SUBAQUA

SPECIAL ISSUE #1 VERSION 6

DISCOVERING **UNDERWATER LIFE**

French Federation of Underwater Studies and Sports
Underwater Environment and Biology Commission

FFESSM

SUBAQUA SPECIAL ISSUE #1 - VERSION 6 *revised and expanded*

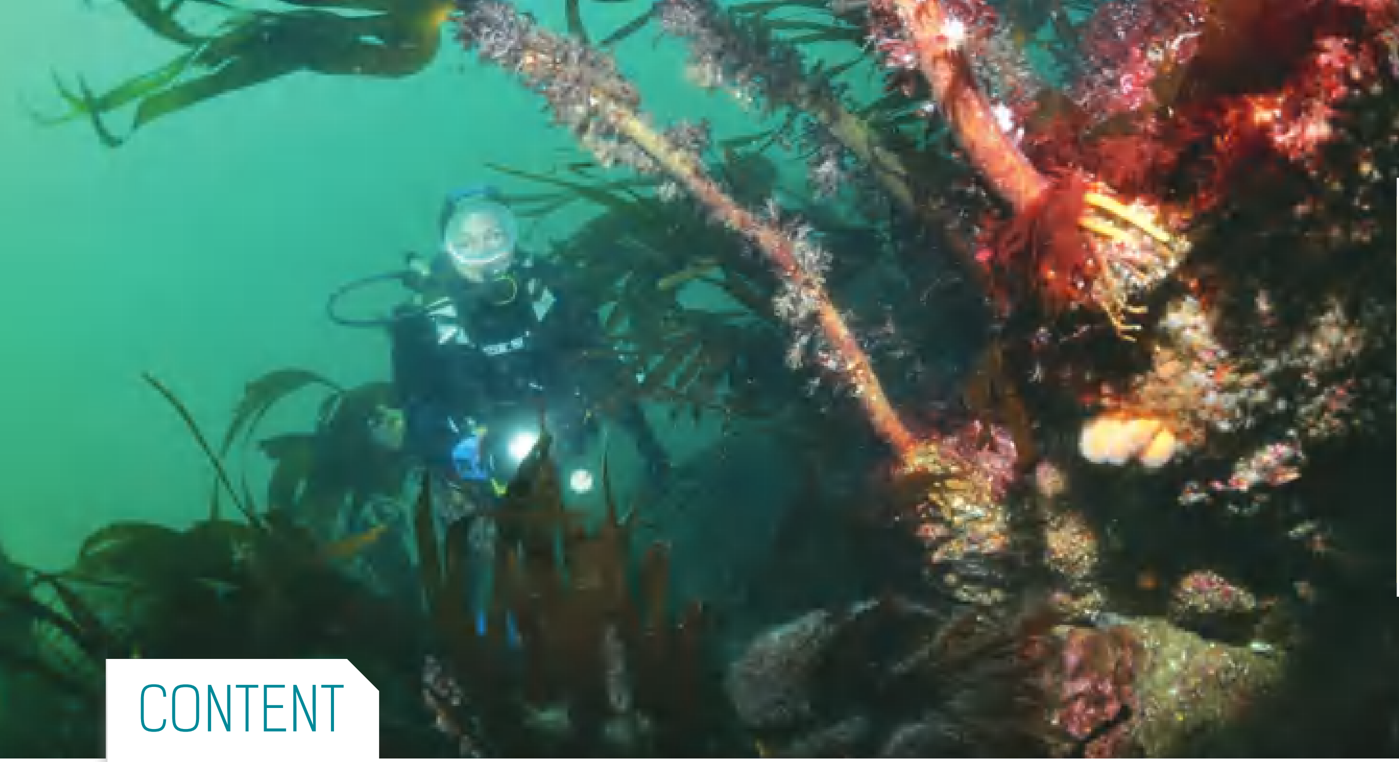
DISCOVERING UNDERWATER LIFE

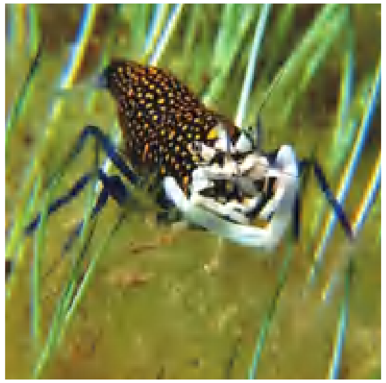
WITH THE UNDERWATER ENVIRONMENT AND BIOLOGY COMMISSION

SPECIAL ISSUE #1 – VERSION 6

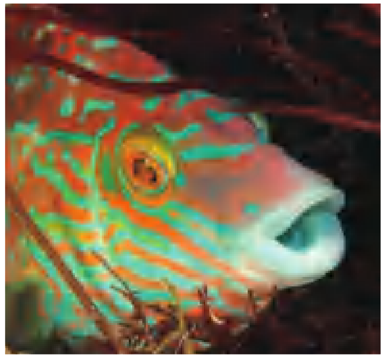
SUBAQUA

SPECIAL ISSUE OF THE FRENCH UNDERWATER FEDERATION MAGAZINE





CONTENT



Translated from the French version by :
Patrick Giraudeau - Peter Culleton - Chris McDowell
Photo credits are on page 152.

INTRODUCTION

You have in your hands the sixth version of the Subaqua special issue « Discovering underwater life», irrefutable proof of the interest of divers in underwater environment and biology.

Indeed, diving has evolved over the years with the awareness of the risks of the reduction in biodiversity and the influence of human activities on the environment. A new diver, responsible, concerned about his/her impact on the environment, has gradually emerged, and has fortunately replaced the diver of old, too often predatory.

FFESSM has resolutely turned towards sustainable development. Thus, partnership agreements with the National Museum of Natural History in Paris, the French Biodiversity Agency and Longitude 181 Nature have been established. Naturally, the Underwater Environment and Biology Commission has been deeply involved in the education and training of divers for many years. The Technical Commission, for its part, has fully taken into account the environmental dimension by integrating a training module on the knowledge and respect for the marine environment into all the technical courses, from the level 1 to the instructor diver. This is a real fit with the International Charter of the responsible Diver from Longitude 181 Nature, to the development of which the National Underwater Environment and Biology Commission contributed, and to which FFESSM adhered from the first day.

This book therefore supports field training designed to «educate» the eye and facilitate understanding of the living environment in which divers are exploring. This book is the result of a collective work of the College of National Biology Instructors in the continuity of this spirit of discovery that is dear to us. Texts, drawings, photographs, all emanate from divers commonly called «bio divers «.

A place has been reserved for the two most beautiful achievements of our commission. Thus, DORIS, known and recognised by the scientific world, whose animation team can be proud, won a gold medal at the Antibes underwater image festival in 2007 in the category «educational site». DORIS allows each diver to know better the common and sometimes rare species found on French coasts, and is complemented by remarkable reference works, «Life in fresh water» and, more recently «The Bryozoans of Europe» and «the Sponges of France».

The second, more recent internet tool, CROMIS, makes it possible to link the descriptions provided by DORIS with the inventory of species encountered during explorations. Everyone can keep a memory of his/her observations during dives and can thus contribute to the enrichment of knowledge, or even now prepare his/her future explorations. The database is shared with the National Museum of Natural History in order to contribute to the National Inventory of Natural Heritage. The contributing divers therefore make a valuable network of observers of marine and freshwater environments, permitting the declaration of observations on all coasts throughout the year.

«The beginning of all sciences is the astonishment that things are what they are,» as Aristotle said. So, the one who is surprised by marine life, science graduate or not, can claim to contribute to citizen- or participatory science.

It is thanks to our three major achievements of the National Underwater Environment and Biology Commission that each diver can, we hope, continue to enrich his/her underwater knowledge, in order better to understand this fascinating aquatic world. Biology trainers, present throughout the territory, will be happy to share their passion and knowledge with you, simply helping you to «see» and thus to appreciate more your exploration dive. Thousands of training days, hundreds of training courses are organised each year by our trainers; do not hesitate to go to them, you will see that biology is perfectly accessible and that the time of speeches in Latin is over.

Oceans ignore the frontiers and the same threats exist all over the world. Our Commission recognizes that the environmental stakes have to be considered at the planetary scale and thus decided to turn its educational approach towards other countries. It is the reason why it has been decided to prepare an English version in-order-to make the international exchanges easier and to allow our CMAS fellow divers to access the results or this common work. Respecting the spirit of the International Charter of the responsible Diver, this book should contribute to protection thanks to knowledge.

And all this knowledge would be useless without the realisation that this fabulous marine heritage is fragile, threatened and perishable. It is this infinite beauty made of biodiversity that we all wish to preserve for future generations, and I hope that all divers will be able to live the emotions of the privileged encounters and be surprised for a long time by the incredible forms taken by aquatic life.

Long live the oceans! Long live biodiversity! Long live the exploration dive!

Jacques Dumas,
Chairman of the Underwater Environment and Biology Commission

A sea hare (Aplysia punctata). Brittany.

The sharp eye of the biologist

American sting ray (Dasyatis americana)

1

The physical environment

After a gust of wind, the sea foam. Noirmoutier Island.

Coral atolls: when life changes the landscape paysage.

Patrice Petit de Voize

Organic beach detritus: a privileged observation.

Battered areas, yet rich in life.

OVERVIEW

Our planet Earth is badly named with 71% covered by the oceans. This mass represents 97% of the free water on the planet, the rest being made up of continental freshwater and polar ice.

50 million km² of land area for 360 million km² of ocean ...
When we know that, moreover, less than 30% of these lands are occupied permanently by the human species, we have a better appreciation for the importance of the marine environment in all the aspects of the planetary life.

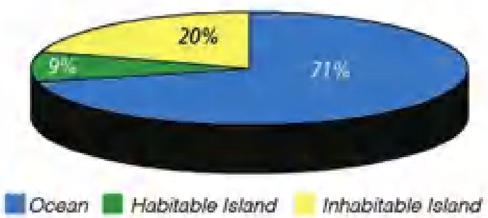


FIG 1 : *land surface occupation.*

This huge quantity of water (1300 million cubic metres) is actually a single huge ocean whose distribution is quite unequal, the southern hemisphere being strongly oceanic. Although the average theoretical depth is 3800 m, the seabed has very high reliefs with peaks, mountain ranges and pits (especially in the Pacific) exceeding 8000 m, the record being 11,080 m in the Mariana Trench.

SUBDIVISIONS OF THE MARINE ENVIRONMENT

We know that the continents are the emergent part of the huge plates that make up the earth's crust. These plates originate under the oceans in areas of intense seismic activity, the rifts, complex systems of faults continuously which produce the rock of the oceanic seabed.
In the case of the Atlantic Ocean, this zone takes the form of a more than 16,000 km long ridge, oriented north-south, at approximately equal distance from the American and Eurafrican coasts, hence its name of mid-Atlantic dorsal.
A line of probes traced between Brazil and Angola would show a very characteristic profile, identical in outline, on all continents.
The land surface is gently sloping, 0.07 ° on average, to an area where the depth increases much more brutally.
On FIG 2 opposite page, the difference in scale between the width of the ocean and its depth, necessary for a good reading of these cuts, gives a false idea of the continental slope whose inclination is generally lower than 1 degree... This platform, whose width varies from a few tens of metres to more than 300 km, is called the continental shelf. Its surface, 8% of that of the oceans, is far from flat, even if it contains large alluvial plains, it is dotted with islands, dug out of canyons which prolong under the sea the bed of the terrestrial rivers or of ancient glacial valleys.

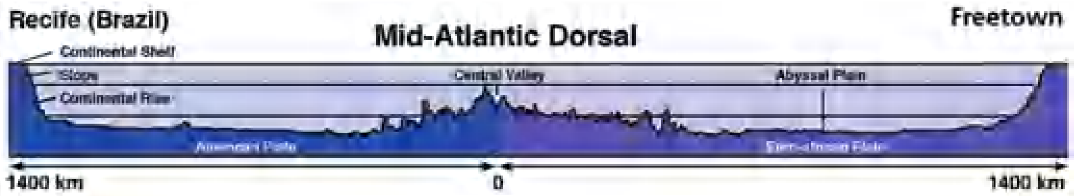


FIG 2 : *Cross section of the Atlantic Ocean according to Heezel.*

At around 130/200 m, the plateau ends with a steeper slope (values ranging from 0.07° to 1° to even 3°) which ends around 3000 m and constitutes the continental slope. It is cut by steep valleys through which sediments from the mainland flow; these flows can take the form of submarine avalanches, turbidity currents, causing various accidents: telephone cable ruptures, tsunamis. The continental rise follows the slope, that it connects to the abyssal plain; the width of this zone is also considerably variable, from 50 to 300 km for a depth between 3000 and 5000 m. It is a landscape of silty reliefs, poorly accentuated, which progressively reaches the abyssal plain. The whole plateau / slope / rise constitutes the continental margin or pre-continent. The abyssal plains make up the majority of the ocean floor. Their slope is low or non-existent. Their average depth is 4000 m. They are covered with sediments whose thickness varies from a few metres (Pacific Ocean) to several thousand metres for the Atlantic Ocean. As soon as one moves away from the vicinity of the continental slopes, the proportion of terrigenous (land-origin) and organic inputs diminishes until it disappears completely. The bottom is then covered with very fine silt consisting of limestone or siliceous envelopes of unicellular planktonic organisms: radiolarians, globigerinas, pteropods, coccoliths. During the slow descent of these organisms towards the abyss, the organic matter is completely dissolved and only the hard parts remain. Beyond 6000 or 7000 m, even these skeletons no longer reach the bottom which then consists of a bed of red clay. The monotony of these plains is disturbed only by the presence of ancient volcanic reliefs (guyots, pitons) or active volcanoes and tectonic ridges and pits. Life exists here, sparse and slow, but most phyla are represented. Given the absence of light, the food chain is based on all kinds of waste falling from the surface.

Did you know?

The Ganges pours into the sea and in one day the equivalent of deposits of the Gironde in one year or 3 million tons of sediment ... There are three types of sediment: littoral (mud, sand and pebbles), neritic (up to 200 m), bathyal (200-3000 m) and abyssal beyond. The limestone dissolves under strong pressure, these contain only clay and siliceous microfossils (diatomae, radiolarians)

Source Quid 2002

- *The continental shelf is also, and always has been, the subject of fierce battles between states, its limits being very difficult to define and even more to materialise.*
- *Fishing, circulation of ships and exploitation of mineral resources (oil, gas, sands, gravel, etc.) are potential reasons for discord, which are still relevant today, even though disagreements are now (generally) more political, rather than martial.*
- *Recent discoveries have shown the presence of true underwater oases between 3000 and 5000 m, around hydrothermal sources. These sources, located around ridges, discharge very hot water (about 350 °C) loaded with metal salts. These salts, usually sulphides, are used by symbiotic or free bacteria which form a very original food chain with their hosts and predators.*

1> The physical environment

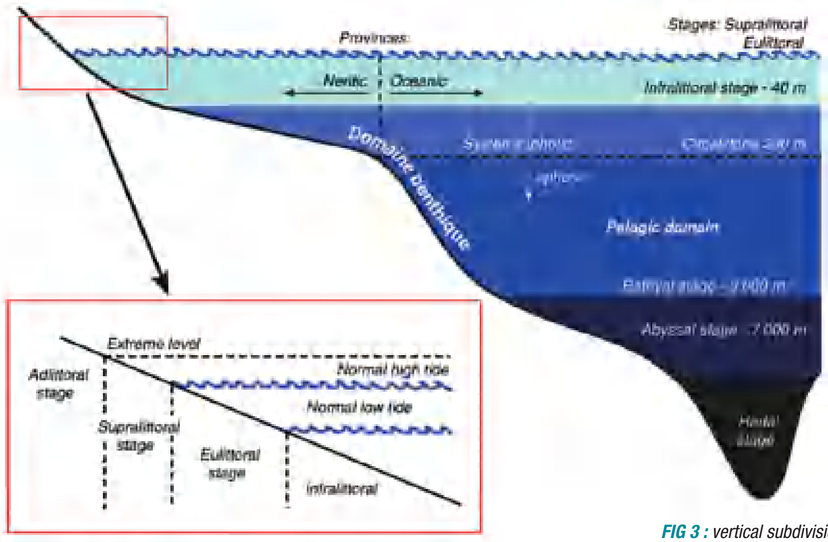


FIG 3 : *vertical subdivisions of ocean depths*

SEAWATER

DENSITY

Seawater is 800 times denser than air; this density varies with temperature: the colder the water, the denser it is. The maximum density is reached around 4 °C.
This physical property explains the tendency of cold waters to «sink» towards the bottom of the oceans, the polar cold waters thus slowly descending towards the great depths and towards the equator where they eventually mix. It is especially in the vicinity of the coasts and the surface that the vertical exchanges take place.
Upwellings, upward currents, carry the mineral salts, nitrates and phosphates resulting from the degradation of organic residues to the surface. In this illuminated zone (euphotic) the phenomena of phytoplanktonic photosynthesis is the first links of the marine food chain.

The seawater density is 1.03 g/cm3 on average for a salinity of 35 g/l.

SALINITY

Why is the sea salty?
For billions of years, the rains have leached the land surface, bringing rock salts to the oceans. These salts were carried away with the runoff, while the evaporation sent back to the clouds only distilled water. This chemical contribution is still going on, right now. Every year 400 million tons of solid substances are discharged into the oceans by rivers.

SEAWATER COMPOSITION

There are on average 35 g of dissolved salts per kilogram. Almost all the chemical elements are there, in variable quantities.

Main elements dissolved in grammes/litre

Chlorine................18,98	*Potassium.......... 0,380*
Sodium...............10,56	*Bromine................ 0,065*
Magnesium...........1,27	*Carbon............. 0,028*
Sulphur................. 0,88	*Strontium........... 0,013*
Calcium................ 0,40	*Boron.............. 0,00513*

All these chemical elements form a variety of combinations; for example, carbon forms both carbonates and bicarbonates. Sulphur gives mainly sulphates, but sometimes sulphides (anoxic waters). Chlorine, the most abundant element, gives mainly chlorides.

Table salt (sodium chloride) alone accounts for 77% of these dissolved salts. This average salinity of 34.5 g/l has many variations, seasonal and geographical. It can reach 40 to 60 g/l in tropical areas where intense evaporation is not offset by freshwater inflow (e.g. Persian Gulf, salt lakes of the Suez Canal).
On the other hand, it is low in the vicinity of estuaries, in the Baltic Sea and in the vicinity of polar ice, which is essentially made up of fresh water (20-30 g/l).

Average salinity: of the Mediterranean Sea: 37 g/l – of the Atlantic Ocean: 34 g/l.

The importance of these dissolved substances is crucial for the development of ocean life.
Calcium, in the form of carbonate, and silica, constitute envelopes, shells, spicules in algae and crustaceans, sponges, bones, teeth, etc. in vertebrates.
Carbon, phosphorus and nitrogen-derivatives are the basis of all organic compounds.
Sulphur, used by some bacteria, allows life to subsist around deep hydrothermal vents, despite the absence of light and oxygen deficiency.
Finally, of all the present chemical constituents, two gases, oxygen and carbon dioxide, play a capital role, in free or dissolved form.

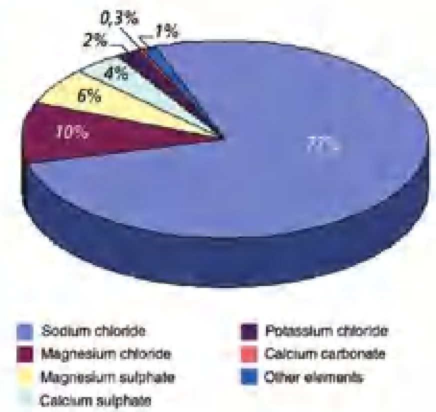


FIG 4 : *main salts dissolved in seawater.*

Did you know?

As an anecdote ...
A cubic metre of seawater contains only 0.06 mg of gold. But considering the total volume of oceans, the stock represents more than 7,800,000 tons!
If only we could extract it ... Chemists, to your stills!

TEMPERATURE

Variable according to latitude and depth, sea temperature is at least -4 °C (freezing point), up to 35 °C in some tropical seas (e.g. the Persian Gulf).

The variations of temperature are observed mainly in the surface-layer of the oceans: winds, currents, swell, sun, facilitate the waters mixing according to the seasons. After 800 metres, temperature decreases linearly, accordingly to the depth increase, reaching 0 °C around 5000 m (Atlantic Ocean). At that same depth, it is 1.7 °C in the Pacific Ocean. A slight warming (about 1 °C) is observed between 6000 and 11,000 m, as a consequence of the enormous pressure which prevails at these depths (600 to 1100 bars!). There is an exception to this rule: the semi-closed seas of the Mediterranean type: their temperature, whatever the depth, is rarely inferior to the one existing in their communication strait with the ocean.

Example: the Mediterranean Sea temperature is the one of Gibraltar Strait at about 400 m depth: 13.7 °C.

This is average temperature, with surface waters being colder or warmer depending on the season. Deep free-diving fanatics will be delighted to learn that in the south of Greece, at a depth of 5000 m, they will not be colder than at Levant Island (French Riviera) with a cool April dive...
Would you be interested ?

Temperature variations only affect the superficial layer of the oceans... Polynesia.

ILLUMINATION *FIG 5*

Penetration of light into water depends on several factors:
> its transparency (presence or absence of suspended matter),
> how agitated it is,
> the angle at which light waves hit the water (the maximum penetration when the sun is vertical).

The water plays the role of a selective filter and absorbs the different radiations which make up the spectrum, according to their wavelength. The ultraviolet and infrared radiations are quickly neutralised by resonance phenomena in the water molecules. As depth increases, red, orange, violet, yellow and green radiations are absorbed successively. Blue disappears last, which explains why it is the dominant colour of (clear) waters.

The influence of dissolved salts is negligible, pure seawater is being almost as transparent as distilled water. However, the presence of suspended particles increases the absorption coefficient considerably.

At around 500 m, in clear water, sunlight no longer has any noticeable effect on a photographic plate. At this depth, the aphotic zone starts.

Light is essential for the growth of plants, the basis of the food chain; when diving, it is easy to observe the gradual disappearance of large algae with depth. Laminar, for example, will be scarce from a dozen metres and will disappear in the 20/25 m area, in the Atlantic Ocean. In the Mediterranean Sea, where the water is generally clearer, they can be found in the 40 m belt, as in the Alboran Island in Spain.

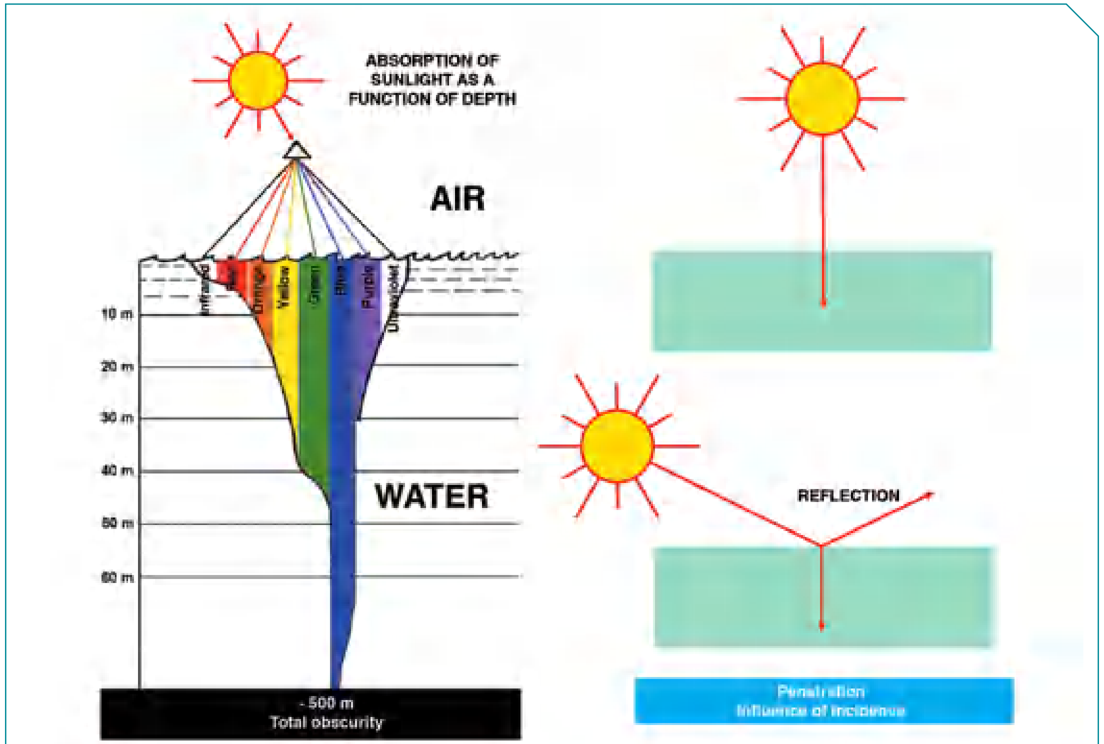


FIG 5 : *penetration of light into the water.*

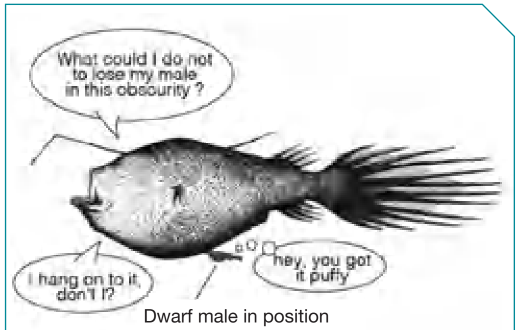


FIG 6 : *blind abyssal fish Ceratias holboelli and its 'parasite male'.*

Beyond 50 m, only a few red algae remain, often calcified, which can be satisfied with a very weak luminosity.

Less visible, unicellular algae living in symbiosis with some marine animals, stony corals in particular, will see their growth stop from fifty metres on average, lack of light. Their absence, preventing these animals from synthesizing the limestone which composes their skeleton, explains that the coral reefs grow from the top, as and when the volcanic relief that carries them, and not down, where we only find dead corals.

Fish and animals of zooplankton (animal plankton), adapted to life in the dark, are nevertheless dependent on the surface for their food. They take advantage of the night to get closer to the surface where phytoplankton lives (vegetal plant). Others will be content with organic debris falling slowly to the bottom: algae and dead animals, debris carried by the rivers.

OCEAN MOVEMENTS

CURRENTS

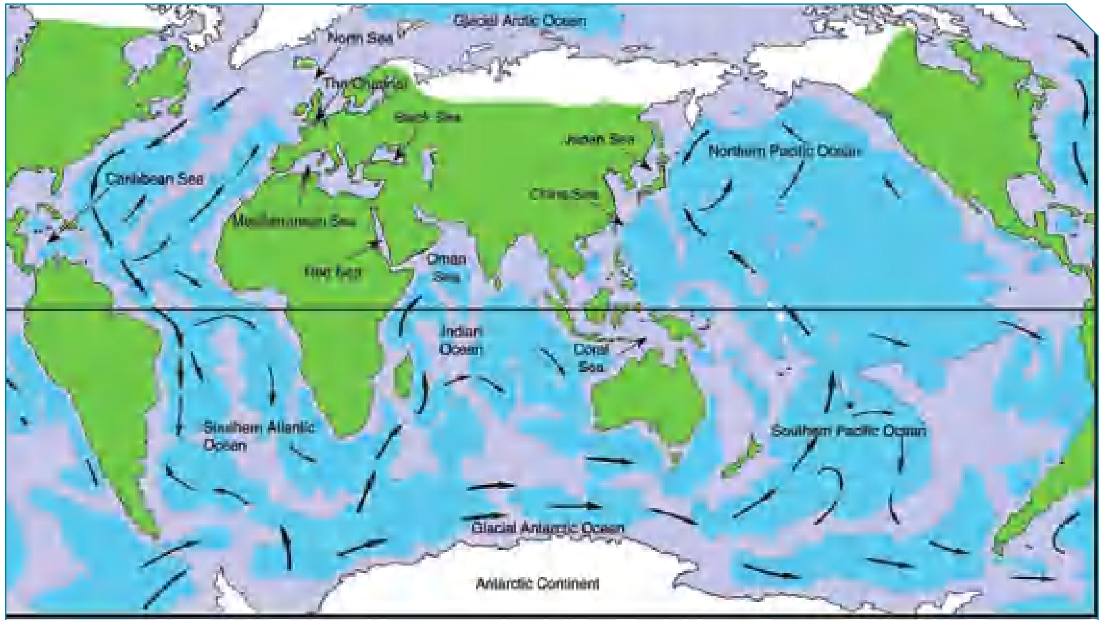


***FIG 7 :** deep cold water circulation.*

The circulation of oceanic waters is a complex machine of which we certainly know the main causes: winds, rotation of the Earth, differences of temperature and/or of salinity (and therefore of density), but whose exact mechanism is still far from being known in detail. Surface currents are only the apparent part, their path and velocity are often disturbed by seasonal or meteorological phenomena, whereas deep cold waters follow almost immutable pathways.

Did you know?

Winds, which are the main cause of surface currents, influence only 10% of the total ocean volume.
Globally, they are the consequence of an unequal distribution of solar heating and changes in low and high pressures from the equator to the poles. The trade winds are the best example.

Source Sealife Waller/Dando/Birchett PicaPress.

Very cold low-salt polar water (glacier meltwater) sinks to the deep sea, its temperature around 4000 m remaining close to freezing point.
North Pole water flows down the Atlantic Ocean along the American east coast and joins the southern hemisphere off the coast of Argentina. That of the South Pole flows north in the Pacific Ocean and returns to the northern hemisphere off Japan and Kamchatka.

The constant temperature at depth explains the wide dispersion of deep-water species. Unlike animals living near the surface, for whom temperature differences are insurmountable barriers, there exists for them only a huge world ocean, uniformly cold and calm.

On the surface, the situation is much more complex: hot currents and cold currents constitute an entangled network of which we understand only partially the geography, and of which we don't know enough to foresee the deviations or the variations. Yet climate and halieutic resources depend on it, and their mood swings can have incalculable repercussions on the economies of coastal countries.

On the surface, the situation is complex

As a rule, the eastern shores of the Pacific and Atlantic oceans are subject to a regime of easterly winds, blowing towards the equator and favorizing upwellings. This is the case of Peru, Ecuador and Chile in the Pacific Ocean and West African coasts in the Atlantic Ocean.
In both cases, they are bathed in very cold waters which contrasts significantly with the furnace temperatures prevailing on land. In Namibia, for example, where the temperature reaches 40 °C or even 50 °C in the Namib desert, seals frolic in water at 10 °C in its immediate vicinity.

These deep, nutrient-rich water lifts are the source of great animal abundance which benefits the fishing industry. Peru, for example, is the world's second largest producer of fish with, in the best years, 10 million tons of anchoveta, a kind of anchovy used for the production of flour for animal feed.

Under the Coriolis Force induced by Earth's rotation, the dominant currents turn clockwise in the northern hemisphere and anti-clockwise in the southern hemisphere.

TIDES

By virtue of the laws of gravity, the moon and the sun exert on our natal potato-like planet an action which tends to deform it, according to their respective orbits; this phenomenon causes the tides.
Of course, the effect of the tide is mostly visible by its action on marine waters, but it is nonetheless true that the entire planet mass is deformed due to orbital movements.
The force of gravity of the Moon attracts the oceans thus forming a water bulge in its direction.
This bulge, whose height has been measured recently with the help of satellites, is relatively small, less than two metres on average, but it can be locally amplified by resonance phenomena due to the particular geography of certain coasts: the English Channel, the Saint-Georges channel, the St. Lawrence Estuary in Canada.
The variations of position of the moon and the sun in relation to our planet cause equal variations in the height of the tides (high-water and low-water) indicated in the yearbooks by a coefficient (theoretical maximum 120). The largest tides correspond to the positions of syzygy, alignment of the moon and the sun with the Earth.

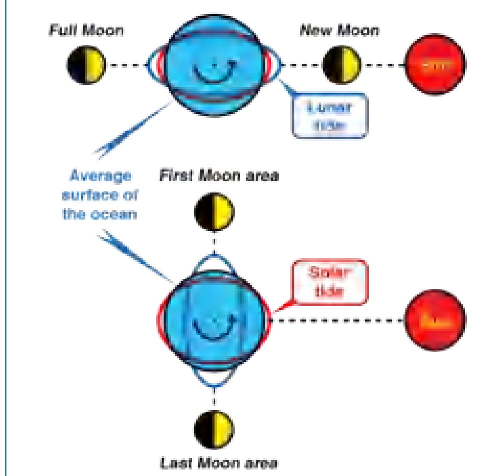


***FIG 8 :** deformation of the oceanic bead.*

Around Europe, the tides are semi-diurnal, with two low tides and two high tides per 24 hours. Their amplitude (the difference in height between high and low tides) can range from a few tens of centimetres in the Mediterranean Sea, to over thirteen metres in the Mont-Saint-Michel Bay (Normandy) and sixteen metres in the Fundy Bay (Canada). These tides generate strong currents whose speed can exceed 10 knots (18.5 km/h).
The French Naval Hydrographic and Oceanographic Service (S.H.O.M.) publishes annual tide directories for all regions of the world. It also publishes tidal currents for several regions around France (the Channel, Brest harbour, etc.).

No diver should get in the water in a tidal area without being fully informed of the schedule and coefficients of local tides.

WAVES, SWELL

Waves result from the action of the wind on surface water. Their height can exceed 20 m during strong storms and their action can still be felt more than 50 m deep. The current and the underwater relief can reinforce their effect by causing them to collapse (breakers). Even when the wind has stopped, the ripples that it caused can persist and come crashing to the shore, this is swell. If a wind blows from another direction, swell and waves can oppose each other, causing a choppy and chaotic sea, very challenging for small vessels.


Tsunami in Acapulco.

Underwater earthquakes can also generate a type of ocean wave propagating in concentric circles around the point of emission: tsunamis. Moving at speeds of up to 700 km/h, especially in areas of high seismic activity in the Pacific, their effects are particularly devastating on shorelines. Cities decimated, port structures destroyed, ships carried inland by waves over ten metres high, these tsunamis have caused hundreds of thousands of victims. In the Atlantic Ocean, Lisbon was completely destroyed by one in 1755.
More recently and with the dramatic consequences on the nuclear power plant which we know, the tsunami of Fukushima, 11 March 2011, caused waves of an estimated height of more than 30 m which destroyed nearly 600 km of coastline up to 10 km inland.

1> The physical environment


Diving in the Atlantic Ocean makes you pay attention to the tides ...


In the atolls, the lagoon empties and fills with the rhythm of the tides. Passes are places of observation of animals that take advantage of the current.

2

The living environment

An astonishing animal : the basket star.

An astonishing animal : the basket star.

Barracudas in a school: a predation strategy.

Rhizostoma jellyfish Rhizostoma pulmo. Mediterranean Sea.

CNIDARIANS

From the Greek word *knidê* : nettle

DEFINITION - GENERALITIES

Cnidarians are radially-symmetrical diploblastic metazoans, whose general shape evokes that of a sac, provided with a single opening, bordered with tentacles which are filled with stinging cells. They are among the oldest metazoans (multicellular animals) which appeared on Earth, probably Precambrian, more than 800 million years ago.

With more than 10,000 species, Cnidarians generally come in two forms:
> a fixed (sometimes definitely) form, called a polyp.
> a free form in the adult state, called jellyfish or a medusa ***FIG 24*** *(see opposite page)*.

These animals are ubiquitous in the divers' world: corals, madreporians, gorgonians, anemones, jellyfish, hydroids. They are visible in all seas and at all depths.

Individuals can be solitary, and in this case, have a size ranging from a few tenths of a millimetre (polyps of hydras), to more than one metre (anemones, jellyfish), or they can be assembled in colonies. These can reach extraordinary dimensions: coral reefs, among others, constitute sets of several hundred kilometres in length. The largest of these reefs, the Great Barrier Reef of Australia, is visible ... from the Moon!

Study of abyssal anemones, collected by exploration submarines, shows that some of them can be more than one thousand years old!

MORPHOLOGY

Cnidarians are diploblastic metazoans, thus consisting of an assembly of cells arranged in two layers separated by a gelatinous intermediate layer: the mesoglea.
The outer layer, or ectoderm, is mainly composed of three types of cells: :
> Epitheliomuscular cells, which allow the animal simple contraction movements.
> Urticating cells or cnidocytes, sometimes grouped into pimples.
> Sensory cells, ciliated, connecting the animal with the external environment (detection of prey ...).

The internal layer or endoderm ***FIG 25*** consists of flagellated cells for digestive purposes, close to the epitheliomuscular cells of the ectoderm, therefore capable to contractile movements. They absorb and digest food particles (phagocytosis), helped in this work by digestive substances made by the glandular cells, and poured into the gastric cavity. The endoderm also has a number of sensory cells.

Some particular types of cells exist in the gelatinous mass of the mesoglea. They are migrating or not, and in particular, in the vicinity of the ectoderm: they are the neurons, which link the epithelioneural cells and the cnidocyts, thus constituting an evolutionary early nervous system.

The urticant cell, common to all animals in this phylum, the cnidocyt, also called nematocyt or cnidoblast, is equipped with an «explosive» ampoule, the cnidocyst (or nematocyst or cnida), in which there is a hollow filament bathed in a paralyzing venom ***FIG 26***.

When the cnidocil, located on the surface of the ectoderm, is touched, a nerve impulse triggers a strong increase in the pressure in the cnidocyst. The filament, turning abruptly, like a rubber glove finger, hits the prey with great speed, and remains anchored by the hooks at its base. Venom, more or less active, depending on the species, can have paralyzing or even deadly effects on prey.

Some cnidarians: Physalia (Portuguese man-of-war), Cubo-medusae (box jellies), some anemones or tube-dwelling anemones, can, in the event of contact with humans, trigger considerable traumatisms: burns, allergic shocks, potentially even leading to death.

NUTRITION

All cnidarians are carnivorous, whether active or passive, this latter depending on the species.
In all cases, the prey, alive or not, is captured by the tentacles, if necessary, paralysed or killed by the venom of the stinging cells, brought to the mouth and then digested inside the gastric cavity.
Non assimilable parts (shell fragments, ridges ...) are subsequently rejected.

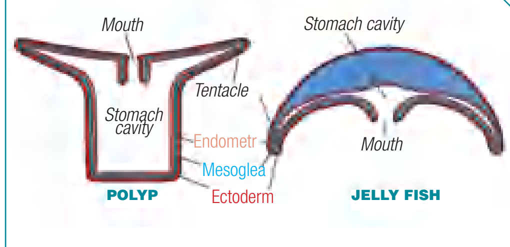


FIG 24 : *Two forms of Cnidarians, polyps or jellyfish*

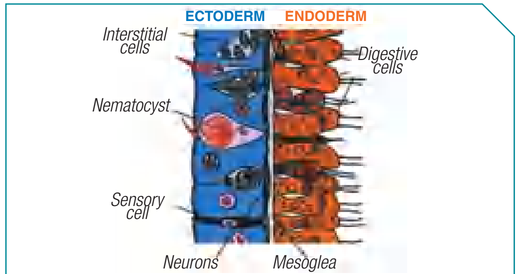


FIG 25 : *the constitution of the ectoderm and the endoderm*

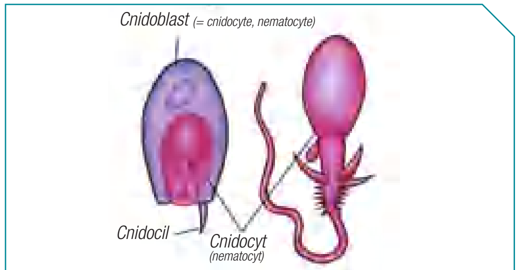


FIG 26 : *the stinging cell of the Cnidarians..*

Great tube-dwelling anemone Cerianthus membranaceus. Mediterranean Sea

REPRODUCTION

Sexed or not, the reproduction of cnidarians is very complex, some jellyfish having a polyp stage and some polyps a jellyfish stage; it will be discussed separately for each class.

CLASSIFICATION

Cnidarians are generally divided into three super classes:

> The Anthozoans
(from the Greek words *anthos*: flower and zoon: animal)

> The Hydrozoans
(from the Greek words *hudôr*: water and zoon: animal)

> The Scyphozoans
(from the Greek words *skuphos*: cup and zoon: animal)

Alcyon Alcyonium acaule. *Mediterranean Sea.*

ANTHOZOANS

About 5300 species are divided into two classes: octocoralians and hexacoralians.

The encrusting alcyon Alcyonium coralloides. Mediterranean.Sea

OCTOCORALIANS

The polyps, with eight characteristic tentacles with pinnules, surround a mouth and a gastric cavity divided into eight parts by endodermal septa.
Six orders group colonial forms, although there are some solitary forms (hartea) sometimes grouped in a subclass, the protalcyonarians.

In most octocoralians, two types of polyps coexist, fulfilling different functions:
> the gastrozooids (or autozooids) responsible for capturing and assimilating food,
> the siphonozooids, a type of contractile valve, responsible for opening and closing the access of the endodermic channels to the external environment.

The polyps of the red alcyon Alcyonium glomeratum. Brittany.

> Stolonifera

Polyps are small-sized and connected by a stolon adhering to the substrate (Clavularia, Cornularia); they sometimes have a horny envelope, secreted by the ectoderm. Larger forms can be calcified: Tubipora musica, known by divers as «music coral», retracts its polyps into a complex set of tubes looking like organ pipes.

> Alcyonaceans – Soft Corals

Alcyonoids (or alcyons), constitute encrusting or erected colonies of rather massive structure. The ectoderm covers the surface of the colony, most of the mass being the mesoglea, here called coenenchyme, which includes the endodermal tubes containing the highly elongated retractile polyps. The siphonozooids let the water of the external environment enter the endodermal channels, helping to stiffen the colony by is essentially a hydro-skeleton. This stiffness is further enhanced by the presence of thousands of tiny calcareous spicules/spikes, the sclerites. The whole colony can retract when touched, forming rigid assemblages, sometimes bristling with spicules, like the great Dendronephtia, in tropical seas, with magnificent colours. The genus Alcyonium is very well represented in cold and temperate seas: *A. digitatum, A. glomeratum, A. palmatum.*

Tropical. soft coral Fiji.

Red Coral. Corsica.

> Corralidae

The famous red coral, «coral of the jewelers», Corallium rubrum, belongs to this order. It lives mainly in the Mediterranean Sea, between 10 and 200 m. The skeleton, consisting of fused spicules, is a beautiful red, and the polyps are white. As in the case of the alcyons, the polyps are housed in endodermic tubes, embedded in a mesoglea armed with spicules (sclerites). The communication between the different polyps is provided by parallel endodermal tubes in contact with the skeleton. Again, as with the alcyons, siphonozooids exist, allowing contact with the external environment.
The colonies of red coral can exceed 60 cm in height, with a branch diameter up to 3 cm. An albino variety can sometimes be found, while neighbouring species, white or pink, live in the Red Sea or the Sea of Japan.

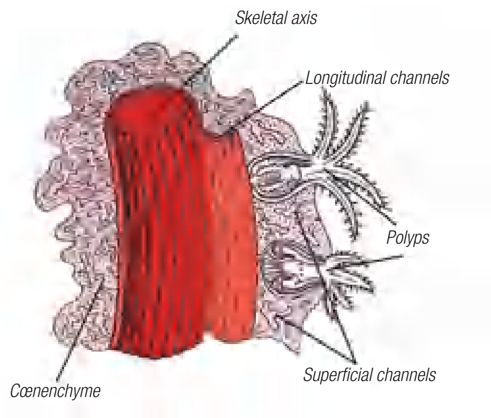


***FIG 27 :** red coral anatomy.*

> Gorgonaceans (Axiferous)

Gorgonians, branched colonies up to several metres high, develop around a corneous axis and consist of a collagen-protein mixture, gorgonin, both flexible and resistant, secreted by the ectoderm (in red in ***FIG 28***) . Sclerites in the coenenchyme are abundant and of various shapes and colours.

The position, the colour and the size of the polyps vary from one species to another, as does the distribution of the «branches», sometimes anastomosed (fan-like) and arranged on the same plane, perpendicular to the dominant current. This arrangement facilitates the collection of nutrient particles.

> Pennatulids

Here the colonies are not fixed but embedded in the sediment by a fleshy peduncle. The lower part, devoid of polyps, is the peduncle used to anchor the colony in mud or sand. Two forms exist in Eurpean seas:

- the veretillums, cylindrical in shape, orange to pink, with translucent polyps, very abundant in certain places (Gulf of Lion).

They can retract their polyps and shrink dramatically, by flushing water out of their hydroskeleton, until they disappear completely into the sediment (mainly during the day). Size when unrolled: 50/60 cm, on average.

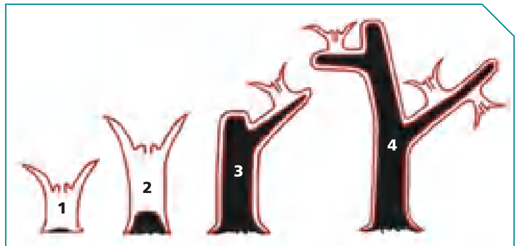
- the pennatuli, or sea feathers, whose polyps are fixed to leaves, disposed on either side of the rachis, and which overlap like the slates of a roof. Less retractile than veretillums, they can curl up on themselves, like some fern leaves. Unwound size: 15/30 cm, on average.

> Helioporidae (blue coral)

Massive colonies secrete, using special ectodermal cells, calicoblasts, a calcareous skeleton of blue colour, consisting of calcium carbonate fibres rich in iron salts. The external appearance is smooth, perforated with star-shaped openings from which retractile polyps emerge. Particularly valued by collectors, aquarium traders and other «curio» enthusiasts, the blue coral of the Indo-Pacific, Heliopora coerulea, is the subject of international protection measures.

> Reproduction

First, reproduction is sexual, by gamete production; the terminal evolution of the germ cells contained in the partitions of the gastric cavity. Fertilisation is external, resulting in the development of a swimming larva, the planula, which, after a very short pelagic life, falls to the bottom and settles to give a first polyp. Then the second step, for the colonial forms, is the asexual multiplication, where the mother polyp buds the rest of the colony.



Axis of gorgonine secreted by the ectoderm.

FIG 28 : *growth of a gorgonian.*

> Predation

Like many cnidarians, the octocoralians are the prey of many molluscs, especially the cowries and Flamingo tongues, resembling small porcelains. The mantle of these animals, which covers the shell, is of the same colour as that of their host, making them very difficult to distinguish.

> Parasitism

Gorgonians and red coral can also be invaded by alcyons, hydroids, bryozoans, ascidians of worms, often as a result of an injury or illness.

Knobby gorgonian - Thailand.

Sea anemon Aiptasia mutabilis. Mediterranean sea.

HEXACORALIANS

Anthozoans with sleek tentacles (no pinnule), six in number, or multiples of six. There are, as in the case of the octocoralians, solitary or colonial forms, devoid of skeleton or, on the contrary, endowed with a calcareous or horny skeleton. Depending on the authors, they are divided into six (sometimes seven) orders.

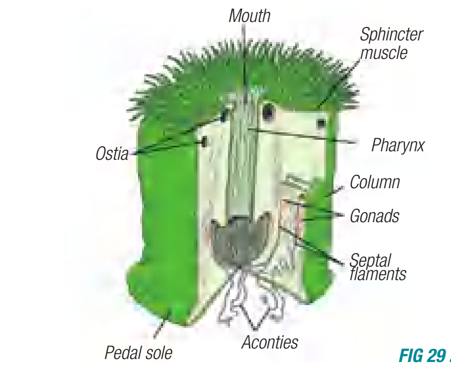


FIG 29 : *polyp.*

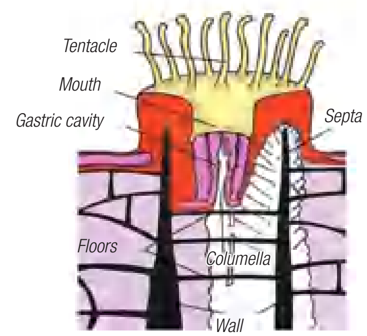


FIG 30 : *section.*

> Actinians

Everyone, even non-divers, knows sea anemones, although some (landsmen...) believe that they are aquatic flowers. Anemones are the most visibly widespread cnidarians in our temperate seas, but they are also found elsewhere, from Arctic seas to the tropics, from the tidal zone to the deepest abysses. All actinians have hollow tentacles, arranged in a crown around the mouth, most often in alternating cycles, always a multiple of six.

The gastric cavity is divided by partitions, complete or not; each box between partitions corresponds to a tentacle. These partitions carry, among other organs, the genital glands and muscular bulges. In their lower part, there are long filaments, acontia, which the animal can expel, in case of aggression or stress, by pores called cinclides, which put the gastric cavity in contact with the outside. The column may be longer or shorter, rough or smooth, encrusted with debris. It carries the pedal sole at the base, which is used to fix the animal to a substrate, and secretes adhesive products which reinforce the fixation.