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KALUOKA'HINA

THE ENCHANTED REEF

TEACHER'S GUIDE

REEF DISTRIBUTION PRESENTS „KALUOKA'HINA, THE ENCHANTED REEF"
OTTO SANDER DANIEL FEHLOW WOLFGANG VÖLZ
WRITTEN AND DIRECTED BY PETER POPP ORIGINAL MUSIC BY FLORIAN KÄPPLER & DANIEL REQUARD PRODUCTION MANAGER DAVID MAAS
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EXECUTIVE PRODUCER SOFTMACHINE GMBH

www.kaluokahina.com

"The prerequisite for knowledge is curiosity"

Jacques Cousteau
French marine biologist
1910-1997

Kaluoka´hina
The Enchanted Reef

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KALUOKA'HINA

the enchanted Reef

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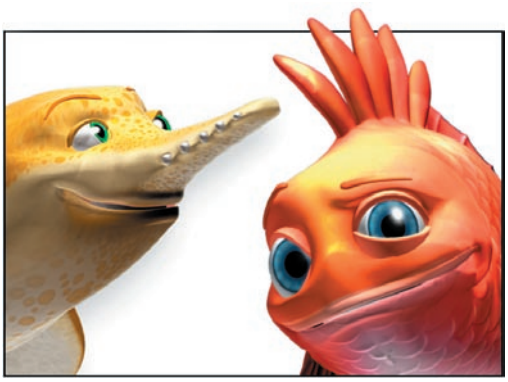


Jake and Shorty, the heroes of our film

The Teacher's Guide

Kaluoka'hina, the Enchanted Reef is the first "family entertainment" feature film produced originally for 360o dome projection cinemas. The teacher's guide contains exciting background information about themes such as coral reefs, volcanism, kelp forests, and bioluminescence, as well as about the interplay between marine fauna and planetary constellations. This companion booklet serves as an info source for all who are interested in these topics, but it may also be used to acquaint students with themes that appear in the movie. Nonetheless, the teacher's guide stands by itself as an educational resource independent from the movie.

The Story of the Movie "Kaluoka'hina – The Enchanted Reef"

The vastness of our planet's oceans guards unimaginable secrets. One of its most precious is "Kaluoka'hina", the enchanted reef whose magic protects it against humans finding it. Kaluoka'hina's colorful inhabitants have thus always lived in peace... until the volcano erupts, and the spell is broken.

Now it's up to the young sawfish Jake and his paranoid pal Shorty to restore the magic of Kaluoka'hina. Their only lead: the ancient legend that tells of touching the moon…

CORAL REEFS – COLORFUL WORLDS UNDERWATER

This chapter offers the reader basic knowledge about corals, their lifecycles, nutrition, incidence, and particularities, as well their ecological endangerment and their significance to people.

One of the main characters in "Kaluoka'hina, the Enchanted Reef" is the coral reef itself – a fascinating and multicolored world that Jake and Shorty call "home." A coral reef is an entire and individual cosmos full of amazing mysteries and exciting questions.

Are corals actually plants or animals?

Corals are neither plants nor stones; they are close relatives of jellyfish, and belong therefore to the phylum (animal branch) of the coelenterate (hollow animals). Each single coral consists of hundreds, sometimes thousands, of tiny animals, or "polyps."

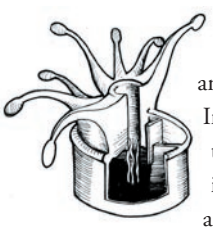
There are two reasons why corals are categorized as animals: even though polyps don't have something like a brain, they do, as opposed to all plants, have a nerve network. And, also different to plants, which produce their food themselves, corals are forced to search for food sources in their environment.

Do corals have a particular way to take in food?

Corals are meat-eaters and have poisonous tentacles, which they use to capture small living beings (plankton) that coincidentally pass by. These "meat meals" have, however, only a small part in the coral's menu.

Their main nutritional source is something else: namely microscopically small plants or algae. Corals and alga have found a clever solution to provide each other with food: millions of algae live inside each coral. Similar to all other plants, algae use the energy of the sun to feed themselves. Algae, during the transformation of solar energy into food (photosynthesis), produce, among others, sugar and oxygen, which the corals use. The sugar is taken up by the corals as food, and the oxygen (just like humans do), is used for breathing. As the corals breathe, they produce carbon dioxide, which, in turn, is used by the alga for their photosynthesis.

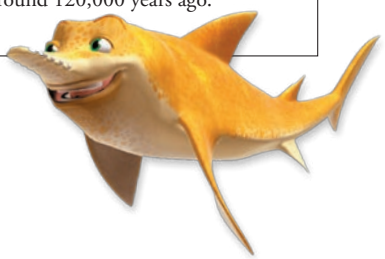
On top of that, algae are also responsible for giving corals their bright and beautiful colors. In turn, corals offer their bodies as housing and a hideout for algae against hungry enemies – a real practical alliance. Such an alliance between two living beings in nature is referred to as "symbiosis."



Cut through a coral-polyp

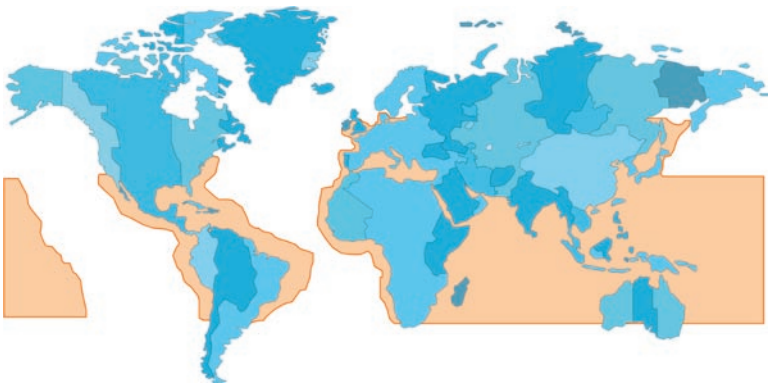
Did you know?

Coral reefs have existed for more than 150 million years on the "blue planet." In comparison, Homo Sapiens first appeared on the world stage around 120,000 years ago.



Can corals live everywhere in the ocean?

Corals are very delicate animals and require very specific environmental conditions.



To feel really well, corals need warm, flat, and clear water. They like temperatures between 18°C and 29°C, and love sunlight. Corals find these requisites mostly in flat, coastal waters. That's why coral reefs are only found in the immediate proximity of coasts, and in tropical regions, like the Caribbean, the Indian Ocean, the Pacific and the Red Sea.

How big are coral reefs actually?

Coral reefs can reach immense sizes: the "Great Barrier Reef," found near the east coast of Australia is the largest coral reef in the world. The reef, which can actually be seen from outer space, has a length of over 2023 kilometers and covers an area of 300,000 square kilometers. The enormous Great Barrier Reef offers more than 1,500 different kinds of animals a home. But only 0.2% of the world's total sea expanse is taken up by coral reefs, which consists of an area of 600,000 square kilometers. In comparison: Germany has a total area of 357,022 square kilometers.

Do all reefs house so many different kinds of animals?

Coral reefs count as one of the most biodiverse (species-rich) ecosystems in our planet. They are only surpassed in biodiversity by tropical rainforests. It is not uncommon therefore to refer to coral reefs as "rainforests of the seas," since corals alone count for over 40,000 different kinds of species.

Moreover, coral reefs are like the "land of milk and honey" for almost all ocean inhabitants, as they offer immense food resources and an ideal living space, offering in fact housing to 25% of all ocean inhabitants (almost all kinds of fish, crustaceans, sea grass, reptiles, bacteria and fungi), who find their home in coral reefs.

What do coral reefs offer mankind?

Human beings have attributed corals with healing and protection powers ever since time immemorial. Already in ancient Egypt were corals used as grave ornaments, to protect the dead from evil spirits. In the middle ages, corals were used as all-healing medicines for various illnesses. Even today, corals play an im-

A satellite photo of the Great Barrier Reef in Australia

portant role in the production of diverse medicaments. For example, AZT, which is a medication used in HIV-treatment, is made up of a chemical substance that's entirely gained from a specific coral.

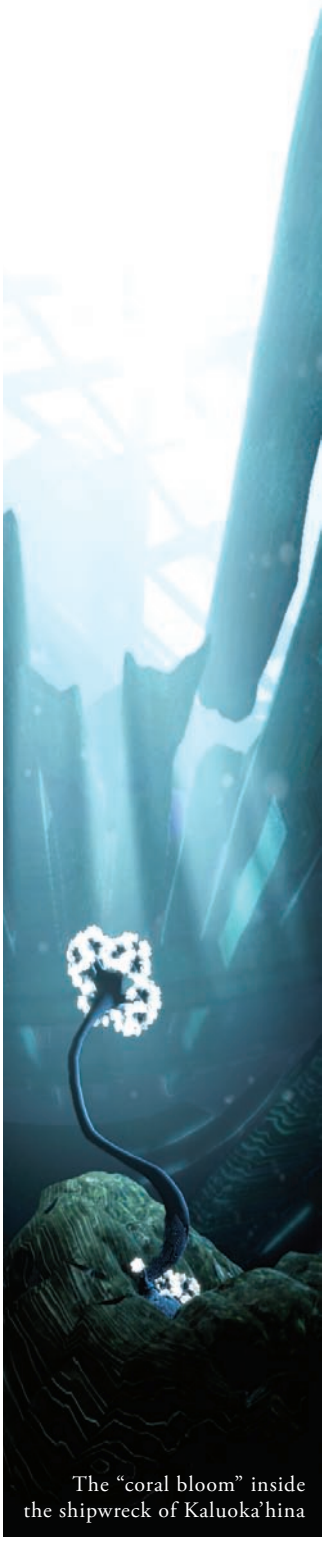
Of course do human beings also use corals as food sources. For example, in South-East Asia, coral reef fishery covers 25% of the protein requirement of the entire coastal population. On top of that, spread out coastal coral reefs offer a natural protection against approaching storms.

Do human beings endanger coral reefs?

Coral reefs are extremely sensible ecosystems. Mankind's intervention deteriorates reefs' conditions increasingly. A main problem is human sewage, which is carried by rivers into the sea. This sewage doesn't only carry harmful substances, but also promotes the growth of algae and seaweed. Algae and seaweed are far tougher and resistant than corals, and can overgrow them, causing corals to perish.

The sedimentation of slime carried by rivers, coral reef over-fishing, and worldwide climate change are also major threats for the highly sensitive animals. The climatic phenomenon of water-warming which occurs every four to six years, caused by El Niño, brings about the so-called "coral bleaching." This coral bleaching, in turn, leads many corals to die.

WHEN THE MOON MAKES THE CORALS BLOOM



The "coral bloom" inside the shipwreck of Kaluoka'hina

This chapter offers the reader basic knowledge about the fascinating way in which corals reproduce, the so-called "coral bloom," and explains the interplay of different factors which cause the corals to bloom.

Kaluoka'hina is a peaceful world where its colorful inhabitants live in harmony with nature – a nature with a breathtaking beauty. One of the most captivating displays that the reef offers year after year is the both multicolored and spectacular coral bloom.

Are there both male and female corals?

Certainly, since corals are animals. And just like with all animals, corals are either male or female. That means: there are kinds of corals which produce only egg cells, while other kinds of corals make only sperm cells. Yet, the majority of corals are hermaphrodites. These kinds of corals produce both egg cells and sperm cells within a single creature.

How do corals reproduce?

Corals have at their disposal two very different ways to reproduce themselves.

They can reproduce asexually through budding: the adult polyp divides itself bringing about a genetically identical clone, an identical twin. The daughter polyp stays and grows together with its parent polyp. When the daughter polyp grows up, it divides itself anew, resulting in a new clone. Another type of asexual reproduction occurs when storms cause individual coral pieces to break. Usually, these coral pieces survive, continue to grow and form a new colony.

Corals can however also reproduce sexually – they spawn. The extraordinary and amazing phenomenon during which corals simultaneously release their sperm and egg cells is called "coral blooming." This unique display was first discovered in 1981 by Australian marine biologists: within a few seconds and only during a very specific time of the year, corals release millions of tiny egg cells and sperm, which sparkle and ascend slowly to the water's surface like Champagne bubbles. When a sperm cell and an egg cell unite, an embryo forms within 24 hours. The baby coral sinks after about five days towards the bottom of the sea and continues its grow there.

How can corals bloom together and at the same time?

It is really sensational! Coral blooms occur year after year during spring after the onset of darkness in the week after full moon, namely during the time of equinox. Such a recurring behavior in the animal world, which always takes place at an exact time, is called a "synchronized behavior."

Scientists have discovered, that three triggers cause this synchronized behavior for all types of corals:

The first trigger is the slowly increasing water temperature during spring, which brings egg cells and sperm cells to mature at specific time of the year. A very specific water temperature must be reached for corals to be ready to spawn.

The second trigger is the time of day. Corals apparently need the darkness of the night to reproduce.

The third trigger is the moon phase.

Coral reef
during the night

The position of the moon coordinates the exact time during which the corals release their precious cells to the ocean. Of course, it is not moonlight that triggers the nightly spectacle; instead, it is the moon-influenced tides (more on this topic in the next chapter). The coral bloom always occurs about five days after full moon. Ebb and flow have the smallest difference during this moon phase. Thus, the water is calmer; there are less currents, and weaker whirlpools. This is the best time for corals to reproduce, since the calm seawater allows for the egg and sperm cells to leisurely drift in the water and to unite.

Why do corals reproduce in this way and not in another?

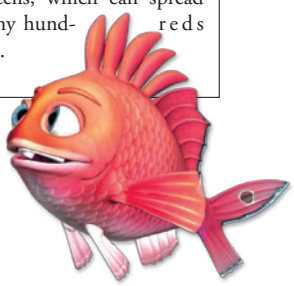
Nature has functional and useful reasons for everything that she bears; likewise, for the synchronized behavior of the coral bloom. If the coral bloom would take place at a different time, then the sea currents would be too strong and the chances for egg cells and sperm cells to unite would sink drastically. Scientists also suspect that the simultaneous spawning of all corals offers its predators a lot of food at once. This immense presence of food exceeds the predators' requirement by far. Thus, the survival chances for the fertilized eggs increases.

How can a reef originate out of individual corals?

A coral reef builds itself out of many layers of corals. Thereby only the outer layer of the reef is alive. Old coral reefs can become over thirty meters thick, while the live part may only have a meter of thickness. During the gradual downward growth of a reef, its old parts die while young corals grow further on top. Some kinds grow up to 15 centimeters per year, while others less than one centimeter.

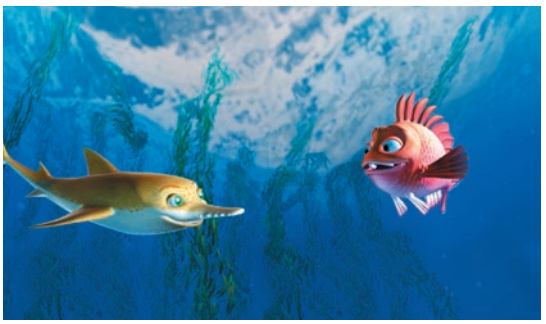
Almost unbelievable!

Coral blooms can be recognized from outer space, because corals produce a colorful substance out of egg cells and sperm cells, which can spread out over many hundreds of kilometers.



THE OCEAN'S BREATHING

The following chapter offers basic knowledge about ebb and flow, the constellations of moon and sun as the cause for the tides, as well as about the influence of the tides on ecosystems and the animal world.



On their way back to Kaluoka'hina, Shorty figures out the solution to Cassandra's puzzle.

On their quest for the key to the rescue of the "Enchanted Reef," Jake and Shorty realize that the "ocean's breathing," namely ebb and flow, plays a very important role. Yet, before the two heroes can find out more, they have to live through a few adventures.

What is exactly meant by the term „tides"?

The water rises on almost all seacoasts twice a day. The beaches become flooded, and boats on initially dry ground rise a few meters with the incoming water. The tide reaches its highest point after about six and a quarter hours; further six and a quarter hours pass and the water descends slowly again – the ebb steps in. This phenomenon of rising and falling water is referred to as "tides" or "tide."

What role plays the moon with ebb and flow?

Ever since ancient times, human beings know that the tides on Earth are determined by the course of the moon. But not until1687, when the physicist Isaac Newton entered the stage with his gravitation theory, could this natural phenomenon be explained.

Newton found out, that the gravitational forces of the moon and the sun have an effect on the Earth. "Gravitation" refers to the attraction between solid bodies like the moon, the Earth and the sun, for example. Solid bodies possess forces, with which they attract other bodies. In this way, the gravitational force of the Earth is responsible for objects falling to the ground. And the gravitational forces of individual planets keep the solar system in "balance."

The gravitational pull of the moon works on the side of the Earth facing it, making the water loom in the shape of a hump: as the moon pulls the water up. But the Earth doesn't stand still, it rotates on its own axis. Through this, another force exerts its influence on the seawater, namely the centrifugal force. Since the gravitational force of the moon is less than the centrifugal force on the side of the Earth opposing the moon, a second, but smaller water hump arises. When these two water humps move towards a coast, the water surface rises as flow, and then, after a few hours, quite predictably, it falls again. Since there are two "water mountains," ebb and flow occur twice a day.

A precise prediction of the tides is indispensable for navigation, but it requires, however, yearlong measurements and clever statistical methods.

What else influences the tides?

Newton also found out that the sun, with its enormous gravitational pull, has an influence on the tides of about 30%. During full moon and new moon, when

the sun, the moon, and the Earth are almost aligned one after the other, the gravitational forces of the moon and sun add up. These forces strengthen the tides, resulting in the so-called "spring tide."

During the crescent and waning half moon phases, a right angle forms between moon, Earth and sun. The forces partially cancel each other, and moon flow and sun ebb fall against each other, reducing the height of the tide, and bringing about the so-called "neap tide."

The height of the tide depends on various factors. In the open sea, the gravitational forces of the moon and the sun cause the water to rise everywhere about 50 centimeters. On the other hand, the height of the tides by the seashores depends on the irregular shape of the sea basins. Also, the current weather might play a role. In addition, there are geographically different strong currents, which are referred to as tide currents.

The highest tide lift on Earth was measured in the Bay of Fundy, one of the funnel-shaped sea bays in the North Atlantic, which lies between the Canadian provinces of New Brunswick and Nova Scotia. The deep bay causes the tidal waves, which appear here within intervals of a few hours, to dam up and to accumulate to great heights in the bay, yielding to water rises up to 21 meters.

How do tides affect sea inhabitants?

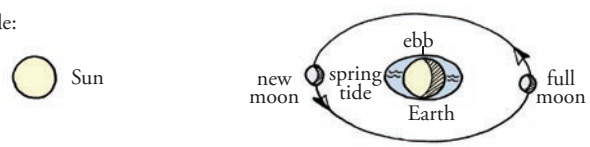
Coastal regions imprinted by tides have developed very own ecosystems. Coral reefs in tropical waters also belong to these ecosystems influenced by the rise and fall of the tides.

Sea inhabitants have, ever since hundred thousands of years, also adapted to the always unchanging rhythm of ebb and flow. Many birds can only eat during ebb, and thus search for their food in the sludge. Seals lay down lazily on sandbanks during ebb and sun themselves. Sludge crabs use the flow and go underwater in search for food, since they can find safety there from hungry birds. Fish, like the Grunion, for example, let themselves wash ashore by a wave during the nights of spring tide, in order to spawn there. Male and female Grunions then take the next wave to return to the sea.

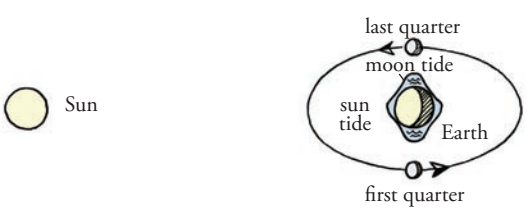
Did you know?

The tides develop enormous forces! In the Antarctic, for example, a single meter of difference between ebb and flow can cause the ice flow of glaciers to stop for a short time.

Spring Tide:



Neap Tide:

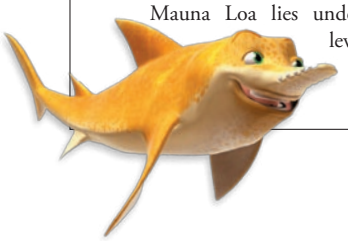


Spring Tide and Neap Tide as a Diagram

"BLACK SMOKERS" – SEA MOUNTAINS AND VOLCANOES

The following chapter offers the reader basic knowledge about the origin of volcanoes, their spreading, and underwater volcano activities.

The highest active volcano is the Mauna Loa in Hawaii. The volcano is about 9000 meters high and is thus higher than Mount Everest. Though its height above sea level is "only" 4139 meters. More than half of the Mauna Loa lies under sea level.



The story around the Enchanted Reef Kaluoka'hina begins with the eruption of an underwater volcano. The peaceful reef life that reigned up until that moment is suddenly threatened. As an old legend says it: when the volcano erupts, the reef's magic is broken.

How does a volcano originate?

To understand how a volcano comes about, it must be known that our Earth is not a uniformly solid body; instead, it consists of four very different layers: the inner Earth core, which is made out of iron and nickel, where temperatures of about 6000oC reign. The next layer is called outer Earth core. Then the earth's mantle follows, and finally, the last layer, the hard Earth's crust, on which we humans live.

In the Earth's mantle, at a depth of about 60 to 1000 kilometers, we find gas-rich and molten stone masses – the magma. Because of the enormous pressure there, the stone masses are not liquid, but rather malleable, like plasticine. In places where the earth's crust is particularly thin, magma can break through as it applies an enormous pressure on the crust. The magma that escapes from the Earth's innards and spreads on the surface is called lava. As the lava cools down, it becomes a hard rock. In this way, each new eruption causes lava masses to tower on top of each other gradually and together, they become a volcano. During an eruption energies are released which can be up to 600 times bigger than those of an atomic bomb.

How many active volcanoes exist worldwide?

The question about the number of active volcanoes is not easy to answer. Each year, there are around 50 to 60 eruptions. On average, that's more than two eruptions in fourteen days. Since people began to observe and record volcano eruptions, there were over 500 active volcanoes. At the moment, about 600 active volcanoes are estimated on the Earth. The correct count is therefore so hard to ascertain, since a large part of all volcanoes are found on the ocean's floor, making their

The eruption of an underwater volcano marks the beginning of the story about the Enchanted Reef Kaluoka'hina

eruptions hard to document.

Where are volcanoes particularly frequent?

Volcano activities are mostly found on the edges of continental plates, where the ocean plates submerge against the continental edges and enter the Earth's mantle, where they melt again. The Earth's crust has particularly many cracks and slits on these plate edges, through which the magma from the Earth's mantle rises, building a volcano on the surface.

Most volcanoes are found in a girdle around the Pacific ("Ring of Fire"), in Africa, in the region of the Red Sea and near the East African ditches. Many underwater volcanoes also bubble on the floor of the Atlantic between Europe and America. The island Surtsey originated on November 14, 1963, in front of Iceland's coast. The trigger for the coming about of this new island, which after ten days already had a length of 900 meters and a width of 650 meters, was the eruption of an underwater volcano.

Underwater volcanoes are also called sea mountains or "seamounts." They are at least 1000 meters high and have a steeply falling slope. Sea mountains can grow up to the water's surface, carrying food-rich waters to the surface, thus becoming ideal ground bases for various kinds of life communities.

What are actually "black smokers"?

"Black smokers" or also "black stinkers" are the eruption chimneys of newly formed underwater volcanoes. In the chimneys, mineral-rich fluids bump against each other with a temperature of up to 400oC – a temperature sufficient to melt lead. "Black smokers" appear mostly in groups, and can cover the area of a football field.

The natural phenomenon of the "black stinker" was first discovered in 1977. Geologists on a research submarine discovered the chimney in the proximity of the Galapagos Islands. In the meantime, "black smokers" have quite imaginative names like "Godzilla" or "Lucky Strike."

These hydrothermal chimneys are found mostly on the middle oceanic floor, and build very special ecosystems. They are worldwide the only ecosystems which don't take their immediate energy from sunlight. Researchers suppose that life on Earth arose under similar environmental conditions to those that reign inside "black smokers."

Jake and Shorty meet Cassandra, the oracle, in a kelp forest. Can she help them save their reef?

THE JUNGLE IN THE SEA

The following chapter offers the reader basic knowledge about kelp forests and their meaning as ecosystems, as well as about their usefulness for human beings.

In the story of the Enchanted Reef Kaluoka'hina, a kelp forest plays a very special role. In their adventurous search for the solution to the mystery about the magic of their reef, Jake and Shorty must find Cassandra: an ancient and wise turtle who reveals to them a crucial but puzzling hint to the solution, and who lives since times immemorial in the jungle of the sea.

What are kelp forests?

Whether they're referred to as kelp, seaweed, salt cabbage or leaf tang, in all cases they are plants which have building blocks that belong to one of the most humble base forms in botanic science: kelp plants, which come in about 100 different kinds worldwide, are brown algae of the order Laminariales. That's why their long fronds are actually not leafs, in the way we know them from trees, but rather far less complex organs which they use to perform photosynthesis.

Algae belong to the oldest plants on Earth and are the ancestors of green plants. Just like all other algae, kelp also takes up its food over its entire body.

How come algae have such a strange name: „kelp"?

The name "kelp" refers originally to the ashes of sea algae, from which iodine, potash, and soda was gained in the 19th century. The name "kelp" was then later carried over to denote various algae genres.

How big can kelp forests actually become?

Kelp is the fastest growing plant of the sea. There are kinds that shoot up to 45 centimeters in height per day. The mightiest kelp plant, the gigantic tang Macrocystis pyrifera, can reach a length of over 80 meters. If kelp forests would grow on land, their area of coverage would be so large as entire cities.

Where can you find kelp forests?

For its racy growth, kelp requires cold, clean, food-rich and moving water. Thus, kelp forests thrive particularly well in those places, where strong currents from the deep-sea rise, next to the steep slopes of continents. That's why the gigantic jungles of the sea are limited to the coastal waters of the Arctic and the Antarctic, as well as to certain costal regions in South Africa, California, Latin America, and South Australia.

Which animals live in the kelp forests?

Kelp forests offer special living environments to a large number of sea animals. They stand as important spawning grounds, food sources and resting places in the sea. In California alone, various kinds of bass, scorpion fish, starfish and mussels live in the kelp forest. The biggest grazing animal of the kelp forest is the Abalone, a gigantic snail, whose shell can become as big as a grapefruit, and is traded as a delicacy in Asia.

Because kelp forests grow up until the water surface, they serve also as resting places for sea birds, which lay down on these tang carpets; and as hideouts for sea lions, who find safety therein against

Some kinds of kelp plants grow 45 centimeters per day!

hungry sharks.

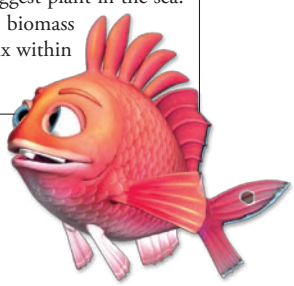
A dangerous inhabitant of the kelp forest is the sea urchin. As opposed to other animals, the sea urchin doesn't spend time eating fallen leafs. Instead, it loves to nibble on young shoots, which causes algae to die. In this way, large kelp forests were destroyed in the 30's of the last century. To blame was the hunt for fish otters, the natural enemies of sea urchins. By means of the mass hunting of fish otters, whose furs were widely coveted, the sea urchin was robbed of its natural enemy and could reproduce without limits. Today, the number of fish otters has recovered. Nevertheless, the sea urchin remains a peril for kelp forests.

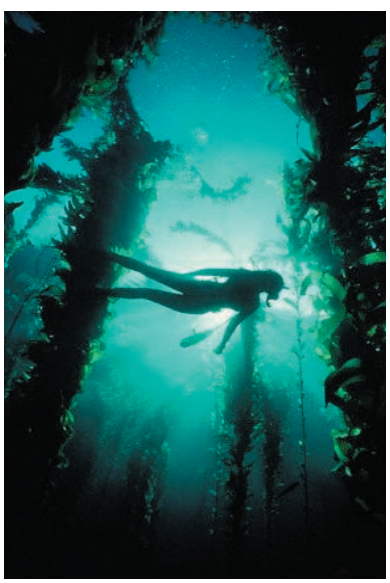
Do people have a use for kelp forests?

Algae is harvested above all in North California. The alga of the kelp forests is not only used as healing medicaments and nutritional supplements, but also as fertilizers. Kelp contains a jelly-like substance called Algin, which is used as a binding agent in the cosmetics industry (for shampoo, toothpaste, lipstick, skin creams), as well as for ice cream and pudding.

Kelp forests are really gigantic!

The perennial kelp is the fastest growing and biggest plant in the sea. It increases its biomass by a factor of six within a single year!





The mightiest kelp plant, the gigantic tang Macrocystis pyrifera, can reach a length of over 80 meters

FIREWORKS OF COLOR IN THE ETERNAL DARKNESS

The following chapter offers the reader basic knowledge about the phenomenon of bioluminescence, evolutionary development and the importance for deep-sea life forms, as well as its use for scientific research.

During their adventurous trip, Jake and Shorty end up by accident in a dark and dangerous world – the deep-sea. No single ray of light reaches these depths. Still, the eternal darkness is home to many rare and strange-looking life forms, which give a rightful scare to our heroes.

What is understood exactly under the term „bioluminescence“?

The term is made up of the Greek word “bios” (life), and the Latin word “lumen” (light). Bioluminescence refers to the ability of organisms to produce their own light, by means of biochemical processes, during which metabolic energy is given off as visible light.

How did this ability of bioluminescence actually come about?

When life on our planet first began to develop, about 3 billion years ago, the primitive Earth atmosphere did not have oxygen, but instead mostly nitrogen, carbon dioxide, carbon monoxide, as well as other nitric oxides and noble gases. The first life forms couldn’t do anything with oxygen; in fact, it was poisonous for them. Then, as blue algae began to develop, about 2.5 billion years ago, it generated a lot of oxygen, so much that all other life forms became threatened by the oxidation of the oxygen. In order to survive, they had to invent metabolic processes which destroyed the dangerous oxygen inside the cells: the solution was bioluminescence.

The phenomenon of bioluminescence thus almost reaches back to the origins of life. The animals, which still possess the ability of bioluminescence today, use it, however, for completely other reasons.

Which animals possess the faculty of bioluminescence?

This phenomenon is common to various animals. Almost every animal phylum has representatives with this feature. The most famous land animals are the glowworm and the firefly. Yet, bioluminescence is more commonly found among sea inhabitants. The dinoflagellates – one-celled algae that thrive around the ocean’s surface – have such a lighting ability. However, particularly extraordinary and fascinating is the phenomenon of bioluminescence among deep-sea inhabitants.

The deep-sea amounts to more than half of the entire Earth’s living space. Most life forms that find themselves at home in these dark and cold regions around 800 to 2000 meters deep have the ability of bioluminescence. In the eternal darkness, there are life forms such as the fish “Anomalopidae,” featuring light cells ordered into a particular structure on its skin; or the anglerfish, which possesses a bioluminescent organ just before its mouth.

Jake and Shorty find many rare and strange-looking life forms in the eternal darkness

How do deep-sea animals produce their light?

There are some fish that have a symbiotic relationship with bacteria. These animals take up the light-producing bacteria into their bodies. Yet, the majority of animals produce light by means of chemical processes within their own body. The general process is the same for all animals: a particular light-prone substance, called luciferine, becomes oxidized with the use of oxygen and chemical energy. The trigger for this chemical reaction is an enzyme called luciferase. During the oxidation of the luciferine a short spark of light is given off.

Bioluminescent light comes in the colors red, green, blue, orange, and red-violet. Most common is, however, the short-wave blue light, as it can be seen over relatively long distances in the water. When deep-sea fish are caught, they usually lose their ability of bioluminescence.

What is the function of bioluminescence?

Deep-sea inhabitants use bioluminescence to search for partners. It is suspected that duration, color and frequency of transmitted light signals play an important role in attracting the right partner.

In addition, the ability to give off light signals is an ideal defense mechanism. A deep-sea cuttlefish, for example, releases a bioluminescent secretion to confuse its aggressor. Thus, the cuttlefish gains enough time to disappear in the darkness.

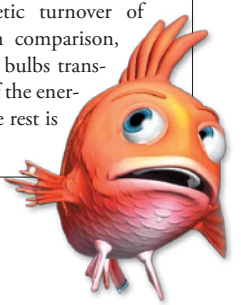
Other animals, on the other hand, use bioluminescence to hunt. They use blue light that's visible at long distances to lure their prey. Meanwhile, the hunter recognizes its prey with red light. Red light reaches out only for a fraction of the distance as blue light does. Nevertheless, the hunter uses the red light to identify its prey just before the latter can recognize it.

Does bioluminescence offer any uses to human beings?

Bioluminescence is used in the form of bio-indicators to identify environmental pollution in rivers quickly and reliably. Bioluminescence also plays a role in biochemistry, namely to verify the presence of proteins, as well as in the form of the so-called "reporters" in genetic research.

Almost unbelievable!

Nature is really brilliant! Many deep-sea inhabitants can produce light with an energetic turnover of almost 90%. In comparison, man-made light bulbs transform only 5% of the energy into light, the rest is lost as heat.



BIBLIOGRAPHY

Coral Reefs – colorful worlds underwater

Books

Allen, G.R. / Stehen, R.
Indopacific Coral Reef Guide
Tropical Reef Research Singapore
1996

Spalding, M. / Ravilious, C. / Green, EP.
World Atlas of Coral Reefs
Unep. Universtity of California Press
2001

Coustteau, J.Y.
Life and Death in a Coral Sea
Bantam Dell Pub Group
1971

Halfmannn, J.
Life in the Sea (Lifeviews)
Creative Education
1999

In the WWW

http://www.aims.gov.au/

http://www.gbrmpa.gov.au/

http://www.fisheyeview.com/FV-Cam640.html

http://www.starfish.ch/starfish.html

http://www.huellen-dive.de/Webcams/body_webcams.html

When the moon makes the corals bloom

Books and articles

Berkes, M. / Canyon, J.
Over in the Ocean: In a Coral Reef (Sharing Nature with Children Book)
Dawn Publications (CA)
2004

Davidson; O.G.
The Enchanted Braid: Coming to Terms with Nature of the Coral Reef
John Wiley & Sons
1998

Wells, S. / Hanna, N.
The Greenpeace Book of Coral Reefs
Sterling Pub Co Inc
1992

Babcock, R.
Synchronous multispecific spawning on coral reefs: potential for hybridization and roles of gamete recognition.
Reprod Fertil Dev.
1995

Mass Spawning in Tropical Reef Corals, in Science
1984
vol 223 pp

In the WWW

http://research.myfwc.com/features/view_article.asp?id=12016

http://www.aims.gov.au/index.html

http://www.reefcheck.org/

http://www.abc.net.au/science/scribblygum/october2002/default.htm

---

The oceans breathing

Books

Cartwright, D.E.
Tides : A Scientific History
Cambridge University Press
1999

Wrigt, J., et al
Waves, Tides and Shallow-Water Processes.
The Open University
2001

Ricketts, E.F.
Between Pacific Tides
Stanford University Press
5th/Rev edition
1992

Herman, G.; Nez, J.A.
The Creeping Tide
(Science Solves It!)
Kane Press
2003

In the WWW

http://www.free-definition.com/Tide.html

http://www.internet4classrooms.com/tide.htm

http://en.wikipedia.org/wiki/Tide

„Black Smokers“, sea mountains and volcanoes

Books

Simkin, T. /Siebert, L. / McClelland, L. Bridge, D. / Newhall, C. & Latter, J. J.
Volcanoes of the world
Smithsonian Inst. Hutchinson Ross Publ.,1-232
1981

Scarpa, R. / Tilling, R. I.
Monitoring and Mitigation of Vulcano Hazards
Springer Verlag
1996

Serrano, M / Nuria, R.
Our Living Planet
Volcanoes (Living Planet Series)
Blackbirch Press
2002

Köthe, R.: Volcanoes
Tessloff Pub
USA Inc.
2002

Rothery, D.A.
Teach Yourself Volcanoes
McGraw-Hill Companies
2002

In the WWW

http://volcano.und.nodak.edu/vw.html

http://www.volcanoes.com/

http://www.geology.sdsu.edu/how_volcanoes_work/Home.html

http://www.soest.hawaii.edu/GG/HCV/volcano_links.html

The jungle in the sea

Books

Stone, L.M.
Life of the Kelp Forest (Under the Sea)
Rourke Publishing
2002

Cole, M. S.
Marine World:
Kelp Forest (Wild Marine Habitats)
Blackbirch Press
2004

Wu, N.
Beneath the Waves: Exploring the Hidden World of the Kelp Forest
Chronicle Books
1997

Hall, H.
The Kelp Forest
(Habitat Series)
Ez Nature Books
1990

In the WWW

http://life.bio.sunysb.edu/marinebio/kelpforest.html

http://www.meer.org/

http://www.mbayaq.org/efc/efc_hp/hp_kelp_cam.asp

http://aquarium.ucsd.edu/learning/learning_res/kelpcam.cfm

Fireworks of color in the eternal darkness

Books

Stanley, P. / Kricka, L.J.
Bioluminescence and Chemilunimescence: Progress and Current Applications
World Scientific Publishing Company
2002

Presnall, J. J.
Animals That Glow (First Books)
Scholastic Library Pub (P)
1993

Jacobs, F. / Caroll, P.
Nature's Light:
The Story of Bioluminescence
Harpercollins Juvenile Books
1974

Hoyt, E.
Creatures of the Deep:
In Search of the Sea's "Monsters" and the World They Live in
Firefly Books Ltd
2001

In the WWW

"The Bioluminescence Web Page":
http://lifesci.ucsb.edu/~biolum/

http://www.glowexhibit.com/

http://www.lifesci.ucsb.edu/~biolum/sdworkshop/

http://www.lumiweb.com/sym2002/sym2002home.html

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www.kaluokahina.com