment levels. If these conditions are not present, there can be coral settling on the artificial reef but these corals don't survive long after that. And it is to keep in mind, that, successful or not in growing corals, any three-dimensional structure works as a fish aggregation area, so fish will in any case dwell by the structures, and thrive there, likely to also breed there and possibly help creating new fish stocks.

In Kuwait KOC investing in hope for a new reef

Through the centuries the effort of building coral reefs was present throughout the Arabian Gulf area. However, due to the oil boom in the last decades, local populations reclaimed parts of their environment. As a result, environmental concerns grew along with the population explosion, which in turn brought with it pollution and environmental degradation. Caused mainly by El Niño, which brought temperatures of 37 °C in local Gulf waters in 1996 and 1998, most of the *Acropora* corals died off in many areas of the region, whereas brain corals did not suffer as much but also became severely affected. The Gulf being a very saline and high-temperature sea body, it is not easy for many species of corals to survive in the first place. In Kuwait especially, corals live through the hottest and coldest temperatures known for these marine organisms on earth, and these extreme temperature changes occur within six months every year.

In the face of declining reef areas due to increased stress factors in the seas around its Headquarters in Ahmadi, the Kuwait Oil Company decided to take action. After a compre-

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"Throughout our history, Kuwait has relied on the waters of the Gulf for trade and sustenance. The KOC Marine Colony, which is composed of 1,000 reef balls, is a project that was initiated by KOC to help revitalize and protect our country's precious marine habitat. We take pride in our responsibility to give back to the local community. Leading by example, we hope to encourage a culture of environmental protection from our employees and contractors to the society at large. We are blessed to have these natural wonders at our doorstep. Let us cherish, enjoy, protect and sustain their beauty for generations to come."

Hashem S. Hashem
CEO of Kuwait Oil Company

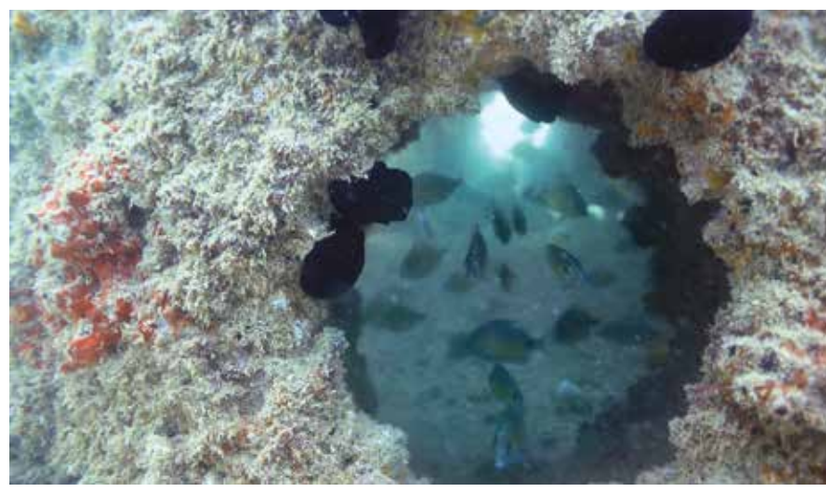
hensive study of the marine environment, KOC created, in a worldwide first for an oil company, a 54,000 square meter man made marine colony to help preserve and develop Kuwait's marine life.

As a country that still suffers from the consequences of the environmental aggression caused by the Iraqi invasion in 1990 - not the least of which was dumping about 1 million tons of crude oil into the Gulf waters - Kuwait is in need of rehabilitating and preserving its marine ecosystems. Working on this concept, KOC launched its Marine Colony Project on International Environment Day 2006.

The project, funded entirely by KOC and carried out in cooperation with the Kuwait Institute of Scientific Research (KISR) and the Kuwaiti Coast Guard, is situated south of Ahmadi Port 1.2 nautical miles offshore at a 7-9 meter depth. It has 1000 reef balls made of treated, environment friendly concrete.

It is the marine colony of Southern Ahmadi's South Pier where the hope of regenerating coral reef life is kept alive. Commissioned by KOC, the Kuwait Institute of Scientific Research is conducting an ecological assessment of the colony to establish whether this effort is being successful. A dedicated diving team from KISR has been monitoring the reef throughout all seasons over the course of each passing year. The results are impressive: Nature's brilliant colours have been brought back to what was once an empty and dismal grey canvas. Through data loggers, divers retrieve the essential data from the reef. Water and sediment samples are collected to measure hydrocarbon levels at different locations of the site.

Life is flourishing again and some of what was once lost is now, again, being restored. The hope is kept alive.



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Swirling reef life in Bnaider reef • VID

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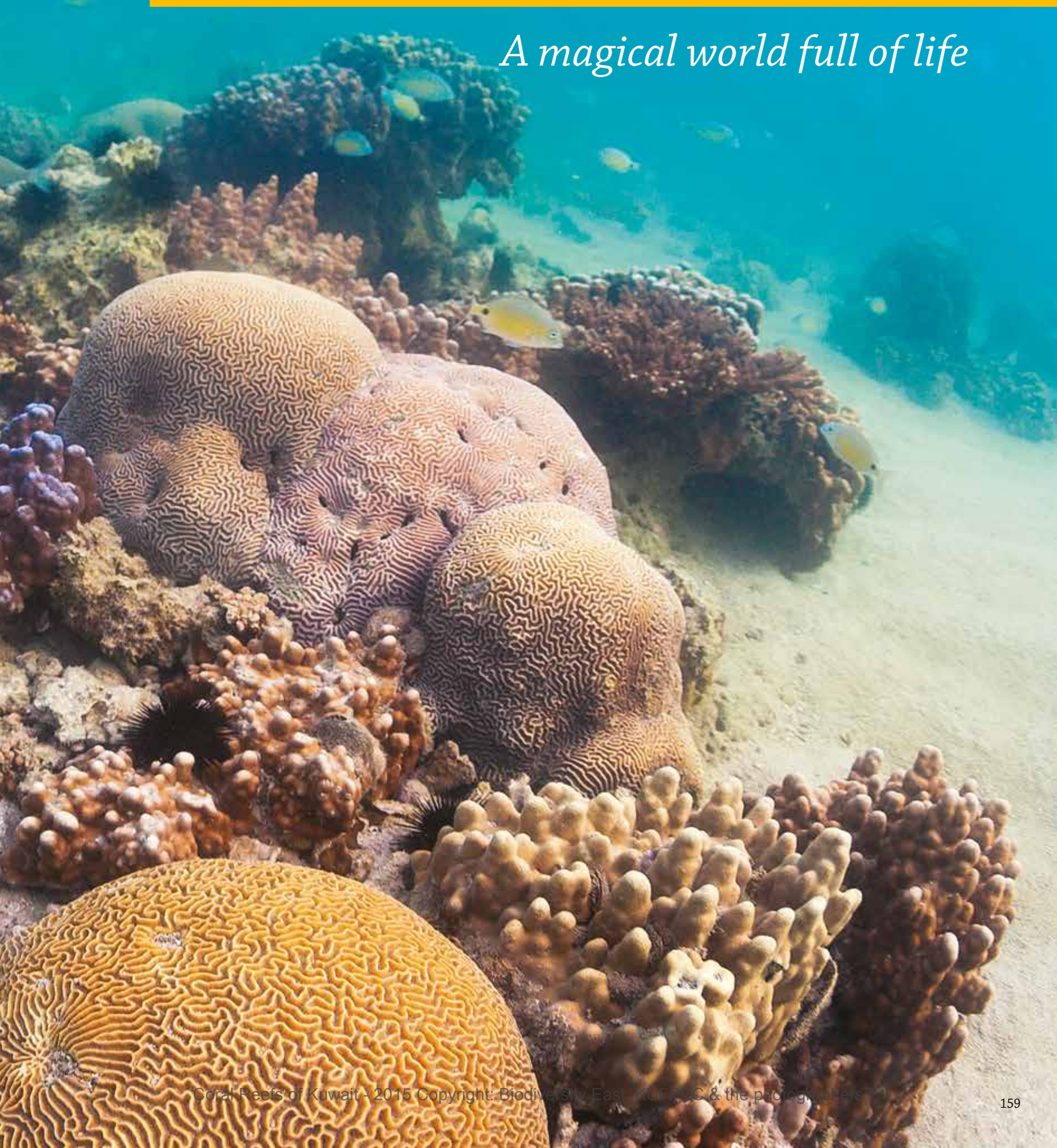
PART FOUR

Life on the Coral Reefs

A magical world full of life



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Life forms of the reefs

One reason coral reefs are globally outstanding ecosystems is the amazing diversity of life forms they support. Kuwaiti reefs may not burst with the brilliant colours and dazzling array of animals and plants seen in oceanic tropical reefs but they do share in this wealth since they have a common evolutionary heritage with Indo-Pacific reefs. The Gulf's reefs are directly descended from the Indian Ocean, coral reef life colonized the Gulf immediately after the last Ice Age. In this way, Kuwait's species composition is closely related to the world's richest reefs systems. Kuwait's reef life is therefore a result of millions of years of evolution during which species survival was dependent on effective adaptations in tropical reef ecosystems.

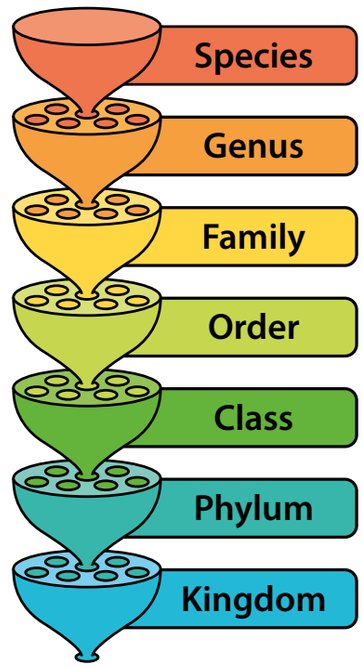
One way of really understanding a reef is to know the names of the species that inhabit it. Scientific classification is the standardized international system for structuring our knowledge of life forms, sorted-out into similar groupings, or taxa. Living organisms are thus set in a taxonomic hierarchy – categories in rank ranging from the broadest level – the Kingdoms – and ending up with the most specific - the Species. Each species has a binomial name that states its genus and species; so, the ultimate aim of any identification is to correctly name the species. If a species is not possible to identify in the field, you can use the next best hierarchical classification, genus or family.

In many cases when trying to positively identify a life form in the field we may not be able to without collection and laboratory examination. In these cases it is best to just give the genus name; as such *Homo* sp. (*Homo* spp. in plural). Also if we are not certain that a species has been identified we can insert cf. which stands for *confer* (meaning "very similar to" in Latin). At other times we may just use the species order or family when we may have no idea what the genus and species of the life form in question is. This is often the case for many invertebrates and marine plants.

An example of this classification can be presented even for the Flowerpot Coral species:

Species: *Goniopora lobata*
Genus: *Goniopora*
Family: Poritidae
Order: Scleractinia
Class: Anthozoa
Phylum: Cnidaria
Kingdom: Animalia

It is important to remember the way the rank-based hierarchical classification system relates to different organism groups at different taxonomic levels. Mnemonic devices to recall the proper ordering of the biological groupings include little humorous phrases such as "Kids Prefer Cheese Over Fried Green Spinach" (Kingdom, Phylum, Class, Order, Family, Genus, Species). Distinct subsets of each category are also used by taxonomists, such as Subphylum Subclass, Suborder.



Are corals rocks, plants, or animals?

Animals! Corals are invertebrate animals related to the sea anemones. However, corals make a calcium carbonate skeleton that looks similar to rock and have a symbiotic relationship with algae plant cells called zooxanthellae. The zooxanthellae actually living in the soft tissue of a coral polyp and being plants, they use sunlight to produce food through photosynthesis and create a byproduct that the coral can use as food too. Thus, zooxanthellae provide corals with food; in return, the coral provides the zooxanthellae with shelter and nutrients. Corals also capture food. At night, they stretch out their stinging tentacles and catch the microscopic organisms that float in the water and digest them in their stomachs. So, corals have two ways of getting food—through zooxanthellae and capturing microscopic organisms.

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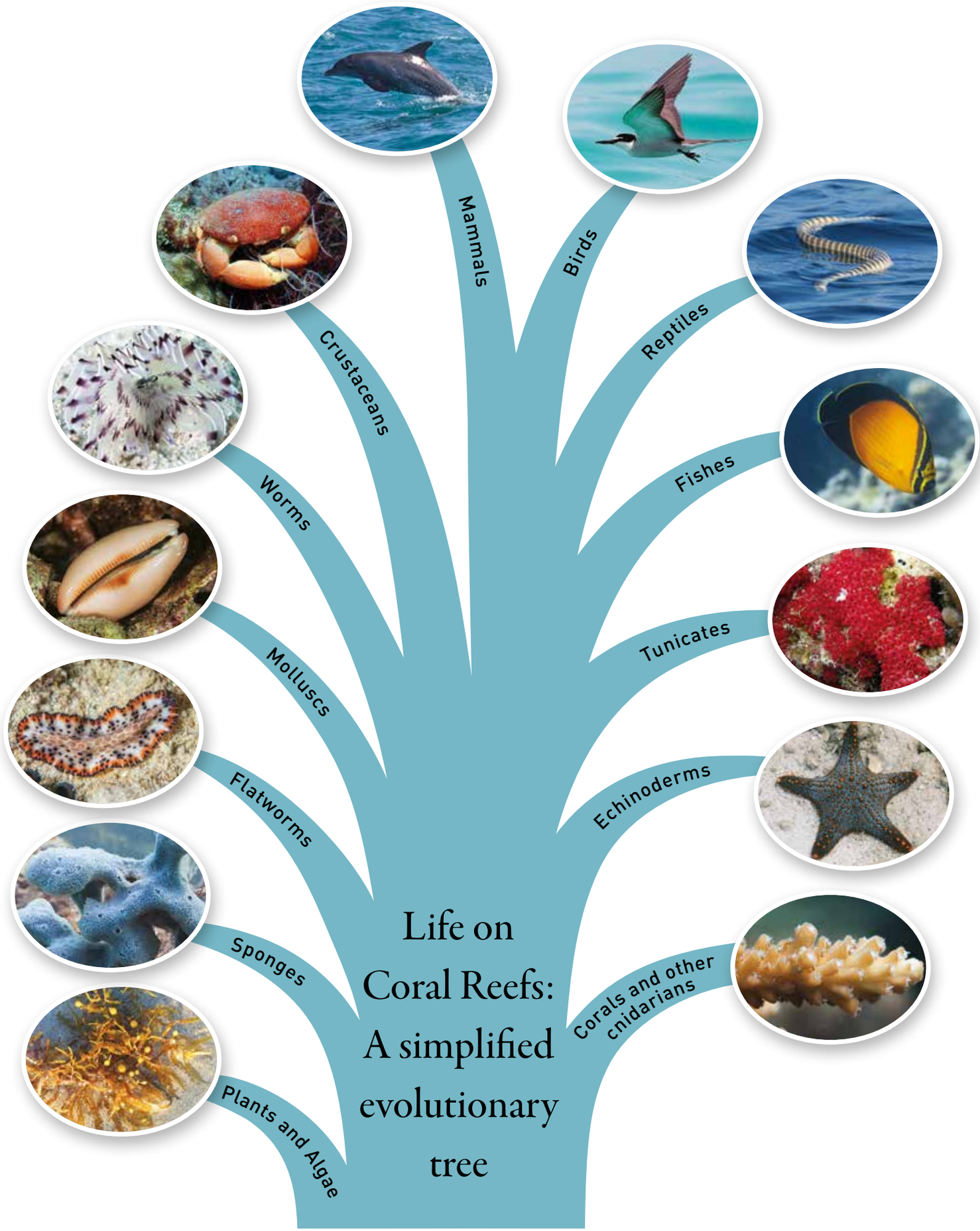

This generalized tree provides a sense of the evolutionary divergence of life forms found on reefs (Adapted from Allen & Steene 1994). The major and most conspicuous groups are shown, as presented in the following pages in this book.

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Corals are living sculptures (Qaru) • YIS

Corals

Coral reefs contain the highest biodiversity among aquatic environments and are one of the most visually attractive aquatic habitats. Living and dead coral create these reefs. Corals living in the northern Arabian Gulf are adapted to the lowest winter and highest summer temperatures and also highest salinities; these unusual extremes make the Gulf a unique living laboratory to study characteristic coral assemblage patterns and the evolutionary adaptations of corals. Clearly one of the most fundamental steps for conservation of coral reefs is the identification and inventory of their fauna and flora, understanding their biodiversity. Nonetheless, as yet there is no recent comprehensive account describing in detail the Gulf's coral reef communities. Although the extreme temperatures and salinity have been suggested as the reason for the low coral species-richness, the low number of published reports reveal the lack of sufficient taxonomic research effort.

There is no comprehensive agreement about the taxonomy of all coral species in the Gulf. At this point in time, we recognize that at least 35 hard coral species are found in Kuwaiti waters, as documented in a study led by KISR and published in 1997 ("The Corals and Coral Reef Fishes of Kuwait" by Kent Carpenter and colleagues). KISR's useful study provides details on how to identify Kuwait's coral species, a very valuable reference. However, 18 years have passed since this important publication, and we now know that other coral species have been discovered in the Gulf and even in Kuwait yet we know little about how widespread they are. We utilize Carpenter and colleagues' (1997) work to provide a standardized taxonomy for Kuwait's corals; however this work is out of date and more research is urgently needed since taxonomic names may have changed.

If one wants to understand the reefs corals; one should learn the inhabitant's names, even the scientific names (at least at the level of genus). Many people know organisms only by their common or "vernacular" names. Unlike scientific names, common names may also vary regionally within a language. Here we provide the best available common English names of distinctive species and species groups to guide naturalists in recognising what they see underwater.

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Qaru • VID

Stylophora • Smooth Cauliflower Coral

A fairly distinctive small reef-forming coral, known as Smooth Cauliflower Coral (*Stylophora pistillata*) in the family Pocilloporidae. In Kuwait, populations seem to have declined after past bleaching events. It is now observed sporadically on the outer reefs, particularly Mudayra and Qaru; it is absent in most inshore reefs. The species is assessed as Near Threatened by IUCN; it has declined in other parts of its wide range as it is susceptible to bleaching. It is also susceptible to anchor and recreational damage since it is most often found in fairly shallow waters.

Coral Reefs of Kuwait - 2015 Copyright: Richard Sheppard, Kuwait Institute for the Photo

Downing's Table Coral at Qaru • VID

Acropora • Table Corals

Acropora arabensis polyps (Qaru) • VID

At least two species of spectacularly branching table corals of the family Acroporidae have now been recorded in Kuwait. Members of this genus have a low resistance and low tolerance to bleaching and disease and in some cases they may be slow to recover. However, they do grow quite rapidly so they may show rapid comeback if propagules survive in parts of the reef. These corals love sunlight, so they are usually found in shallower areas of the reef, primarily just below the reef flat and on the reef slope.

One of the most distinctive of these corals is the Arabian Table Coral (*Acropora arabensis*) that was described only in 1995 as a species new to science. This small table coral is recognized as Near Threatened by IUCN, but this prickly-looking coral has a disjunct distribution, thought to be found in the Arabian Gulf, southern Red Sea, and northern

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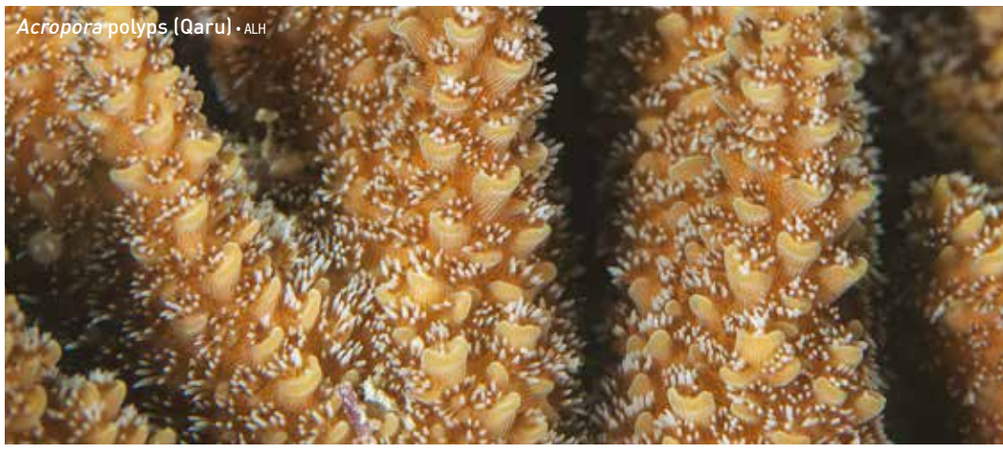
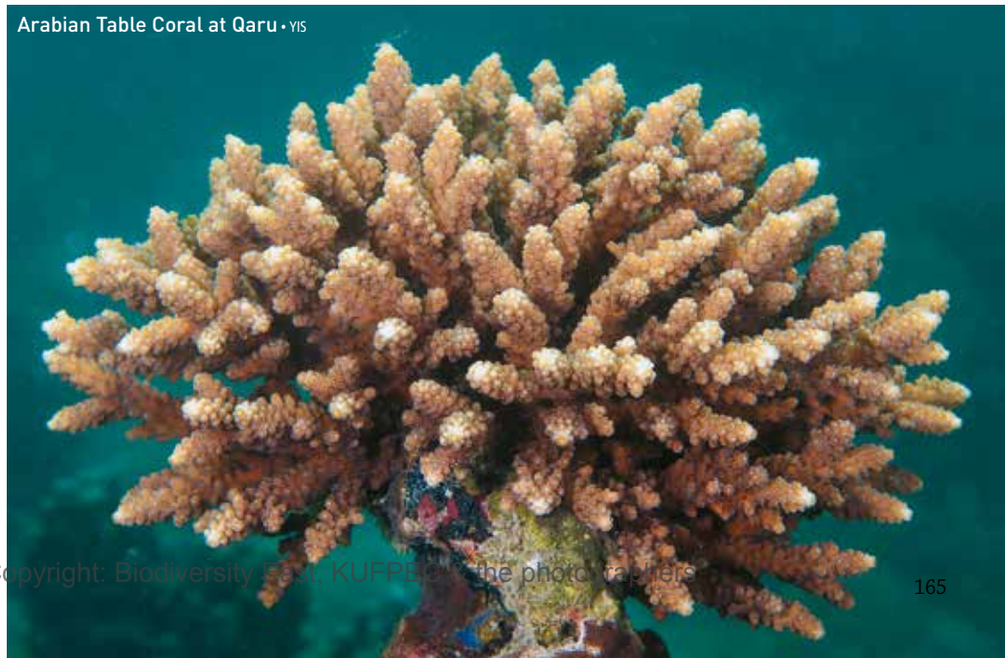
Two table coral species together at Qaru • YIS

Madagascar. Although originally described from the Arabian Gulf there is some uncertainty about the validity of the records outside of the Gulf. If this species is restricted to the Arabian Gulf then the Arabian Table Coral would qualify for the IUCN category Critically Endangered. Nonetheless, this fascinating coral species is locally common on nearly all Kuwaiti offshore reefs but less common or sometimes absent from the inshore reefs.

Downing's Table Coral (*Acropora downingi*) was also described recently for science (in 1999). It was overlooked since it is very similar to the Solid Table Coral (*Acropora clathrata*), a widespread table coral found throughout the Indo-Pacific. The Downing's Table Coral is widespread in the outer reefs of Kuwait and creates wonderful and sometimes extensive table formations on several reefs. In some inshore reefs the species is now scarce; however, some reefs near Bnaider, for example, still have healthy formations. Table corals, as other branching corals, are very important for sheltering a huge variety of fishes and inverterbrates on the reefs, and as such they are truly keystone species of the reefs' food webs.



Acropora polyps (Qaru) • ALH

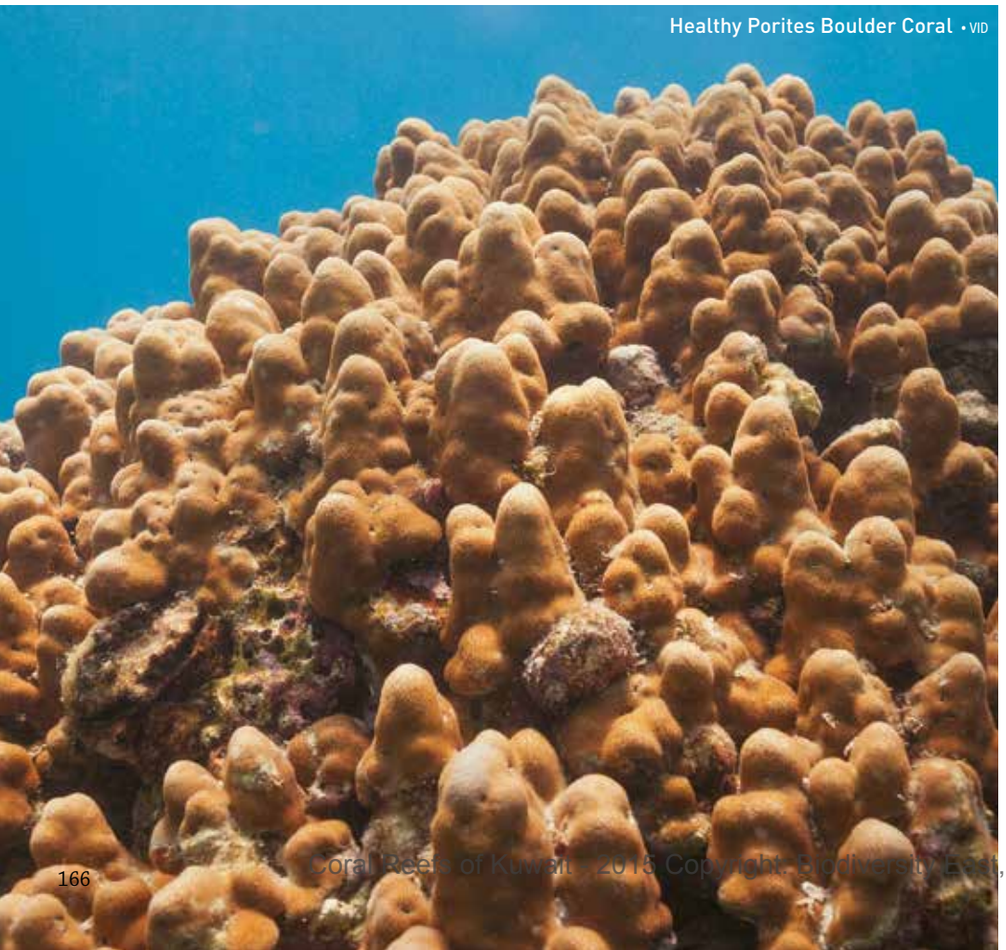


Arabian Table Coral at Qaru • YIS

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photo takers

Porites Boulder Coral at Qaru (foreground) • YIS

Porites • Porites Corals



Healthy Porites Boulder Coral • VID

Porites corals are in the family Poritidae, one of the most important reef-building families. According to Carpenter and colleagues (1997), Kuwait has two species: Finger Coral (*Porites compressa*) and Porites Boulder Coral (*Porites lutea*); other species are found in other parts of the Gulf as well. These corals are famous keystone reef species in Kuwaiti reefs because they create massive boulder-like coral heads. As the coral head erodes with age it may form various shapes and sometimes a pilar-like spindle shape is all that is left. *Porites* corals are often abundant on the reef flat in shallow waters such on the extensive fringing reefs of Ras al-Zour where they dominate.

Porites is the most widespread of the massive reef-forming corals in Kuwait; both Kuwaiti *Porites* coral species are widespread and found on all the major reefs of the southern part of the country.

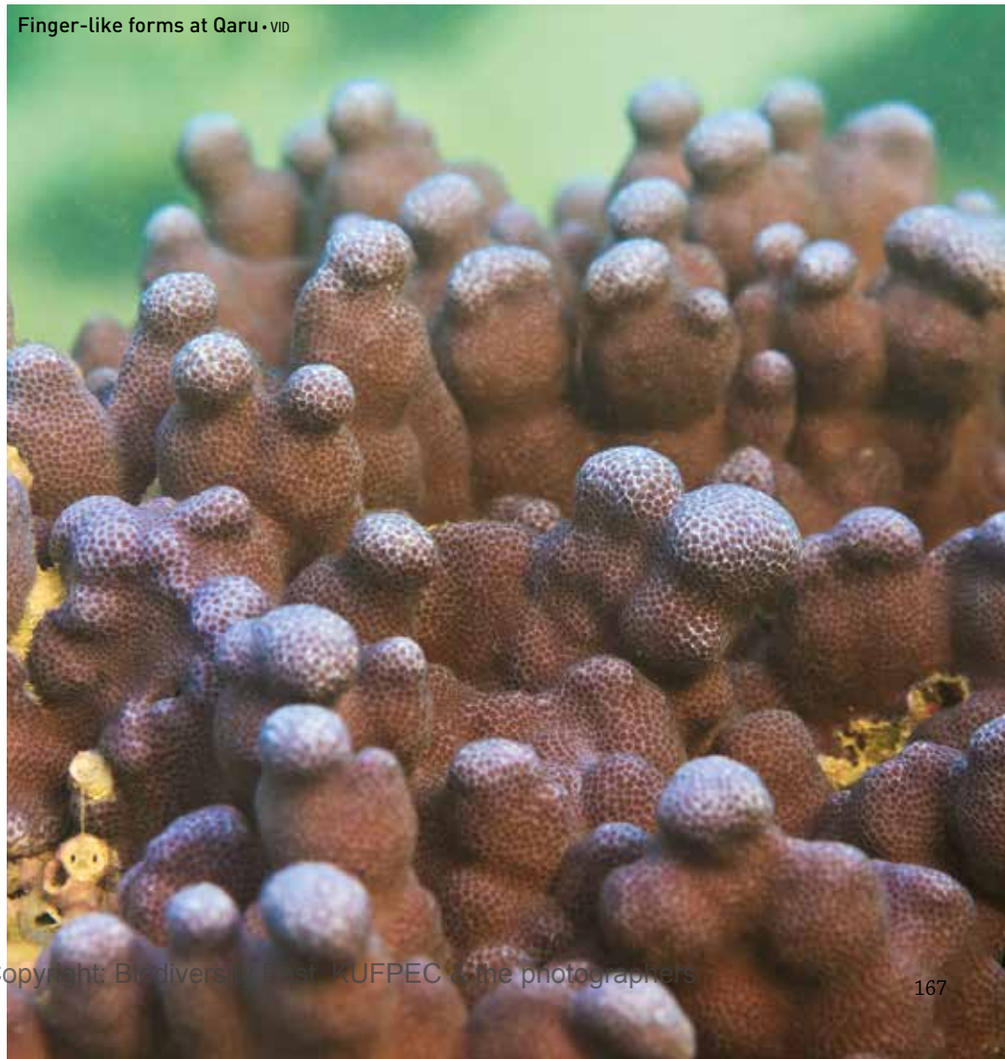
Porites lutea dominates some reef flats

Coral Reefs of Kuwait 2018 Copyright: Biodiversity Trust, KUFPEC & the photographers

Massive *Porites* forms at Qaru • YIS

forming various sculpture-like mound formations, in Kuwait these are sometimes called "cows" by local divers and fishermen. Some of these coral heads are several meters in diameter and have a huge helmet-shaped form – in the turbid waters they may look like huge domestic cattle! At the base of this helmet mound, many fishes take shelter in the dark undercuts. In other situations, this coral and other *Porites* species also form characteristic "pavements" of living and dead coral colonies sprawling on the reef bottom. Dead *Porites* "rock" is often colonized by many sessile animals and microscopic plants. The small animals that live in and around the crevasses make up the so-called cryptofauna – tiny animals that live in cavities and are important elements of the reef food web. In this way the dead coral is an important microhabitat.

Finger-like forms at Qaru • VID



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Detail of the polyps (Qaru) • VID

Goniopora • Flower Pot Coral

Unmistakable distinctive polyps at Qaru • ALH

One species of this distinctive coral genus is documented as living in Kuwait: the Flower Pot Coral (*Goniopora lobata*). Although in the family Poritidae, the Goniopora are sometimes erroneously considered to be "soft corals" by amateur divers! This is because their polyps are extremely long and fleshy and are normally extended both day and night. These polyps extend from a stony coral base (like a flower-pot) and are very large (about 10 cm long); this species cannot be mistaken for any other kind of coral in Kuwait! It is found in many reefs, particularly the offshore reefs and usually in deeper waters, down to 10 or more meters below surface. A large assemblage of *Goniopora* dominates the deeper waters of the reef base just outside the Coast Guard harbor of Umm Al-Maradim Island. The species is found on all the outer reefs and on some of the inshore reefs as well.

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Typical encrusting colony at Qaru • VID

Siderastrea • African Pillow Coral

The family Siderastreidae has various corals, a few of these are common in Kuwait reefs, including the *Siderastrea, Anomastraea, Psammocora* and *Consinaraea*. One species, the encrusting coral identified as African Pillow Coral (*Siderastrea savignyana*) in Carpenter and colleagues (1997), is found on nearly all major reefs in Kuwait and sometimes on artificial structures as well. These small encrusting colonies are really like very small pillow mounds in white, cream or pale pink so they usually are noticeable and very easy to identify.

Qaru • VID

Coral Reefs of Kuwait - 2015 Copyright Biodiversity Trust of Kuwait (KUPRED) & the photographers

Massive domed colony at Uraifjan • VID

Anomastraea • Crisp Pillow Coral

Uraifjan • VID

The Crisp Pillow Coral (*Anomastrea irregularis*), documented by Carpenter and colleagues (1997), is present in most reefs in Kuwait. These colonies are large thick and dome-like, growing up to 50 cm high and wide. Although superficially similar to the Porites corals, this species is distinguished by its comparatively large corallites rimmed by a white polygonal wall. It is usually found in deeper water near sandy areas.

Kubbar • VID

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Encrusting form with symbiotic blue barnacles at Qaru • VID

Leptastrea • Crust Coral

The Crust Coral (*Leptastrea transversa*) is an uncommon coral and the only one in this genus recorded in Kuwait by Carpenter and colleagues (1997). The species is seen as an encrusting mass usually with an irregular surface form. Often small symbiotic iridescent blue barnacles live among the coral colony. Usually grey, brown or yellow with dark sides to the colony; sometimes the grey-blue centres of the corals are characteristic. In Kuwait it has been recorded in most reefs but is often hidden in corners and not easily spotted. Although a rather scarce coral in Kuwait it is found throughout the range of depth, from the reef flat to the reef base.

Qaru • VID

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Encrusting greyish form next to knob-like green form of *Psammocora* at Qaru • VID

Psammocora contigua • Branched Sandpaper Coral

Qaru • VID

The Branched Sandpaper Coral (*Psammocora contigua*) is one of the more distinctive corals and very widespread on all major Kuwaiti reefs. It is also widespread throughout most of the coral reefs of the Indo-Pacific. Once you learn its characteristic form it is easy to distinguish it even in encrusting and branching forms. The colonies have fused rounded or angular branches that look like characteristic door knobs. Sometimes these colonies are bright green or slate blue in colour.

Benaya • VID

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Explanate form on Kubbar reef • ZOG

Coscinaraea • Wrinkle Corals

Carpenter and colleagues (1997) mention one species of this genus in Kuwait, the Wrinkle Coral (*Coscinaraea columna*). A characteristic species with colonies creating encrusting forms or low massive hillocky formations. This species can grow up to 75 cm in diameter, forming dark brown mounds. *Coscinaraea* polyp patterns are superficially reminiscent of a 'brain coral' pattern with little maze-like forms. This coral is fairly common in most reefs in Kuwait and is often found in both rather shallow and deeper waters.

Salama • VID

Uraifjan • VID

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity Editor, KISR/PEC & the photographers

Cyphastrea cf. *serailia* at Qaru • VID

Cyphastrea • Lesser Knob Corals

The *Cyphastrea* are represented by two species in Kuwait according to Carpenter and colleagues (1997): *Cyphastrea serailia* and *Cyphastrea microphthalma*. Both species have a honey-coloured or brownish nodular form; sometimes they form impressive mounds up to 50 cm in diameter. *Cyphastrea serailia* generally has a smoother and more regular appearance than the rougher-looking *Cyphastrea microphthalma*. Both species take various forms and are usually very distinctive due to their large corallites. Both species are very common and widespread on all of Kuwait's coral reefs; they are most abundant in shallow and intermediate depths of the reefs.

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Sea snails on *Cyphastrea* at Qaru • VID

Kubbar • VID

Cyphastrea cf. *microphthalma* at Kubbar • ZOG

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Distinctive leaf-like form form Qaru • VID

Pavona decussata • Cactus Coral

Qaru • VID

The Family Agariciidae is represented by two species in Kuwait (Carpenter and colleagues 1997); a particularly distinctive coral species is the Cactus Coral (*Pavona decussata*). This coral is widespread and common throughout its range; in Kuwait it is found in all major reefs. However, it is susceptible to bleaching, and extensive reduction of coral reef habitat due to a combination of threats, so it is now assessed as Vulnerable by the IUCN.

Umm Al-Maradim • ZOG

Coral Reef Guide Kuwait 2015 Copyright: Biodiversity East, KUFPEC & the contributors

Large fleshy polyps on encrusting form Qaru • VID

Acanthastrea • Starry Cup Corals

The Starry Cup Coral (*Acanthastrea echinata*) is grouped in the family Mussidae. The corallites have long septal spines which are only visible on dead coral but they give the species its common name. The spiny appearance is exaggerated by the thick fleshy tissues in living coral colonies. The irregularly rounded hillocky form of the species can create mounds up to 75 cm in diameter; sometimes a mound like this can look like a large sleeping grouper!

Qaru • VID

Qaru • ALH

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Typical rounded knob-like form Qaru • VID

Favia • Honeycomb Corals

Qaru • ALH

Throughout the Indo-pacific biogeographic realm corals in the Favia group are common. These are known by many common names including "honeycomb corals" because they have a characteristic polyp pattern. The rounded form the corals often take is immediately noticeable and distinctive of the *Favia* species.

In Kuwait this is a characteristic and widespread genus of corals; Carpenter and colleagues (1997) record two species in Kuwait but there may be more, some being difficult to identify in the field. The two species mentioned in the above account are the Favia Knob Coral (*Favia speciosa*) and the Favia Moon Coral (*Favia pallida*). These corals are abundant in Kuwait and are considered one of the hardiest of the corals in the region; Favia Moon Coral is more common. Favia corals are also found scattered along the harder substrates away from reefs and they will readily colonize wrecks, artificial reefs and debris of all kinds.

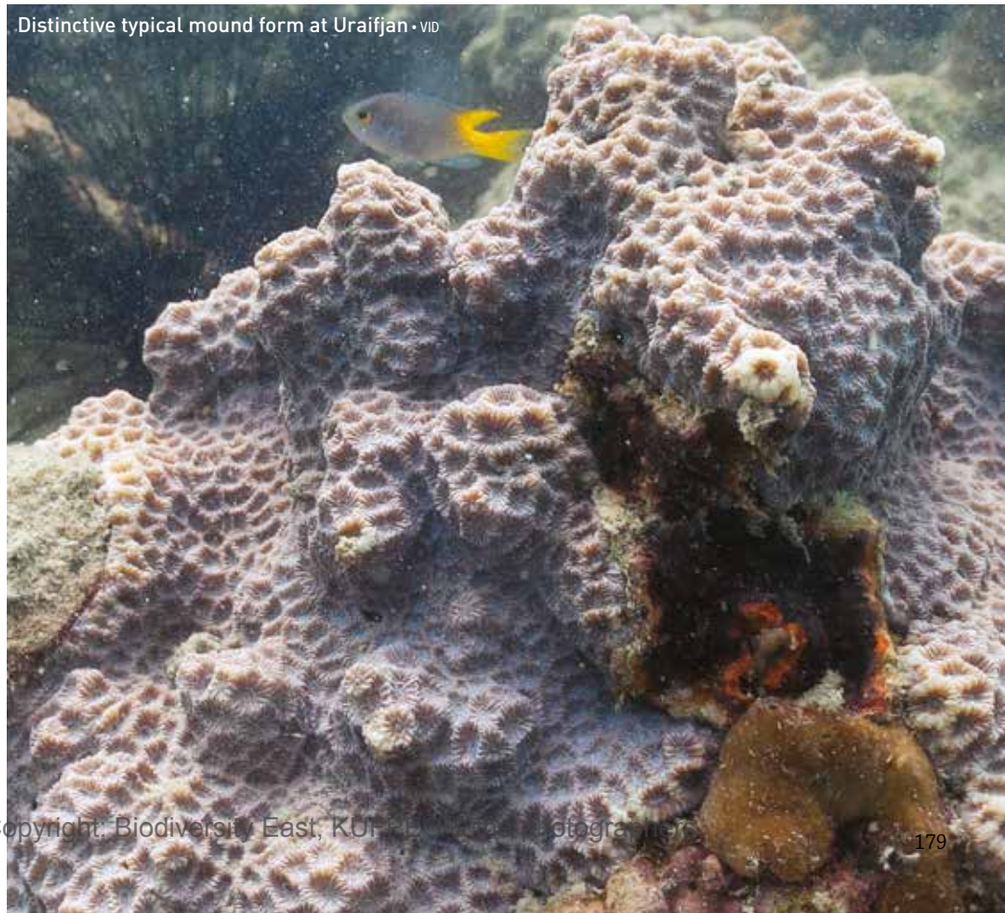
Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

An encrusting form at Uraifjan • VID

Favites pentagona • War Coral

This species is known as War Coral because in tropical seas further south it usually takes on bright violent red and purple colour. In Kuwait a common colour form is a slate blue; most colonies are brownish, grey or greenish. Although it is in the Faviidae family it looks quite different from the so-called 'honeycomb corals'. Colonies of War Coral are encrusting or form small mounds; often they form wonderful irregular columns. A common and very distinctive species, found on all major reefs in Kuwait.

VID


Distinctive typical mound form at Uraifjan • VID

Coral Reefs of Kuwait © 2015 Copyright, Biodiversity East, KUFS Photographer

Uraifjan reef flat • VID

Platygyra • Labyrinthine Brain Coral

Uraifjan reef flat • VID

Platygyra daedalea is the only true "brain coral" recorded in Kuwait by Carpenter and colleagues (1997), yet other species of this genus may also be found in the southern part of the Gulf (and the taxonomy of this widespread species is still under investigation). The Labyrinthine Brain Coral gets its common name from the distinctive brain-like pattern that the polyps form; the maze-like valleys of the colonies look like a labyrinth, the mythical maze design of the classical ancient Greek architect Daedalus.

This is definitely the most distinctive large coral species in Kuwaiti seas and fortunately it is very common and found on every major reef in the country. Even in very silty conditions in inshore reefs such as Uraifjan, Ras al-Zour and Benaya it is a common coral forming massive colonies with some coral heads growing up to 3 meters in diameter. These

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Uraifjan reef flat • VID

colonies are sometimes brightly coloured tan yellow, whitish, greyish, greenish or brownish. It is amazing this exotic-looking brain coral finds its northernmost distribution in the northern Arabian Gulf even though it is just as common in the Great Barrier Reef of Australia and the South Pacific islands.

VID

Qaru • YIS

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Distinctive coralite arrangement (Umm Al-Maradim NW) • VID

Plesiastrea • Small Knob Coral

Different colours (Qaru) • VID

The Small Knob Coral (*Plesiastrea versipora*) is the only coral of the *Plesiastrea* genus found in Kuwait, as documented by Carpenter and colleagues (1997). These colonies are quite characteristic and rather common in all major coral reefs in Kuwait. Colonies form small encrusting masses often light brown or green with noticeable large polyps. The thick tentacles of the polyps are often extended during the day. This species of coral has a wide distribution in the Indian Ocean and the Pacific and it is considered one of the few coral species that can survive in seasonal temperate waters (such as southern Australia).

Urailjan • VID

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Under a cavern at Um Al-Aish • ZOG

Dendrophyllid cup corals

The Family Dendrophylliidae includes a group of cup corals that grow in dimly lit conditions in caverns, overhangs and deeper waters. The Dendrophyllid Cup Coral (*Dendrophyllia gracilis*) is a tiny characteristic species and the smallest of the corals in Kuwait. Colonies have a bright yellow or orange colour that is immediately apparent among the colourful corallingenous algae encrusting deeper caverns on the reef slope. The species, along with others in the genus *Tubastraea*, is found on nearly all major reefs in Kuwait.

Polycyathus & Paracyathus cup corals

Polycyathus is a genus of very small stony corals; they are sometimes called cup corals. These are tiny little cups about 5 or 6 cm in diameter. These corals are in the family Rhizangiidae, which includes at least three species in Kuwait according to Carpenter and colleagues (1997). Fairly common in deeper and turbid water environments on most Kuwaiti reefs, these species usually go unnoticed because they are so small. The little whitish *Polycyathus* Cup Corals and *Paracyathus* Cup Corals are found in dimly lit overhangs, most commonly in slightly deeper water; they are also found on steel walls of shipwrecks.

Kubbar • VID

Under a cavern at Benaya reef • ZOG

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Turbinaria cf. *reniformis* at Benaya reef at • VID

Turbinaria • Disc Corals

Turbinaria cf. *reniformis* with corallites closed during the day • VID

The disc corals are within a family of corals known as the Dendrophylliidae. Disc coral colonies are flat laminae often forming overlapping tiers, while sometimes they form vase-shaped formations. These corals are usually found in deeper water at the reef base and even beyond, in the sandy areas around the reef. Two species are recorded in Kuwait and they are widespread.

The Kidney Yellow Scroll Coral (*Turbinaria reniformis*) is considered an uncommon and Vulnerable species in a recent IUCN assessment. Although not common in Kuwait it is easy to find in the outer reefs, particularly Qaru and Mudayra

The Turban Disc Coral (*Turbinaria peltata*) is also assessed as Vulnerable by IUCN, although this species is widespread and rather common throughout its range. It is seen in deeper waters on most of Kuwait's reefs.

Since both disc corals found in Kuwait are globally threatened species, steps should be taken for their protection. Because they

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Kidney Yellow Scroll Coral at Umm Al-Maradim Northwest • VID

may grow just beyond the reef base in deeper waters and on sandy shelves, they are very susceptible to anchor damage. Evidence of an overall global decline in coral habitat is an indication that these species are almost certainly declining worldwide. On top of the multitudinous threats already described, disc corals are heavily harvested for the aquarium trade, particularly in Indonesia, where disc coral pieces are exported in the tens of thousands.

Turban Disc Coral corallites • VID

Turban Disc Coral corallites fully open • VID

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Gorgonians of the genus *Manella* or *Echinomuricea* at Qaru • YIS

Soft Corals • *colourful trees and shrubs of the deep*

Gorgonian, *Manella* sp. deep at Northwest Qaru reef • VID

Soft corals are in the subclass Octocoralia – some are also called Gorgonians. They take different forms and do not actually build reefs. They resemble thin or thick-trunked tree branches. The coral polyps have eight tentacles that bear tiny feather-like projections; these are clumped on the coral branch tips. The pliable colony is composed of a rubbery or thick jelly-like material that is often embedded with skeletal spicules. These wonderful formations take on a wide range of colours, often in pastel shades. Usually soft coral colonies are found in deeper or more turbid waters. Sometimes they are found far from major coral reef areas. These bushy, tree-like forms attract many other species of life forms, notably the beautiful brittle stars.

In the Gulf these corals are poorly studied and a few species are yet to be identified for science.

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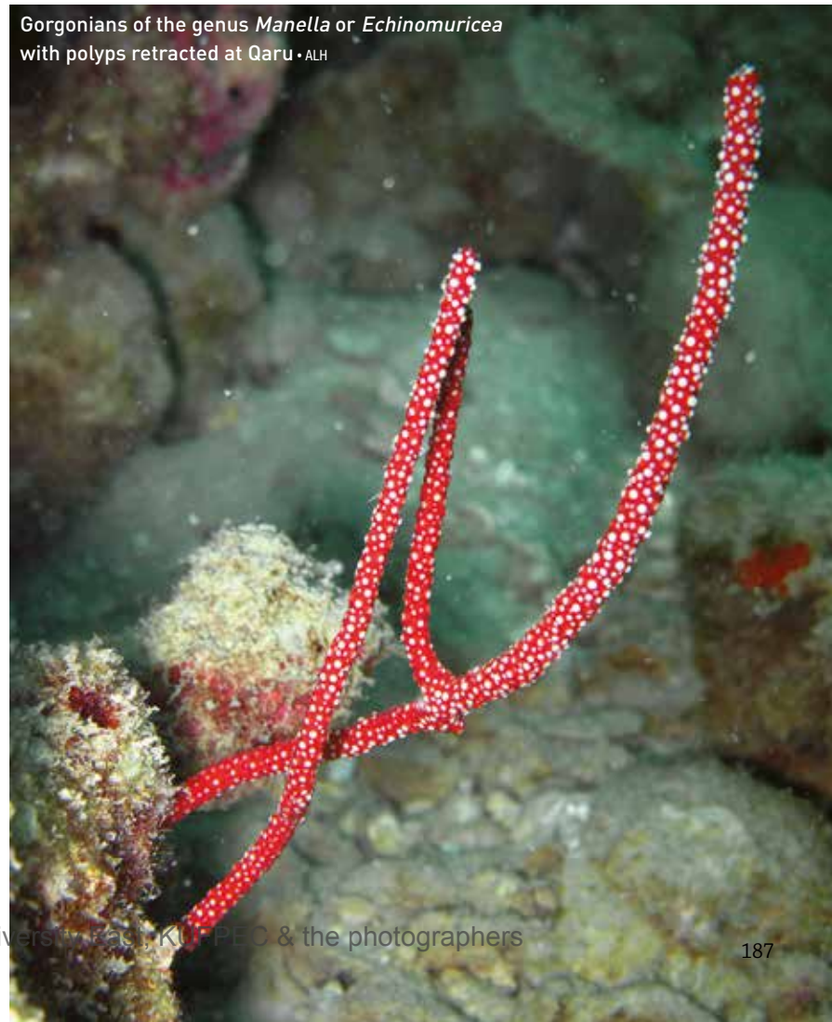
Gorgonians at Qaru • ALH

Unidentified soft coral with polyps extended at Qaru • ALH

Black coral *Antipatharia* sp. at Umm Al-Aish • VID



Gorgonians of the genus *Manella* or *Echinomuricea* with polyps retracted at Qaru • ALH

Coral Reefs of Qatar © 2015 Copyright: Biodiversity Qatar, KU-PEC & the photographers

Various algae species including Peacock's tail (*Padina* sp.) on marine pipeline (photo by Amy Elder)

Glob Weed algae • MDE

Algae species • MDE

Algae and other plants

Producers of the reef

Crustose coralline algae come in many forms and colour hues • ZOG

It is remarkable that very few plants are noticeable on Kuwaiti coral reefs. Although plants exist in the millions on these reefs, they are almost unrecognisable because they are really too small or are in forms most people don't know are plants!

Most plants on Kuwait's reefs are algae. There are a variety of these tiny plants and plant-like organisms: green algae (Chlorophyta), brown algae (Phaeophyta), red algae (Rhodophyta), microscopic diatoms (Chrysophyta) and dinoflagellates (Dinoflagellata). Blue-green algae, the Cyanobacteria, a type of slimy film is also common on many reefs.

We should not forget that microscopic

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algae also live inside living coral tissues, the zooxanthellae are dinoflagellates. They live symbiotically in the tissues of both stony and soft corals, sea anemones, and zoanthids!

Algae are given very little press on reefs and this is not fair to them since they are actually the foundation of reef food chains. According to their size and structure they can be classified as microalgae and macroalgae. Microalgae are really microscopic, either single-celled or a string of cells. Most people don't know this but certain microalgae species actually bore under the surface of live and dead corals. In dead stony corals boring algae can be red or green or cyanobacteria; while green algae may form stubble on some living corals as well. These boring algae are an important food for parrotfishes. Most people don't know that when crunching-up dead coral with their beak-like teeth the vegetarian parrotfishes are actually after the algae!

Macroalgae are the typical sea-weeds. They look more like what terrestrial beings would consider normal plants. Some of these are attached to the reef, some just float away such as the Sargassum that litters beach lines. The algae that appear on reefs are usually cropped back by a myriad fishes and invertebrates.

Coralline algae is a special form of crustose macroalgae that most people take to be a kind of coral. No it is a plant! And in fact there are over 4000 species these marine algae. These coralline red algae (Rhodophyta) are very important in coral reef development. They cover dead coral or rocks in thin matress-like encrusting and laminar forms. Sometimes they form little appendages –almost coral-like forms– these are articulated forms of coralline algae. Crustose coralline algae grow as a crust over and between the fragments and gaps in coral reefs and essentially help cement the coral pieces together, strengthening and enriching the coral reef habitat. Coralline algae is fed upon by many reef creatures, many fishes and other animals.

Marine plants washed on the beach at Ras Al-Zour

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Red sponge, Qaru • ALH

Sponges

Water filters of the reef

Blue sponge, Qaru • ALH

Sponges, in the phylum Porifera, are extremely important reef animals – the most famous of the filter-feeders on a reef. They filter-clean the waters, provide homes for a myriad small marine beings and are an important part of the food chain. Sponges are some of the simplest and so-called "primitive" of life forms. They lack true tissues and they don't have specific body organs like most other multicellular animals. They are made up of thousands of cell colonies, supported by "spongin" – a special kind of elastic skeletal structure all rapped-up in a tough skin. Being fantastic filter feeders they draw in water through the many pores that permeate the sponge's skin. These incurrent pores bring seawater inside with its nutritious microscopic particles, while filtered water is then spewed out through larger pores. Although sponges may actually grow quite large they feed on microscopic food particles,

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Blue sponges and encrusting green sponges at Benaya reef • VID

most too small to be seen by a standard microscope: bacteria, dinoflagellates and other microbes. Sponges can filter an incredible amount of water each day, they have remarkable water-pumping abilities. A small sponge can circulate more than 2000 times its own body volume of water each day!

All adult sponges are sessile, permanently attached to substrate. Many tropical sponges are colourful; yet brilliant colours may be a sign of toxicity. Despite their unusual spicule-packed tissues many animals of the reef feed on sponges, these include many reef fishes, such as angelfishes and boxfishes. Hawksbill turtles and sea slugs also feed on them. Finally many sponges provide homes for many other animals – some are tiny like bacteria and algae, others more conspicuous such as certain crabs, gobies, and blennies. Kuwaiti reefs do not have a lot of sponges as do reefs in the Caribbean or other parts of the world yet it is worth looking out for them, some have beautiful colours and have evolved to survive right beside the corals.

Sponge among corals, Qaru • ALH

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Rose of the Sea in the genus *Schizoporella*, Salama reef • ZOG

Bryozoans

Lace clothing the corals

Rose of the Sea, Salama reef • ZOG

These primitive beings are known as "moss animals" or bryozoa (bryo means "moss" in Greek). They are tiny sessile, mostly colonial animals that form large and variable colonies that may be branching or mesh-like. Sometimes their colonies look like lace wrapped around the coral. They colonize hard substrates like coral, rock, plants and debris. Each bryozoan colony is made up of individual zoids. And each zoid feeds with tiny hair-like tentacles on diatoms, bacteria and other types of micro-plankton. Individuals are not interconnected but they typically react to external stimuli simultaneously – retracting into their microscopic cases as one.

The Rose of the Sea is a large lacy bryozoan colony that sometimes really looks like the flower! With careful observation you can see the hair-like tentacles of the zoids and the honeycomb pattern of the colony.

Coral Reefs of Saudi Arabia © 2004 Marine Biodiversity East, KUFPEC & the photographers

Rose of the Sea exposed during low tide at Ras Al-Zour • MDE

Lace-like bryozoan colony on Acropora coral • ROB

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Bubble Anemone (Qaru) • ALH

Sea Anemonies

Relatives of the coral polyp

Bubble Anemone (Mudayra) • VID

Sea anemones are very closely related to corals in the phylum Cnidaria, order Actinaria. However unlike most corals they are not colonial but solitary polyps. Unlike corals they do not create reef rock. They have a columnar body with an oral disc equipped with hollow tentacles. Food is ingested and waste expelled through a slit-shaped mouth in the disc's centre.

One of the most spectacular tropical sea anemones is the Bubble Anemone (*Entacmaea quadricolor*), in the family Actiniidae. This anemone displays two growth types based on where they live in the water column, one of which gives it its common name.

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Bubble Anemone with sea urchins at Qaru • VID

Anemones attached on a hermit crab's shell • ALH

Bubble Anemone tentacles (Qaru) • VID

Sea fern hydroid at Qaru • ALH

Hydroids

The branching hydrozoa

Sea fern hydroid at Umm Al-Maradim • ZOG

Hydroids are largely sessile bottom-living cnidarians. They are colonial animals - close relatives of the anemones- and are characteristically composed of many polyp clusters.
The polyps are tiny (1mm tall with a smaller diameter). In branching forms, the polyps are encased in a 'skin' made of chitin. Since hydroids feed on plankton, they likely play an important role in marine ecosystems. Hydroids are often found growing on a variety of other marine organisms, including sponges corals, molluscs, arthropods, and algae. They commonly decorate parts of several coral reefs in Kuwait.

Coral Reefs of Kuwait, Copyright Biodiversity Desert, KUFPEC & the photographers

Green zoanthid colony on coral at Ras al-Zour • ZOG

Zoanthids

Flower-like and coral-like

These tiny but tough sea anemone-like animals often carpet rocky and rubbly areas. Some are adapted to be regularly exposed to the air at low tide. These animals are often the first to settle on any vacated space in a reef. Zoanthids belong to the same Class Anthozoa just like sea anemones, which they resemble. Nevertheless, while sea anemones belong to the order Actiniaria, zoanthids belong to the different order Zoanthidea. Zoanthids look like tiny sea anemones. However, sea anemones are solitary polyps, while most zoanthids live in colonies just like corals do. Zoanthids don't produce a hard skeleton like the hard coral colonies do, but their tissues are leathery and composed partly of chitin.

Although they look harmlessly pretty, some zoanthids contain powerful toxins to protect themselves against predators. One of the most toxic marine poisons, palytoxin, was discovered in a zoanthid. Minute quantities of palytoxin can paralyse and even kill. Therefore, it is advised not to handle zoanthids with open wounds on your hand or touch your mouth or eyes after handling them. It is believed that the toxins are not produced by the animal but by bacteria that live in symbiosis with the polyps.

Green zoanthid colony at Ras al-Zour • VID

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity Unit, KUFPEC & the photographer

Widespread in Kuwaiti waters is the Jelly Blubber (*Catostylus mosaicus*) • VID

Medusas

Gelatinous roving wonders

Details of a medusa's stinging tentacles • VID

Sea jellies or jellyfish are in the phylum Cnidaria just like the corals, but in their own subclass the Medusozoa. These are simple creatures made mostly of water, by about 95%. Sea jellies have no supportive skeleton or exoskeleton; that is why out of water they turn into gelatinous blobs. Inside the water they are beautiful and elegant alien-like creatures.

Actually, other cnidarians such as the corals and anemones also have microscopic medusa phases in their life cycle, but they actually spend most of their lives as sessile polyps. Sea jellies typically consist of a "bell" and often they have long tentacles that extend down beyond the bell's edge. These tentacles are often armed with stinging cells called nematocysts. The stinging ability is used for defence or to seize and immobilize prey. Most stinging jellies do not have virulent toxins and the potency is not dangerous to humans. Some species do have very dangerous toxins that can cause welts on human skin, or even worse, interfere with the central nervous system. Although these dangerous tropical jellies, such as the notorious sea wasp or box jelly are not found in northern Gulf waters however some very venomous species are sometimes encountered in Kuwaiti waters and care must be taken around them.

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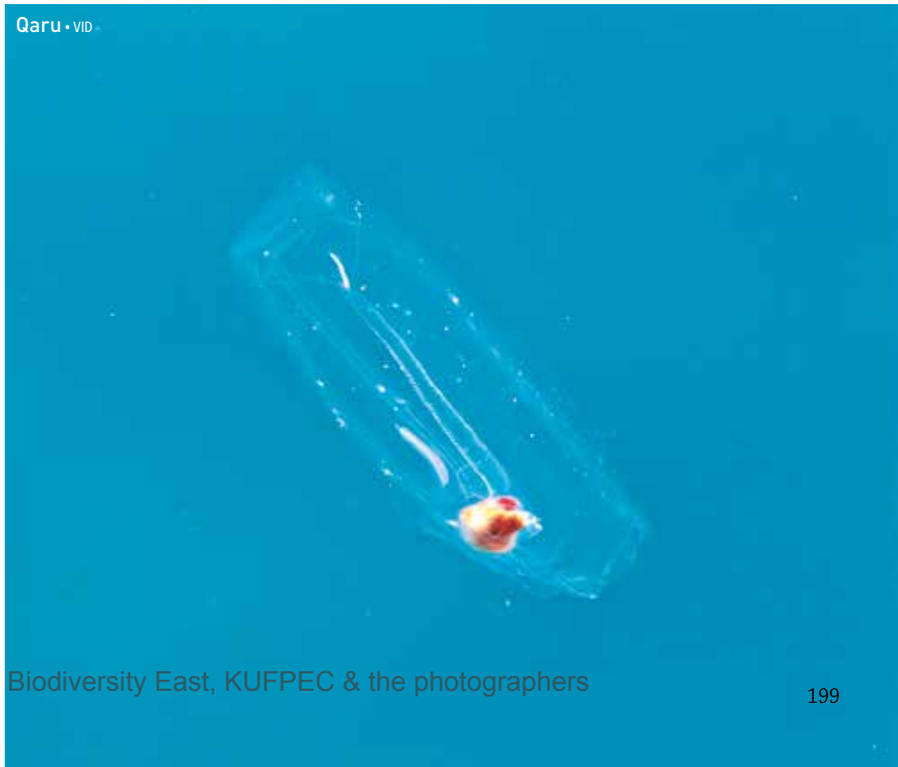
Comb jellies

The alien-like ctenophores

Comb jellies or ctenophores (from *chtena*, Greek for comb) are very similar to sea jellies. In fact for a very long time scientists placed them in the phylum Cnidaria (the big group containing sea jellies, anemones and corals). Recently the difference between comb jellies and the other jelly-like beings in the plankton have been described and a new phylum has been created, the Ctenophora. This phylum hosts the 150-odd species of ctenophores.

These gelatinous elongated or spheroid jellies have eight bands of cilia arranged in vertical comb-like rows along the body. The cilia beat synchronously to move the ctenophore slowly through the waters. Just like the sea jellies, comb jellies are important consumers and predators over reef waters. They feed on tiny zooplankton, this includes small sea jellies, young shrimps and even minute fishes. Some comb jellies have sticky threads that ensnare their tiny planktonic prey. The overwhelming number of ctenophores just move through the ocean searching for prey, however a few species actually settle on the sea bottom or live in association with other animals or plants. Such simple beings have such a variety of life forms perfectly adapted to nourishing themselves from the plankton – the marine soup.



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Impressively coloured polylclad flatworm, probably *Maritigrella makranica* from Qaru reef • ALH

Worms and their allies

Hidden workers of the reef

This tiny flatworm photographed at Qaru is probably a first for Kuwait • ALH

Many worms exist in coral reefs however usually they are not even noticed by divers. Polychaete worms (belonging to the phylum Annelida) are probably most noticeable. Some species known as sedentary polychaetes construct permanent tubes.

The feather duster worms have a series of feathery tentacles on top that are used to filter nutrients from the water.

The flatworms get their names from their unusual flattened shape. Some species, found in a wide range of bright colours, look surprisingly like nudibranchs. These colours serve as a warning to potential predators because the worms excrete a foul-tasting mucus.

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Qaru • ALH

One of the feather duster worms from Qaru. The tentacles rapidly close if disturbed and only a tiny hole is visible.

Qaru • ALH

Qaru • ALH

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Cowrie *Mauritia grayana* at Qaru, first record in Kuwait • AH

Sea snails

Molluscs with beautiful shells

Cowrie *Erosaria turdus* at Umm Al-Maradim • ROB

Sea snails are known as gastropods (meaning "stomach-feet" in Greek), the classical taxonomy classified them in the sub-class prosobranchia. They are the most species-rich group within the molluscs with roughly 55,000 species worldwide. Snails are very successful on tropical reefs.

Unlike the other molluscs in shells, snails have a distinct head and they actually withdraw it within their shell. Although most of the body is tightly twisted inside the snail-like shell, sea snails have a muscular foot that propels them along the rocks, sand, corals and other substrates. An interesting detail on the foot is a close-door hatch, the operculum, which plugs the shell opening while the head and food are retracted inside. The head and eye are rather primitive-looking. In fact snail eyes see mostly different shades of light – they don't really need to see much more than the dark crevasses they need to take cover in. The snail's mouth has a unique organ called the radula – a kind of scraping tongue with thousands of tiny teeth.

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity Lab, KUFPEC & the photographers

Living cowrie *Erosaria turdus*, Qaru • VID

Shiny operculum of a turban shell on Mudayra • ZOG

Rock snails, probably *Cronia konkanensis*, Umm Al-Aish • ZOG

Conch species at Uraifjan • ZOG

A wide variety of snails exist and different species feed on very different things. Many just clean up algae, others are carnivores. Many carnivorous snails drill through the shells of other molluscs to ingest their prey's bodies. Many different species of snails prey on a variety of reef animals, this includes corals, sponges , worms, bivalves, starfishes, crustaceans and even fishes. Some snails are extremely specialized predators.

The cone snails of the genus *Conus* feed on quite mobile animals, including large worms, and even small fish. They use a highly modified radula tooth that looks like a barbed hypodermic syringe. The cone snail propels this sharp needle in its quarry and injects a venom. The venom is meant to paralyse its prey but some species' venom can be highly toxic and even lethal to humans!

Cowrie shell *Luria pulchra* at Qaru, first record in Kuwait • ALH

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The nudibranch *Goniobranchus annulatus* at Qaru • ALH

Sea slugs

Tiny dancers of the deep

Goniobranchus annulatus, Qaru • SIM

Sea slugs are molluscs in the subclass opisthobranchia. There are over 3000 species world wide including the famous nudibranchs.

Unlike other snail-like animals, opisthobranchia have no real shell. The name opisthobranchia means "gills behind" (in Greek) and this refers to these animals' specialized gills and gill-like features on their backs. They have these rather advanced appendages for respiration and to smell-out their prey. Most sea slugs feed on small sessile animals such as hydroids, bryozoans and sponges. Others are hunters and go after flat worms.

Coral Reefs of Kuwait - 2015 Copyright; Biodiversity East, KUFPEC & the photographers

Glossodoris pallida, unique record for Kuwait in Umm Al-Maradim island area (photo by Samantha Jane Howlett)

Flabellina bicolor - unique record for Kuwait (photo by Mohammad Al Saleh)

Nudibranchs are one of many elements of the biodiversity of Kuwait that is still poorly explored. New species are being constantly added to Kuwait's faunal list since some inquisitive divers do take digital photographs. Some species display bright warning colour and are poisonous, they use their sting cells or tissue toxins as protection from predators. Others are camouflaged to mimic the sandy substrate and rough coral forms. Nearly all of these shell-less snails are very small, sometimes smaller than a thumbnail. So, a closer look and a photograph may help contribute to a discovery for Kuwaiti nature!

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The nudibranch *Goniobranchus obsoletus* at Ras Al-Zour • VID

The flower-like feathery gills called rhinophores • VID

Goniobranchus annulatus • ALH

The slow-motion dance of a nudibranch!

These very small animals move very slowly, grazing and feeling their way on the reef bottom. At only a few centimetres in size they seem extremely fragile and vulnerable creatures. Yet they are colourfully patterned - perhaps one of the most dazzling animals on the reef. This is believed to be an example of aposematic colouration; the shocking colouration warns potential predators that these tiny slugs are distasteful or poisonous. Therefore being noticeable has given them an evolutionary advantage; the colours and patterns are threateningly calling out: "don't bother me!".

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Goniobranchus annulatus • ALH

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A common species of pecten scallop, probably *Azumapecten ruschenbergerii*, with tentacles and tiny black eyes • ROB

Bivalves

Pearly shells

Scallop retracting its tentacles • ALH

Of the shelled animals in the sea the bivalves are the most valuable and most famous. Oysters, mussels, pinna shells and clams are members of the invertebrate order Bivalvia. As the name suggests bivalves possess shells comprising two parts these are called valves. These are hinged by ligaments and completely enclose the mollusc's body. Bivalves are filter feeders; they have highly developed gills that play an import role in feeding. There are many species of clam-like molluscs many of them are buried out-of-sight, some actually bore inside the coral! They do this be slowly rocking from side-to-side and opening and closing their valves.

Scallops are more visible because they do not attached to substrate; they can actually evade predators by flap-swimming. They do this by slapping their valves closed, which causes them to move about with tiny burst of jet propulsion.

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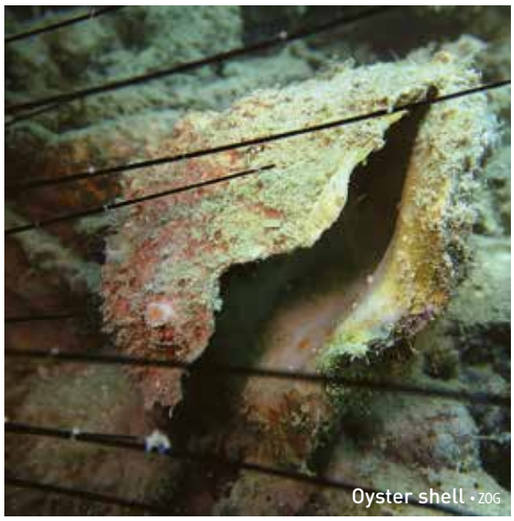
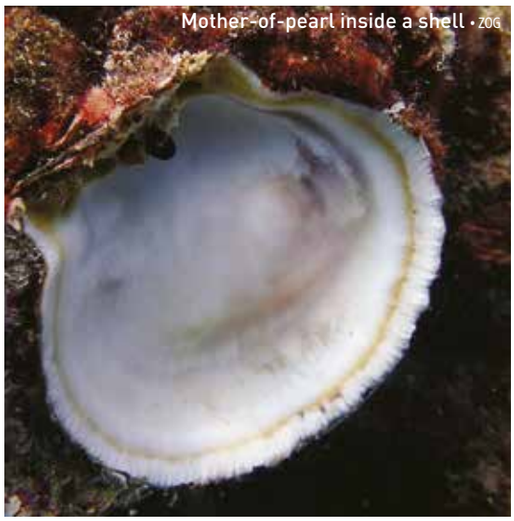


Oyster shell • ZOG

Azumapecten scallops covered in coralline algae • ZOG



Mother-of-pearl inside a shell • ZOG

Oysters are the most precious of the shelled molluscs and pearl oysters are still found on the reefs and sometimes in sandy "oyster reef"; these aggregations are known as "hair" in Arabic.

Living scallop, Salama • VID

Pinna shell off Qaru • VID

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Pharaoh Cuttlefish in courtship at Qaru • YIS

Cephalopods

Chameleons of the reef

Male Pharaoh Cuttlefish in aggressive pose at Qaru • VID

Cephalopods are a special order of the phylum Mollusca, "cephalopod" meaning "head-feet" in Greek. Most members of this group really do have a large head and many feet. They are considered the most progressively evolved of the molluscs and this group includes the cuttlefishes, octopuses, squids and nautiluses. Unlike many other molluscs these are very mobile and actually act very much like vertebrate animals.

The cephalopods have highly developed sensory organs, eyes and brain. The eyes of cuttlefish for example are very similar to those of the vertebrates – almost looking like sheep eyes! The tentacles have hundreds of chromoreceptor cells, that enable them to use their arms to discriminate between different items from their chemical make-up. Cephalopods are remarkable for their ability to learn and they have a very good memory. Surely they seem to be the most intelligent of the in-

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Octopuses, like this one, are rarely observed in Kuwaiti waters (photo by Meshal Al-Omar)

Cuttlefish skin can quickly change colours and patterns • VID

vertebrates!

The Pharaoh Cuttlefish is the most prominent cephalopod in Kuwait's reefs and is really quite abundant. The cuttlefishes' most striking attribute is their rapidly camouflaging skin, which is separated into three layers. The first is composed of pigmented chromatophores, some 200 per square millimetre, which open and close with tiny muscles to reveal yellow, red, and brown, or slight variations of those colours. The second layer is made up of structural reflectors, which bounce light to give off a sort of iridescence. Finally, below this is a bottom-most layer of solid, unchanging white, which the cuttlefish can expose to produce high contrasts against the vivid colours of the chromatophores. Working in concert, these layers allow the cuttlefish to put on nature's most dazzling light show. And it is all powered by one of the biggest brains relative to body size among invertebrates. The cuttlefish can match the colours and patterns and textures of virtually any background.

This species has a wide geographic distribution extending from Zanzibar and Madagascar in the west to northern Australia in the east and as far north as southern Japan. In the northern Arabian Gulf, the spawning season occurs February to April. The white-yellowish eggs are attached to hard substances, sometimes inside the corral maze or inside disused shells, old nets or on fish traps!

Crabs are prey (Qaru) • VID

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Male cuttlefish fighting at Qaru • YIS

Pharaoh Cuttlefish in "courtship dance" • YIS

YIS

Pharaoh Cuttlefish engage in elaborate courtship rituals. A large male caresses the smaller camouflaged female. During courtship amazing colour changes take place -really lending these mollusc's their nickname "chameleons of the sea". The cuttlefishes change into tones of blue, green, brown, and silvers for communication, defence and courtship display. Finally the pair mate in a face-to-face embrace. The eggs are laid on stationary objects on the reef.

Coral Reef [illegible] 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Copulating cuttlefish at Qaru • YIS

Cuttlefish eggs in a disused oyster shell, Kubbar • ZOG

Cuttlefish eggs at Kubbar • ZOG

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

This is not the eye of an Long-spined Sea Urchin! YIS

Sea urchins

The reef's gardeners

Burrowing Sea Urchin, Umm al-Maradim • ALH

Sea urchins are related to starfishes, crinoids, and sea cucumbers in the phylum Echinodermata (meaning spiny-skinned in Greek).

The most impressive urchin species in the coral reef is Long-spined Sea Urchin (*Diadema setosum*); immediately distinguished by its long and thin black spines that are mildly venomous. It also has an eye-like feature with an orange ring, which is actually its anus.

The *Diadema* sea urchin's spines are considered mildly venomous. There is a toxin sac at the end of its thin black spine, which is fragile and easily broken off. When a person's skin is pierced by the spine, the toxin sac is released and delivers a painful sensation. The level of irritation depends on the sensitivity of an individual, some people feel numbness at the pierced area and some won't even feel a thing. The broken spine, which is left in the skin will slowly disappear, so there is no need to make an appointment with a surgeon! The immediate remedy for a painful stinging sensation from sea urchins is to pour vinegar on it. If the injury worsened due to allergic reaction, one must seek medical attention as soon as possible to avoid more serious aftereffects.

In deeper waters there are several other species of sea urchins. One of the most distinctive species on the reefs is the Pencil Sea Urchin with its characteristic thick spines. Perhaps the most abundant sea urchin species on Kuwaiti reefs is Burrowing Sea Urchin (*Echinometra mathaei*). This species

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Long-spined Sea Urchins, Qaru • YIS

actually can carve a hole into the coral rock. It is often abundant on degraded and dying coral reefs.

Sea urchins are viewed as pests by most people, but they are one of the most important inhabitants of the reef ecosystem. They help the reef to counter-check populations of fast-growing algae. Algae are sea weed, they grow very fast and if they keep on growing, they could overgrow the entire reef and transform the coral reef ecosystem into an algae dominated reef. Sea urchins are herbivores, their main diet is actually algae, and they are active grazers. They graze all the time, everywhere! They are the gardeners of the reef and with the help of other herbivore reef fishes, keep the algae at bay.

Sometimes an over-abundance of sea urchins may harm coral reefs. They have a mouth structure, which is called 'Aristotle lantern', which can break coral skeletons. When their main food source is scarce, they may even feed on coral polyps. The structure of their jaws allows them to break the calcareous skeletons of coral. Although their feeding on corals do not cause as much damage as that made by their relative, the Crown-of-thorns Starfish (*Acanthaster planci*), this kind of pressure could weaken the coral structure, which would leave the corals susceptible to erosion. Finally, the next time you see a sea urchin, please remember not to underestimate its presence and importance to the ecology of a reef ecosystem.

Pecil Sea Urchins at Umm Al-Aish (Taylor Rock) • ZOG

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East Kuwait and the Photographers

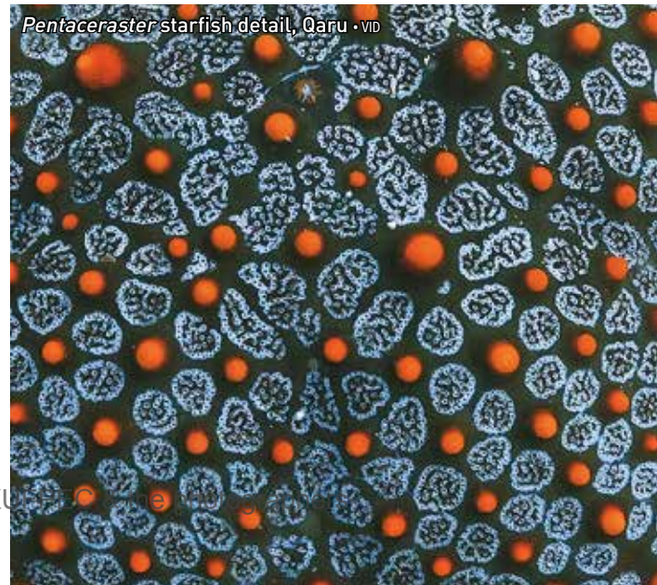
Starfish in the genus *Pentaceraster*, Qaru • VID

Starfish

Sea stars of the deep

Starfish are highly predaceous, feeding on a wide variety of reef and sand bed animals. They love to hunt bivalves, sea snails, worms and other echinoderms. There are several species on sandy substrates, only a few seem to scale the reefs.

Details of the starfish's "spiny skin", Umm Al-Maradim • ROB



Pentaceraster starfish detail, Qaru • VID

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Sea cucumber in the genus *Holothuria* at Mudayra • VID

Sea cucumber at Ras Al-Zour • ZOG

Stichopus sea cucumber at Umm Al-Maradim • VID

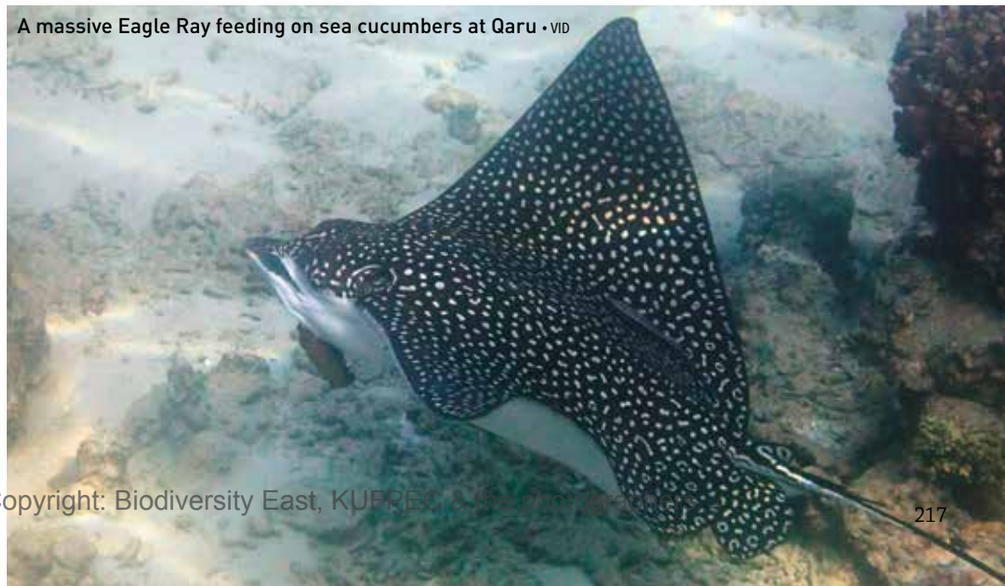
Sea cucumber in the genus *Stichopus* at Qaru • ALH

Sea cucumbers

Cleaners of the reef

Sea cucumbers protect themselves with a thick almost rubbery and somewhat slimy skin. This skin makes them probably unappetizing for predators. Many sea cucumbers are so-called deposit-feeders, they actually mop-up detritus with their feeding tentacles.

Sea cucumber at Qaru • VID



A massive Eagle Ray feeding on sea cucumbers at Qaru • VID

Coral Reefs of Kuwait 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Ophiuroid brittle stars probably of the polymorphic species *Ophiothela danae* • ALH

Brittle stars

Colourful works of art

One of the most colourful groups of animals on Kuwaiti reefs is none other than a frail but spectacularly patterned brittle star. Brittle stars have a peculiar body plan. A round central body disc carries five slender, radiating arms that move like tiny snakes. The arms gave these animals not only their other common name, serpent stars, and their scientific name, Ophiuroidea (ophis means snake in Greek).

In some species, the arms also form numerous branches. Another difference between brittle stars and starfishes is that brittle stars are able to move their arms sideways, which allows for rapid locomotion. The arms consist of individual calcite vertebralossicles that are hinged together. Tube feet are located on the bottom of the animal. As in other echinoderms, the feet are controlled and moved by a hydraulic canal system inside the body. They lack the suction cup extensions that strafish use to attach to the substrate, but they do have some adhesiveness, allowing many species to dab up food particles with them. Brittle stars use their feet mainly for olfactory sensations.

Brittle stars are related to crinoids and are just as ancient. They are known from fossils since the Early Ordovician, a geological period that began 485 million years ago, but their scientific classification has not been particularly well studied. Because of their delicate bodies, these echinoderms rarely formed continuous fossils that could provide scientific information about the relationships of extinct species. So although they are living fossils, the tougher skinned crinoids are much more famous as ancient fossils.

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Qaru • ALH

Umm Al-Maradim • ZOG

Kubbar • ZOG

Qaru • SCA

The more colourful brittle star species live on soft corals.

Qaru • ALH

Coral Reefs of Kuwait - 2015 Copyright Biodiversity East, KUFPEC & the photographers

Crinoid, Qaru • ALH

Crinoids

Living fossil sea lilies

Qaru • ROB

Known also as feather stars or lily stars (crinos means lily in Greek), these are relatives of the starfish. Unlike many other starfishes, crinoids are filter feeders, capturing plankton. These primitive echinoderms are a breed apart, they resemble an underwater flower. Some even have parts that look and act like roots anchoring them to the ocean floor. In Kuwait these species are poorly studied and their taxonomy is still under investigation. They are quite common on coral reefs and come in different colours and patterns.

The most amazing thing about crinoids is that their ancestors existed way back in the Paleaozoic era, with fossils that are 450 mil-

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

lion years old! In fact, fossils of the relatives of today's crinoids are also some of the oldest fossils on the planet (the earliest date back to the Ordovician Period). During the Paleozoic era they could be found all over the world, creating forests on the floor of the shallow seas. There were so many in places, that thick limestone beds were formed almost entirely from their body parts piled on top of each other. While the living crinoids are not the same species as those of the past there are enough similarities to help us understand how these plant-like animals lived.

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Hiding in the coral, Qaru • ALH

Crustaceans

Charismatic crabs and their relatives

A rich variety of crabs inhabit Kuwaiti reefs like this one at Qaru • ALH

Crabs are crustaceans (Phylum Arthropoda, subphylum Crustacea) – a group of animals rich in species taking up many charismatic forms, many are very small living right in amongst the coral or hiding under the coral

Qaru • YIS

Reef Fishes of Kuwait, 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Qaru • VID

Trapeziid crab, housekeeper of the coral, Qaru • ROB

rubble. There are more than 38,000 species of crustaceans worldwide. This includes the crabs, shrimps, prawns, mantis shrimps, lobsters, crayfish, hermit crabs and barnacles but also some lesser known tiny animals, such as the ostracods, copepods, and isopods. Some of the last three crustacean groups live in the plankton and some are nearly microscopic, inconspicuous members of the coral reef community.

Crabs are omnivores, feeding primarily on algae and taking any other food, including molluscs, worms, other crustaceans, fungi, bacteria and detritus, depending on their availability and the particular crab species.

Like most crustaceans, crabs have an exoskeleton composed of chitin. In order to grow, they must periodically shed this tough armour. Before the old exoskeleton is moulted or shed away, a new one is laid down beneath it. The old one splits open and the animal walks its way out of the old shell. It takes some time for the new skeleton to harden so just after the moult, crabs are very vulnerable and often hide in the coral or under debris.

Red Egg Crab (*Atergatis integerrimus*) off Qaru • ZOG
It is highly poisonous and should not be eaten!

Qaru • ALH

Qaru • ALH

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The Ghost Crab *Ocypode rotundata*, Qaru • YIS

Qaru • ALH

Ghost crabs build courtship mounds - common on pristine Kuwaiti beaches, Qaru • ALH

Ghost crabs

Ghost crabs of the subfamily Ocypodinae are actually semi-terrestrial crabs, they live on coral sand beaches not inside the reef itself. The name "ghost crab" derives from their nocturnality and their generally pale colouration – like tiny ghosts running up and down the beach! They are common shore crabs in tropical and subtropical regions throughout the world, inhabiting deep burrows. They are generalist scavengers and predators of small beach organisms.

Ghost Crab, Qaru • YIS

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Various hermit crabs thrive in Kuwaiti waters - this one belongs in the genus *Diogenes* • ALH

Hermit crabs

Hermit crabs are more closely related to squat lobsters and porcelain crabs than they are to true crabs (Brachyura). As the hermit crab grows in size, it must find a larger shell and abandon the previous one. This habit of living in a second-hand shell gives rise to the popular name "hermit crab", by analogy to a hermit who lives alone. Since suitable intact gastropod shells are sometimes a limited resource, vigorous competition often occurs among hermit crabs for shells. The availability of empty shells at any given place depends on the relative abundance of gastropods and hermit crabs, matched for size.

Qaru • ALH

Qaru • ALH

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Marbled Shrimp (*Saron marmoratus*), Qaru • ALH

Shrimps and allies

Funny creatures

Upside-down in a coral crevasse, Qaru • ALH

Like other crustaceans, shrimps have a segmented body with head, thorax, abdomen and tail. The head has two pairs of antennae, mandibles for feeding and two pairs of accessory feeding appendages. Shrimps and lobsters have a segmented tail used to swim backwards. On Kuwait reefs some very interesting shrimps hide inside the corals. Many species are nocturnal so to really see more one must dive at night.

Barnacles are related to shrimps! But as adults they are sessile – entrapped in a protective armour. Most barnacles are suspension feeders; they dwell continually in their shells, which are usually constructed of six plates and reach into the water with modified legs to scoop in plankton. These feathery appendages beat rhythmically to draw plankton and detritus into the shell for consumption. Around 1,220 barnacle species are currently known. A few of these may be found on reefs, attached to dead corals, living off the plankton rich waters.

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Titan barnacles on dead coral, Qaru • ALH

Hole-boring shrimp that lives with shrimp gobies, Salama • VID

Mantis shrimp, Bnaider • VID

Mantis shrimp *Gonodactylus* sp. in coral hole, Qaru • ALH

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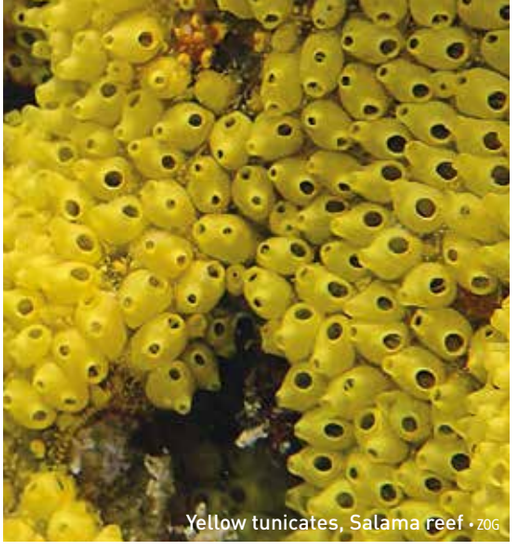
Yellow tunicates, Salama reef • ZOG

Tunicates

Highly evolved filter feeders

Tunicates at Qaru • VID



Yellow tunicates, Salama reef • ZOG

Tunicates are almost like tiny sponges, but they are in a unique class of their own. Sometimes called sea-squirts or ascidians, they are classified as Ascidiacea (numbering more than 2000 species worldwide). Like sponges they are filter feeders and they have characteristic siphon holes and are wrapped not in a spongy but a rubbery tunic! There are many kinds of tunicates in form and colour; many of them are quite small and form colonies. Often they really bring out some fantastic colours. The bright lemon-yellow or raspberry red colours signal danger, not nutrition! They warn other animals of their toxic qualities – and these toxins include heavy metals (e.g. vanadium and iron) and sulphuric acid that is deposited in the tunicates "tunic". These substances make tunicates undesirable to dine on, at least for most reef organisms. In addition, tunicates with these toxins in their tunics are rarely overgrown by algae or other invertebrates. But tunicates are very much part of the food chain, despite their impressive defensive arsenal. Many specialized reef dwellers, sea snails, slugs, polyclad flatworms, and several reef fishes feed on tunicates. In an evolutionary sense, unlike their primitive sponge look-a-likes, tunicates are actually very advanced. And they take on different life forms, some are not sessile but move through the waters, such as the alien-like salps.

Red tunicates, Salama • ZOG

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

The colonial tunicate *Didemnum* sp. at Salama • ZOG

Salps floating in the plankton, Qaru • YIS

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Predators such as these pelagic trevallies visit the reef to feed • VID

Fishes

Coral reefs host one third of all marine species of fish on 0.1% of the world's ocean's surface. Yet scientific understanding of this biodiversity is still limited. In fact, even in the shallow waters of the Arabian Gulf, fish communities are not completely explored or properly inventoried. The Gulf's fishes have colonized these waters from the Indian Ocean during the last twelve thousand years, since the end of the last Ice Age. Yet the species composition of the reefs is quite different from the Indian Ocean. Thus the biogeographic history has played an important role in shaping the character of coral reef fish communities we see today. And the reefs of Kuwait have a unique history and unique environmental conditions. The extreme temperature variations in Kuwaiti waters may sometimes approach or exceed the tolerance limits of many tropical reef fish species. Coral reef fishes in Kuwaiti reefs are not as rich in species or dominated by brilliantly coloured tropical species. Several species that are found in Kuwaiti reefs are rather scarce and localized as is typical of species on the edge of their range. However, almost all the typical components of tropical reefs are present in these more "simple" subtropical reefs. And the reefs are extremely important as nursery grounds, feeding and staging areas for many of Kuwait's fish species. Over 145 of Kuwait's 345 fish species have been documented to use coral reefs. And the assemblage of fishes is varied from reef to reef; the outer reefs have different communities than the inshore reefs. Over 40 species of fishes can be recorded within an hour's diving in a spectacular reef setting, such as Qaru reef. Over a few days this number may double. Most of these species are easy to identify and one can fairly easily study the species composition, frequency of occurrence, their use of different habitats and learn much about coral reef ecology by taking notes and photographs. Because these reefs are in fairly shallow waters anyone can learn to identify fishes, it is very similar to birdwatching on land! If one takes special care to look at the smaller fishes, those in nooks and crannies of the reef, small cryptic species may be observed. These are the less studied species of the reef. As recently as 2014, a new species of cryptobenthic blenny was discovered in Kuwaiti waters that is totally new for the Gulf as a whole! Kuwait's reefs are a great place to learn about coral reef fishes.

ZOG

The rare Oman Blenny *Oman ypsilon* swims upside-down in a cavern on Qaru reef. It was discovered in Kuwait during the making of this book; previous to this record, the species had been recorded only in the Indian Ocean, in Oman, 1500 km away!

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Undulated Moray

Gymnothorax undulatus

An eel of the family Muraenidae, widespread in the Indo-Pacific and east-central Pacific Ocean. Its length reaches up to 1.5 m but it is usually much smaller. It is a cryptic resident of coral reefs; probably rather scarce on the reefs of Kuwait, it nevertheless is observed usually at nightime and feeds mostly on molluscs and crustaceans.

Undulated Moray at Qaru • ROB

Military Turkeyfish

Pterois miles

These fish are mostly dark brown and have numerous thin, dark, vertical bars on their head and body. This colouration is a warning sign! And this very spiny fish has highly venomous spines that have even caused human deaths! Although they are rarely aggressive towards divers, they should not be bothered or captured by amateurs. Turkeyfishes (also known as lionfishes or firefishes) are mainly nocturnal and may hide in crevices during the daytime; usually they are observed at dusk and are quite common on Kuwait's outer reefs. They feed on fish and small crustaceans. They are native to the Indian Ocean, from the Red Sea, to South Africa, and to Indonesia; in Kuwait they seem to be fairly common in the outer reefs.

Military Turkeyfish at Qaru • VID

Military Turkeyfish head detail at Qaru • ALH

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Yellowfin Hind at Qaru • VID

Whiteblotched Grouper at Qaru • VID

Orange-spotted Grouper at Umm Al-Aish • VID

White-spotted Grouper at Qaru • VID

Groupers

Groupers are the sheikhs of the reef! Being important predators, most are large-bodied fishes the need complex reef habitats and lots of fishes to feed on. On the coral reefs they fall prey to spearfishers. And they are a good indicator of overfishing since these long-lived fishes quickly decline when spearfishing pressures are high. Many are also caught by other fishing methods such as long-lines and recreational fishing by rod-and-line.

Yellowfin Hind
(Cephalopolis hemistiktos)
This is actually a "dwarf grouper" rarely attaining a size larger than 25 cm. It has a brownish-red body with numerous blue spots on its body. Abundant on most Kuwaiti Reefs this is the most widespread and easily seen grouper. It mostly feeds on fish and crustaceans in the daytime.

White-spotted Grouper
(Epinephelus caeruleopunctatus)
Brownish-grey in colour, with white or cream-coloured spots on its body, this grouper is the least common on Kuwaiti reefs. It reaches lengths up to 55cm and is mostly encountered on the outer reefs, such as Qaru and Umm Al-Maradim. It feeds mostly on fish and crustaceans.

Orange-spotted Grouper
(Epinephelus coioides)
A widespread species that used to be common throughout the Arabian Gulf. It is a large grouper, that can grow up to one meter in size; featuring a darker upper body colour and yellow-orange spots all over its body. Due to its great commercial value for culinary purposes, it has been overfished and efforts are made all over Gulf countries to limit consumption and to regulate its fisheries to properly replenish stocks.

Whiteblotched Grouper
(Epinephelus multinotatus)
This less common grouper reaches up to 1 m in length. Juveniles and subadults are usually found in the reefs of Kuwait, whereas adults are encountered in deeper waters. Its colour is mostly dark grey and the body is covered in whitish irregular blotches. The juvenile mimics a damselfish species.

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Arabian Bluestriped Dottyback

Pseudochromis aldabraensis

Common on all reefs of Kuwait, as in general in the Arabian Gulf and the Gulf of Oman, this little fish reaches up to 10cm in size. It is one of the most colourful coral fishes on Qaru, Umm Al-Maradim and the nearshore reefs of Kuwait. Feeds mostly on tiny planktonic and benthic invertebrates.

Arabian Bluestriped Dottyback at Qaru • YIS

Persian Dottyback

Pseudochromis persicus

A common species but less frequent than the Arabian bluestriped dottyback in the outer reefs; this species is abundant on the nearshore inner reefs. It also is found on rocky substrates or dead coral in sandy areas away from the reefs. It occurs in different colour phases and averages 11cm in length. Most people may think the different light and dark colour forms area different fish species. Both colour forms have a scattering of bright blue spots.

Persian Dottyback, light phase at Qaru • ALH

Persian Dottyback, light phase at Uraifjan • VID

Persian Dottyback, dark phase at Salama • ZOG

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Juvenile Golden trevally at Uraifjan • VID

Orangespotted Trevally at Qaru • VID

Blackspot Snapper (*Lutjanus ehrenbergii*) at Qaru • VID

Golden trevally in Oman • SCA

Trevallies

The trevallies are in the Jack family, Carangidae. Although several other jacks do come from deeper waters to feed on the reefs, two species are characteristic of coral reef fish communities. The Golden Trevally (*Gnathanodon speciosus*) is usually seen solitary but young fishes form schools. Young may also associate with sea jellies. When hunting, schools descend to the seafloor and close over the coral to chase smaller fishes. Eats a variety of small fishes, molluscs, crustaceans, and worms. Adults have nearly no hint of yellow, but the young are a beautiful golden yellow. Engages in "piloting behaviour", swimming in front of other fishes such as large rays and sharks. The young will also sometimes swim close around divers too. The Orangespotted Trevally (*Carangoides bajad*) reaches about 50 centimetres. It is the most common jack found in the markets of Kuwait and is encountered in large numbers around all Kuwaiti reefs.

Snappers

The snappers in the family Lutjanidae are very common schooling fishes in all reefs of Kuwait. Shoals will often form with breams and other fishes. Two similar looking species are characteristic of Kuwaiti reefs. Their colouring and patterns are variable making them difficult to identify with certainty. They are encountered in both inshore and offshore reefs. They feed on fishes and benthic invertebrates and adults grow quite large, up to a maximum of 45 cm; however, shoaling fishes on the shallow reefs tend to be much smaller.

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Variablelined Fusilier

Caesio varilineata

A characteristic tropical fish that creates dense schools; it visits reefs often but can be seen in open water habitats as well. Although Carpenter and colleagues in 1997 considered this fish as "very common" on the outer reefs more recently we observed it sparingly, mostly on Qaru reef.

Variablelined Fusilier at Qaru • ALH

Blackspotted Rubberlip at Qaru • VID

Blackspotted Rubberlip at Qaru • VID

Grunts

Grunts include a distinctive group of fishes that make sounds underwater. Blackspotted Rubberlip (*Plectorinchus gaterinus*) is a beautiful reef fish that is actually crepuscular and nocturnal; usually spotted at dusk. Colour patterns between juvenile and adult are different. The adult is yellowish-white with black spots on its body and reaches up to 40cm in size, but the juvenile is mostly pale-coloured with dark brown stripes. This species is rather scarce on Kuwaiti reefs.

The Minstrel Sweetlip (*Plectorinchus sordidus*) is widespread in reefs and rough sandy areas. This fish reaches up to 25cm in length and has light and dark forms. It is one of the most common and friendly fishes on Kuwaiti reefs, often approaching divers (and spearfishers). It feeds mostly on benthic crustaceans. In the outer reefs some large-sized individuals may be encountered that have escaped the intense spear-fishing pressure.

Minstrel Sweetlip at Qaru • VID

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Twobar seabream at Qaru • VID

Twobar seabream at Qaru • VID

Twobar Seabream

Acanthopargus bifasciatus

This unmistakable bream features a silvery head with two prominent vertical black bars. It is found on all reefs in Kuwait but larger individuals are more common on the outer reefs, such as Mudayra and Qaru. The most frequent sizes are small, showing the over-fishing pressure, 20-30cm. In less fished area it can reach up to 50cm in length.

Twobar seabream at Qaru • VID

Onespot Seabreams and Indo-Pacific Seargents at Qaru • VID

Onespot Seabream

Diplodus sargus kotschyi

One of the most abundant reef fishes in Kuwait. It takes its name from a prominent black spot on the side of the caudal peduncle and it is unmistakable. Although huge shoals are seen on the reefs at Kubbar and all the other two coralline reefs as well, this fish has been observed in many different habitats along the coast, even spawning in Kuwait Bay. Its maximum length reaches 30cm but it usually is found in much smaller sizes.

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Emperors

Emperors of the family Lethrinidae are highly prized for their culinary qualities and their populations have also suffered overfishing. Snubnose Emperor (*Lethrinus borbonicus*) is found in sandy reef areas during the day, or down to the deepest parts of the reef, sometimes in small groups. This fish is commonly about 20 cm in length; rarely attaining maximum length of about 40 cm. It feeds on echinoderms, molluscs and crustaceans and mostly encountered during nighttime in Kuwaiti waters. The Spangled Emperor (*Lethrinus nebulosus*) is found on all parts of the reef and adjacent sandy areas in schools or solitary, this emperor is often encountered just off the deep edge of the reefs in Kuwait. Although commonly, very small fishes (about 20 cm at most) visit the reef, the fish is known to reach a size of 80 cm.

Spangled Emperor at Qaru • VID

Arabian Monocle Bream

Scolopsis ghanam

Moncle breems are big-eyed breams in the Nemipteridae family; this species is one of two common species in Kuwait. With an adult length of 19cm, the Arabian Monocle Bream is very common on all coral reefs in Kuwait. It is one of the most widespread and charismatic fishes on reefs and surrounding sandy areas. It feeds on crustaceans, echinoderms and tiny fishes.

Arabian Monocle Bream at Qaru • VID

Spangled Emperor at Bnaider • VID

Goatfishes

Pearly Goatfish (*Parupeneus margaritatus*) is a very common fish on sandy bottoms in the Gulf. Widespread also in the Arabian Gulf and the Gulf of Oman, this fish, commonly reaches 15-20cm. It often appears reddish and sometimes greyish. Like all bottom dwelling mullets of the family Mullidae, it features a pair of barbels at the tip of its chin, which assist it to find food in the sand, usually small invertebrates. The Freckled Goatfish (*Upeneus tragula*) is also found frequently on most reef areas of Kuwait. Its bright yellow chin barbels help this benthic fish to probe in the sand for its food, usually small invertebrates.

Freckled Goatfish at Bnaya • VID

Pearly Goatfish at Bnaya • VID

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Blackspotted Butterflyfish at Qaru • VID

Blackspotted Butterflyfish

Chaetodon nigropunctatus

Tropical reefs are characterized by their Butterflyfishes! With its brown, deep and laterally compressed body, and its characteristic profile of a distinctly concave snout, this species is a distinctive endemic to Arabian reefs. A range restricted tropical species known only from the Arabian Gulf and Oman. This butterflyfish feeds on coral polyps. It is encountered abundantly on all reefs in Kuwait.

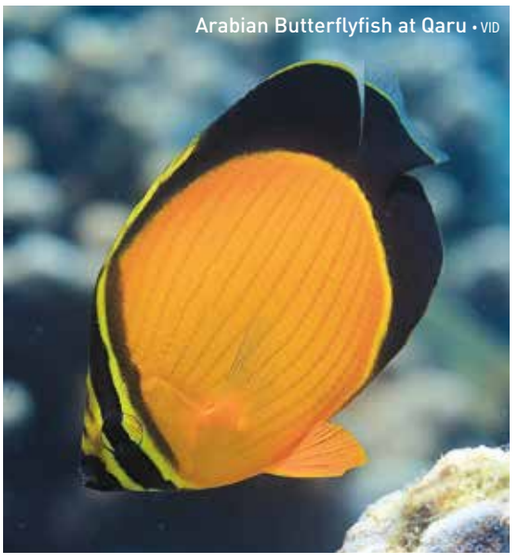
Subadult Arabian Butterflyfish at Qaru • VID

Arabian Butterflyfish

Chaetodon melapterus

With its deep and laterally compressed body, a bright yellow and black body, this beautiful fish is a mascot of Arabian reefs. Usually seen in pairs around the reef areas of Kuwait but also throughout the Gulf and as far around the Arabian peninsula as to reach the Southern Red Sea, it one of the most exotic-looking creatures on our reefs. One of the favorites of scuba divers and coral reef enthusiasts, it appears like a flare among the dark shapes of the corals, where it usually roams in search of food.

Arabian Butterflyfish at Qaru • VID



Arabian Butterflyfish at Qaru • VID

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Longfin Bannerfish

Heniochus acuminatus

Bannerfish are also in the Butterfish family, the Chaetodontidae. This is a common tropical bannerfish widespread in the Indian Ocean. This fish has a unique body pattern and is unmistakable: with the long, curved white dorsal fin, the two thick black vertical stripes on its white body and the yellow anterior fins and caudal fin. It is encountered on reef areas, usually swimming close to the substrate and even around artificial structures where it feeds on small invertebrates. It is common on all reef sites of Kuwait.

Longfin Bannerfish at Qaru • VID

Yellowbar Angelfish

Pomacanthus maculosus

Aesthetically probably the most impressive fish on Kuwait's reefs, mainly due to its electric blue body colour contrasting with the bright yellow bar in the middle. It is also impressive because it is one of the largest exotic-looking fishes seen on the reef, reaching an adult size of 30cm length. This angelfish features different colourations in different stages of life: small-sized juveniles have a totally different colour pattern of parallel white, blue and black stripes and progressively this pattern changes to the colour pattern of the adult. This is Kuwait's only angelfish species, it is very common on all of the country's coral reefs and is seen feeding on invertebrates, often on sponges, within the reef.

Juvenile Yellowbar Angelfish at Qaru • VID

Yellowbar Angelfish at Qaru • VID

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Indo-Pacific Seargent at Qaru • VID

Sind Damselfish at Umm Al-Maradim • ZOG

Yellowfin Chromis at Qaru • ALH

Damselfishes

The Indo-Pacific Seargent is the most colourful and distinctive species of the Damselfish family, the Pomacentridae. It is also the largest growing up to about 15 cm (but usually smaller). It is common and forms large groups on all of Kuwait's reefs. Like the other damselfishes it has a very small mouth and feeds on tiny zooplankton, zoanthids, algae, and barnacles. It forms groups when foraging on plankton in the water column, but will wonder solitary on the reef and inside reef crevasses feeding on a variety of substrates. Males form spawning territories to which they attract multiple female mates; they will dash out into the water column to attract mates. When in breeding nuptial colours males are more intensely coloured.

Damselfishes are the little butterflies of the reef. Several species are found, some of the most common are mentioned here. Sind Damselfish (*Neopomacentrus sindensis*) is another very small damsel, just 7cm in length. It has a bright yellow caudal fin and turquoise outlines in parts of its upper and lower fin areas. This little fish is the most common damselfish on the inshore reefs of Kuwait and abundant on Kubbar and Qaru island reefs also. Yellowfin Chromis (*Chromis xanthopterygia*) is the most common damselfish on the offshore reefs of Kuwait, where thousands of individuals are often encountered, this 11cm long fish breeds during springtime, guarding nests of eggs that are attached to rocks. Slender Damselfish (*Pomacentrus leptus*) is one of the rarest damselfishes on Kuwait's reefs. It is characteristically pale on the upper part of its body making it fairly distinctive and easy to identify. It is found in the shallower parts of some outer reefs.

Slender Damselfish at Qaru • VID

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Parrotfishes

These are one of the most colourful large fishes of the reefs. With strong parrot-like 'beaks" they feed on algae that live on the skeletons of corals. Usually they form roving groups that constantly peck at the coral. When feeding they are sometimes followed by opportunistic wrasses as they forage. Some of them have a wider home range but they are not thought to be territorial. Like many fishes they change sex as they grow. Parrotfishes are protogynous hermaphrodytes, meaning that the fish are all born females and undergo a change into males as the mature. A female can change into a functional male in less than three weeks.

Gulf Parrotfish (*Scarus persicus*) is the commonest of three parrotfish species regularly occurring in Kuwaiti waters. This parrotfish features three colour phases; it changes phase as it matures. Juveniles are brown with a white belly and three whitish stripes on the sides. Changing to intermediate colour phases, it turns bluish pink with irregular green markings on the scales and deep blue-green dental plates as an adult. Adults can reach up to 50 cm in length. This fairly common parrotfish is abundant on Qaru and Mudayra reefs and some other outer reefs. It is rather scarce on the inshore reefs. Bullethead Parrotfish (*Clorurus sordidus*) is a scarcer species but often seen alongside the latter on the outer reefs. As an adult male it is a beautiful brilliant blue and green colour. These fish grow to about 40 cm in length.

Bullethead parrotfish at Qaru • VID

Gulf Parrotfish at Qaru • VID

Gulf Parrotfish at Qaru • VID

Initial phase Gulf Parrotfish at Mudayra • VID

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Black-and-blue Cleaner Wrasse at Qaru • VID

Moon Wrasse at Qaru • VID

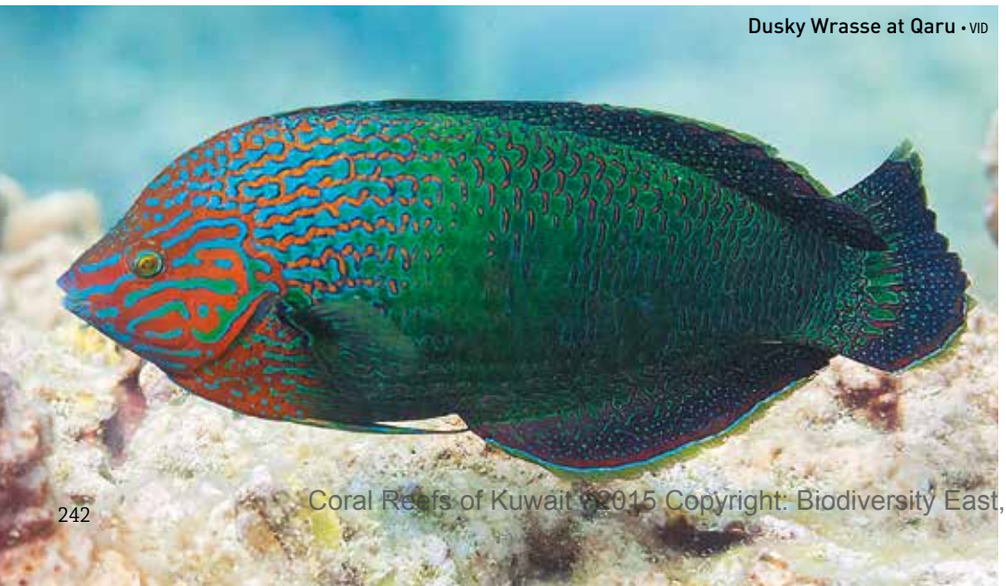
Sub-adult Moon Wrasse at Qaru • VID

Wrasses

Wrasses are one of the most interesting and ingenious inhabitants of the reef; there are many species, here we showcase some characteristic members of the Labridae family. Dusky Wrasse (*Halichoeres marginatus*) has an impressive adult phase, during which the 13cm long male is greenish with dark blue scale centres while the head is reddish with blue and red irregular stripes. This fish is uncommon on most reefs of Kuwait, but is found frequently in Qaru island reef.

Black-and-blue Cleaner Wrasse (*Labrooides dimidiatus*) is another distinctive fish. This wrasse also has two colour phases in its lifetime. Juveniles are black with a bright blue stripe on its upper sides. Adults have a whitish head and body with a black stripe from mouth through eye and along the centre, the body becomes wider posteriorly and extending onto the caudal fin. This fish establishes cleaning stations at specific conspicuous spots for other fish, the parasites and mucus of which are its main source of food. It is found more commonly on the outer reefs of Kuwait, but is rather difficult to locate sometimes.

Moon Wrasse (*Thalassoma lunare*) is probably the most exotic-looking and fastest moving wrasse. This fish features three colour phases during its lifetime, with juveniles being greenish above and white below, a black spot on the tail and a black spot on the middle of the dorsal fin. The subadult becomes pinkish with patterns on its head and the terminal adult phase, during which body length reaches 13cm, is similar to the initial phase but more bluish in colour.



Dusky Wrasse at Qaru • VID

Dusky Wrasse wonderful head colouring • VID

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Blennies

Blennies are small slender fishes that know how to hide well in crevices and holes in the reef. There are several species in the family Blennidae in Kuwait. The Gulf Blenny (*Escenius pulcher*) is the most conspicuous of the blennies on Kuwaiti reefs. The species' "yellow star" around its eye outline is characteristic. This blenny comes in three colour phases which are not related to sex, size or age. One phase is uniform dark greyish brown, another a bicolour phase with dark brown on upper sides and lower sides abruptly white and a vertically bicolour phase, where the front half of the body is brownish-grey and the posterior half is yellow with irregular dark brown bars. It is very common on all reef areas of Kuwait where it frequently is seen half hidden in a small hole with only its head peeking out. It feeds on benthic algae.

The Aden Blenny (*Antennablennius adenensis*) is a tiny nondescript blenny usually about 4 cm long. This blenny is only found in the seas around the Arabian Peninsula and near Pakistan, but is often hard to spot on Kuwaiti reefs. It often hides in tiny holes peeking out, only its head visible. There are other species of blennies some even smaller than the Aden Blenny but they are often well hidden in the corals. Very common tiny blenny-like fishes are the triplefins (*Enneapterygius* spp), also having a maximum size of just barely 4 cm. These tiny specialists are in the Family Trypterigiidae and spend nearly all their lives on the coral, they are common and widespread on all Kuwaiti reefs.

Gulf Blenny (two colour phases) at Qaru • VID

Aden Blenny at Qaru • VID

Triplefin species at Mudayra • ZOG

Triplefin species at Kubbar • VID

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Luther's Shrimpgoby at Salama • VD

Luther's Shrimpgoby at Qaru • ALH

Gulf Gobies at Kubbar • VD

Gobies

A large number of goby species in the family Gobiidae, are resident on reefs. These superficially are a lot like blennies. Some of these species are also very cryptic, and very small; they hide well in the reef corals and sandy flats around the reefs. The most obvious and charismatic of the gobies are the shrimp gobies, usually seen on sandy parts next to the corals. These have a unique relationship with hole-boring shrimp. Shrimp gobies act as sentinels at the entrances of the burrows excavated and maintained by host shrimps and warn the latter of perceived threats through tactile communication. A wide variety of food sources are made available to these shrimps by their goby associates such as prey items, ectoparasites and faecal matter. The most distinctly patterned of these fishes is Luther's Shrimpgoby (*Cryptocentrus lutheri*). This brown and grey barred goby, with 8 dark brown bars on its body and numerous blue spots, lives in association with alphaeid shrimps in a burrow. This is one of the most commonly seen gobies in the sandy parts of all reefs in Kuwait. Another common symbiont is the Slantbar Shrimpgoby (*Amblyeleotris diagonalis*) also found on sandy areas. Finally a very interesting goby on the sands is the Gulf Goby (*Valenciennea persica*) a near-endemic of the Arabian Gulf. It lives in burrows excavated by shovelling out sand with its mouth. Usually found in pairs, living in the same burrow, it does not live with shrimp. It feeds on small interstitial invertebrates by sifting through mouthfuls of sand. A common species in sandy parts of Kuwait's reefs

Slantbar Shrimpgoby at Qaru • VD

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Yellowtail Tang

Zebrasoma xanthurum

Reaching a size of 22cm in length, and coloured deep blue with dark sports on the head, front part of body and belly, this tang features a bright yellow tail, making it truly unique compared to other reef fish. It is found regularly on the reefs of Kuwait.

Yellowtail Tang at Qaru • VID

Sohal Surgeonfish

Acanthurus sohal

This is a species of surgeonfish quite common but localized mostly on Kuwait's outer reefs; it is common on Qaru. A highly territorial species; it feeds mostly on plantlife growing on the dead coral substrates. It will defend its "garden" of algae on a coral head for other herbivores. It dashes in dance-like bounds over the coral heads occasionally stopping to gaze on algae and other plantlife growing among the corals. It has a large venomous spine in the front of the tail fin like most surgeonfish species.

Sohal Surgeonfish at Qaru • VID

Picasso Triggerfish

Rhinecanthus assasi

A rather uncommon fish of Kuwait's outer reefs, it is more frequent on Qaru and Kubbar reefs. Solitary or in pairs, it feeds on algae and wide variety of benthic invertebrates. It blows a jet of water from its mouth at sand to uncover buried prey. Known only from the waters around the Arabian Peninsula, this outstanding reef fish looks as if it jumped out of a painting by Pablo Picasso. It reaches lengths up to 30cm.

Picasso Triggerfish at Qaru • VID

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Whale shark in Kuwaiti waters • MIP

Whale shark in Qatar • ROB

Scaly Whipray (*Himantura imbricata*) at Qaru • VID

Sharks and rays

The Whale Shark (*Rhincodon typus*) is the biggest shark and the biggest fish in the world's oceans. Up to 14 m long and weighing up to 15 tons. Its mouth is at the very front of its head, not on the underside of the head like in most sharks. Like most sharks, females are larger than males.

The whale shark has distinctive light-yellow markings (random stripes and dots) on its very thick dark grey skin. Its skin is up to 10 cm thick. There are three prominent ridges running along each side of the shark's body. This enormous shark is a filter feeder and sieves enormous amounts of plankton to eat through its gills as it swims.

In Kuwait, whale sharks are uncommon visitors on passage spotted in spring and summer months not far from the reef areas of Kuwait such as Al-Khiran, Qaru and Umm Al-Maradim.

Rays are somewhat like flat-bodied sharks. Both rays and sharks belong to the subclass Elasmobranchii. The Elasmobranchs are cartilaginous fishes, meaning they have a boneless skeleton made of a tough, elastic substance, mostly cartilage. These primitive-looking fishes are important predators and today many of their populations have seen dramatic declines and are globally threatened.

Whiprays are related to stingrays in the family Dasyatidae. Usually always solitary. They rest or lay almost buried under sandy substrates often near reefs. They prey mostly on crustaceans and fishes, doing most feeding at night. These fishes shows strong site fidelity, living in the same general area for long periods. Commonly seen on sandy sections of Kuwait's reefs.

The larger stingrays are less common but are one of the most spectacular fishes observed regularly on Kuwait's reefs. Some species in the genera *Taeniura* and *Pastinachus* can reach a disc width of 1.8 m and a length of 3.3. m. The very long tail has a huge venomous spine; although these large fishes are not aggressive care should be taken when one swims very close to them.

Copyright: Biodiversity East, KUFPEC & the photographers

Spotted Eagle Ray at Qaru • VID

The Spotted Eagle Ray (*Aetobatus narinari*) is one of the most awe-inspiring large rays in the family Myliobatidae. Usually solitary or in pairs, it rarely forms schools. It probes sand, coral rubble and dead coral areas to locate bivalves, sea cucumbers, gastropods and hermit crabs. It is a gentle giant, the largest specimens have a disc width up to 2.3 m. The tail is very slender and much longer than the disc, it is armed with 1 to 5 venomous spines at the tail base.

Cowtail Stingray (*Pastinachus sephen*) at Qaru • ROB

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Sharks and rays on Kuwait's reefs; the little that we know

Not long ago, when fish populations were in a natural state, Kuwait's coral reefs were alive with the awesome presence of sharks. Today very few divers or snorkellers have had the fortune of actually seeing a shark underwater. There is no doubt that a decline in shark population has taken place in the waters of the Northern Gulf. These awe-inspiring fishes have not only enthused scientists for many years but also formed the mystical core of many cultures. Their body design, adaptation, survival and resilience made them symbols for strength, power and superiority.

Yet humans have been hunting sharks to extinction in many seas; the shark's culinary value has promoted the mass slaughter of these animals. This imposes a risk of population depletion since they are particularly slow to rebound due to their slow life history characteristics (slow growth rate, late maturation and few offsprings).

Along the Arabian Peninsula utilization of sharks and rays dates back to at least the Iron Age. Remains of different types of sharks and rays, including sawfish, carcharhinid and sphyrnid sharks, were recorded in archaeological findings along the coasts of the Arabian Peninsula. The most important parts of sharks and rays that are consumed locally are the meat and liver. Shark meat was regarded as poor quality meat but was mostly used due to its good preservation quality. Once the meat is dried under the sun, its storage life extends for many months to years. This made it suitable for consumption in long seafaring trips and as a fish supply for residents of inland deserts. On the other hand, the shark's heads and rotting meat were used as a fertilizer for date palms. Shark's liver was also utilized locally. The extracted liver oil (known locally as *Sell*) was used to coat the hull of wooden boats to protect it from marine fouling. Sharks' liver oil was also used in cosmetic and as a healing product for skin and joints. As a cosmetic, the liver was used to produce *Kohl*, a dark material used to contour the eyes. According to Um Hamad, a wife of an Omani shark fisherman, livers of different shark species produce different qualities of *Kohl*. She later explained that the liver of hammerhead sharks is the worst as they have a burning effect on the eye. Sharks' liver oil was also used to heal joint pain and skin disease.

Up to date research focusing on sharks and rays is scarce in the Gulf; most of what we know is a product of trawling surveys that aim to assess marine resources. The first survey that focused on sharks and rays was conducted by Alec Moore, who recorded the occurrence of a total of 26 shark species and the possible occurrence of a further 17 shark species. His work covered multiple landing sites including; Kuwait, Qatar and UAE. This survey not only provided an updated checklist for local sharks species diversity, but also rediscovered the presence of the Smoothtooth Blacktip (*Carcharhinus leiodon*) from Kuwait. *Carcharhinus leiodon* was only known from a single specimen collected from Yemen in 1902. Later, Rima Jabado confirmed the occurrence of three shark species, which were added to the list. Her work was based on conducting seasonal surveys at the main shark landing sites in the UAE.

Moore has also reported a geographical difference in the abundance of sharks and rays along the Arabian Gulf. For example he noted that, *Carcharhinus leiodon, Rhizoprionodon oligolinx* and *Aetobatus flagellum* are more common in the waters of Kuwait. While *Carcharhinus dussumieri* is more abundant in Kuwait, Qatar and Iran but not as much in Oman. On the other hand, *Loxodon macrorhinus* is absent from Kuwait but relatively abundant in Qatar, Abu Dhabi and Oman. Kuwait seems to show different abundance of sharks and rays which could be a result of its proximity to the fresh water

Dried shark meat

Shark slaughter in Oman (both photos by Dareen Almojil)

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Blacktip Reef Shark in Palau (SIM)

input from the Shatt al Arab that also makes the water more turbid and highly nutritious.

In Kuwait the most commonly occurring sharks today are small shark species (<100 cm total length) such as the Milk Shark *Rhizoprionodon acutus* and the Whitecheek Shark *Carcharhinus dussumieri*. The most commonly occurring rays are the cownose rays *Rhinoptera* spp. and whiprays *Himantura* spp. Sharks and rays migrate so it is important to consider the broader region beyond Kuwait's reefs. Based on the little we know from catches of demersal trawl surveys it is believed that the abundance of sharks and rays increases during the warmer months of May- June and decreases during October-November. For example, the Arabian Carpet Shark *Chiloscyllium arabicum* and the Spot-tail Shark *Carcharhinus sorrah* are reported in higher densities during spring. While larger sharks (>2 m) start to appear in the waters of Kuwait between June-August, this includes the Whale Shark *Rhincodon typus*. Moreover, the great hammerhead is reported to occur between April-October. It is suggested that Kuwait Bay acts as a pupping ground for this species, as fishermen have reported seeing gravid females of the Great Hammerhead *Sphyrna mokarran* swimming in Kuwait Bay on multiple occasions. The Sand-tiger Shark *Carcharias taurus* is occasionally encountered in Kuwait and mostly reported in spring and summer.

Rays are seen more frequently than sharks on Kuwaiti reefs. And it is an astonishing experience to come face-to-face with the spotted eagle ray – a gentle giant that is quite common on the outer reefs. Rays and skates seem to show more seasonal variation in abundance than the sharks. For example, the electric ray, *Torpedo* sp., is reported to occur more frequently in winter. Yet, based on personal observations from the fish market in Kuwait, the cow-nose rays are more dominant in landings around April. Most of these records are based on occasional sightings or demersal trawl surveys for marine resources monitoring. Given the paucity of data on local sharks and rays, there is a clear need for basic information on their biology, ecology and migration along the Gulf. These studies will form the basic scientific pillars needed to design effective management plans.

With a stroke of good fortune, important steps were recently made to protect sharks in Kuwait. Currently the existing shark and ray related legislation in Kuwait prohibits fishing, display and sale of all sharks and rays except for the Graceful Shark *Carcharhinus amblyrhynchoides* and the Grey Sharpnose Shark *Rhizoprionodon oligolinx*. These two species are morphologically hard to distinguish from other similar species and seem to be selected based on a random measure. This legislation was released in 1980s but was not enforced until April 2011. In 2011 a complete ban on landing sharks or rays in local fishmarkets was actively enforced and efforts of the Public Authority for Agriculture Affairs and Fish Resources were visible. Such regional efforts are very much needed to sustain the ecological integrity of the Arabian Gulf.

by ***Dareen Almojil***
Marine Biologist and Molecular Ecologist

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Hydrophis sea snake at Fuwairit, Qatar • YIS

Sea snakes

Serpents of the reefs

According to the IUCN, approximately eight per cent of sea snake species have been classified as endangered, while a third are "data-deficient". We do not know enough about these animals to know how threatened they may be. Sometimes entire species are known only from one or two specimens. Because many live in remote seas and may seasonally migrate, it is only through incidental capture in fishing trawler nets that some species are known at all.

Completely aquatic, the sea snakes of the Arabian Gulf are all from the genus *Hydrophis*, referred to as true sea snakes.

Like most sea snakes, the tail of these species is flattened and paddle-like, and helps to propel the snake through the water. They live for 10 to 15 years. Females start giving birth after two years, to live young rather than laying eggs, and produce three to 15 offspring every year or two. They have to come to the surface to breathe. Highly venomous –but not aggressive to humans– sea snakes are common in some parts of the shallow waters of the Arabian Gulf. They feed on small fish such as gobies, sometimes entering their burrows in the seabed to snag the occupant. Sea snakes can remain underwater for up to two hours before surfacing to breathe.

Of the roughly 70 known species of sea snake, only five or six live in Kuwaiti waters. They are really large snakes, they

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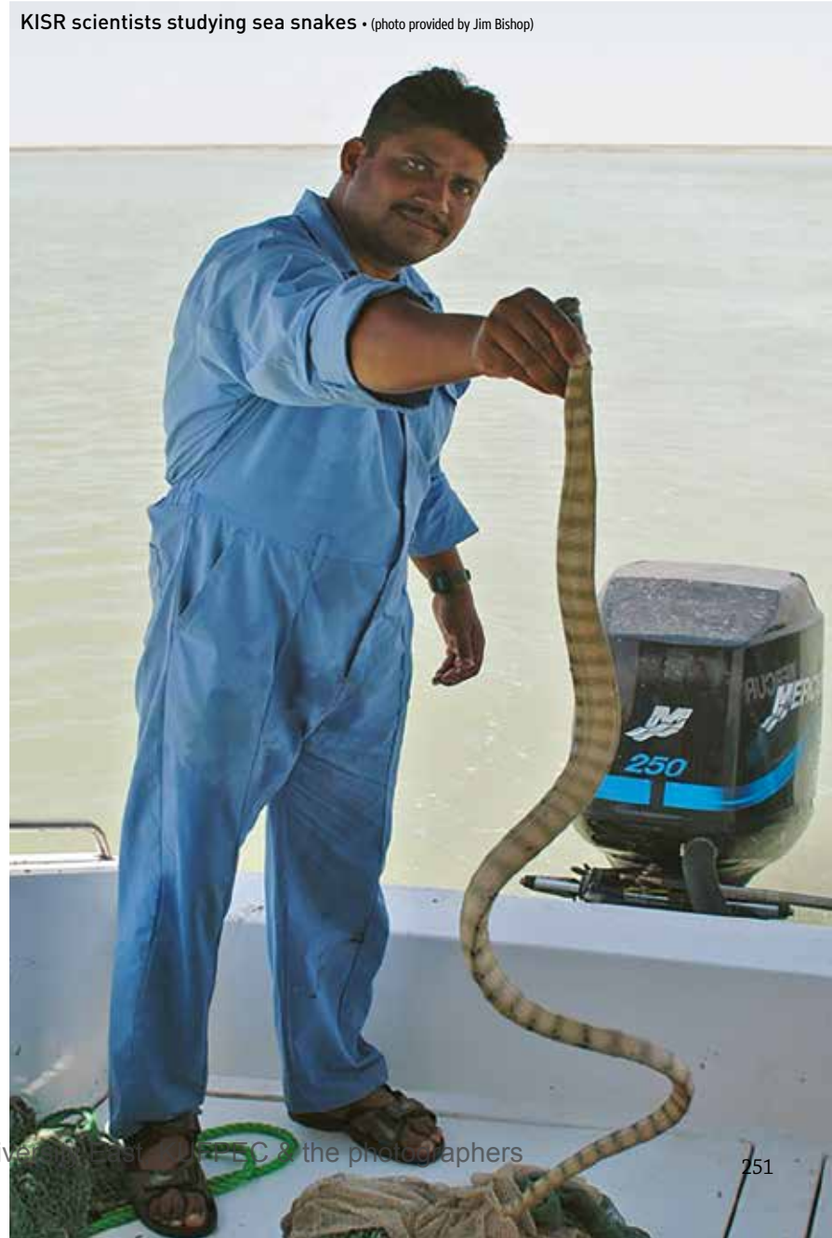
For a breath of air at the surface • ROB

grow up to two metres long and are usually to be found near coral, attracted by the abundance of food.

Their venom is reported as being 10 times more toxic than that of the King Cobra, but the good thing is that they have small heads and cannot open their mouths as widely as that of a terrestrial snake. There are very few incidences of sea snake bites here in the Gulf or globally. They do not attack or bite, even if you are in close contact with them on the beach or underwater. Their fangs are inwardly directed, so they do not have the muscles to bite effectively while striking. They would have to chew your finger, which they would do if they got defensive or angry. In the unlikely event that someone is bitten, they need to get to a hospital as quickly as possible. Respect not fear is what is needed when one is around these fascinating sea serpents.

Sea snake in trawler catch in Kuwait • (photo provided by Jim Bishop)



KISR scientists studying sea snakes • (photo provided by Jim Bishop)

Coral Reefs of the World 2010 Copyright: Biodiversity Press, UNEP-WCMC & the photographers

Hawksbill in Qaru waters • ALH

Sea turtles

Mysterious ancient creatures in need of protection

Sea turtles are air breathing marine reptiles that inhabit most of the world's seas. All sea turtles, except one, the Leatherback, have a hardened shell covering their body. The upper part of the shell is called the 'carapace' while the lower shell is called the "plastron". Sea turtles cannot retract their head inside their shell like tortoises do. Sea turtles have modified 'beaks' instead of teeth, which are adapted for their particular diet consisting of jellyfish, crustaceans, molluscs, coral and, in the case of the Green Turtle, seagrass.

Sea turtles live all their lives in the sea, and only females come ashore to nest, usually on the same beach where they were born themselves. Males never return on land.

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Male Hawksbill swimming around Qaru • ALR

Why are sea turtles important?

They have lived on the planet for more than 100 million years and are therefore a symbol of connection between past and present for marine ecosystems.

Most species clean coral reefs from dead or sick organisms so the reef can develop in a healthy, sustainable way. They are a food source for larger predators in all stages of their life cycle.

Life Cycle

Sea turtle hatchlings hatch from their eggs that are laid deep in the sand by their mothers 55-60 days beforehand. Once out of their eggs, they dig their way upwards, try to avoid crabs and hungry birds which chase them, and head to the open sea. They swim and feed there for several years, until they become adults.

Hawksbill sea turtle breathing above Kubbar's reef • VID

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Hawksbill sea turtle returning to the water at Qaru • VID

It is then time, at 20-35 years of age, according to the species, to head back to the waters near the shores where they were born, in order to mate and lay eggs again. Sea turtles nest every two or three years, usually laying two to four egg clutches during nesting season. Between nesting years, they may travel hundreds, even thousands of kilometers in search of food.

Sea turtles travel for long distances, crossing borders among countries, either to feed or to nest. Therefore, it is important to protect sea turtles at all stages of their life cycle, and cooperation between countries is necessary.

Many hatchlings, few survivors

A female turtle can lay up to 150 eggs every time she nests. But even in natural conditions, it is estimated that only one or two in a thousand hatchlings will survive to adulthood. Crabs, birds and other animals may eat the babies as they crawl towards the sea, and fish may eat them in the water. Human activities, such as polluting beaches and artificial illumination of nesting beaches diminishes the chances of survival even further.

Where do they live?

There are seven species of sea turtle found around the planet, two of which have very restricted distributions. In the Arabian seas, five species of turtle can be found: The Green, the Hawksbill, the Loggerhead, the Leatherback, and the Olive Ridley. Apart from the big black Leatherback Turtle that inhabits the open seas, all other species mostly live in continental shelf waters.

Threats to the turtles

- Habitat loss and degradation, mostly to beach construction of all sorts.
- Human consumption of turtle eggs and meat.
- Accidental capture in fishing gear.
- Pollution of their home: seas and beaches.

What is Satellite Tracking?

Satellite tracking, or 'satellite telemetry' involves attaching a special piece of tracking equipment (transmitter) to a sea turtle's carapace (shell). The transmitter sends a message to a satellite each time the turtle comes to the surface to breathe. Messages are received by the satellite that calculates the loca-

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Baby Hawksbill takes to the water leaving Qaru • VID

tion of the turtle, which can be plotted on a map.

We track sea turtles because they are highly migratory animals, feeding and living in one place but breeding and laying eggs in another place that may be hundreds of kilometers away. Of the five species of sea turtle found in the gulf, the Hawksbill is listed as Critically Endangered, the Green Turtle, like the Loggerhead is listed as Endangered and the Olive Ridley and Leatherback are listed as Vulnerable.

Satellite transmitter on a Hawksbill sea turtle • NPA

To date we have tracked four Hawksbill Turtles from their nesting sites of Qaru and Umm Al-Maradim and they each moved to separate coastal areas around Kuwait and Saudi Arabia. Hawkbills nesting in Kuwait therefore do not have a single preferred feeding and over wintering area in Kuwait, which is similar to findings from other tracking work undertaken elswhere in the Gulf.

Scientists place transmitters on Kuwaiti sea turtles • NPA

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Indian Reef Heron • MIP

Birds

Feathered visitors

Lesser Crested Terns • MIP

Reefs are visited by a variety of birds. Since many wading birds and waterbirds migrate along Kuwaiti shores they often gather near beaches and near the corals or stop to rest on coral islets. Many fish-eating seabirds are attracted to the coral reef since they find small fishes in abundance there. These include herons and egrets such as the Indian Reef Heron (*Egretta gularis*). Reef herons are one of the most elegant herons and come in two colours forms, light and dark morphs.

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Socotra Cormorant taking off • VID

Of the diving seabirds, the most characteristic and fiercest of all fishers is the cormorant. Two species regularly visit the reefs, one of them is really significant because it is a distinctive Arabian species – restricted the coasts of Arabia and Socotra – it is called the Socotra Cormorant (*Phalacrocorax nigrogularis*). This species is classified as Vulnerable by IUCN and disperses north in spring, summer and autumn from its breeding grounds in the central Arabian Gulf.

Socotra Cormorant from below the surface • VID

Socotra Cormorant • MIP

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Bridled Tern wetting feathers to moisten their nestlings • MIP

Eurasian Blackcap on Qaru • VID

Tern nestling and eggs on Kubbar • HBO

The most elegant flyers above the reefs are the terns. Both on Kubbar and Umm Al-Maradim islands huge colonies of tropical terns nest in late spring and summer. These feed by plunging into the water surface to gather small fishes. In winter and during migration various gulls and terns also visit the coral reef beaches.

During both spring and autumn migration the reef islets are also visited by many terrestrial birds that have nothing to do with reefs. They are just looking for a place to rest for a few hours on their long-distance migrations. It is really surprising how dozens of species may congregate on a tiny islet like Qaru or Umm Al-Maradim on a single stormy April day.

Kestrels on Qaru • VID

The rare Corncrake on Qaru • VID

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White-cheeked Tern feeding young • VID

Slender-billed gulls and Lesser Crested Tern on a coral beach • MIP

Coral Reefs of Kuwait - 2015 Copyright: Biodiversity East, KUFPEC & the photographers

Bottlenose dolphins off Qaru • VID

Dolphins and other cetaceans

Intelligent beings

Bottlenose dolphins off Qaru • ZOG

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Most larger marine mammals that enter Kuwait's waters such as whales rarely come really close to the shallow parts of the coral reefs. Dolphins however do. Two species of dolphins are commonly sighted, the larger Bottlenose Dolphin (*Tursiops truncatus*) and the Indo-Pacific Humpback Dolphin (*Sousa chinensis*).

The Bottlenose Dolphin lives in social units of 5 to 15 individuals; sometimes joining together with other groups to form pods of over a hundred animals. They are famous for using echolocation to find and capture prey (fishes, squid, benthic invertebrates).

Apart from these two characteristic dolphins we should not forget that there are several other cetaceans in Kuwaiti waters, sometimes they do wonder into the shallows. One of the scarcest and least noticeable of these sea mammals is the Finless Porpoise (*Neophocaena phocaenoide*).

Humans will always be enthralled and awe-inspired whenever dolphins and porpoises are sighted. They are uniquely intelligent and sensitive beings. Since these mammals are at the top of the food chain, their health is an indicator of healthy seas.

Indo-Pacific Humpback Dolphins at Kubbar (all the photos on this page)

An underwater galaxy of plankton at Qaru • YIS

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Appendices

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Glossary

This account briefly helps define some of the terms used in this book.

Artificial Reef: a human-made underwater structure, typically built to promote marine life in areas with a generally featureless bottom, to control erosion, block ship passage, or improve snorkelling/scuba diving.

Atoll: a ring shaped coral reef that grows upward from a submerged volcanic peak and encloses a lagoon; may support low-lying islands composed of coral debris.

Barrier Reef: a coral reef that parallels the shore but is separated from the landmass by open water

Biogenous: originating from living organisms.

Buoy: a floating object anchored to the sea bed or attached to another object; used as a navigational aid or surface marker.

Coral(s): the skeletal formations secreted by small marine polyps; their unique form makes them easily mistaken for plants.

Coral Bleaching: the loss of intracellular endosymbionts (Symbiodinium, also known as zooxanthellae) through either expulsion or loss of algal pigmentation.

Coral Carpets: consist of laterally thin, but continuous frameworks of coral that do not reach the water surface. Coral carpets do not develop into reefs because of the following conditions: a) underlying flat (usually sandy) topography and b) the intense disturbance of the local coral community by climatic, oceanographic or other perturbations.

Coral Cay (or Coral Key): is a small, low-elevation, sandy island on the surface of a coral reef.

Coral Polyp: a tiny animal that looks like an upside-down jellyfish; a benthic cnidarian that can exist individualy or in colonies and may secrete external skeletons of calcium carbonate.

Coral Reef: formed when hundreds of hard coral colonies grow next to and on top of each other; a mainly calcareous reef composed substantially of coral, coralline algae, and sand; present only in waters where the minimum average monthly temperature is 18 °C or higher.

Current: a steady horizontal movement of water or air in a definite direction; ocean currents flow in complex patterns affected by wind, the water's salinity and heat content, bottom topography, and the Earth's rotation.

El Niño: an episodic movement of warm surface water south along the coast of Peru associated with the cessation of upwelling in this region.

Fringing Reef: a reef that is attached to the shore of an island or continent with no open water lagoon between the reef and the shore.

Hatchery: a place where eggs are deposited and hatch in higher densities than elsewhere.

Lagoon: a shallow body of water, seperated from the sea by sandbars and/or coral reefs.

Larva: the newly hatched, earliest stage of any of a variety of animals that undergo metamorphosis.

Marine Protected Area: essentially a space in the sea, where human activities are more strictly regulated than the surrounding waters - similar to parks we have on land.

Migrate: to change location periodically, usually seasonal.

Mollusc: marine invertebrate, from the phylum Mollusca.

Ocean Acidification: a reduction in the pH of the ocean over an extended period time.

Overfishing: harvesting a fish population at a rate exceeding the maximum harvest that would still allow this population to maintain itself at current levels through reproduction.

Patch Reef: small reefs, only a few meters to a few tens of meters in extent. They are distinguished from other hard substratum by being made up entirely by reef-building coral.

Photosynthesis: the process by which chlorophyll-containing cells in green plants convert light to chemical energy and synthesize organic compounds from inorganic compounds, accompanied by the release of oxygen.

Predation: capture and consumption of prey as a means of sustaining life.

Red Tide: ocean waters coloured by the dramatic increase of dinoflagellates that cause fish kills and paralytic shellfish poisoning.

Reef Balls: is a Designed Artificial Reef used to restore ailing coral reefs.

Reef Base: the area below the consolidated slope extending up to 1 km but no deeper than 50 m.

Reef Flat: the horizontal upper surface of a coral reef.

Reef Slope: found at the outer edge of the fringing reef, closest to the open ocean. This area of the reef is often quite steep and descends either to a relatively shallow sand bottom or to depths too great to allow coral growth.

Salinity: a measure of the quantity of dissolved salts in ocean water; defined in terms of the conductivity of a salt solution. Higher salt concentrations are more likely in arid regions where water evaporates leaving the same amount of salt in less water and thus increasing the salinity.

Satellite Telemetry: involves following an object on the Earth's surface through the use of orbiting satellites. Researchers use this technology to track the migratory patterns of marine animals such as sea turtles, sharks and rays in the world's seas.

Symbiosis: an association between two species in which one or both benefit. A species in such an association that does not benefit may be harmed or may be unaffected by the association.

Undercurrents: a current below another current or beneath a surface.

Upwelling: a current of cold, nutrient-rich water rising to the surface. Upwellings are caused by strong seasonal winds and currents moving surface coastal water out from the coast and leaving a space that the upwelling fills in. Many marine plants and animals live off this nutrient-rich water.

Zooxanthellae: a form of algae that lives symbiotically in the tissue of corals and other animals and provides some of the coral's food supply by photosynthesis.

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How to dive and snorkel on the reef

These guidelines are adapted from the Coral Reef Alliance (CORAL). Website: http://www.coral.org © 2005 CORAL

Divers and snorkellers are some of the strongest and most effective advocates for coral reef conservation. Please follow these simple guidelines to become a "coral friendly" diver. Good divers know that the best way to enjoy a reef is to slow down, relax and watch as reef creatures go about their daily lives undisturbed.

AS A RESPONSIBLE VISITOR TO THE REEF

- For your vacation, choose an environmentally friendly resort or hotel; one that practices energy conservation, recycles, and treats sewage and solid waste in responsible ways.
- Choose coral friendly dive and snorkel operations that practice reef conservation by:
  - Giving environmental briefings.
  - Holding buoyancy control workshops.
  - Using available moorings.
  - Using available wastewater pump-out facilities.
  - Actively supporting local coral parks wherever they exist.
  - Participating in local conservation projects.
  - Paying user fees or make a donation when visiting coral parks and other marine conservation areas.
- Avoid purchasing souvenirs made from coral, turtles or other marine life—this is often illegal, and it is never environmentally wise.
- Learn all you can about coral reefs—they are fascinating and fragile environments.

IN THE WATER

- Never touch corals; even a slight contact can harm them and some corals can sting or cut you.
- Carefully select points of entry and exit to avoid sensitive areas of the reef.
- Make sure all your equipment is well-secured.
- Make sure you are neutrally buoyant at all times.
- Maintain a comfortable distance from the reef.
- Practice good finning and body control to avoid accidental contact with the reef or stirring up the sediment.
- Stay off the bottom and never stand or rest on corals.
- Take nothing living or dead out of the water, except recent garbage.

MINIMIZE CONTACT WITH MARINE LIFE

- Never chase, harass or try to ride marine life.
- Do not touch or handle marine life.

PHOTOGRAPHY & VIDEOGRAPHY

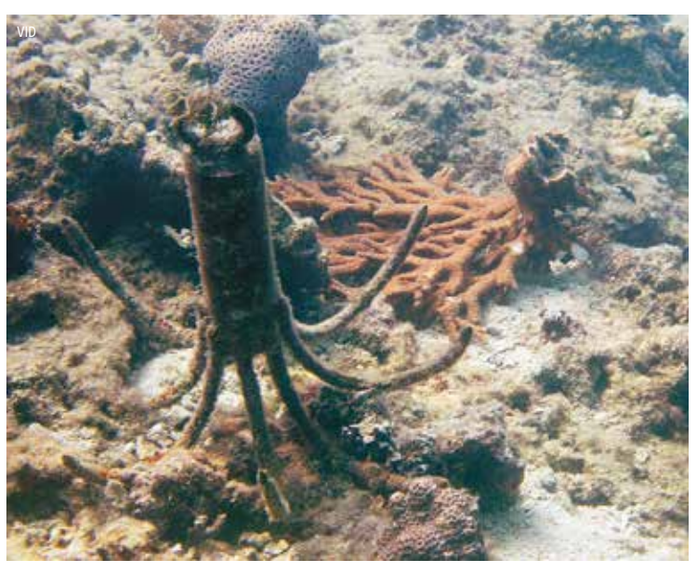
Divers need advanced diving skills to take pictures and video underwater. Photographic and video equipment is cumbersome and affects a diver's buoyancy and mobility in the water. It is all too easy to touch and damage marine life when concentrating on "the perfect shot."

ON DIVE BOATS

- Choose dive and snorkel operations whose boats make use of available moorings—anchors and chains destroy fragile corals.
- Make sure garbage is well stowed, especially light plastic items and cigarette butts.
- Be sure to take away everything you brought on board, such as packaging, used batteries and bottles.

SHORESIDE

- Support protected areas and other conservation projects.
- Visit established protected areas and pay applicable user fees that support marine conservation.
- Encourage and support the use of dive moorings.
- Participate in local initiatives to monitor the marine environment.
- Participate in cleanups.
- Make a donation or volunteer your skills to support a protected area. For example, you can participate in a reef survey, conduct outreach, or help educate others about coral reef conservation.
- Donate used equipment such as cameras, dive gear or reef identification books.
- Speak up. Make sure your dive and snorkel buddies understand these simple but important conservation practices.



Acropora corals destroyed by anchor damage on a Kuwaiti reef: Please help stop this!

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Arabian Butterflyfish at Qaru • VID

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