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fish – heat

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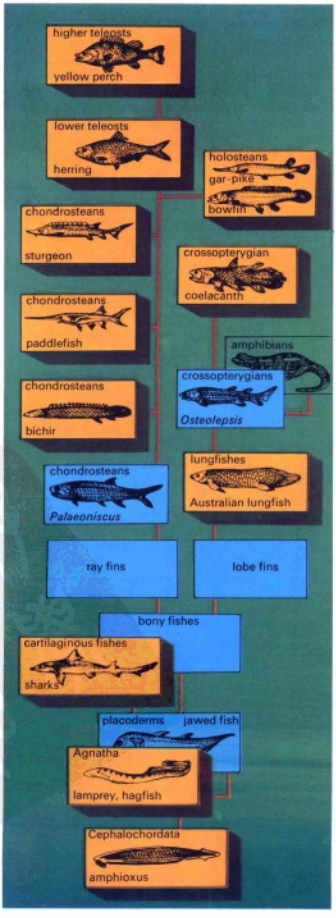
Fish are cold-blooded animals with backbones. They live in water, breathe through gills and, with few exceptions, swim by wriggling their bodies. As they wriggle, their bodies thrust against the surrounding water, so driving them forward. They have two sets of paired fins, the breast fins and the pelvic fins, and they have single fins along the back and underside, as well as a tail fin. Their bodies are covered with scales. The 21,000 or more species are of three kinds: jawless fishes, cartilaginous fishes and bony fishes.

The jawless fishes, of which there are 45 species, include the lampreys and hagfishes. They are direct descendants of the earliest known fishes which had 'suctorial' or sucking mouths and no jaws. They are believed to have lived on the sea bed sucking in the mud to feed on the dead matter in it. They lived 450 million years ago. Lampreys still have sucker-like mouths but use their file-like tongue to rasp away the flesh of other water creatures. Hagfishes live in the sea. Some lampreys live in freshwater, others in the sea.

The 600 cartilaginous fishes include sharks, skates and rays. Only a few, including the Nicaraguan shark, enter rivers. Their skeleton is entirely of cartilage, or gristle. Many of them are little changed from the cartilaginous fishes of 350 million years ago. Apart from their skeleton they differ from bony fishes in many other ways. Their gills are naked, that is, the gill slits open direct at the surface and are not hidden under a gill-cover. Their bodies are covered with peculiar scales called denticles or 'little teeth'. Each denticle is made up of a central pulp covered with dentine, a layer similar to tooth enamel. They do not grow in size with age, as the flattened scales of bony fishes do, and they make the skin rough to the touch. Sharks have the usual streamlined fish shape – roughly that of a torpedo. They feed on flesh, living and more especially dead, which

The shark's head ends in a blunt snout with eyes on either side. Underneath is its large mouth lined with many triangular teeth. Its mouth is supported by a gristly jaw of cartilage

▽The story of fish evolution begins with the fish-like amphioxus (*bottom of diagram*). Jawless fish (Agnatha), including the lamprey and hagfish, evolved from it. From the Agnatha developed fish with jaws (placoderms). These gave rise to the two classes of fish alive today, cartilaginous fish and bony fish. Two major branches of bony fish evolved, lobe fins and ray fins. The ray fins evolved into three groups. A few chondrosteans and holosteans survive today. The third group, the teleosts, are the dominant fish in waters to this day. Lobe fins were the ancestors of land animals. Lungfish and coelacanths still live today. From some lobed-fin crossopterygian ancestor descended animals that could live on land — amphibians. Extinct fishes are shown in blue boxes



they find by smell. Blood from a wound, flowing into water, will attract sharks, and so will the odour of flesh. The larger sharks are a danger to bathers and divers. There are, however, two exceptions – the whale shark and the basking shark. The first lives throughout tropical seas and may be 15 metres (50 feet) or more long and weigh several tonnes. Basking sharks of warm seas are up to 12 metres (40 feet) long. They have only tiny teeth and feed by filtering plankton, microscopic animals and plants that drift in the surface waters of the sea.

The most dangerous sharks include the great white shark or man-eater, which is found in all tropical seas. It may be 12 metres long, and its largest teeth nearly eight centimetres long.

Skates and rays are flattened sharks living mainly on the sea bed, usually feeding on shellfish and other small animals. Skates have diamond-shaped bodies with long slender tails. Rays are more rounded. The electric rays are 1-2 metres (3-6 feet) long. The muscles of their large fins have nerve cells constructed like electric batteries. They can discharge 200 volts at 50 amps, enough to electrocute a man (see: *electricity*).

The largest of all rays, found in tropical seas, is the manta ray, also called the devilfish or batfish. The largest is 6 metres (20 feet) across the fins and it looks like an enormous bat when swimming. Sometimes mantas leap from the water. Should one fall back onto a small boat its tonne-weight can be disastrous.

The 20,000 or more bony fishes are divided into those living in freshwater and those in the sea. Their shapes and way of life vary considerably more than those of the cartilaginous fishes and jawless fishes. This is largely because they have gill-covers. Sharks must keep swimming to keep a good flow of water through their gills. The gill-covers in bony fishes enable them to pump water over the gills, so there can be more methods of breathing. They can alter the rate of breathing according to need.

Some bony fish, like the giant loach of Europe, breathe air. The loach gulps air and swallows it. Breathing takes place in its intestine. Lungfish have lungs. In many fish these have been converted into swim bladders to help them float. The swim bladder is an air-tight sac lying just beneath the backbone. It is filled with gases. The fish can control the depth at which it swims by adding or removing some of the gas from the bladder. In this way, it can adjust to the changing pressure as it moves in different depths of the sea.

The mudskipper of South-east Asia can leave the sea and hop about over the mud at low tide. It carries a supply of water in its gills while on land. Eels also can travel overland and carry water in the gill chamber.

No bony fish is as big as the largest of the sharks. Russian sturgeon reach 4 metres (14 feet) and a tonne weight. Halibut may reach 2·5 metres and the freshwater arapaima, of South America, has been credited with 4.5 metres length but probably seldom exceeds 2 metres. The smallest of all fish, and the smallest back-

The perch (*above*) is a bony freshwater fish. Its spiny top fin is stiff at the front. The rayfish (*left*) is a relative of the shark and has a gristly skeleton. Its thick fins give it a triangular shape. The mudskipper (*far left*) is a tropical fish. Its front fins are adapted to be used as legs. Its eyes, like a frog's, are raised and each can move separately. It sometimes sits on rocks and breathes air. The loach (*below left*) is a freshwater fish. Fleshy threads (barbels) on its chin are sensitive to touch and are used to search for food on the river bed. They eat insect larvae, worms and algae

boned animal, is the Luzon goby, or pygmy goby, of the Phillipines, which reaches about a centimetre when fully grown.

The ocean sunfish is named for its supposed habit of basking at the surface – which it does only when dead or dying. The true sunfish is a small, freshwater, perch-like American fish that enjoys the Sun and is less active under an overcast sky. The ocean sunfish has a disc-shaped body with no tail, only a tail-fin. The largest is 3 metres (ten feet) long, weighs a tonne and has only about 2 centimetres of spinal cord. The female is said to lay 300 million eggs.

There are other marine fishes that lay enormous numbers of eggs, and the fishes themselves exist in astronomical numbers. The herring has been fished in large quantities for centuries. In the North Atlantic three billion are caught each year. However, their numbers now seem to be decreasing.

Another good example is the bluefish, a 40-centimetre (15-inch) bass-like fish living in shoals in the Atlantic. It is estimated there are a thousand million bluefish. They feed on other fish and kill 1,200,000,000 in a season.

After World War II bluefish appeared in the Mediterranean. Italian fishermen believe they followed American troop and supply ships across the Atlantic.

Bony fishes come in all shapes: streamlined, flattened, ribbon-like and nearly spherical. This is especially true of marine fishes. The fastest swimmers are shaped like the fuselage of a jet-plane. They are those that migrate long distances, like the salmon, or need speed either to catch other fish, as tuna and marlin do, or to escape from enemies. Fishes that live around coral reefs are often flattened from side-to-side. They can easily slip through the branches of the coral. Flatfish lie on the bottom. They are slow swimmers and rely on camouflage to escape enemies. Eels are long and rounded, for squirming among rocks or in mud.

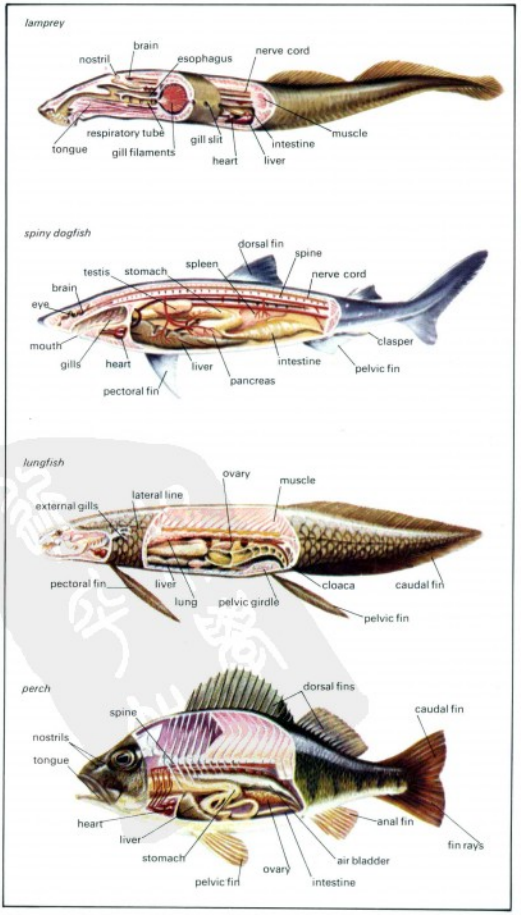
One of the more unusual shapes is seen in seahorses. These swim in the upright position, very slowly, driven forward by wave-movements of their back fin. Boxfish, trunkfish, and cofferfish look like boxes. The cowfish is a boxfish with two horns on the front. Pufferfish, globefish and porcupine fish have spines on their bodies. They can blow themselves up like balloons, making the spines stand out. This is a protection against enemies.

Flatfish like plaice, turbot and flounder are shaped like other fish when young. As they grow they turn on one side and become flattened. At the same time one eye moves around the skull so that as the fish lies on its side both eyes look upwards.

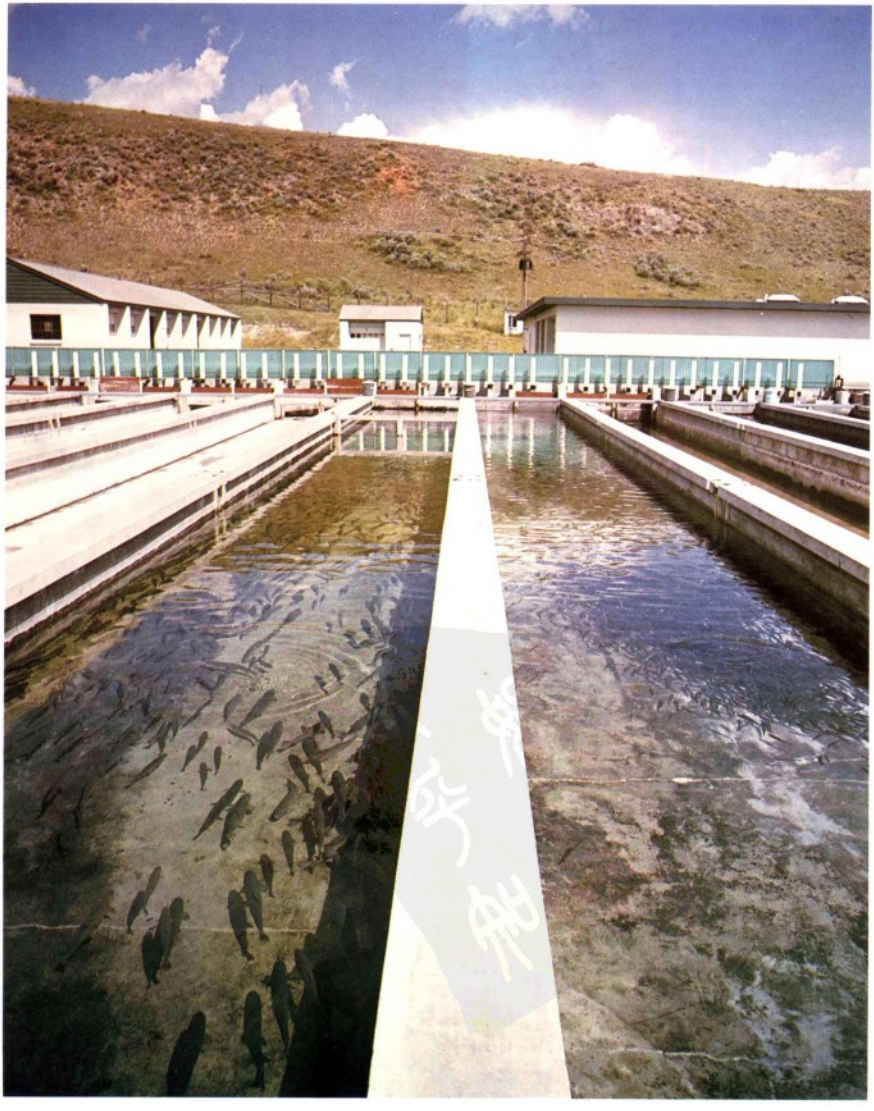
All fish swim but some walk on the seabed or even crawl or skip on land at times. In some kinds of batfish the breast fins are almost like legs with webbed feet and the fish waddles over the bottom. Other fish move by jumping. Small blennies that live between tide-marks jump from one pool to another at low tide. They can even jump over a rock to reach the next pool, with accuracy. They seem to know exactly where to jump even when the pool is out of sight to them.

Both freshwater and marine fish will at times leap clear of the water when in danger. Salmon migrating upstream to spawn will leap waterfalls to reach the river in which they were hatched. Eels achieve the same end by wriggling up the rocks. Trout and black bass are also noted for their leaping. In the sea, marlin, tarpon and sailfish make tremendous leaps into the air when hooked.

Flying fish are leapers that can spread their



The jawless lamprey is a living relative of the ancient fish that lived on Earth more than 400 million years ago. From these ancient fish, two groups evolved—bony fish (such as the perch and lungfish) and cartilaginous fish (such as the spiny dogfish). Lungfish developed air-breathing lungs. They are related to the first land animals



Another method of maintaining the supply of fish is to raise them in controlled conditons and then release them back into their natural environment. This is done at fish hatcheries; the three pictures on this page are all taken at a trout hatchery on the River Test, in Hampshire. (*Left*) In November, eggs are stripped from female (hen) trout. These are then fertilised with sperm stripped from male trout. The eggs are kept in constant temperature conditions until they hatch. Of course, in the wild many of the eggs and young fish would be eaten by predators. In the hatchery they are protected so most eggs hatch. The newly-hatched trout (*below*) feed on the yellow yolk sacs from the eggs until these are used up

◁Adult fish swim in their tanks in a Wyoming fish farm. With stocks of fish in the seas declining due to over-fishing and pollution, intensive farming of fish may become as important as battery-raising chickens

▷At the trout hatchery, young fish that have used up the food supply provided by the egg yolks are moved into bigger tanks where they are fed regularly by automatic feeding mechanisms. When they have grown to a good size, the young fish will be released into the River Test

fins and glide once they are in the air. They swim rapidly to the surface, leap nearly clear of the water, then skim across the surface using the tail-fin like an oar, until they get enough lift from their fins to become airborne.

In South-east Asia lives the famous climbing perch. It hitches itself along over dry land, digging the spines on its gill-covers into the ground. It used to be credited with climbing trees until someone discovered the secret. Climbing perch found in trees had been carried there by birds and lodged among the branches.

There are fishes that hitch-hike. The most famous is the remora or shark-sucker. It is about 60 centimetres (two feet) long and has an oval sucker on its head. The remora fixes itself to a shark, turtle or ship and gets free transport.

The pilot fish is only a few centimetres long. It travels about the sea with a shark. There may be several swimming beside a large shark. Scientists have been puzzled that so small a fish can swim as fast as a shark. The explanation is that over any body moving through water there is a layer of water moving forward at almost the same speed as the body. The pilot fish enters the layer of moving water around a shark and is carried along by it with little effort.

Freshwater fish are mainly a dull colour on the back with a silvery belly. So are many marine fish. Even the freshwater fish can show splashes of colour, especially in the breeding season. But fish tend to have brighter colours the nearer they live to the Equator, that is, in the warmer waters. It is particularly true of marine fish and, in tropical waters, fish living around coral reefs present a riot of colour. Sea perches of the Caribbean, known as groupers, outclass the chameleon for colour change. A grouper will swim into a gap in the rocks and come out a different colour the other side. At any one moment a party of groupers, all of the same kind, may show eight or nine different colours or colour patterns.

Usually colours are for camouflage and changes in colour serve the same purpose. Flatfish like plaice or flounder can change colour to match almost perfectly the floor of the sea.

Some fishes have eye-spots. These are circles of colour that look like eyes. They are usually at the rear end of the body, so the front and hind parts of the fish look alike. Often, an enemy cannot tell whether the fish is coming or going.

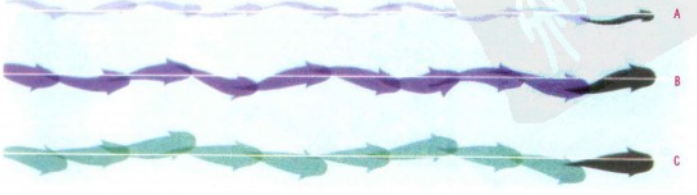
The dark back and silver belly seen in so many fish is also camouflage. When an enemy looks down on a fish the back fades into the green or blue of the water. The silver belly, seen from below, matches the light of the sky.

Apart from whales and other large animals, there is hardly an animal or plant living in water that is not eaten by some fish or other. The shape of a fish's mouth, and of its teeth, often give a clue to its food. Fish with the mouth directed upwards get their food at the surface. Those with the mouth directed downwards grub about on the bottom. Carp have no teeth in their jaws but some have teeth in the throat. Some fish have sharp nibbling teeth. Parrotfish teeth are joined to form a 'parrot's beak'. Parrotfish nibble lumps out of coral and digest the coral polyps, the limy coral itself passing through the body almost unchanged (see *coral*).

There are fishes, the herring being one, that filter sea water for their food. They feed on tiny plants and animals. On each gill-bar are bony rods. These may number two hundred or more.

◁The trout is a common freshwater fish. It has a strong tail and large mouth with strong teeth

◁The puffer fish blows itself up like a ball so that its enemies cannot swallow it



◁This diagram shows the movement of three different fishes as they swim from left to right. **A** Muscles tighten and relax along the whole body. The fish wriggles forward like a snake. **B** The body wriggles and the tail moves from side to side pushing the fish forward. **C** The body is stiff. Tail movement is the main force that pushes the fish forward

△ Lion-fish (*above left*) live in tropical waters among coral. The fins are long and feathery. They help to disguise it because they are like the growth on the coral. Tetras, or characins (*above*), are colourful tropical fish. They are often kept in aquaria

Lying criss-crossed over the entrance to each gill they form filters. The food is caught on these filters and swallowed.

The archer fish of South-east Asia is only 15 centimetres (six inches) long. It can squirt a stream of water droplets from its mouth, shooting down insects resting on overhanging foliage. It puts its nose out of the water to do this and can shoot the drops 60 centimetres.

Fish are the only animals that use electric currents to obtain food. Some use them also in defence or for other purposes. In skates, small muscles in the tail form electric organs that discharge four volts. What this is for is not yet known. There are a number of fish, like the electric catfish of Africa and the knifefish of South America, that use electricity. The torpedo ray has electric cells in its front fins. The best known is the electric eel of South America. It is up to 275 centimetres (nine feet) long. About seven-eighths is tail and the electric organs in it make up 40 per cent of its body. It can give out 370 to 550 volts, enough to stun a horse wading into a river.

The most remarkable electric fish is the *Gymnarchus*. It lives in the rivers and lakes of Northern Africa. *Gymnarchus* is leaf-shaped and has no tail-fin. It can swim backwards as well as it can swim forwards, and it never collides with an obstacle. Its electric organs create an electric field around its body. Any solid object, or anything swimming, entering this field bends the lines of force in the electric field. This tells the fish to alter course, to avoid an obstacle or an enemy.

Freshwater fish have many difficult situations to deal with. Important among these are problems of living in water that is stagnant and contains little oxygen, in very hot or very cold places, and in waters that periodically dry up.

In water containing little oxygen dying fishes come to the surface and gasp air for a while before they die. Some kinds live all their lives in foul water. African catfishes have a spongy organ in their gill-chambers that can take oxygen direct from the air. So they have double-purpose gills because the other part of the gill is for breathing in water.

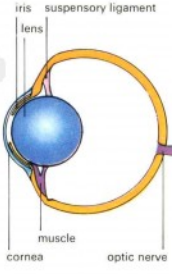
Most fish live in water at temperatures of 30°C (86°F) or less. But in soda lakes of Lake Magadi, in Kenya, the temperature may be much higher. One kind of fish, a tilapia, feeds on tiny plants called algae. It makes quick dashes into the hot patches of water to get algae and dashes out again. If it stayed more than half a minute it would be killed by the heat.

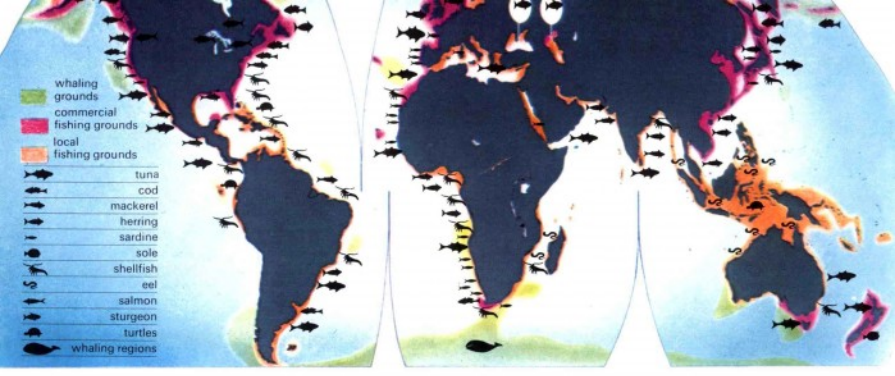
Some fish have the opposite problem and live in very cold water. It has often been said that the Alaska blackfish can be frozen solid in a block of ice. Then when the ice thaws out the fish is found to be still alive. This is not true. But they do survive at the bottoms of lakes in waters near freezing point.

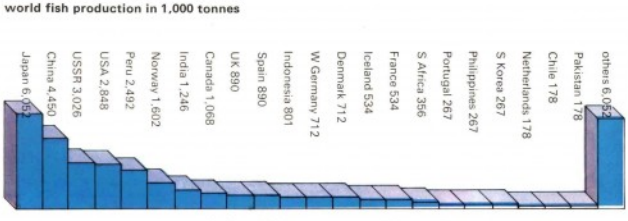
In the Arctic and Antarctic, where temperatures average 6°C (43°F) throughout the year, there is an abundance of fish. In seas just south of the Arctic circle fish are especially numerous. Enormous shoals provide the great fishing grounds of the North Atlantic and North Pacific, with such fish as cod.

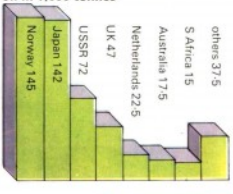
There are fish in underground waters and in caves. When an artesian well is bored the water gushing out sometimes contains small animals, among them fish. Most cave fish are white or pink and they are blind, with no eyes at all or with eyes that no longer work. They find their food, and find their way about, by touch and

A fish has a wide range of vision (*below left*). It can see in front, behind, above, and below. At the front the range of each eye overlaps. Both eyes can focus on the same point. Judging distances is more accurate with two eyes than one. Light entering the eye causes nerve messages along the optic nerve to the optic lobes. These are the parts of the brain where seeing takes place. A vertical cut through a fish's eye (*below*) shows the firm lens. It is round and to the front so that it can direct light from the water onto the back of the eye









△ Where fish, shellfish, whales, and turtles are caught commercially. The graphs below show the production of fish and of whale oil by different countries in the world

(*Right*) This Canadian fishing boat catches salmon in coastal waters with a large net called a seine. This has floats along the top and weights along the bottom edge

smell. Cave fish are very sensitive to vibrations, using these to inform themselves about what is going on around them. The famous Kentucky blind-fish, found in underground limestone caves, are colourless and almost transparent. The eyes are small and hidden under the skin. They have, however, sensitive pimples on the head that are organs of touch.

Fish living in swift mountain streams have sucker-like mouths, for clinging to rocks, or else their paired fins are set low on the body and can be pressed against a rock. Their undersides are flattened, which helps this, and water flowing over such fish tends to press them down so that they cling more securely.

The majority of fish lay their eggs in the water, the males shedding their sperm into water also, to fertilize the eggs. There is often an elaborate courtship, the males having much brighter colours at such times. Some males build a nest in which the female can lay her eggs. This may take the form of a pit dug in the sand of the river or sea bed or it may be made of plants.

Siamese fighting fish are favourites for keeping in aquaria (see: ***aquarium***). The male blows bubbles which rise to the surface to form a raft. The bubbles do not readily burst because they are coated with saliva. As the female lays her eggs the male picks up each in turn and presses it onto the underside of the raft.

Many sharks and other cartilaginous fish are born alive. Some freshwater fish of Africa and South America are called mouth-breeders. After the eggs are laid, either the male or the female, or both, hold them in their mouths until they hatch. Sea horses and pipefish have reversed the usual order. The male has a pouch on his belly and the female lays her eggs in it. There the eggs are fertilized and the young develop. Finally, the male gives birth to his family.

Deep sea fish live at depths greater than 450 metres (1,500 feet), where hardly any light penetrates and the water is just above freezing point. The fish living there are mostly small, the largest being no more than about a metre (three feet) long. They often have weird shapes, fragile skeletons and very delicate muscles. They are mainly dark brown or black, and are either blind of have large sensitive eyes.

Food is scarce at these great depths and the fish must be sure of holding any food they can catch. As a result, many have large mouths in

relation to their size and long needle-like teeth. Some are able to swallow fish larger than themselves.

Most deep sea fish carry light organs. These are often in rows along the sides of the body and they light up the sea immediately around the fish. The lights may act as camouflage. They may also help male and female to recognize each other for breeding. In many deep sea fish the foremost spine of the back fin is very long and carries a light at the end. It is used as a lure to draw smaller fish close so that they can be snapped up. (See: *bioluminescence*.)

The earliest known fossils of fish are about 480 million years old. They were freshwater, jawless fish with the head and front part of the body covered with bony armour. These gradually died out, until today only the lampreys and hagfish are left, and even these have undergone big changes. From the jawless fish sprang two main kinds, the cartilaginous fish and the bony fish. There were many different kinds and during the course of these millions of years some groups have become extinct. Others have become nearly extinct. These have left behind a few survivors which are known as living fossils. The most famous living fossil is the coelacanth (see: *coelacanth*). It belongs to a family that everyone thought had long died out. Then on December 24, 1938, one of them was caught off South Africa. Since then, more have been caught. Other less well-known living fossils include the sturgeon, the garpike and the bowfin of the United States. The lungfish of Australia, Tropical Africa and South America could also be included as living fossils. The sturgeon, garpike and bowfin are of special interest because their skeletons are mainly of bone but also partly of cartilage. They are therefore halfway between the true cartilaginous fish and the bony fish.

There is a widespread belief that some fish live to a great age. The naturalists of the 18th and 19th centuries spoke of carp more than 150 years old and of pike more than 200 years old. None of these has stood up to scientific test. It is possible to tell the age of a fish from the annual rings on its scales or from the annual rings on small bones in the inner ear (see: *annual ring*). These are not true bones, but are made up of lime salts. Like the scales, they grow continuously. They form part of the fish's organs of balance. It is possible that some pike live to 60 or 70 years of age, but so far no scientist has been able to examine a pike that showed signs of being as old as that. The oldest known fish is probably the lake sturgeon. Twenty years ago nearly a thousand of these were caught in Lake Winnebago, Wisconsin. The oldest, judged by the growth rings on the rays of the breast fin (which is another way of counting the age of a fish) was 82 years old. A white sturgeon is recorded as being 50 years old.

There are several fish that live for one year only. They are usually spoken of as annuals and they include the top minnow, a sea horse and the pygmy goby. The pattern of the life history of some of these annual fish is that they live in rivers that dry up every season. All the fish then die off, but not before they have laid their eggs in the mud. When the rains come again the stream flows once more over the eggs, they hatch and the cycle is repeated. Laboratory tests have shown that unless the eggs are allowed this period of drying out they do not hatch.

See: *deep sea creatures, evolution, flying creatures, ocean, plankton, shark*.

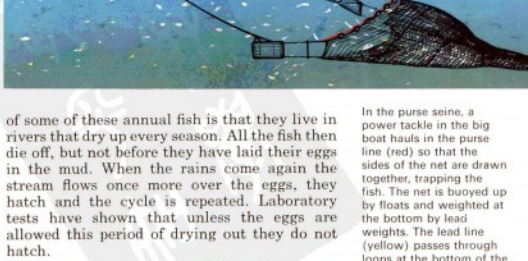
Find out by doing

Look at a fish in an aquarium. Can it stay at the same depth without moving its fins? How? (Clue: *a fish has a swim bladder*.) Watch the fish while it is looking through the glass. How does it breathe? (Clue: *is its face moving?*)

purse seine

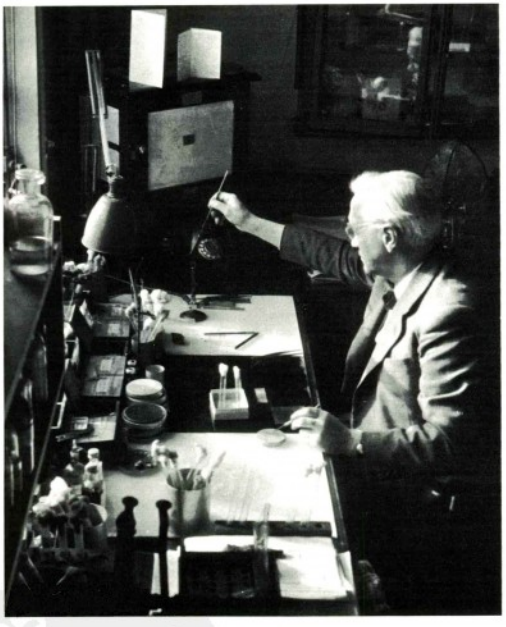
the drift net

the trawl net



In the purse seine, a power tackle in the big boat hauls in the purse line (red) so that the sides of the net are drawn together, trapping the fish. The net is buoyed up by floats and weighted at the bottom by lead weights. The lead line (yellow) passes through loops at the bottom of the net drawing it closed. The drift net is payed out against the side. Both boat and net drift together. Fish hit the net and are entangled. The trawl net is dragged along the seabed, its mouth held open by wooden 'otterboards'

Fleming, Alexander (1881-1955)



(*Above*) Alexander Fleming growing cultures of bacteria in flat dishes. (***Above left***) The mould *Penicillium chrysogenum*. In 1939 the British scientists Florey and Chain found that this kind of *Penicillium* yielded 200 times more penicillin than *Penicillium notatum*, discovered in 1928 by Fleming

Alexander Fleming discovered a drug which he named penicillin. This drug has become one of the world's best known and most useful medicines. Yet, like many brilliant discoveries, penicillin was found almost by accident.

Fleming worked as a bacteriologist (a scientist who studies bacteria) at St Mary's Hospital in London. In 1928 he was growing colonies of bacteria in flat open dishes. One day he noticed that fluffy masses of mould had also grown on several of the dishes. Many scientists would have decided that the experiment was spoiled, and thrown the dishes away. But Fleming was curious. He examined the dishes carefully.

He noticed that no bacteria were growing near the mould, although they were growing normally in other parts of the dishes. He began experiments to find out if the mould had killed the bacteria. He found that a chemical from the mould had indeed killed the bacteria. Both bacteria and mould were fighting for the same food supply. The mould had secreted (released) a chemical which had destroyed its competitor. Later the mould turned dark green in colour, and Fleming identified it as the mould *Penicillium notatum*. This mould is a relative of the green and white mould that is sometimes found on oranges. Fleming called this chemical that killed the bacteria penicillin. He published his results but they did not arouse any interest among scientists until many years later.

Fleming was born on a farm in Scotland in 1881. He was one of a large family. When he was young his favourite occupation was to wander around the fields and woods near his home. He learnt, and remembered, a great deal about nature. He left school at 13 and went to live with his brother, who was a doctor in London. He began to study for a career in commerce. He finished his 4-year course in two years, and at 16 years of age became a clerk in a shipping company.

Four years later he inherited a sum of money from an uncle. His brother suggested that he should use the money in studying to become a doctor. Fleming took an entrance examination and got the highest marks of all the students taking the examination. He decided to study at St Mary's Hospital.

When he discovered penicillin in 1928, Fleming found the first antibiotic. Antibiotics are drugs produced by living organisms. Many years before, the French scientist Louis Pasteur had noticed that some bacteria were 'antagonistic' to other bacteria. Although his ideas were followed up by other scientists, the work was eventually abandoned. Fleming found this same 'antagonism' in his mould. He made an extract of the mould and used it to kill various bacteria.

At the beginning of World War II, scientists realised that new drugs would be needed to fight infection caused by wounds. Two scientists named Florey and Chain produced the first large quantities of penicillin. Many lives were saved, and in 1945 Fleming, Florey and Chain were awarded the Nobel prize for medicine.

See: *antibiotics*, *drugs*.

flood

Flooding on the River Chenab in Pakistan. Along with several other of the world's large rivers, it floods every year. Unlike most, the deposits it leaves behind are sandy and relatively infertile. Notice that the floods have not stopped some people from opening a shop on the river bank.

In the spring, as the snow melts, rivers rise. This sudden flow of water is normal. But from time to time the water rises so high that it overflows the banks. This is a flood. It may just mean that riverside meadows become soggy but it may mean disaster. Roads can be washed away, along with any cars that were on them. Houses and property can be ruined by mud and water, and people may be drowned. Flooded sewers and water pipes spread disease.

Rapid melting of the snow in the spring often causes floods. If the winter's snow-fall is heavy, warm weather will fill the streams with melted snow. If the ground is still frozen, so that the water cannot sink in, the streams may overflow. But there may not be enough snow to cause a problem. Floods do not occur every year.

Some floods are caused when too much rain falls. A cloudburst may pour huge quantities of rain onto the ground in a few minutes. If the land is flat, and soaks up water fast, no flood results. But if the land is steeply sloping, the water will run off it. If the land is hard because it is rocky or frozen, water cannot sink in. Rain that falls day after day may fill up the water-holding spaces in the soil. If the rain keeps falling, the extra water runs off the land towards a river.

Some floods are due to wasteful farming, ranching and logging methods. If farmers plough straight up and down on hilly fields, the water runs straight off, causing flooding further down. If forests are cut down, and if too much grass is eaten by sheep or cattle, there will be no plant roots to soak up water. Certain areas of the world have frequent floods. The Missouri-Ohio-Mississippi river system is one. The Yangtze and Yellow rivers in China often flood. The Ganges in India and the Danube in Europe are known for their regular floods.

When rivers return to their normal level after flooding, they leave rich soil behind. So people tend to settle and build their houses, farms and factories in river valleys. Then, when the river floods, the damage is immense.

The numbers who live along rivers known for flooding is amazing. Along the lower Yellow river, there are more than 270 people per square kilometre (700 per square mile). Along the lower Ganges, 400 to 800 people live in each square kilometre. Near river mouths, the river divides

Flood waters caused by very heavy monsoon rains completely cover the plain of the Mahanadi River in the Orissa district in India. The original course of the tributary river can still be seen