Co-funded by the
Erasmus+ Programme
of the European Union

ABOUT THE PROJECT

In September 2018, Jakub Krčín´s High School of Fisheries and Water Management (SŠRV) joined the Erasmus+ programme again. This has resulted in the three partner schools: SŠRV, Nord-Troms videregående skole and Lyceé Professional de Guérande - Olivier Guichard, once again joining together in the two-year international project Food from water Used To Urge Revolution in Eating habits (FUTURE). The school's project teams were tasked with concentrating their attention on aquaculture, the ecological aspects of sustainable healthy food production and the promotion of fish, seafood and freshwater products.
The first project meeting took place in November 2018 in Třeboň, where students concentrated on carp, grass carp and crayfish. In May 2019, the teams met in Skjervøy, Norway, to get a closer look at salmon, sea urchin and seaweed. The third student mobility took place in October 2019 in Guérande in France, where attention was drawn to oysters, green algae and to an introduction of the aquaponic system.

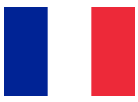
INVOLVED SCHOOLS

JAKUB KRČÍN´S HIGH SCHOOL OF FISHERIES AND WATER MANAGEMENT
TŘEBOŇ
CZECH REPUBLIC

Jakuba Krčín's High School of Fisheries and Water Management is located in Třeboň, a town close to the border in the south of the Czech Republic. Due to its untouched landscape and unique pond system, the region of Třeboň is a UNESCO World Heritage Site.
A professional fishing apprenticeship school was established in Třeboň in 1951, the only one in the entire Czechoslovakia. The fishing apprenticeship tradition was then followed by the Jakub Krčín´s High School of Fisheries and Water Management in 2008.

NORD-TROMS VIDEREGÅENDE SKOLE
SKJERVØJ
NORWAY

The Nord-Troms videregående skole – seek this school far beyond the Arctic Circle, around the 70th parallel, in the county of Tromso. The school was founded in 1990 in an area typical for farming Atlantic salmon, Alpine grayling and Rainbow trout. Today, it is not only involved in aquaculture and fishing, but also in fish gastronomy.



LYCEÉ PROFESSIONNEL DE GUÉRANDE -- OLIVIER GUICHARD
GUÉRANDE
FRANCE

The Lyceé Professionel de Guérande is located near the Atlantic Ocean, in a tourist and agricultural area near Nantes. Founded in 1972, this school was the first in France to deal with water management. Today, it educates future experts in catering, landscape architecture or fish and shellfish farming.

eTwinning

You can find all of the project's outputs on: *http://twinspace.etwinning.net/71124/home*

HEALTHY FOOD - SELECTED SPECIES

SPECIES TYPICAL FOR THE CZECH REPUBLIC

CARP

(*Cyprinus carpio*)

HISTORY AND ORIGIN OF THE SPECIES

The common carp belongs to the evolutionary younger fish – the bony fish and according to recent knowledge carp appeared for the first time around the Black Sea and from there migrated and got to further places like Russia, China and the Czech Republic.

The first reference about carp breeding is around 1000BC in ancient China. Carp was considered as a symbol of luck and wealth and also was part of an important food source. It is also interesting that quite often there were colourful variations which we know nowadays as Koi carp. In Europe carp began spreading in the catchment area of the Danube River, nowadays we call this wild form ´Sazan´. The carp got into the catchment area of the Elbe River thanks to Romans who fished for it and used it as a food source for their soldiers. These soldiers were moving a lot so they needed to take carp with them. So the carp got into the Elbe River where it escaped the Romans and migrated further west. This was the way the carp got into the whole Europe. It was really popular around 1000AC when it was considered as a suitable fasting dish. Therefore the professional breeding was really started by the monasteries and then by aristocratic dynasties like the Pernštejns and Rosenbergs who helped spread carp further.

DESCRIPTION, BIOLOGY AND GROWTH

Carp is the most typical representative of Cyprinidae family all over the world. It has spindle-shaped form of the body with a distinctive spine. The height of the spine can differ according to genetic line or environment where it lives. The head is distinctive with pharyngeal jaws. A great recognizable sign is also a pair of whiskers/barbels/ at each corner of the mouth. The single dorsal fin is prolonged and simple. The forked tail fin is quite big with deep shape. The interesting part are the scales as thanks to genetic breeding we know four variations of scales on carp. They include large shiny scales, absence of scales, scales in a line along the flanks or smooth scales. Carp is a very easily satisfied species. It needs higher temperatures but it is also able to survive in a very cold waters.

Stagnant or running waters are suitable and this species is not liable to organic pressure. It even manages on a minimum concentration of oxygen. It creates a big shoal and is not aggressive to other fish even though it is actually omnivorous.

Growth is dependent on the amount of food and the water temperature. In the waters of the Czech Republic it grows up to weight of 2,5kg in about 3-4 years. But in the warm waters of Australia it would grow to this size in just over a year.

NATURAL HABITAT AND AQUACULTURE

Naturally the common carp only occurred in Asia. Today with human activity carp spread extremely and we can find it in almost any country.
It is a really flexible species which can prosper in rivers, dams, ponds and lakes or even in various small storage reservoirs. From these locations it also migrates to further distances. This way it is able to spread naturally practically anywhere.
Thanks to these qualities carp is either loved or hated. In USA waters or Australia carp is extremely overbred and is pushing other species out.
Opposite to that, in the Czech Republic it has been actively bred in ponds for hundreds of years. It is stocked in lakes, fed by corn and is much liked. It is the most bred species of fish and the Czech Republic is able to produce 17000t of carp a year which is the fourth largest production of carp in the world.

REPRODUCTION IN THE NATURE AND ARTIFICIAL REPRODUCTION

The carp in our conditions matures around 3-4 yrs of age. The male fish matures a year sooner. The mating usually takes place during the spring months when the water temperature is above 20°C. Both male and female carp don´t migrate because of reproduction. They only look for parts close to the bank with plenty of vegetation. Carps put their fish eggs onto water plants. There has to be lots of plants because one female can produce 1.5 million fish eggs.
If all conditions are met, males start to follow females usually 2:1. One female would have at least two males and flow in a shape of an arrow. Then they all flow into the water plants where the females release the fish eggs and the male the sperm to fertilize the eggs. Mating is quite fierce but doesn´t take a long time. Fertilized eggs stick to the plants where they stay for about three days.
Nowadays the reproduction of carp in nature happens very rarely because natural reproduction is not very effective and wouldn´t cover the need of the breeders. So therefore today artificial reproduction is mainly used. That is worked out so well with the carp and it is not very difficult.
Mature and prepared fish are moved to incubators where they are weighed, sorted and marked. Twenty four hours before reproduction they are given hormones to help start reproduction. Most of time hypophysis – part of the carps brain is given by injection.
After 24 hours the fish are picked up and by massaging the belly we get fish eggs and sperm in clean bowls. After getting enough amount they are both mixed and covered with water. Then the fertilization starts and takes about 3-5 minutes. Fish eggs become very sticky which is undesirable so with the help of the milk fat it´s possible to get rid of the stickiness.
Fertilized eggs are moved into special incubation bottles where they stay for 3 days before carp embryo is born.

QUALITY OF MEAT AND NUTRITIONAL TABLE

The description of carp meat isn´t clear. Generally it is a dietetic meat, easy to digest and overall beneficial. But the quality is strongly influenced by the environment and type of breeding. It's possible to find a carp meat where quality and taste is perfect. But it is also possible to find a carp which is practically inedible.
In the Czech Republic carp has been bred for hundreds of years and its breeding is worked out in detail. That leads to a fact that the Czech carp has such a name as Norwegian salmon or French wine.

Sugars(g/100g)	7
Fats (g/100g)	10
Proteins (G/100g)	20
HUFA(%)	36
PUFA(%)	18
MUFA(%)	39
Omega 3 (%)	8
Vitamins	A,E,K
Energetic value (kJ/100g)	648

SIGNIFICANCE OF THE SPECIES NOWADAYS AND IN THE FUTURE

Carp is a very important species and belongs to the fifteen most bred freshwater fish in the world. Some breeding is entirely based on its production and wouldn´t be possible to exist without it. It is also a truth that recently carp is not able to compete with other species especially seawater fish which are imported practically anywhere.
So it is presumed that the production of carp won´t be growing in the future but will stay where it is now.

CRAYFISH

(*Astacidea*)

HISTORY AND ORIGIN OF THE SPECIES

There are about five species of crayfish in the Czech Republic. Recently there were also other species imported because of aquaristics and these species are now getting into our waters.
The crayfish were naturally part of our waters and their fishing and consumption were common There is a proof in past documents which mention that in 1910 there were over 500 official crayfish fisheries.
The Natural habitat of crayfish is not limited only to nature parks or conservation areas where the quality of water is carefully looked after. Natural habitat is documented all over our country. Quite often it´s invasive population of crayfish which is found as they are less demanding and push native crayfish out.

DESCRIPTION, BIOLOGY AND GROWTH

The body of the crayfish is formed by the head and joined thorax, abdomen and limbs. The top of the body is protected by chitinous carapace. Midsection is divided with diagonal nape line to two parts head and body, which became one part. Abdomen of the crayfish is formed by seven segments.The last of them turned into a tail fin/ uropod.The abdomen is very flexible and mobile.
The crayfish have 19 pairs of limbs.That also include antennae, mandibles,claws, maxillipeds – out of which only five pairs of limbs are for walking.
Crayfish need a really good quality of water and lower temperatures. Organic presssure can cause problems and chemical strain is deadly. Often they are seen as indicators of the quality of water. Most crayfish are most active at night and spend most of the time being hidden. They are mainly herbivores but can eat bits of meat or even their own species.
Growth is atypical and dependent on molting of the shell. In optimal conditions crayfish can molt their shell 10-12 times in the first year of their life. Our heaviest crayfish can reach weights of 200g in 4-7 years.

NATURAL HABITAT AND AQUACULTURE

Natural habitat of crayfish all over the world is influenced by native or non native species. All crayfish need locations with very clean water, pebbly river bottoms, lots of hiding spaces, abundance of oxygen and a lot of food. These waters can usually be found only in mountain rivers in protected areas.
Invasive crayfish have far less demands so can appear in less suitable waters where native crayfish wouldn´t survive. So all over the world we can see the disappearance of native species of crayfish and the expansion of the others. The waters of the Czech Republic are no exception and the situation is getting worse due to importing crayfish for aquaristics, these crayfish then get out into the waters.
For these reasons we create farms for crayfish which should function as rescue centres for native species, support of crayfish in their natural habitat and recently also forms for consumption. Crayfish live in earthy ponds or special tanks with an abundance of hiding spaces and are fed with special granules or carrots.

REPRODUCTION IN NATURE VERSUS ARTIFICIAL REPRODUCTION

Crayfish in the Czech Republic mate from September to October when they´re 4 years old. During mating some mature males can migrate a bit. Reproduction happens through spermatophore, which is a bag of non active sperm which male sticks to a female. It´s interesting that the female can decide whether to accept this bag or discard it. That´s why one male can mate with 15 females.

About 2-3 weeks after mating the female starts to lay eggs. Depending on the species it could be between 40-550 eggs. During the laying, the spermatophore is also dissolved and activates the sperm. Then the eggs are fertilized. The female sticks the eggs under her abdomen and hides away to stay without any food. New crayfish are born in April.

During the first few days the newborns hide under the tail of their mother until the first or second molting of their shell. This happens within two weeks. After that the crayfish start to become independent and search for safety. They feed independently and carry on molting their shell.

Because of a bad situation there are lots of farms set up, which are using artificial reproduction to get a new generation of crayfish. It is interesting that even in these professional breeding places the crayfish have a very good way of looking after the descendants.

Artificial reproduction is very simple. A breeder just waits for the right time to put the crayfish together in special tanks and waits for the mating. Then he takes the females with their eggs and leaves them in the tank alone. Females look after the eggs really well, a breeder just need to check the quality of water.

The female tries to push away the hatched crayfish after four weeks as they are independent and the breeder has an ideal opportunity to take them away and move elsewhere.

QUALITY OF MEAT AND NUTRITIONAL TABLE

The quality of crayfish meat is very high and is compared with the quality of prawns, lobsters or crabs. This isn´t by chance as all these mentioned above belong to crustaceans and therefore are very similar. The next proof of a high quality of crayfish meat could be in any historical documents, which talk about crayfish as an aristocratic food.

It is a dietetic meat, easily digestible and with no risk of disease transfers. The only exception could be a seafood allergy for some consumers which could potentionally happen after eating crayfish meat.

Last but not least it is also important to think about the fact that the original species of crayfish are protected and their consumption is a crime. Meat could be obtained only from non native species of crayfish

Sugars (g/100g)	3
Fats (g/100g)	2
Proteins (G/100g)	17
HUFA (%)	29
PUFA (%)	14
MUFA (%)	41
Omega 3 (%)	0
Vitamins	A,E,K
Energetic value (kJ/100g)	591

SIGNIFICANCE OF THE SPECIES NOWADAYS AND IN THE FUTURE

Nowadays the crayfish is considered to be an endangered species so it is really necessary to keep an eye on their protection and survival. Unfortunately the recent studies show that despite all the efforts the original species of crayfish is pushed out by non native species all the time. In many countries there is no need to save the native species as the non native species has taken over the waters.

This way the population of non native species is still rising and become more available. In the USA or in France it is common to eat crayfish in restaurants or homes. And also crayfish meat becomes more popular all the time even though it will always be just non native species..

GRASS CARP (WHITE AMUR)

(*Ctenopharyngodon idella*)

HISTORY AND ORIGIN OF THE SPECIES

Amur is native to Asia but was introduced to many parts of the world including Europe and the Czech Republic. It also appears in Africa and the USA. Originally amur was only found around the Amur River in the east of Russia and naturally migrated to China.

It was mainly a river species living in the big lowland rivers and their branches. It was imported into our country after 1960 from the Soviet Union, mainly to Třeboň and its job was to naturally eliminate higher vegetation in water. Also because of the political situation of the world in the sixties we could debate about the political reasons of bringing amur to the Czech Republic.

DESCRIPTION, BIOLOGY AND GROWTH

It´s a typical fish of the Cyprinidae family which is quite often confused with carp by the public. But there are some typical differences to a carp. Amur hasn´t got any whiskers on both sides of the mouth. Its head is wedge-shaped and flat on the top. The position of the eyes is low and there is a distinctive round dorsal fin. But the golden colour of its sides and white belly is the same as carp.

Amurs live in big shoals in warm and deep waters and feed on higher plants. They are called ´living lawnmowers´ as they manage to eat abnormal amounts of high plants. Sometimes it´s like 50kg of reed to 1kg of weight.

The sizes can sometimes appear abnormal. Some resources talk about weights of 30-45kg. This extreme growth could only show with older fish which can add every year 2kg. Young fish grow slowly and a year old amur´s weight is only 5g.

NATURAL HABITAT AND AQUACULTURE

The natural home of this species is the Amur River which is also classed as one of the biggest rivers in the world which also separates countries like China and Russia. Thanks to humans we can find amurs in many parts of the world. The exceptions aren´t states like USA, Canada, JAR, Hungary, Austria and the Czech Republic. The natural habitat is divided into two camps. In some countries the species is accepted as positive and in other countries it could be classed as an extremely invasive species which is pushing other species out. A scary example is the over reproduction of Amur in North America where they were stocked as a weed control in canals. The situation is out of control and massive shoals of amurs are pushing other species out. But even with using electricity or special poisons for fish, they still can´t get this under their control.

Opposite to that a good example is breeding amurs with carps which is done in Czech ponds. Carps and amurs need similar environment so they can be bred together. Also worldwide amur is quite a favourite so it belongs to five most bred freshwater fish.

REPRODUCTION IN NATURE AND ARTIFICIAL REPRODUCTION

Reproduction of this species is totally connected with the Amur River which gives fish ideal conditions for reproduction. The fish ready for reproduction create massive shoals which are 10-15m long. Females start to release fish eggs. It's interesting that these eggs contain a big amount of fat which helps their floating. Also every female can release up to hundreds of thousands of fish eggs. Then the males flow through a cloud of eggs and release the sperm which fertilize the eggs.

Amur is really a warm water lover and in many rivers where they was imported, they can't get these temperatures. It needs temperatures over 25°C. This affects its reproduction which is then very limited. So it's a fish which can´t naturally reproduce in the Czech Republic.

So the Czech Republic is 100% dependent on artificial reproduction. But the good news is that this species has the easiest artificial reproduction out of all the fish in our waters. It's important to follow up several basic information and procedures.

Amurs are mature around 5-7 years old. The males mature sooner. The water temperature shouldn´t fall under 23°C.So the artificial reproduction is done between the end of June and beginning of July.

The artificial reproduction starts with dividing the male and female fish and giving them hormones. Most of time it is hypophysis given by injection which comes from carp brains and is given 24hours before the planned mating. The fish is kept separated so it doesn´t go into spontaneous reproduction.

After 24hours the fish is picked up and by massaging its belly we get fish eggs and sperm into clean bowls. After getting enough of the amount it is all mixed together and water is poured over it. Development of embryo lasts 30hours and is finished by leaving the fish egg.

QUALITY OF MEAT AND NUTRITIONAL TABLE

In recent years there are a lot of people in the fishing industry who are in agreement about the high quality of amur´s meat. Even in sensory tests amur´s winning against other fish of Cyprinidae family, mainly carp itself. The consumption of amur´s meat grows every year and some study say that one day amur could compete with carp even during Christmas sale.

Sugars (g/100g)	5
Fats (g/100g)	4
Proteins (G/100g)	18
HUFA (%)	33
PUFA (%)	18
MUFA (%)	45
Omega 3 (%)	4
Vitamins	A,E,K
Energetic value (kJ/100g)	638

SIGNIFICANCE OF THE SPECIES NOWADAYS AND IN THE FUTURE

The significance of amur is today divided between positive and negative. In areas, where it´s popular, the popularity grows every year. Because of its meat and for sports fishing we expect that popularity will grow in the future and this species will belong to three mainly bred freshwater fish in the world.

In opposite areas where amurs are causing problems it is expected that even with all the effort it won´t be possible to manage the situation. The problems will grow and lead to elimination of other species of fish.

In the Czech Republic amur is a real favourite and it would be good to slowly raise its production.

HEALTHY FOOD - SELECTED SPECIES

SPECIES TYPICAL FOR FRANCE

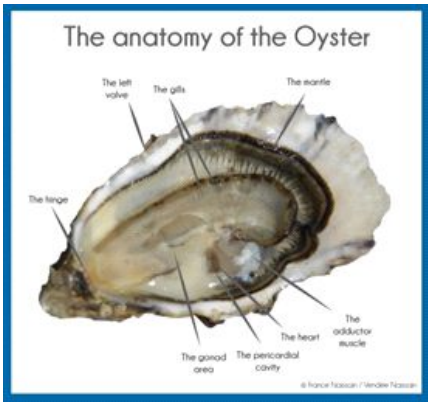
OYSTER

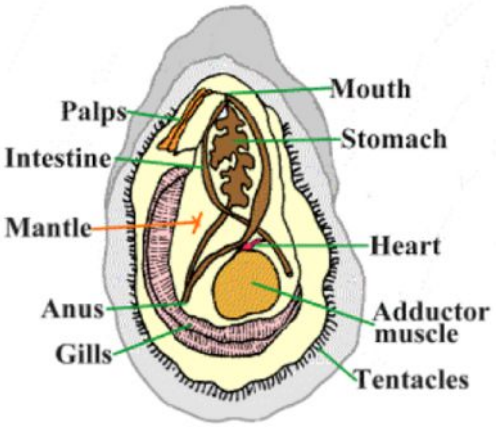
(*Ostrea edulis*)

HISTORY AND ORIGIN OF THE SPECIES

Oysters has always been eaten since Ancient times. The culture of the indigenous flat oyster (Ostrea edulis) began in France in the17thcentury. The oyster beds were overexploited from the 18th century, especially along the Atlantic coast and the landings became poor and irregular during the 19th century. So, in 1860, the Portuguese cupped oyster (Crassostrea angulata) was chosen to replace the flat oyster until the 1970s, when a disease led to the total extinction of the Crassostrea angulata in France. It was then replaced by the Japanese cupped oyster (Crassostrea gigas) which was more resistant to the disease. Nowadays it is the most cultivated species in France and worldwide.

DESCRIPTION, BIOLOGY AND GROWTH





Oysters are bivalve molluscs which live in salt water. The optimal temperature for the growth is 21°C. Their diet is based on phytoplankton. Oysters are filter feeders, drawing water in over their gills through the beating of cilia. Suspended plankton and particles are trapped in the mucus of a gill, and from there are transported to the mouth, where they are eaten.

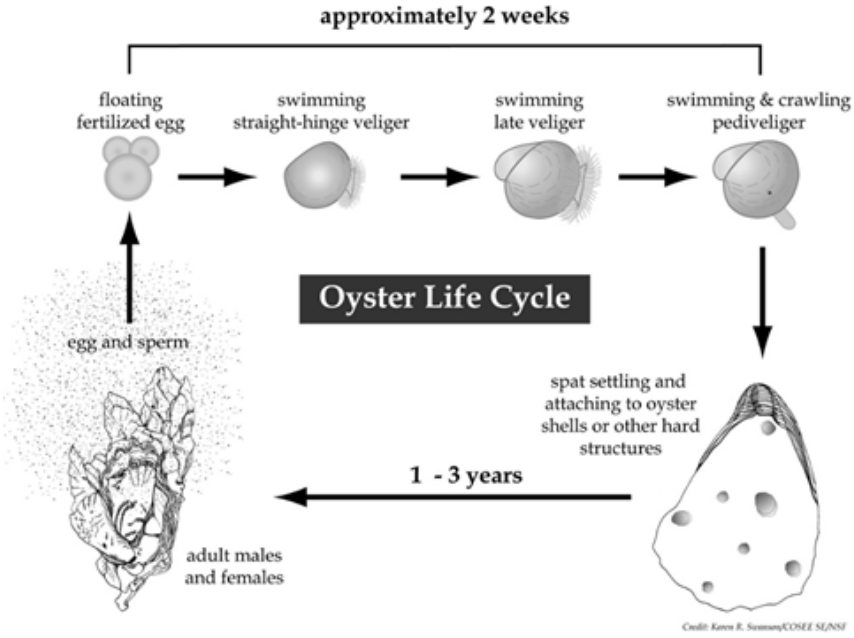
NATURAL HABITAT AND AQUACULTURE

Different production techniques according to the rearing area:

Along the Atlantic coast: Off-bottom culture is done by using plastic mesh bags set on trestles (tables) in the intertidal zone.

Along the Mediterranean coast: Suspended culture (5%), is done by hanging oysters fixed on ropes or in baskets from special frames (tables).

REPRODUCTION IN NATURE VERSUS ARTIFICIAL REPRODUCTION



QUALITY OF MEAT AND NUTRITIONAL TABLE

Nutrition Facts
Oyster, Pacific, cooked

Amount Per 100 grams	
Calories 163	
	% Daily Value*
Total Fat 4.6 g	7%
Saturated fat 1 g	5%
Polyunsaturated fat 1.8 g	
Monounsaturated fat 0.8 g	
Cholesterol 100 mg	33%
Sodium 212 mg	8%
Potassium 302 mg	8%
Total Carbohydrate 10 g	3%
Dietary fiber 0 g	0%
Sugar 0 g	
Protein 19 g	38%

Vitamin A	9%	Vitamin C	21%
Calcium	1%	Iron	51%
Vitamin D	0%	Vitamin B-6	5%
Vitamin B-12	479%	Magnesium	11%

*Per cent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

SIGNIFICANCE OF THE SPECIES NOWADAYS AND IN THE FUTURE

We eat oysters more particularly during Chistmas and New Year period. It is a tradition in most French families. They are really healthy since they are rich in omega 3 fatty acids and trace elements important for the body (skeletton, blood). Once you have understood how to open them, it is a real pleasure to share a plate of oysters with your friends!

SPIRULINA

(*Arthrospira platensis*)

HISTORY AND ORIGIN OF THE SPECIES

Spirulina was a food source for the Aztecs and other Mesoamericans until the 16th century; the harvest from Lake Texcoco in Mexico and subsequent sale as cakes were described by one of Cortés' soldiers.

Spirulina was found in abundance at Lake Texcoco by French researchers in the 1960s, but no reference to its use by the Aztecs as a daily food source was made after the 16th century, probably due to the draining of the surrounding lakes for agriculture and urban development.

DESCRIPTION, BIOLOGY AND GROWTH

Spirulina is a type of cyanobacteria, or blue-green microalgae, that appeared on Earth 3.5 billion years ago, particularly recognizable by its 0.2-0.5mm long spiral shape.

The two species are Arthrospira platensis and A. maxima.

Cultivated worldwide, Arthrospira is used as a dietary supplement or whole food. It is also used as a feed supplement in the aquaculture, aquarium, and poultry industries.

Like most cyanobacteria, Spirulina is a photoautotroph and cannot grow in the dark in media containing organic sources of carbon.

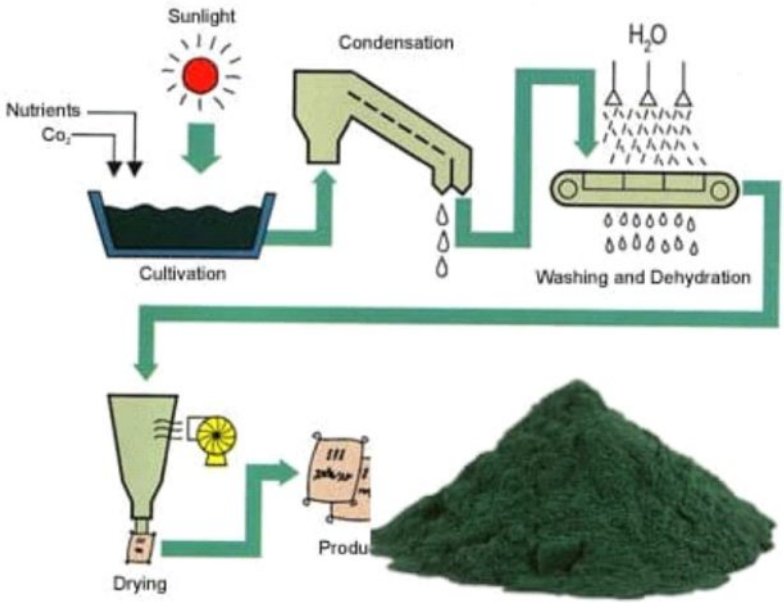
It's a cyanobacteria classified in the family of algae.

It has a blue pigment which is used to absorb the intensity of photosynthesis.

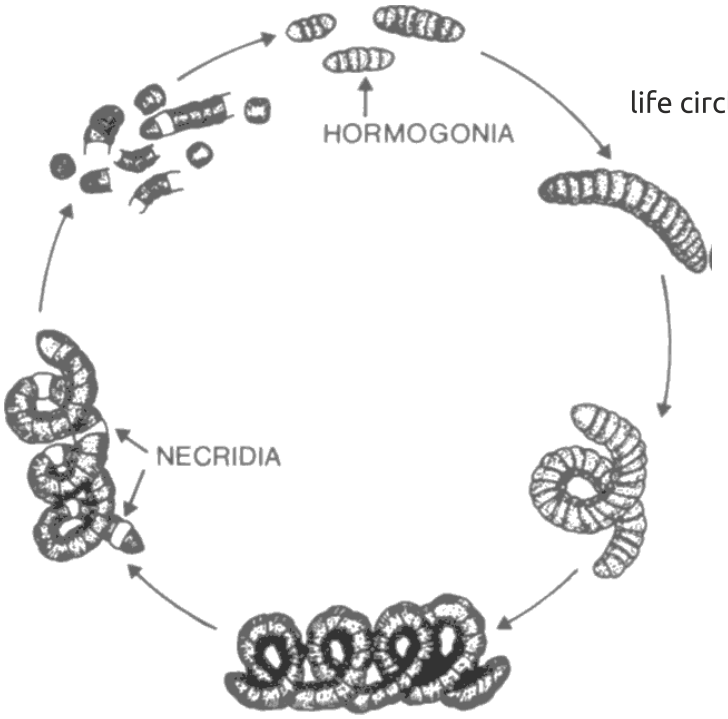
Spirulina only lives in freshwater but some live in seawater.

NATURAL HABITAT AND AQUACULTURE

Most cultivated spirulina is produced in open-channel raceway ponds, with paddle wheels used to agitate the water. Spirulina thrives at a pH around 8.5 and above, which will get more alkaline, and a temperature from 25 to 30 degrees.

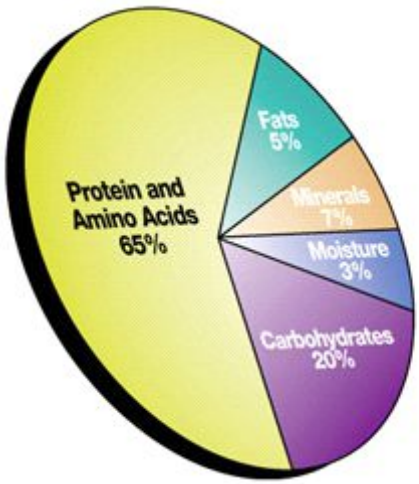


REPRODUCTION IN NATURE VERSUS ARTIFICIAL REPRODUCTION



life circle of spirulina

QUALITY OF MEAT AND NUTRITIONAL TABLE



Spirulina vitamin content

Vitamins	per 10 grams	U.S. DV	% DV
Vitamin A (beta carotene)	23000 IU	5000 IU	460 %
Vitamin C	0 mg	60 mg	0 %
Vitamin E (a-tocopherol)	1.0 IU	30 IU	3 %
Vitamin K	200 mcg	80 mcg	250 %
Vitamin BI (thiamin)	0.35 mg	1.5 mg	23 %
Vitamin B2 (riboflavin)	0.40 mg	1.7 mg	23 %
Vitamin B3 (niacin)	1.40 mg	20 mg	7 %
Vitamin B6 (pyridoxine)	80 mcg	2 mg	4 %
Folate (folic acid)	1 mcg	0.4 mg	0 %
Vitamin B12 (cyanocobalamin)	20 mcg	6 mcg	330 %
Biotin	0.5 mcg	0.3 mg	0 %
Panthothenic Acid	10 mcg	10 mg	1 %
Inositol	6.4 mg	***	***

It is an excellent nutritional contribution to the body and to healing effects on the human body due to its high contents of protein, vitamins, essential amino acids, minerals, essential fatty acids and antioxidant pigments such as carotenoids

Laboratories take the blue pigment of spirulina for biopharmaceuticalb (phycocyanine).

SIGNIFICANCE OF THE SPECIES NOWADAYS AND IN THE FUTURE

Spirulina is more and more eaten by sportsmen since it is natural, and helps to enhance sport performance. It improves muscular recovey since it has an anti inflammatory and healing action. It is also used as an antioxidant. In brief : it is the food of the future!

STURGEON IN AQUAPONIC SYSTEM

(*Acipenser*)

HISTORY AND ORIGIN OF THE SPECIES

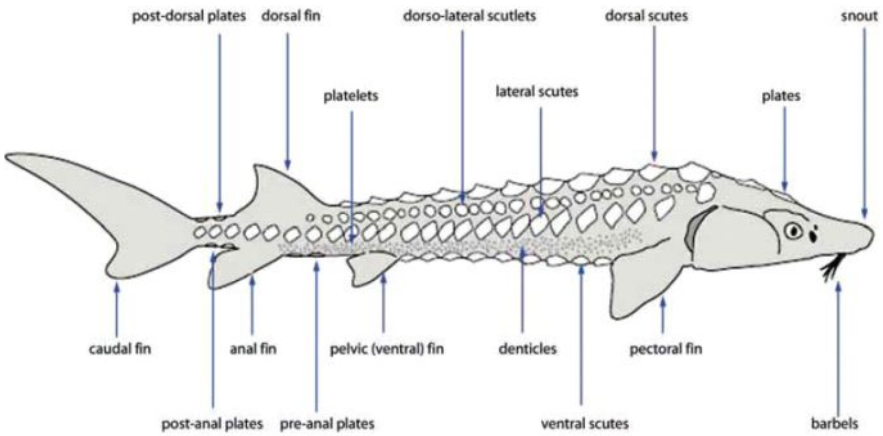
Sturgeon are one of the oldest groups of living vertebrates and are often described as « living fossils », with records dating back more than 150 million years.

The Siberian sturgeon (*Acipenser baerii*) was first imported into France in the 80's for research institutions : its biology is quite similar to that of the common sturgeon (*A. sturio*) but with a shorter biological cycle (seven to eight years of growth instead of 15). The common sturgeon could be found in French rivers but its population was decreasing. So, the second reason for the importation of Siberian sturgeon was for consumption (fish meat for the males and caviar for the females)

Today, France produces 35 tonnes of caviar and 500 tonnes of fish meat.

Moreover, the aquaponic system which combines fish production and vegetable production in hydoponics is particularly adapted to the needs of sturgeons.

DESCRIPTION, BIOLOGY AND GROWTH



Although some traits vary among species, Acipenseriformes are generally long-lived fishes with a slow growth and maturation rate. Some species (*e.g, Huso huso*) can live for 100 years and exceed 2,000 kg in mass. Such specimens are no longer found but fish over 100 kg are still caught.

NATURAL HABITAT AND AQUACULTURE

Sturgeons inhabit rivers, estuaries, near-shore oceanic environnements and inland seas. Some sturgeon species as A. baerii are able to spend their entire life in freshwater.

Sturgeon feeds on benthic invertebrates, annelids, insects, crustaceans and molluscs in river and brackish water, various invertebrates, polychaetes and small fish at sea.

In aquaponic system we use pellets and water is at a temperature of around 20 °C.

QUALITY OF MEAT AND NUTRITIONAL TABLE

For caviar:

Nutrition Facts

Serving size	**100g**
Amount per serving	
Calories	**276**
Total Fat	18.1g
Saturated Fat	4.1g
Monounsaturated Fat	4.7g
Polyunsaturated Fat	9.3g
Cholesterol	542mg
Sodium	1080mg
Total Carbohydrate	3.7g
Total Sugars	0g
Protein	27.2g

Vitamin A	271µg	Iron	11.9mg
Vitamin D	2.9µg	Calcium	275mg
Vitamin E	1.9µg	Magnesium	300mg
Vitamin B-6	0.3mg	Potassium	181mg
Vitamin B-12	20µg	Selenium	65.5µg

* The Percent Daily Values are based on a 2,000 calorie diet, so your values may change depending on your calorie needs.

For fish meat:

Nutrition Facts

Serving size: 3 oz (85 g)

Change serving size

Amount Per Serving

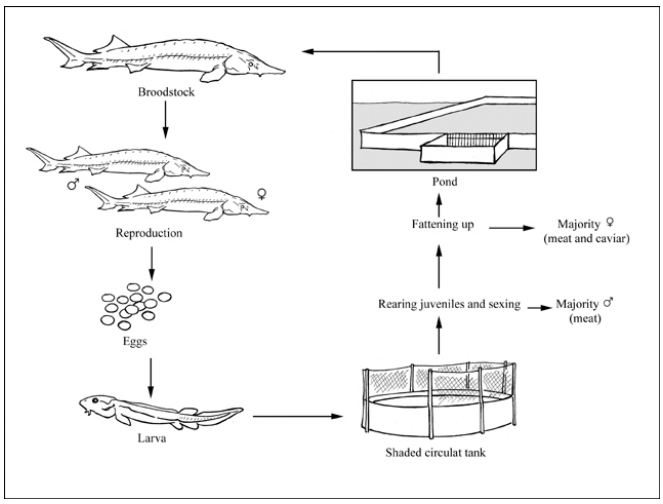
Calories 150	Calories from fat 30
	% Daily Value*
Total Fat 5g	6%
Saturated Fat 1g	6%
Cholesterol 6g	25%
Sodium 630mg	25%
Total Carbohydrate 0g	0%
Dietary Fiber 0g	0%
Protein 27g	50%

Vitamin A 15%	•	Vitamin C 0%	
Calcium 0%	•	Iron 4%	
Zinc 4%	•	Thamin 6%	
Riboflavin 4%	•	Niacin 45%	
Vitamin B-6 10%	•	Folate 4%	
Vitamin B-12 40%	•	Phosphorus 25%	
Magnesium 10%	•	Vitamin D 440%	

* Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs

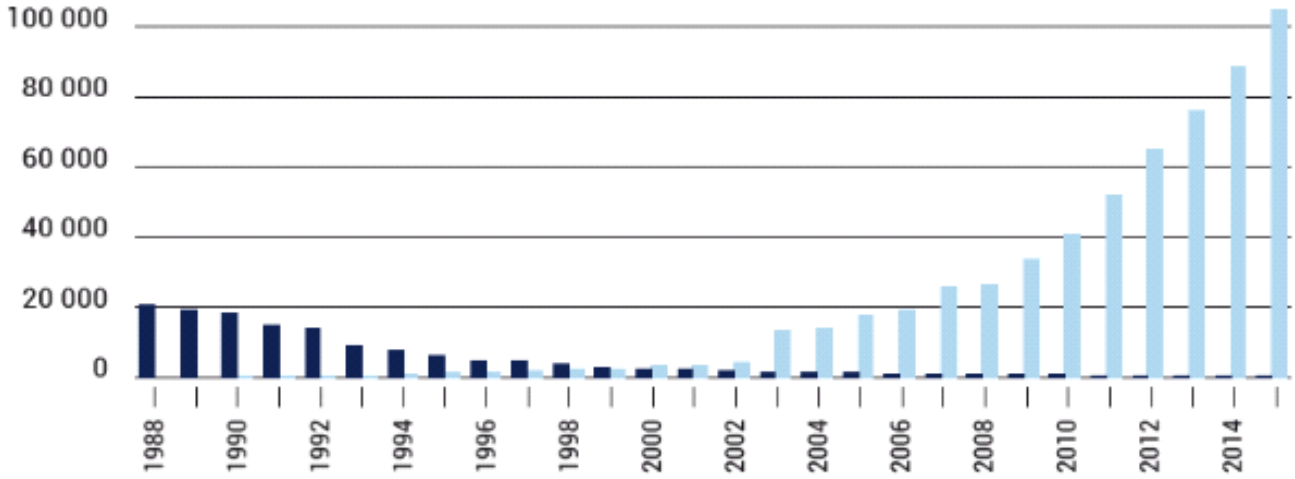
REPRODUCTION IN NATURE VERSUS ARTIFICIAL REPRODUCTION

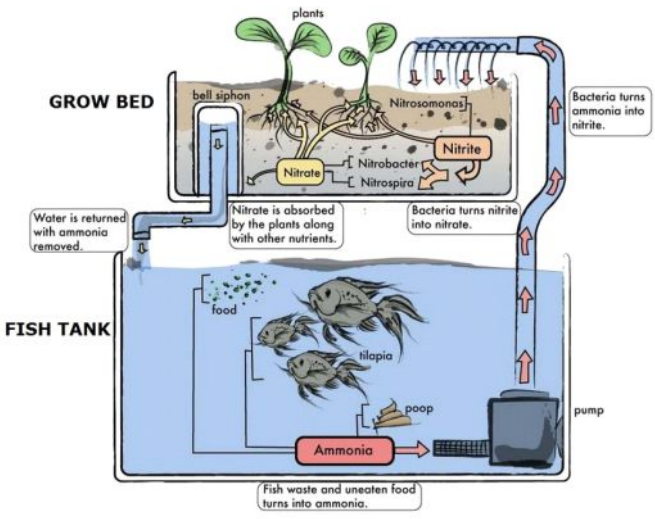
When bred in a farm, Siberian sturgeons need between 6 and 10 years to become mature.



SIGNIFICANCE OF THE SPECIES NOWADAYS AND IN THE FUTURE

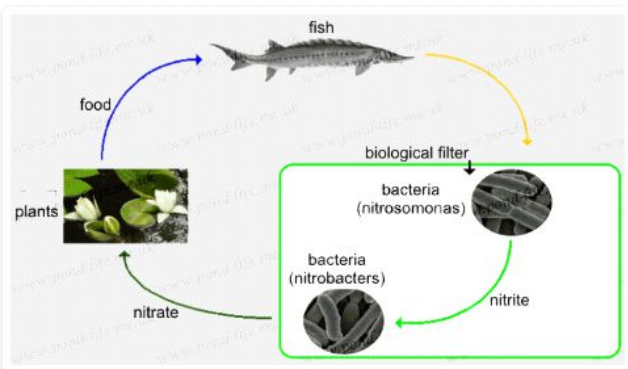
Since 1982, the European sturgeon (Acipenser sturio) has been protected and cannot be captured or sold in Europe. Besides, some species have disappeared because of overfishing and poaching , the price of caviar has increased, that's why we can say that sturgeon farming has a prosperous future if it is sustainable.





Less and less tonnes of sturgeon fisheries and more and more aquaculture.

Producing sturgeons in aquaponics is an interesting solution to make a profit while protecting the environment.



HEALTHY FOOD - SELECTED SPECIES

SPECIES TYPICAL FOR NORWAY

SALMON

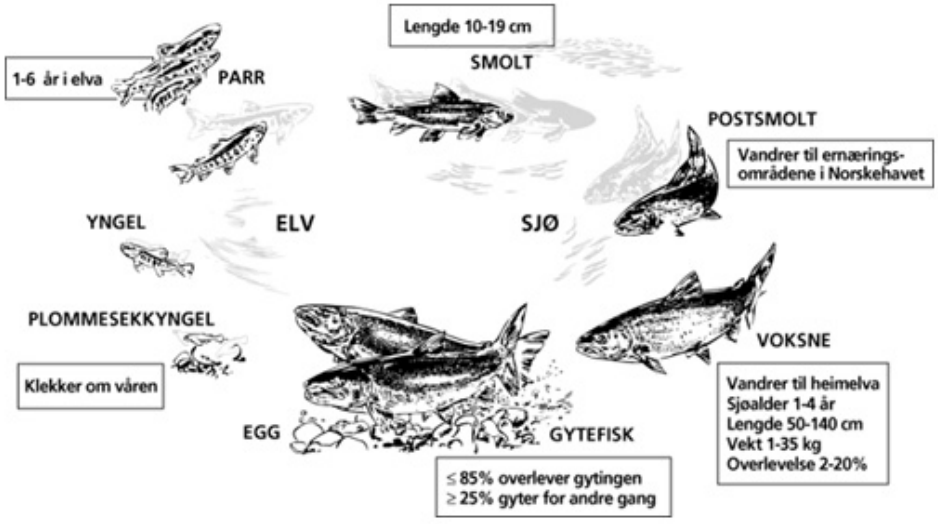
(*Salmo salar*)

HISTORY AND ORIGIN OF THE SPECIES

Salmo salar is the scientific name of salmon. They usually spawn in October-November, exceptionally as late as December – January, on rapids with coarse gravel and rock. The eggs are dug 20–40 cm deep into the gravel by the female. The eggs hatch in the winter, and the fry remain in the gravel until the sack is exhausted. In the spring, depending on the temperature, the then 2–2.5 cm long fry - which parr - up out of the gravel and eventually establish territories in the river. After 2–5 years, salmon eggs undergo smoltification which prepares the fish for marine life. The emigration takes place in the spring, often at the same time as the spring flood. Salmon is an anadrom fish. Anadrom means that it's born in fresh water, and then migrates to the sea. However, in most river systems, there will be some males that will be sexually mature without having been in the sea, so-called dwarf children. Very rarely do we find that female salmon do this. In Norway, there are two stocks of salmon that are freshwater stations, that is, they do not migrate at sea. This is the bleach in the Byglandsfjord and the small shelf in Namsens upper parts.

DESCRIPTION, BIOLOGY AND GROWTH

In Norwegian watercourses, the salmon spawn from October to January. In winter warm rivers the rye is developed rapidly, and here the salmon spawns later than in winter-cold rivers in the north and cold breelverv. Thus, the salmon stocks are adapted to hatch the hatch when the conditions for the newly hatched salmon eggs are favorable. The salmon spawn on gravel and rock bottom in rapidly flowing water. The females dig spawning grounds while males fight among themselves to spawn with the females. Spawning success increases with body size and a female fish often places its eggs in several spawning pits. The geographical variation and the complex get behavior are important for the species' survival, and a mechanism such as hunting for pray.



NATURAL HABITAT AND AQUACULTURE

Some of the main differences from the farmed salmon to wild salmon are:
The wild salmon often has better bodyshape then the farmed salmon, their fins are straighter and sharper. There is more fat in the farmed salmon meat because they eat fat food, and the wild salmon eats flyes and other small fish, thats why the wild salmon has more power in their flesh. The wild salmon also swim up thight rivers with very much stream, they have to use a lot of power to maintain their flow. But, the farmed salmon only uses it power to go around and around in the sea pen.

REPRODUCTION IN NATURE VERSUS ARTIFICIAL REPRODUCTION

The group is working on issues related to reproduction and recruitment in important fish species such as cod, herring and mackerel in the Norwegian sea areas and on the coast, as well as basic studies of reproduction, normal development and welfare in important fish species such as salmon, rainbow trout, cod and halibut with a focus on environmental requirements and environmental tolerance. The studies also include effect studies of environmental pollution and climate change, with a particular focus on reproductive and developmental disorders. The aim of the research is to provide knowledge base within reproductive biological issues for sustainable management of living marine resources, marine environment and aquaculture, as well as good fish welfare in farming. The group contributes with advice in aquaculture and fish welfare, as well as reproductive and recruitment biology in important fish species in Norwegian sea areas. The group mainly works with experimental studies at the stations of Austevoll, Bergen, Paris Water and Matre, where a number of morphological, physiological, chemical and molecular techniques are used to map biological effects of various environmental factors such as temperature, salinity, light, water flow, feed composition and contaminant components. . We have a special focus on studies of processes related to germ cell development and early development of the shell system in fish. These two systems are often particularly vulnerable to environmental disturbances, and can be of great importance to fish welfare. In gender maturation, we study in particular how outer and inner factor affects gender formation, age and size at puberty, repeated maturities linked to growth and fitness, as well as fecundity (egg number), season maturity and quality of eggs and milk.

QUALITY OF MEAT AND NUTRITIONAL TABLE

Nutritional content in 100 g farmed salmon, raw (edible part)
Energy: 932 kJ / 224 kcal
Protein: 20 g
Fat: 16 g
Nutritions:
Saturated fatty acids: 3 g
Cis monounsaturated fatty acids: 5.9
Cispolyunsaturatedfatty acids: 5 g
Omega-3 fatty acids: 3.6 g
Omega-6 fatty acids: 1.2g
Cholesterol: 80 mg

Vitamins:
Vitamin A: 26 RAE
Vitamin D: 10 µg
Riboflavin: 0.11 mg
Vitamin B12: 3.5 µg
Minerals:
Iron: 0.3 mg
Selenium: 30 µg
Iodine: 12 µg

SIGNIFICANCE OF THE SPECIES NOWADAYS AND IN THE FUTURE

If you use a feed factor of 1.22, this means that the gross increase in biomass is 40,000 tonnes. From this, we have to subtract the change in the stroke in the same period, which is slightly lower than in 2016, writes Nordea.-They point out that they assume that the change in exported volumes is similar to the change in slaughter, although the accumulation of frozen stocks may indicate that the slaughtering in the first nine months of 2017 was higher than the exported volume.- Increased carcass weightThey also point to another interesting parameter that reflects good growth in the sea, namely increasing harvest weight.- A year ago, the average weight was 400 grams below the 10-year average, while now it is 300 grams higher. Higher autumn weight means fewer fish taken out of the biomass. It also indicates lower production costs. This is also the basis for our forecasts for growth in supply in the coming quarters, it says.

SEA URCHIN

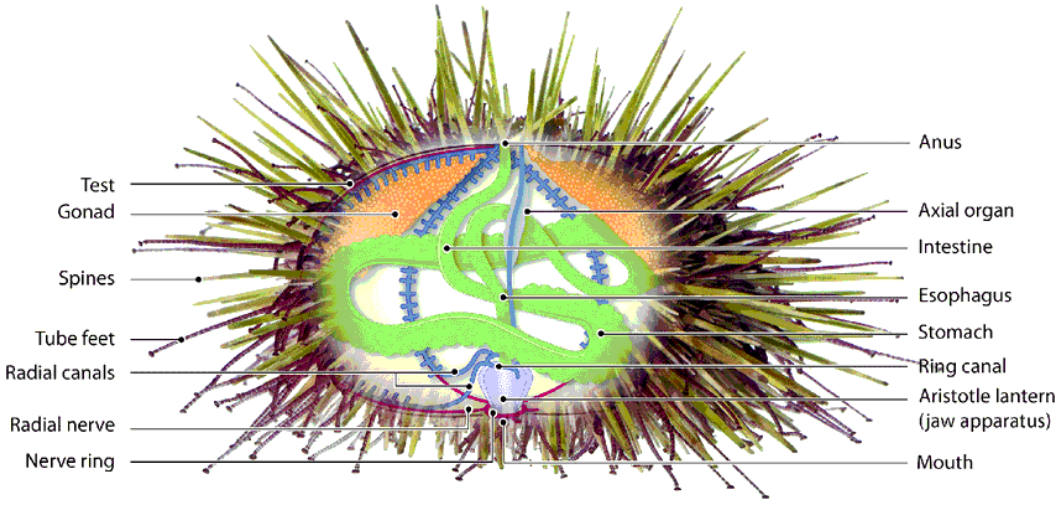
(*Strongylocentrotus pallidus*)

HISTORY AND ORIGIN OF THE SPECIES

Sea urchins are some of the world's most ubiquitous marine animals. About 950 different species lives on the sea bed. 16 of these species are in Norway. Their history goes back to about 450 million years ago, and they have ever since been adapting to changing environments and conditions over eons to maintain their place in evolutionary history. Although this creature has no brain, it has an amazing capability for survival. If its main food source is present, sea urchins can be found in nearly every corner of the world. They live in the Pacific Ocean, Atlantic Ocean and in the Arctic. Sea urchins are also known to prey on other invertebrates, like mussels and sponges. Since they prefer to live in relatively shallow coastal waters, the presence of crabs, sea otter, eels, large starfish and sea birds keeps the population from exploding. The scientific name of sea urchins is *Echinoidea*.

DESCRIPTION, BIOLOGY AND GROWTH

Sea urchins' average lifetime is about 8-10 years. They spawn in spring. The body of a sea urchin is protected by a test (hard shell), which typically gets about 3-10 cm across. Sea urchins move slowly, crawling with their tube feet, and sometimes pushing them selves with the spines. Their top speed is 8-10 cm per minute. Sea urchins live of sea weed, diatoms and decaying materials. Since sea urchins not have eyes, their body is full of photosensitive cells that helps them navigate. The temperature for growing sea urchins is recommended to be about 10 degrees. The best way to grow sea urchins is to avoid touching them regularly. In aquarium it's important to clean water filter and scrub the aquarium weekly. It's also important to use ocean water to grow them in.



NATURAL HABITAT AND AQUACULTURE

Sea urchins, both alive and processed gonads are sold to Asia, Europe, and North and South America to their sushi marked mostly.
Sea urchin aquaculture began with management of fishery resources, where adult animals were transplanted to more favourable habitats.
This fishery management tool led to sea urchin aquaculture research.
The Sea Urchins might look like a sea urchin in less than two months, but he's far from mature. Sea urchin offspring can take up to six years to reach their full maturity.
Sea urchin eggs produced spawn directly into the sea. When the male sperm and female eggs come into contact, urchin fertilization and development will begin.

REPRODUCTION IN NATURE VERSUS ARTIFICIAL REPRODUCTION

Fertilization is the union of two gametes, the sperm and the egg to create a new organism. Although some unicellular animals reproduce asexually, sexual reproduction is the preferred method of propagation in most multicellular animal species. The resulting zygote contains genetic information from both parents. Sea urchins and other echinoderms have long been favorite subjects for the study of fertilization and early development. They produce large numbers of gametes which can be combined to create embryos which rapidly develop in real or artificial sea water. The embryos are transparent, allowing the direct observation of internal and external structures. Sea urchins spawn during the spring, and the female sea urchin releases millions of tiny, jelly-coated eggs into the water that are then fertilized by the sperm of the male sea urchin. The tiny sea urchin eggs become part of the plankton and the sea urchin babies (larvae) do not hatch for several months. Sea Urchin Dev. Fertilization is the union of two gametes, the sperm and the egg to create a new organism. Although some unicellular animals reproduce asexually, sexual reproduction is the preferred method of propagation in most multicellular animal species. Purple sea urchins breed yearly from January through March and are ready to do so when they have turned two year of age. This reproduction process occurs through external fertilization during which males release their gametes into the ocean and fertilize the female's eggs at random. Fertilization is external. They live and spawn in tide pools and reefs in the ocean, where there is a tremendous amount of water rushing about. To prevent the sperm and eggs from being washed away and diluted, sea urchins have evolved mechanisms to bring the gametes together, including synchronizing spawning and chemotaxis of the sperm towards the egg. The artificial sea urchins.
Sea Urchin Dev. Fertilization is the union of two gametes, the sperm and the egg to create a new organism. ... They produce large numbers of gametes which can be combined to create embryos which rapidly develop in real or artificial sea water.

QUALITY OF MEAT AND NUTRITIONAL TABLE

Sea urchins are also quite popular among sushi enthusiasts, where the roe is collected for consumption.
Uni is actually very healthy. A 100g portion of sea urchins contains 172 calories and very little fat. The fat is also almost all unsaturated fat. For every 100g of sea urchin, there are only 1.75 grams of polyunsaturated fat. And, we all know that eating polyunsaturated fats in place of saturated fats can help lower your cholesterol levels. Sea urchins also contain omega-3 fatty acids, which can help lower blood pressure and reduce the risk of an abnormal heart beat.
Sea urchins are quite popular among sushi enthusiasts, where the gonads are used as nigiri sushi or sashimi. To those who prefer sea food, this food is a rare delicacy. It has a light and sweet taste that fits perfect for sushi. The clear yellow-orange colour is eye catching for the sushi plate.
Sea urchins are very healthy. A 100g posjon of sea urchin contains 120 calories. One item of sea urchin is in general about 10g, and the number of calories is therefore 12 calories. There is also 1.6 grams of protein, 0.48 gram fat and 0.33 carbohydrates, based on researching.
Sea urchins are also rich in vitamins and minerals such as Folate and Vitamin E.

SIGNIFICANCE OF THE SPECIES NOWADAYS AND IN THE FUTURE

Worldwide the supply of sea urchins has been reduced in the last few years. In 1995 the peak landings were about 120 thousand tonnes. The current levels are about 75 thousand tonnes. The biggest marked for sea urchins today is Japan, who is consuming about 80-90% of the total current global supply. The Japanese market for known for good quality and appropriate price. Even though this is what the marked is known for, the value of this product will never be as high as in the European (French) marked. The reason why is due to the logistics of getting the product to Japan. The price of Sea urchins today varies between 600-800 Euros per kilo. It also varies if they are sold whole or if it's just the gonads that's sold. It also varies if the sea urchins are grown wild or in aquaculture.

SEAWEED

HISTORY AND ORIGIN OF THE SPECIES

Seaweed has been used for thousands of years and is a type of algae. About three and a half billion years ago, algae came into existence, and is in 75% of the air we breathe. For thousands of years in many cultures, seaweed has been used for food and fertilizer. Japan has been using seaweed from the beginning. Records show that for over 2000 years, seaweed has been used as a supportive food in the Japanese diet. It is reported that at least six types of seaweeds were used in 800 A.D in everyday cooking in Japan. In 794, Japanese people used seaweed to make nori, a dried sheet of seaweed, which is used in sushi. It is also used as medicine, anti-age, in garlands, and more.

DESCRIPTION, BIOLOGY AND GROWTH

Algae is an informal term for a large, diverse group of organisms that are not necessarily closely related. This majestic giant of the kelp forest grows about three to five inches each day in our exhibit, which is faster than tropical bamboo. Under ideal conditions, giant kelp can grow an astonishing two feet each day. Seaweed is photosynthetic, so it needs sunlight. It converts sunlight to energy through photosynthesis, which uses chlorophyll. More than half of the oxygen you breathe comes from marine photosynthesizes. Both use carbon dioxide, water and energy from the sun to make food for themselves, releasing oxygen in the process. Seaweeds, also known as macroalgae, comprise a diverse group of organisms representing various growth forms. The marine algae are divided in three groups: brown algae, green algae and red algae.

NATURAL HABITAT AND AQUACULTURE

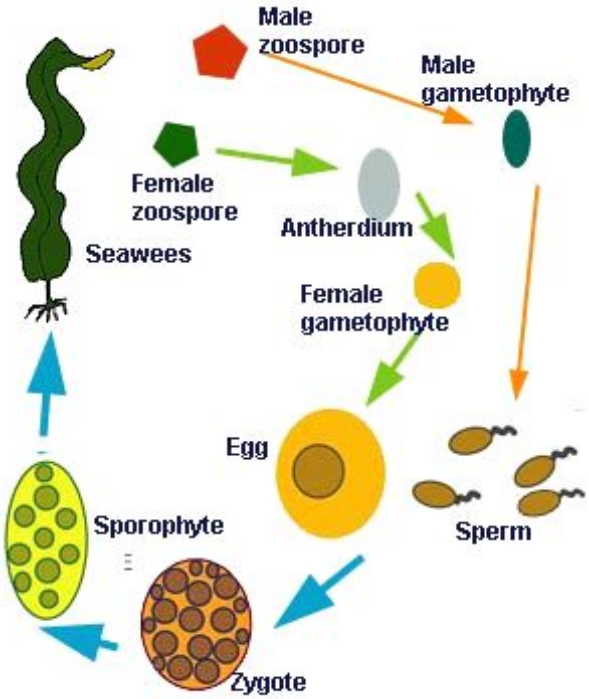
Seaweed is to be found in every world sea around the globe. Seaweed species such as kelps provide essential nursery habitat for fisheries and other marine species and thus protect the food sources, other species, such as planktonic algae. Seaweed are a source of biologically active compounds including proteins and polysaccharides, and holds promising uses in nutrition, biomedicine, bioremediation, as well as other uses. Seaweed is consumed around the world, particularly in East Asia. The growth of the seaweed aquaculture industry is good for the economy and the ocean, and the process of growing seaweed is environmentally friendly. Apart from planting the seeds and ensuring the seaweed is in a clean environment, the plants can grow naturally. Seaweed farms also create safe and healthy nursery grounds for young fish and crustaceans that can later be harvested commercially or improve wild population levels.

REPRODUCTION IN NATURE VERSUS ARTIFICIAL REPRODUCTION

Seaweed farming is the practice of cultivating and harvesting seaweed. In its simplest form, it consists of the management of naturally found batches. In its most advanced form, it consists of fully controlling the life cycle of the algae. The main food species grown by aquaculture in Japan, China and Korea include gelidium, pterocladia, porphyra and laminaria. Seaweed farming has frequently been developed as an alternative to improve economic conditions and to reduce fishing pressure and over exploited fisheries. Seaweeds have been harvested throughout the world as a food source as well as an export commodity for production of agar and carrageen products.

The practice of seaweed farming has long since spread beyond Japan. In 1997, it was estimated that 40,000 people in the Philippines made their living through seaweed farming. Cultivation is also common in all southeast Asia, Canada, Great Britain, Spain, and the United States.

Some red seaweeds have a life span of 6 to 10 years. Seaweeds can reproduce sexually, by the joining of specialized male and female reproductive cells, called gametes. After they are released from the sporophyte, the spores settle and grow into male and female plants called gametophytes. Seaweed can also reproduce asexually through fragmentation or division. This occurs when parts of a plant break off and develop directly into new individuals. All offspring resulting from asexual reproduction are clones; they are genetically identical to each other and the parent seaweed.



QUALITY OF MEAT AND NUTRITIONAL TABLE

Butare

Protein dry weight 9-20 %, Fat 1-2%, Carbohydrates 46%, Calcium 11670 ppm, Potassium 7,4 ppm, Magnesium 8960 ppm, Vitamin C (ppm) 100-500, Vitamin B12 50 ppm, Vitamin B6 62 ppm, Vitamin B1 5,5 ppm, Iodine 165 ppm, Iron 126 ppm.

Sugar

Protein dry weight 6-11%Fat 0.55%, Carbohydrates 61%, Calcium 8910-9282ppm, Potassium 5ppm, Magnesium 5670-6944ppm, Vitamin C 13-18ppm, Iodine 5000ppm, Iron 100ppm.

All seaweeds contain minerals, trace elements, vitamins, and amino acids. They're excellent sources of calcium, iodine, and iron, and each type has its own specific nutrition profile as well. No other group of plants contains more minerals and nutrients than seaweed. The bonus? Seaweed has about five calories per serving.

Like their terrestrial cousins, all seaweeds contain chlorophyll, which creates their green color. However, red and brown seaweeds also contain other pigments that diminish their green coloring.

You may be most familiar with nori, a type of red seaweed used in sushi. Other varieties are gaining popularity, as the health benefits of seaweed become more widely known.

SIGNIFICANCE OF THE SPECIES NOWADAYS AND IN THE FUTURE

The seaweed industry is increasing; countries like China and France are leading. Seaweed is important because it is sustainable and environmentally friendly to harvest, which is important in today's world. Seaweed is also a good source of nutrients with lots of vitamins, protein and minerals. The growth of the seaweed aquaculture industry is good for the economy and good for the ocean. The process of growing seaweed is environmentally friendly, apart from planting the seeds and ensuring the seaweed is in a clean environment. Increasing seaweed aquaculture production may open the door for a more efficient form of renewable energy which is biomass. Seaweed's ability to break down environmental pollutants also makes its development a top priority for the aquaculture industry. Seaweed farms also create safe and healthy nursery grounds for young fish and crustaceans that can later be harvested commercially or improve wild population levels.

VIDEOS

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SPIRULINA

SPIRULINA COMPANY

STURGEON

NORWAY

SALMON

SEA URCHIN

SEAWEED