IT'S ABOUT TIME!

FEATURE **PATRICK VAN HOESERLANDE**

At the end of my dive during which I have admired the attractive depths of the Spanish coast, I start rising to the surface. A glimpse at my dive computer tells me that I must perform a decompression stop of 6 minutes at 5 meters. At my decompression depth, I check my computer to verify the stops and I start the long wait. My thoughts wander off during the stop. What is '6 minutes'? Or more generally, what is time?

We all know the feeling of, 'not having enough time'. Time is the only thing we can never have enough of. We can have too little or too much money, food, diving equipment…but we all have too little time. But what is time exactly? Is time an observable, measurable phenomenon?

REFERENCE AND DURATION

The past is fixed while we live in the present and look forward to an uncertain future. As humans, we are the only living creatures aware of the time phenomenon, but we experience time only by what it does with tangible things and not in its intangible, naked fourth dimension.

Time was for centuries an incomprehensible mystery. Even scientists like Aristotle and Einstein could not completely unravel the concept of 'time'. This attempt to shed some light on this issue must be read with the necessary sense of relativity.

I would like to propose an approach to our time problem by splitting it into two: the first is the question of the 'reference' and the second is the 'duration of the unit of time'. After all, in order to meet the other, we must know how long we have to wait by starting from a particular moment.

TYPES OF CYCLES

In the beginning, man lived in relative harmony with nature. It is therefore not surprising that the first measurements of time were in relation to the cyclical phenomenon of nature. For example; the moon cycle gave our ancestors an indication of the progression of time. 'We'll meet over 3 full moons,' was an ancient, brute, but accurate determination of time. The problem, however, was to pick the best cycle to use, because nature offers plenty of possibilities.

The rotation of the earth around the sun causes a number of cycles such as day/night or the seasons. These cycles are very inaccurate. For example: how accurate can you, without a calendar at hand, determine the beginning of spring? At what hour would you be at a rally point if you, without a watch, had agreed to meet at sunset? Not only is the reference point a problem, also the duration causes a headache.

The time it takes earth to orbit around the sun from equinox to equinox is not exactly 365 days. It is exactly 365 days, 5 hours, 48 minutes and 45 seconds. A standard year of 365 days would cause a 1 day shift every 4 years. A neglect of this small deviation would, after centuries, result in a shift of the seasons in relation to the yearly calendar year. After some time, summer would start in January.

It is therefore not surprising that in 54 BC, the leap year was introduced in the Julian calendar. However, the method was not exact enough and needed, in 1572, the intervention of Pope Gregory III, because the difference was already 10 days. From then on, thanks to the application of the current rules, the shift of the seasons is considered negligible. But caution is needed; our method is still not perfect, because every 100 years we have a difference of almost three-quarters of an hour.

Also, our days are not equally long, because the earth rotational speed is not constant. The rotational daily speed of our planet can vary up to 15 milliseconds. The sun is therefore not always at noon on its highest point of the solar arc. There are also differences during the year. The result of the ellipsoidal orbit and the inclination of earth's axis makes it that the sun runs in the month of November more than 15 minutes ahead, while it lacks behind in the summer months. Moreover, due to the variation in velocity, our northern summer lasts longer than in the southern hemisphere. Thus, we, Northerners, can enjoy the beach and the sun longer.

In addition, earth's rotational speed decreases by the influence of the tides caused by the attraction of our moon and sun. In order to correct the increasing length of our days, after some years, a second leap is inserted. Some people say that with getting older the days fly faster. There is a psychological explanation for this feeling which lies in the decreasing relative size of the present day compared to the complete period of the already lived days. But from an astronomical perspective, this feeling is completely wrong!

The many variations in the solar time are explained by the interaction between the earth and the sun. From the day humans looked to the stars, they began to use the more stable star time (even in Star Trek they use star dates). A star (also a sun) is so far away from earth, we talk of distances in light years, that days and seasons are not influenced by the irregular circulation of earth around the sun. Nevertheless, even this time is subject to the rotational whims of our earth. So star time, except by astronomers, is no longer used.

Some scientists thought that the moon was a better celestial body for measuring time. The earth-moon combination constitutes a stable system. We observe the influence of the moon by the tidal movements. Every 12 hours and 25 minutes, we may observe high and low tides. The complete tidal cycle takes 24u50 and is called a "moon day". The moon rotates around the earth in 29.5 days and spins, not by chance, in that time once around its axis. Therefore, we always see the same side of the moon. The system earth-moon slows down with one 16 millionth of a second per year. A long time ago, earth spinned much faster. The moon was also closer to the earth than now, because the centrifugal force of the system pushes the moon away. Although a better system, this results in non-stable time.

THE ORIGIN OF THE SECOND

You can essentially make the partition of a day as large or as small as you want. We have to thank the ancient Egyptians for our current partition of a day because they already used a 24 hour system. The old Babylonians distributed everything in parts of 60: the day had 60 hours; the hour had 60 minutes which had 60 seconds. From them, we inherited our 60-part system of minutes and seconds. The second is an old unit based on earth's rotation. As we have discussed earlier, an earth day is not a constant, and thus the old second was not a constant either. Attempts to capture the second with the aid of a clock failed. The clepsydra or water clock, the hourglass, candles and oil lamps (marked with a number of stripes) and the sundial all had their disadvantages: water may freeze, an hourglass must be constantly watched, candles or oil lamps can be blown out by the wind, and a sundial only works when there is sun. Apart from the sundial, these basic 'clocks' could usually only measure the duration of an event, not the point in time at which the event took place.

Sailors, postal services, train services, traders …all needed a clear indication of time and moments. In order to fix appointments, a stable second was desperately needed. The invention of the mechanical clock in the last decade of the thirteenth century brought the solution.

The first clocks were large and expensive artwork that had, for reasons of visibility, to be placed in the centre of the town. Belforts and church steeples were particularly suited. Of course later on, those big clocks had to be synchronised with each other. In England there were entrepreneurs who made a living by getting the time in Greenwich and for a fee, went to bring time to their subscribers. They were sellers of time. Another way to synchronise watches was with the sound of the big clocks. Later, the synchronization was achieved by telegraph lines. The network of synchronised clocks spread slowly. The moment each country had its standard time, it became necessary to introduce a world standard.

The mechanical clock ensured a constancy of time, but there was still a need for a world reference. Because the prime meridian of Greenwich was for centuries the reference for nautical charts – England was the global sea power in that era – it was decided, although not easily, to accept this meridian as the reference. The time associated with the meridian of Greenwich, was baptised the Greenwich Mean Time (GMT).

To stick as close as possible to the local time, time zones were introduced. In 1928, the 'Universal Time' (UT) was introduced. This is a more precisely defined time based on the GMT. The polar motion made that this time was not equal across the globe. To solve this, a corrected time was introduced, the UT1.

With the invention of the atomic clock in 1955, the atomic time was introduced. The second was no longer defined as a fixed part of the unstable day, but as the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium 133 atom, at rest and at a temperature of 0 K. Quite astonishing, in 500 BC Pythagoras already had the suspicion that measuring time had something to do with vibrations. This is not synchronised with the UT and therefore the UTC was introduced. The international acronym UTC is a compromise between the French 'TUC' (Temps Universel Coordonné) and the English 'CUT' (Coordinated Universal Time). UTC is itself not an abbreviation. The UTC is regularly adjusted to stay within a second of difference with UT1. By doing this, UTC and atomic clock times are drifting away.

It is now technically possible to globally synchronize the clocks within a deviation of a small fraction of a second. The Global Positioning System (GPS) works on the basis of runtime measurements with an accuracy of a few tens of nanoseconds. For the internet and other computer networks there is the Network Time Protocol to synchronise the internal clocks of computers.

WHERE DOES OUR NEED FOR PRECISION STOP?

You are likely to find an atomic clock the ultimate measurer of time, but for some scientists, it is still too imprecise. Remember that the speed of light is slightly less than 300,000km/s. In 1/1000th of a second, light still travels 300km. We want to explore the even smaller building blocks of the cosmos. Therefore the Europeans built an underground, circular tunnel of 27km in Cern, near Geneva in Switzerland. In this steel circle, superconducting magnets accelerate atoms up to almost the speed of light. If those high speed atoms collide they break up in even smaller particles. Filming the moment of impact reveals the existence of particles like muons.

The lifespan of the muons is but two millionth of a second. But they also fly through our atmosphere. Is the explanation for their longer existence in the cosmos that they travel at near light speed? Bombarding atomic nuclei creates other exotic particles that live but a millionth of a billionth of a billionth of a second. Where do we stand with our capacity to measure 1 nanosecond (10-9s) in relation to particles that only last 10-24s? Neutrinos originated from exploding stars and are heading with the speed of light towards our planet and are, despite their limited life expectancy, able to visit us. Einstein explained this by the relativity of 'time'. He claimed, however, that nothing could travel faster than light, but the existence of tachyons could contradict this statement. Did this famous scientist not fully comprehend 'time'?

EPILOGUE

My dive computer beeps and tells me that my time is over. Or does it only begin now?

SPECIAL INTERLUDE

Einstein predicted in 1905 that the clock of a fast traveller is running slower than that of a person who stays at home: the famous twin paradox. Travel at high speed means that you spend less time than someone at home: the contraction of time. This phenomenon is detectable on board of an airliner. This was proven in 1971 by Hafele and Keating by flying four atomic clocks around the world. At the end of the experiment the clocks had a clear, measurable time delay.

YOUTH DIVING – LIFE IN THE FRESH

FEATURE **KIKI VLEESHOUWERS** AND **PATRICK VAN HOESERLANDE**

Although youth diving becomes more popular by the day and the number of publications on this topic is increasing, there are very few books on diving for young divers. To fill this gap, a group of divers from the Flemish Diving Association (NELOS) published a book focused on the youngsters and their parents. Two young heroes, Skubba and Fred, together discover the world of diving, guiding you through the book covering many topics.

While the stories and the book are in Dutch, we would like to present two extracts because it is interesting stuff and it gives you an idea on how we can inspire young people to take up diving. The two articles show what you can discover underwater in our Western European waters. Remember, the book is for young divers, but we are sure that grown-ups will have fun reading it aswell. They might even learn something new.

The chapter on biology was co-written by Kiki Vleeschouwers, a vet with special interest in underwater biology and is very comprehensive. Parts of the articles are shown here and are limited to a few special plants and animals. The book contains information on common encounters in fresh water, such as the pike and the carp, but in this summary we are picking out the "special encounters".

DIVING IN 'REAL' WATER? COOL!

You are not going to be alone in that 'real' water! And we are not talking about your diving buddy. What can you see and explore down there? Let Scrimpy be your guide. Together with our funny shrimp you will discover a bunch of underwater creatures. He will advise you how to find them all yourself.

Marine biologists, smart people who know everything about underwater plants and animals, talk about two types of water: fresh and salt. Take a glass of drinking water. Drink it. That is fresh water. Now take the saltshaker and sprinkle a lot of salt in a glass. Really, a lot of salt. Mix it well and drink it. Yuck! That is salt water. It sounds odd, but far more plants and animals live in salt water than in fresh water. Weird, hey?

If you're out walking, you will probably see a lot of plants (grass, flowers, trees, etc.) and if you take a really good look around you, you may spot an animal (rabbit, bird, squirrel, etc.). On land there are many plants, but not so underwater. Underwater there are many more animals than on land. Some even look like plants, but they are actually animals.

Scrimpy is becoming impatient. He wants you to meet his fresh water friends and match them up with their descriptions.


Amphipod

RED WATERMITE

What is this? A small red dot of just a few millimeters which rolls and spin here and there in the water. This is the red watermite.

SOMETHING SPECIAL

Get your underwater magnifying glass out, have a look through it and what do you see? That small animal has 8 legs! Yes, because of his many legs it belongs to the family of the arachnids, spiderlike creatures.

FACT

Why such a bright red colour? Well, this small animal tries to look mean and very dangerous to predators that like to eat him. What do you think? Does it work? Are you afraid?

GREAT RAMSHORN

What is this? A small shell, only a few inches large, with a very special round and flattened shape. This is the house of the great ramshorn.

SOMETHING SPECIAL

Snails are simultaneously both boy and girl. They are hermaphrodites.

FACT

Scientists, whom are also very smart people, gave them this name because their house looks like the coiled horns of a ram.

WATERWEED

What is this? A green plant with a long stem and small green leaves. Sometimes free-floating in the water, sometimes with roots in the soil. This is a waterweed.

SOMETHING SPECIAL

Now you really should take your magnifying glass out because waterweeds form a perfect shelter for a lot of small life such as tadpoles, cute amphipods, eggs of salamanders… Make sure you have enough air in your tank so that you have the time to discover all these small animals!


Zebra Mussel

FACT

You will easily recognize waterweeds. It is a plant that you find in just about every aquarium with a goldfish swimming around.

HARDER TO FIND IN FRESH WATER

So, this was the warm up in which we went looking for common animals, plants and weeds. This was just an appetizer for more to come. Now the more difficult work starts because Scrimpy takes you in search of underwater animals that like to play hide and seek. Sharpen your senses and follow Scrimpy very closely!

AMPHIPOD

What is this? What kind of pale animal with many legs wriggles on the bottom and in water plants? Look very closely because it is only a few centimetres long. If you find it and try to touch it, you will discover that it is a fast swimmer and that it can change direction very quickly. Meet the amphipod.

SOMETHING SPECIAL

The amphipod has many legs. Each of them looks very different and has a certain form


Freshwater Hydrozoa


Waterweed

because they all have a specific task. An amphipod has swimming legs, feeding legs, cleaning legs… Its legs are really quite handy. With his feeding legs he catches small bits of food, this may be plant fragments or small creatures like mosquito larva. It bundles it in a small packet and then brings it to his mouth to enjoy.

FACT

At certain moments in the spring, you often see an amphipod with another smaller amphipod between its legs swimming around. And, they don't let go of each other. They really stick together. No, the big one is not eating the smaller amphipod. That is the male that keeps his beloved female between his legs so he doesn't lose her.

ZEBRA MUSSEL

What is this? A nice, little shellfish about 3cm big (or small). It is triangular in shape, with dark stripes on a light-yellow background on its shell. The shells are firmly attached to a hard surface and sometimes there are many of them together. This is the zebra mussel.

SOMETHING SPECIAL:

These animals originally come from the regions of Russia and they they like our fresh water very much. That is why you can find them in almost all fresh waters. This is very much approved by the tufted duck, because this duck really loves to eat zebra mussels. They are incredibly tasty! Despite the fact that these mussels are very firmly fixed to the ground or to each other by strings, these are solid byssus threads that they make themselves and the duck can easily pull them loose. You should try it too, it's not easy though! You will see that those strings are really very strong.

FACT

There are male and female zebra mussels. And where are those baby mussels? In mom's shell? No. Dad and mom zebra mussels just throw their seeds and egg-cells in the water. If those find each other, then a baby mussel is born. These are called larvae. These very small larvae float and grow in the water. When they are big enough, they descend to the bottom, fixing themselves to grow into a mature mussel.

A COLONY OF MOSS ANIMALS

What is this? It seems to be a caterpillar under water! It's a slim yellow-white somewhat fluffy caterpillar of about 3cm long, called a colony of moss animals.

SOMETHING SPECIAL

No, it is not really a caterpillar. Take your magnifying glass and look at the creature again. These are all small creatures, called polyps, who live together in a colony. The fluffy things are small tentacles which the creatures use to catch their food. Tap gently against the tentacles and you see that they withdraw these with lightning speed and you see that the 'caterpillar' loses its fluffy appearance.

FACT

Moss animals are not fond of cold. Once the water temperature drops below 8°C, each polyp creeps back in his own room which is a bit like a survival capsule. These capsules sometimes stick to the legs of a duck and that is how these moss animals travel from one pond to another.

FRESHWATER HYDROZOA

What is this? If you are able to discover moss animals, then you're ready to find an animal that looks a bit similar. It really is smaller, it is less than 1cm. It also lives together with its friends, but not as closely packed together. It looks like a fine stem of a plant, or twig with threads at the end with its feet firmly anchored in a hard surface.

Have you found it? Awesome! You have found the fresh water hydrozoa!

You also have fresh water polyps. These grow on aquatic plants and look like stretched anemones. They are white-transparent and can be up to 10cm long.


Red watermite


Freshwater Sponge


A Colony of Moss Animals


Great Ramshorn


Pondweed

SOMETHING SPECIAL
The threads that you see are actually tentacles with genuine sting cells. These are the same cells that sting when you touch a jellyfish. If you touch such a polyp, it retracts its tentacles and reduces itself completely to a small bead. Now you really need your magnifying glass!

FACT
A fresh water hydrozoa is firmly fixed by his feet, but it can move. This is not at high speeds as you can imagine. If you want to observe the animals during a walk, you will need more than one well-filled dive tank to stay long enough under water…

FRESHWATER SPONGE
What is this? A yellowish somewhat jellylike with tabs and holes in it, it seems a bit like a flattened bath sponge. It sticks against a wall, on wood, stone, metal or twigs.

Congratulations! You have just found a very particular animal, a freshwater sponge.

SOMETHING SPECIAL
Really! A sponge is an animal! It is not a plant! Therefore, your bath sponge was an animal! Although that one came from the sea. It is a very primitive animal. It eats by filtering the water. Each cell of the sponge may grow into a new sponge.

Does a sponge worry if it loses a piece? Not really, the broken piece becomes a new sponge. Life can be very simple for an animal like the sponge.

FACT
In salt water, you'll find many different types of sponges, in a great variety of colours and forms. In fresh water however, there are not that many sponges.

Sometimes, fresh water sponges are green instead of yellow. Make no mistake, it is not another sponge species. The green colours are algae which live in the sponge. Sponges and algae can live together.

PONDWEED
What is this? It seems to be a nice little water plant. A green stem with fine branches as a crown stuck around the little stem. Sometimes you see a small orange ball at the end of such a branch. Super, you have discovered a pondweed.

SOMETHING SPECIAL
Well, pondweed seems similar to a little shoot, but it is not really a plant. Pondweed has no real roots like a plant. That is why pondweeds have little styled feet to hold on to a hard surface. These feet are part of the stem which are not roots like that of a plant, standing in the sand. It is actually a very, very old plant, which exists since 400 million years ago. Respect!

FACT
The nice thing about pondweeds is that when you see them, you know that you're diving in water of good quality. Pondweed only grows in nice, clear water.

SALT WATER
Was this discovery tour with Scrimpy fun? Nice to hear.

And what about animals and plants found in salt water? You can discover the animals in our next article coming out in the September issue. So you have to wait just a little bit.