FISHKEEPERS' AND WATER GARDENERS'

BULLETIN

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PICTURE: ***Web Leopard Discus***
Owned by Dougall Stewart Bsc PGCE

See article on page 13

JOURNAL OF THE FEDERATION OF BRITISH AQUATIC SOCIETIES

www.fbas.co.uk

Fellow Fish keepers,

I look forward to seeing you all at The Festival of Fishkeeping in October (14th to 16th to be precise). We have some of the finest speakers in the hobby this year, The Location - Mill Rythe Holiday Village, Hayling Island, Hampshire.

David Lim - On Discus; Geoffrey Tan, speaking on general fishkeeping topics; Dr David Ford will present his own personal history of the 30 years of "Aquarian" aquarium foods & products; Rupert Bridges will again give excellent advice on one of his own chosen Aquatic Themes.

This year the UK Discus folk are holding a two day competition putting on some 50 24" tanks of Discus.

We must not forget of course the regular shows: The Hagen Masters Tropical & Coldwater Fish Show (Sunday) The British Open Final (Saturday) The Supreme Championship (Sunday) Goldfish Show to GSGB rules (Saturday) Catfish Show (Saturday).

If you can only come for a day entrance is free sponsored by "Aquarian"

If you think you might like to come for the weekend Contact Grace Nethersell 020 8847 3586.

Regards,

Peter Furze, Editor

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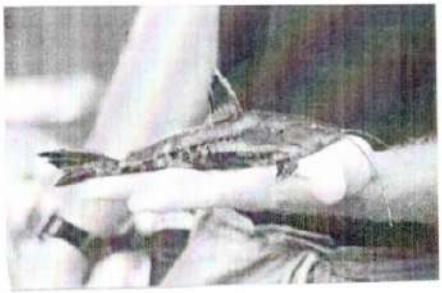
MEGALODORAS URUNOSCOPUS *Eigenmann, 1925*

by Chris Ralph

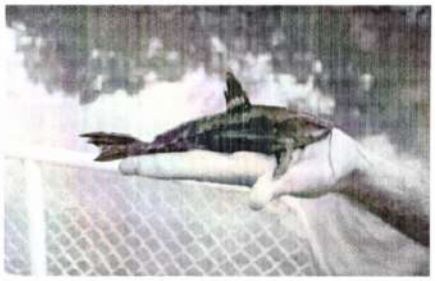
Mother of Snails Catfish, Giant Raphael Catfish, Giant Talking Catfish

This particular catfish is perhaps one of the more colourful of the members of the family *Doradidae*, and is also one of the larger species hence the common names. His catfish is quite often described as being one of the 'Tank Busters' due to the fact that it can grow up to 610mm or 24" standard length (from the tip of the snout to the base of the caudal peduncle). The local name given to this fascinating catfish is 'Key-way-mamnia' which refers to the common name of 'mother of the snails'. The reason for this common name being due to the fact that when a specimen was examined the intestine was lined with large aquatic snails along its length. Some of you reading this information may be wondering why the scientific name for this fish is not *Megalodoras irwini*, the reason being that the name has been recently changed and that the old name is now a synonym.



It has an interesting colour pattern with dark brown markings on a light brown background. The body and head are covered in dark brown to black blotches. The ventral (underneath) region of this catfish has a mottled pattern, which is dark brown in colour. The fins are mottled or spotted irregularly with black coloured markings. The pectoral fins tend to be lighter in colour towards the base and darker towards the edge. The adipose fin is light brown at the top edge of the keel and darker towards the base. *Megalodoras urunoscopus* has 15-18 lateral scutes that increase in size towards the caudal fin. There are many caudal fulcra or bony plates. There are no plates above or below the caudal peduncle. The adipose is described as continuing forward in the form of a hard keel. This catfish has two pairs of barbels, one pair maxillary and one pair mandibular.

Keeping *Megalodoras urunoscopus* is relatively easy assuming that you have the available tank space in which to keep them at their optimum. Ideally they are best housed in an aquarium which is at least 72" x 24" x 24". The preferred substrate is sand such as BD Aquarium sand, although rounded gravel can also be used. They tolerate a wide range of water conditions, but do like to be able to hide away. Aquarium décor should include bogwood and if you don't mind the appearance large diameter pieces of drainage pipe.



This species of catfish despite the size that it can attain is really a 'Gentle Giant' and can be kept with other large or medium sized fish. They are not commonly available, if you have the space for one or more as they do tend to like their own company, they are well worth obtaining.

Family: Doradidae

Common Names: Mother of Snails Catfish, Giant Raphael Catfish, and Giant Talking Catfish

Synonyms: *Megalodoras irwini*

Countries of Origin: Peruvian and Brazilian Amazon, Maranon and Guianas

Size: 61cm (24")

Temp: 22-26°C (72-79°F)

pH 6.5-7.5

Breeding: There are no known documented aquarium spawnings to date, although there may be some breeding-taking place in Czechoslovakia using hormone inducement.

Feeding: Their natural diet includes crustaceans such as aquatic snails, which should be included as part of their captive diet. In the aquarium they will feed on sinking catfish pellets, floating food sticks, whole prawns, earthworms, chopped and whole mussel. They also relish sinking tablet foods.

References: Catfish Association of Great Britain, Volume 1. Baensch, Aquarium Atlas 3.

HAYDN O'GRADY

AN OBITUARY

Foreword by DICK MILLS

If you happened to be in Swansea on a recent Summer's morning looking for a taxi, you were destined to be out of luck there were none to be had. The reason was quite simple but, regretfully, tragic.

It seemed that all the drivers were attending the funeral of Haydn O'Grady one of their ranks - who died suddenly whilst on duty. But recognition of Haydn's popularity and position of affection was not confined to just one section of the community, as around 250 people from across the UK gathered to say farewell to this Port Talbot Aquarist Society member.

Those expecting a rousingly Welsh send-off, with 'Cwm Rhondda' echoing from the rafters would have been surprised at the stark simplicity of his departure service. True, it reflected his love of life and his friendships built up over his short life but such was the devastating effect of his loss on the community that all it really needed was quiet remembrance and personal reflection.

All those present (including the very many gathered outside the full-packed chapel) felt honoured to be included in such an intense occasion and, through the choice of personal music selected by Clare and Haydn's family, really came to appreciate what a gap the loss of Haydn will mean to so many people.

Port Talbot's John Egan has composed this tribute:

IN MEMORIAM

It is with deep regret that we announce the tragic death of Haydn O'Grady and our heartfelt condolences go to Clare, Robert and the family.

Haydn was both loved and respected on the Show circuit where his humour, cheery disposition and willingness to assist anyone were always on display.

Haydn's initial aquatic experiences were in 1995 with Swansea A.S. where he and Clare quickly came to prominence and by 1997 he had already achieved 2nd place in the Supreme Championship and 3rd place in the British Open. However in 1998 they both crossed the River Neath and joined Port Talbot A.S. - a move which proved to be Swansea's loss and Port Talbot's gain.

They soon established themselves as key members of the Port Talbot set up and became Treasurer and Show Secretary respectively.

Haydn's interest in keeping and showing fish increased and he consolidated his already formidable "track record" by winning the British Open in both 2003 and 2004 and also 3rd place in the Supreme in 2004. But Haydn was not only a "show man" he loved social events such as Weston and Bracklesham Bay where in 2004 he and Clare entered and won the Fancy Dress competition dressed as Mickey and Minnie Mouse and he was delighted to receive his prize of a bottle of champagne - a cheese sandwich!

He will be sadly missed by his many friends in the hobby and the Show scene will be poorer by his absence.

Clare and the family wish to thank everyone who kindly paid their last respects at the service and also those who sent their kind messages of condolence and support at this difficult time.

Haydn is pictured below receiving a recent award (just one of his many) from Dr Peter Burgess at this year's Southend Show.

GOOD WILDLIFE PONDS

Pond Conservation at www.pondconservation.org.uk

PONDS CONSERVATION TRUST

INTRODUCTION

Different types of ponds support different kinds of wildlife - so the best way to encourage a wide variety of pond plants and animals is to maintain a range of different pond types in the area. This could include ponds that are seasonal, permanent, shady, open, overgrown and so on. Individual ponds are often richest where they contain a wide variety of different habitat types (see over page), including abundant vegetation in the water and on the bankside. But, overall, it is better to maintain a range of different pond types than to try and cram every habitat into a single pond.

Whatever type of pond you have, however, water quality is critical. Unpolluted ponds not only have the best wildlife communities, but have far fewer management problems. So where ponds are polluted it can be worth trying to improve their water quality - although this is not always easy! (see water supply).

DIFFERENT TYPES OF POND

Five useful types of ponds to have in any area are described below.

Seasonal or Temporary Pond. Because temporary ponds dry out in most summers they are often overlooked, or assumed to be 'lost'. In fact they support a vital range of specialised pond species and it is important that they are retained, and not deepened. A surprisingly high number of temporary ponds support very rare species, particularly where they occur in semi-natural landscapes such as ancient woodland, old meadows or heathlands.

1 in 4 seasonal ponds in semi-natural habitats support Red Data Book species

Semi-Permanent Ponds. Semi-permanent ponds dry out occasionally in drought years. They are usually very rich ecosystems, particularly for amphibians and invertebrates such as water beetles. This is because the occasional drought gets rid of fish which are a major predator and this allows other species to thrive.

Shaded Ponds. Trees are often thought of as undesirable around ponds but, in fact they provide many types of habitat for pond animals. The best advice is never to clear fell all the trees around a pond and to make sure that, if there are only a few examples of shaded ponds in any area, that some are kept undisturbed.

Overgrown Ponds. As they age and fill in with sediment and marginal vegetation, ponds become shallower and more overgrown. This is a natural process that has been repeated constantly throughout geological history and does not inevitably lead to the pond becoming a poorer wildlife habitat. In fact it is usually the time when wetland plants are at their richest, and many associated pond animals thrive living amongst the shallow water and dense vegetation.

Shaded woodland ponds are host to some of our most rare invertebrate species

Classic Ponds. These are the sorts of ponds pictured on the top of chocolate boxes. They hold water all year round, often have a fringe of rushes and a smattering of waterlilies. As long as they have unpolluted water they can be very rich in wildlife - but they are only one type of pond, and can only support some of the wide range of plants and animals found in different pond types nationally.

WATER SUPPLY

The best wildlife ponds are usually unpolluted. Knowing where the water comes from can help to control or eliminate pollution. Apart from rainwater, there are three main sources of water for ponds. Individual ponds may be fed by one or more of these water types and the importance of each can vary during the year.

(i) Surface run-off is water that runs into the pond from higher ground. It flows either through the vegetation or, more often, through the soil and subsurface. It can be amongst the best or worst water supply depending on how polluted the catchment of the pond is. Water running off from unfertilised grassland or woodland is likely to be unpolluted but water draining from an intensive arable field or car park will, for example, usually be highly contaminated.

(ii) Groundwater is water that is already present in the ground - usually in sands and gravels. In urban and intensive arable areas it is usually the cleanest water source because it has been pre-filtered through the sub-surface.

(iii) Streams and ditches seem like attractive water sources but can be problematic in the long term. In the lowlands, in particular, inflows are commonly polluted. Streams also bring in large amounts of silt so that the Pond fills in much more quickly - often with polluted sediment.

GOOD WILDLIFE HABITATS IN PONDS

What Makes a Good Pond Habitat? Most pond animals, such as dragonflies, water beetles, mayflies, snails and other pond creatures, are tiny animals - often much less than length of a thumb-nail. Their first need in a pond is for suitable living-quarters where they can feel protected. Any structure under the water which provides this protection will be useful - and the more complex it is the better.

Open water is usually the most dangerous habitat in a pond and these areas usually have few species. Plants provide much better cover - but some are better than others. Tall reeds may look lush above water but their underwater structure is often quite simple, with lots of open water areas around the stems. This means that they can be useful for aquatic animals, but are not usually the richest areas. Far better are areas around the pond edge which have low wetland herbs and grasses growing out from the bank. Other structures can serve a similar purpose, including the underwater root mats that grow out from willows and even the spaces between coarse leaf-litter or gravel at the bottom of a pond.

Some of the most valuable habitats in ponds for both plants and animals are described below - not all are immediately obvious!

Bare Mud at the Pond Edge. Pond water levels fall naturally between winter and summer creating a 'drawdown zone' which is valuable for many animal species and a natural germination area for many wetland plants. If the pond is grazed by livestock or trampled by people, falling water levels will often expose a bare muddy or stony drawdown zone. The mixtures of bare ground and occasional plants here provide an important habitat for a wide range of invertebrates. Some pond animals use the drawdown zone during the wet phase; others when it is damp or dry; and some synchronise their life cycle with the seasonal change in water levels. Dragonflies like the Southern Hawker (*Aeshna cyanea*) and the Brilliant Emerald (*Somatochlora metallica*), for example, often lay their eggs in the damp exposed mud of the drawdown zone - perhaps to avoid fish predation in the period before their eggs hatch. The damp and dry pond edge is also used by many semi-terrestrial animals including snails, spiders, fast-running ground beetles and shore bugs. It is also a favoured feeding ground for many wading birds, and even small mammals like shrews use it, catching insects trapped in the mud.

The ever-changing drawdown zone is one of the most important parts of any pond.

Trees and Wood. Trees growing in, over and around ponds can create a variety of pond habitats. Rotting logs in the water are a favoured egg-laying site for hawker dragonflies, fallen branches are used as bird-nesting sites, and dead leaves on the pond bottom provide both a food source for shrimps and slaters and case material for caddis flies. Trees

on the bank create a winter hibernating site for newts amongst their roots. Trees growing in the water are also useful - especially willows, which send out underwater root bundles creating a habitat for mayflies and beetles. Many wetland plants can survive under moderate shade, but highly invasive plants like bulrush do not grow so densely. Partial shade can, therefore, be used to help maintain a more diverse plant community.

Very Shallow Water. You can tell an experienced pond surveyor by where they first search in a pond for wildlife. The widest range of pond animals are found in exceptionally shallow water only a few centimetres deep (less than the height of a matchbox!), at the very edge of the pond. Try to ensure that whatever the season, some part of the pond always has extensive shallow edge areas of about this depth - preferably with a broad band of grasses or herbs in the water to provide shelter.

Wetland Plants. Wetland plants are a very important part of any pond: many pond plants are declining nationally so protecting them for their own sake is worthwhile. They also provide a vital habitat for many different kinds of pond animals. For example, every part of a Bulrush (*Typha latifolia*) is used by animals, from the tiny Bulrush Bug (*Chilacis typhae*) living in the flower heads, to water voles that eat the succulent growing tips and the Ruddy Darter dragonfly larvae (*Sympetrum sanguineum*) which live in sediment around its roots.

Amongst the most useful plants are low-growing herbs and grasses. Marginal grasses, such as Creeping Bent (*Agrostis stolonifera*), and the floating Sweet-grasses (*Glyceria* species) are commonly regarded as weeds and pulled out when they begin to spread into the water. In fact, grasses growing in just a few centimetres of water are excellent habitats for water beetles, whilst in deeper water, floating sweet-grasses are amongst the most favoured habitats and egg-laying sites for Smooth newts (*Triturus vulgaris*) and Great Crested Newts (*Triturus cristatus*).

Submerged and floating-leaved plants are also valuable - particularly for providing a habitat in deep areas of the pond that would otherwise be barren open water.

The Surrounding Land. For many animals the land around the pond is a critical part of their life cycle - dragonflies need tall plants to help them shelter from the wind as they dry their wings for the first time, water beetles pupate in the pond banks and many pond insects feed on the nectar of flowers once they have emerged as adults.

The best surroundings for ponds are usually natural habitats like woodland, unimproved grassland, scrub, heathland or moorland. If pesticides or fertilisers are used in the surroundings of the pond, try to create a buffer of scrub and rough grassland to protect the pond and provide a habitat.

KEEPING DISCUS - FACT FROM FICTION

By Dougall Stewart BSc. PGCE

Discus - Fog, Rumours and Lies

Over the years I have listened to, and read, many so-called 'hard cold facts' about the discus fish - *Symphysodon sp.*, e.g:

- discus are shy & nervous
- you need special water making equipment
- they are always sick and need to be permanently fed a diet of medicated food
- discus are fussy eaters and will only eat bloodworm
- they cannot be kept with plants, angelfish or other fish
- all Asian discus are inferior to German discus and carry the 'discus plague'

Discus - Reality

Needless to say all of the above are utter nonsense and over the years I have found that it is more important to apply a common sense holistic approach to rearing and keeping your discus - which after all is what we should we should be doing for any species we choose to rear and to keep in good health for maximum longevity - than to listen to poorly thought out strategies, rumours and innuendo. Almost any healthy discus fish will survive in a variety of water parameters, eat any quality food offered and live for over 10 years . . . IF you pay a little forethought to their needs and their environment.

Discus - Fish

Thanks, in the main, to the hard work of the Asians, Germans and Americans we have over 130 different discus colour and pattern morphs to choose from today. Good beginner's fish include: red or blue turquoise discus, Marlborough reds, Pigeon Bloods, or any of the derivatives of these morphs. Discus are a shoaling fish and are best kept in groups of 6 or more - though smaller numbers are not impossible.

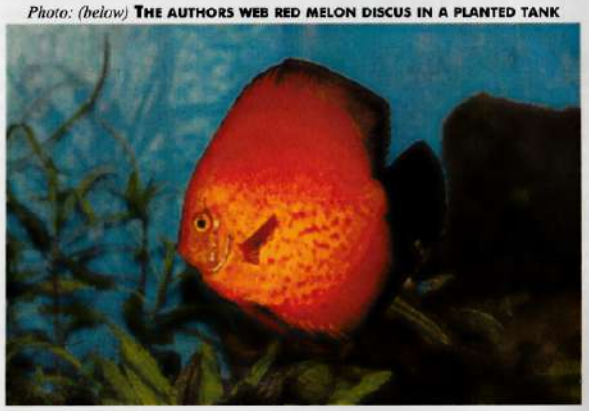
The purchase of quality discus is essential. Your fish should be round, well formed, and should not show any signs or poor water quality of malnutrition i.e. choose carefully from a reputable dealer/breeder.

Discus - Water

It is true that discus are acidophilic i.e. they have evolved to thrive in the predominantly soft, acidic water of the Amazon; however, for fishkeeping

Photo: (above) **THE AUTHORS WEB LEOPARD DISCUS IN A PLANTED TANK**

Photo: (below) **THE AUTHORS WEB RED MELON DISCUS IN A PLANTED TANK**



purposes it should be noted that discus fish are tolerant and will thrive in a wider range of water parameters than previously assumed - if those parameters are STABLE! i.e. your discus would be less stressed in an aquarium that has a stable pH of 7.8 than in an aquarium where the pH of the water is acidic but wildly fluctuates, due to the careless addition of acids or so called 'safe buffers'. My personal water parameter range or recommendations for raising discus include:

- water temperature of 27-30°C
- stocking levels at 1 (adult) fish per 10 gallons of water
- water changed at 10% or more per day
- KH/GH 3-10
- pH 6-8

An additional safeguard for your discus would be to employ a water purification strategy that is capable of removing: chlorine/chloramines, heavy metals, pesticides and any other unwanted chemicals. This strategy may include any combination of the following: reverse osmosis, deionisers, CBR2 units, selected resins, liquid water conditioners etc. Your choice should be driven by your source water quality and your desired product water.

Discus - Tankmates

I have safely kept discus with angelfish, clown loach, tetras, gibbiceps, corys and many other small Amazonian catfish and even silver sharks. I have also seen discus kept with different types of rays and on one occasion a goldfish - though I wouldn't recommend the latter! The key to success is to avoid water parameter extremes and to ensure that your discus are in good health, active, and remain 'confident' in their environment. If you have nocturnal cats, make sure that you provide plenty of settling areas for your fish in the evening where they can avoid the main tank activity.

Discus - Planted Tanks

Many people struggle with planted discus tanks and either the discus or the plants suffer. The deleterious effects to plants and discus can be minimised if the fish are introduced to a well established tank that already has strong plant growth. Many plants will cope with discus and the above water parameters - if they have an adequate light source, an appropriate supply of carbon dioxide and nutrients! My personal favourites include: *hygrophila* and *ludwigia sp.* - be warned though, these can become incredibly dense and limit free swimming space in a suitable environment; *Echinodorus sp.*, *Anubias sp.*; *Cryptocoryne sp.* e.g. *C. wendtii* and *C. blassi*, and also the tried and trusted Java fern *Mirosorum pteropus*.

In Summary

Don't be put off by many of the old horror stories that are out there - discus can be kept by almost anyone in a wide variety of circumstances . . . why not take a chance and get your feet wet? Just a little attention to the needs of your fish and your rewards will be immense!

ENCYCLOPEDIA OF AQUARIUM AND POND FISH

Reviewed by Dick Mills

Is it possible to produce a book that will be appreciated by every fishkeeper?

Dorling Kindersley obviously thought so and David Alderton rose to the challenge splendidly. The result is ENCYCLOPEDIA OF AQUARIUM & PONDFISH (Dorling Kindersley 2005 ISBN 1-4053-0268-2).

To begin with, the whole range of indoor aquarium keeping is here including tropical and marine fishes. So you're not an aquarium person? The book also includes ponds and pond fish too, so there's complete coverage no matter where you choose to keep your fish!

Within these segments, the 'storyline' is similar: firstly, what to consider, information about creating the right environment for the fish, caring for them and breeding.

With freshwater tropical fishes this information is right up to date even including details of genetic-modified fish which have been in the news in recent months. Species-wise, the inclusion of recent Rainbowfish, generous helpings of 'L' numbered catfish and, in the main, correct nomenclature should allay any fears that this is just another fish book.

Acting as a 'green buffer' between the two aquarium types, an albeit brief Directory of Freshwater Plants gives a good selection of the different species available.

The marine section does not disappoint and again is correspondingly up with current practices such as using the combination of living rock with a protein skimmer as opposed to more outdated filtration methods. A chapter on Monitoring and Adjusting rightly emphasises the mandatory nature of maintenance required to keep water conditions correct. Aquarium breeding of marines may still be in its infancy but it is not overlooked and neither is the important component within it – that of feeding the tiny fry. Rotifer food is explained, something not always featured in popular aquarium books.

A Directory of Marine Invertebrates replaces the corresponding space occupied by the previously mentioned Directory of Freshwater Plants and this leads on to Pond Fish.

The information on setting up of a pond, with all its planning, installation and fitting of ancillary equipment is supplemented with a welcome chapter on keeping coldwater fish in the home and a brief item on the now familiar BiOrb again reflects the book's topicality.

Pond management includes feeding, health matters and breeding, before the fish – Goldfish, Koi and other coldwater species arrive. There is reference to legislation to keeping certain coldwater species.

Finally an excellent section on plants for the pond brings this Encyclopedia to a conclusion.

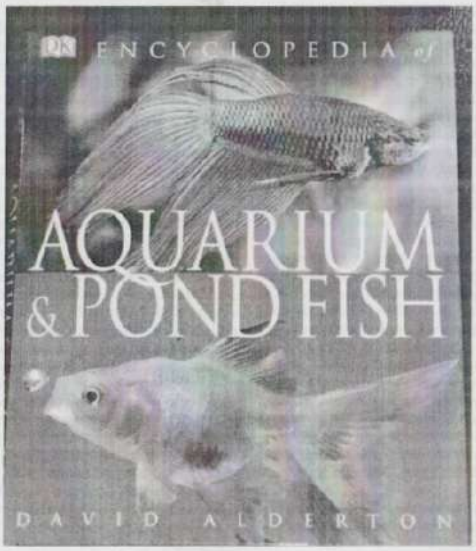
As might be expected with any publication from DK, production quality is nothing short of magnificent. When the name of Max Gibbs is credited for the photography you know you're in for a visual treat. All you might want to know about fishkeeping, should you be the process of taking up the hobby or modifying your interests within it, seems to be contained within this books covers. You might even spend more time looking at it than your aquarium!

There is a Special Offer price available on this book to FBAS Bulletin readers:

The RRP price of £25.00 is reduced to £22.00 together with free postage and packing. This offer, **open to UK residents only**, is subject to availability and you should allow 28 days for delivery.

Call the DK Bookshop on 08700 707 717. Offer Reference Number: FAS/EAPF Please quote the title and ISBN number of the book:

ENCYCLOPEDIA OF AQUARIUM & PONDFISH ISBN 1-4053-0268-2



FEEDING AQUARIUM FISHES

By Dr David Ford, Consultant to Aquarian®

Dr David Ford presents the first part of a new series about feeding the fishes in your home aquarium based on his 25 years of research at the Waltham Aquacentre. Beginning with basic nutrition, future articles will cover prepared and live foods, feeding for growth and colour and recipes for economical feeding.

PART 1 - FISH NUTRITION

Fish nutrition? What a boring subject! You have probably read articles in the past where the contents show lists of vitamins and minerals and the dreadful diseases that ensue if just one is missing from a diet - or even worse consequences if too much is fed. As if you could control such things! Some articles read like scientific research paper, for example, one such piece begins "Adenosine diphosphate and triphosphate are found in fish tissue indicating that the same catabolic energy processes are used in the cold-blooded fishes as the warm-blooded mammals." (I know, I wrote it.)

Yet fish nutrition is of paramount importance to the aquarist and a matter of life and death to the fish themselves. Think about it - what personal and routine interaction do you have with your fish? Feeding them! What most influences the quality of their water, the rate of their growth, the colours of their skin, the health and indeed happiness of their lives? It is the food that you supply. You nurture through nutrition...

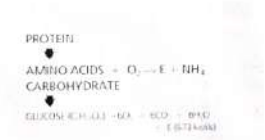
FOOD COMPONENTS

The main constituents of food, whether for your fish or for yourself, are:

- *Protein* - the building blocks of life itself
- *Lipids* - the proper name for oils and fats
- *Carbohydrates* - the energy sources from plants
- *Vitamins & Minerals* - trace elements essential for life

Protein is the building blocks of life forms. It is always the first item in any fish food ingredients list because it has the highest concentration in their natural diets. This applies to the omnivores (fish that digest anything edible), the carnivores (predatory fish) and the herbivores (plant eaters - they have enzymes that digest plant protein and so need vegetable matter in their diet). Most fishes' natural diet (insects, worms, other fish, algae) is very rich in protein so the metabolism of fish uses this food component as an energy source, as well as for growth and repair.

The problem for aquarists (and pondkeepers) is that in using protein for energy the excreted material is pure ammonia, which pollutes the fish's water giving stress at low levels, gill damage and skin irritation at medium levels and death at high levels.



The effect of a high protein diet on aquarium fishes, with ammonia (NH3), ammonium (NH4+) and nitrite (NO2 -) causing the pH to fall and bacteria to use the Oxygen (O2) that the fish needs.

In the flowing rivers, lakes and oceans the dilution of ammonia is so great that the fact the fish are swimming in their own toilet is not a problem. In the confines of the aquarium, pond, or worst of all, a bowl, it is a killer. That is why protein must be restricted to those levels that fish need for growth and repair. This means the fish then use carbohydrate as an energy source. The advantage is that the by-products are only Carbon dioxide and water itself, i.e. non-polluting.

Fish nutrition studies have shown that the adult fish needs, as an average value, less than 40% protein, although fry will need a higher value; 47% is ideal. Foods over 55% will supply the fish with proteinaceous energy and subsequent ammonia problems. Fish farmers use foods over 55% - up to 80% protein is available - for rapid growth of Salmonids for the table. However, they also supply running water to flush away the ammonia (and consequential nitrites) that form - something aquarists cannot do.

Not only *quantity*, but *quality* is important in protein nutrition. Fish have this amazing ability (wish we had) to eat continuously, digest what they need and excrete the rest. If the protein is totally digestible, all will be utilised with little or no ammonia to excrete. If poor quality protein is used (i.e. some is indigestible or the balance of protein components are wrong) the undigested portions are excreted to pollute the waters or cause bacterial blooms - and excess algae. Good quality commercial fish foods have low levels of highly digestible proteins.

Look for values around 34% *digestible* protein for Goldfish, 37% *digestible* protein for Tropicals and 38% *digestible* protein for Marines.

The name 'lipids' covers the many compounds that we know as fats, oils, waxes, fatty acids and related compounds.

Each chemical group is amazing in its complexity and fascinating in the ways nature has used their properties. There are two major groups of lipids important to fish: the fats and oils. Chemically they are the same, being composed of Carbon, Hydrogen and Oxygen (just like the carbohydrates). However, they have fewer numbers of Oxygen atoms than the carbohydrates and are present in life in mildly acidic forms, the so-called fatty acids.

Some fatty acids are made by the fishes in the actual digestive processes, but some have to be ingested in their correct chemical form. These are called the 'essential fatty acids' and must be present in any diet for it to be 'complete nutrition'.

All fats contain Carbon which has four valencies (arms to which 1, 2, 3 or 4 other atoms can attach - called bonding). If all four arms are bonded completely and separately, the Carbon is said to be 'saturated', but if double or even treble bonds are present, the Carbon is said to be 'unsaturated'. This is where the names 'saturated fats' and 'unsaturated fats' originate - see any advertisement for margarine.

One basic difference in Carbon chemistry is that when saturated the compound has a higher melting point. This is because a Carbon atom with all four valencies bonded - the arms outstretched - has a crystalline structure and can pack together to give a solid form (the ultimate is the diamond).

Unsaturated Carbon compounds have less rigid structures; the double and treble bonds give a kink in their molecular shape and so cannot pack together so well. This gives a liquid that only solidifies at very low temperatures. At normal temperatures the so-called hard fats (butter, lard, cheeses) are solid and are mainly composed of saturated Carbon, whereas unsaturated fats are liquid (cod liver oil, cooking oils).

FAT IS STORED ENERGY

Nature exploits this solid-liquid behaviour in fat storage. In humans (and other hot-blooded animals) fat is stored in adipose tissue (under the skin) and since this is about 37°C (or 98.4°F) a liquid oil would be a problem, but at that temperature hard fats are a soft solid, ideal for movement, protection and body shape. If fish stored the same kind of fats, they would be as hard as a candle because even tropical fishes are over 10°C cooler than their owners.

Hence fish store fats as oils made from unsaturated Carbon compounds, which remain liquid even at 0°C (which is important to that endangered species Cod swimming in Icelandic waters!).

THE OMEGA

The fats and oils are given a formula that describes the Carbon structure. A 'C' number is quoted, which is the amount of Carbon groups, and the Greek letter 'Omega' for the double bond with the number of the 'C' group where it occurs.

The bulk of fish oils are 'linoleic' type that has a structure of 'C18 Omega3', which gives it a solidifying temperature of *minus* 5°C.

Fish store their fat as oils, either in the flesh (oily fish) or the liver.

Look at the food supplements shelf in the supermarket or chemists and you will find Omega3 oils for sale 'for your heart'. Saturated fats can clog arteries but oils will not, so fish oils are better for you. It may, or may not, prolong your life, but it is essential for the life of a fish.

It is always obvious on a post-mortem examination of a fish if it has received a fatty diet, the liver will be swollen and pale, sometimes with spots of hard fat. The fish will never have been a good specimen in its shortened life.

THE CARBOHYDRATES

Herbivores and the omnivores (fish that can eat and digest both animal and plant food - practically all ornamentals are omnivores) can digest carbohydrates and use them as a source of energy. The complex CHO chemicals are reduced to glucose by enzymes and taken around the body in the blood for instant use as an energy supply - in just the same way we humans do. The end products are simple Carbon dioxide, breathed out by the fish through the gills, and water itself.

However, unlike (most) humans, the digestive process in fish is not very efficient. As Balfour Hepher ('Nutrition of Pond Fishes' Cambridge University Press, 1988) said "Insulin control seems to be inefficient, making fish similar to diabetic mammals".

So fish can get energy from carbohydrates, but it is an inefficient process, however this is not important since the energy requirements are low. This is because fish are cold-blooded, so the large amount of energy spent by higher, hot-blooded animals in maintaining warm blood is just not needed.

The support of the water means less energy is needed for moving around (land animals have to fight gravity all the time). Even breeding is less energetic - higher animals succour their young, most fishes just scatter eggs and milt and ignore (or even eat) the results.

The following table compares the energy needs of various animals, note how little fish must have for a healthy life:-

Animal	*Energy Requirement* KJ* per kg body weight per day
Budgerigar	1,670
Dog	460
Human	190
Goldfish	40

*a KJ is the scientific method of counting 'calories' - it is in kilojoules and if divided by 4.2 will give the equivalent amount in the older term of kilocalories, popularly known as just 'Calories' (more than Calories are 1000 calories).

THE VITAMINS

As they were discovered the vitamins were logically named vitamin A, B, C etc., but errors developed. Vitamin B was found to be a mixture, hence B1, B2, B3 was needed. Then 3,4 and 5 were found to be the same chemical, so the next correct one became B6. Eventually we had B12, but not until after B10 and B11 were found not to be vitamins after all.

Nowadays vitamins belong to the group called the 'trace elements', a title used by nutritionists to mean the elements of food that are present in only minute amounts, but are essential for health and growth. These include minerals and phytochemicals (food components that were made by plants and passed on to animals via digestion) as well as the vitamins.

It is no coincidence that the compounds are only present in trace amounts because their effect is so powerful excess can be harmful, indeed life-

threatening. Look on any bottle of multivitamin tablets in the supermarkets etc. and it will carry warnings such as "do not exceed the stated dose" or "not suitable for expectant mothers" or "not suitable for children". Perhaps it should state "not suitable for fishes" for their requirements are quite specific too.

Vitamin deficiency will give symptoms that resemble bacterial diseases or parasite infestation problems. The aquarist who feeds his/her fish with any diet that does not contain the correct level of a particular vitamin will see the these symptoms and assume an infectious disease is present. Treatment is then given with chemicals such as Methylene Blue, Malachite Green, Acriflavine or even worse, antibiotics (which kill off valuable nitrifying bacteria). These chemicals just add to the distress of the fish and give a downward spiral that can lead to death.

Other aquarists prepare their own foods and, recognizing that fish need a range of vitamins, grind-up multivitamin tablets or add liquid vitamin solutions. There are two problems with this DIY dieting: the fish need different levels of each vitamin than humans (and more of them too) and hypervitaminosis can occur.

Cod liver oil is often used as a binding agent for food mixes, which is very rich in vitamin A if this is also added in the multivitamin mix, the over dosing can give a symptom that resembles fin rot. The aquarist will certainly turn to classic fin rot remedies (which are antimicrobial) and never suspect that the basic cause was their DIY fish food.

MINERALS

Fish have an 'open system' in that they interact with their environment. Humans live in a 'closed system' because we have a waterproof skin and only react with the outside world via gases in the lungs. Life started in the oceans 600 million years ago, but by then the Earth was already 4,000 years old and those oceans were full of minerals, which were incorporated into the cells of the life-forms that eventually developed into the fishes.

It is a fascinating fact that the body fluids of modern fishes have the same salts as that primordial ocean, roughly 1% solutions of Sodium chloride, Magnesium sulphate, Calcium sulphate, and so on. The oceans continued to concentrate the minerals from the land via evaporation and rainfall until the modern ocean is around 3% salts. This gives all kind of problems to marine fish who have to cope with 'osmotic pressures' of the surrounding saltier seas. Problems too for the freshwater species who migrated from the seas with that 1% salt content. However, that is a physiological topic, not a nutritional one.

The nutritional consequences of life developing in that primordial ocean are that certain minerals are now essential for body chemistry. These need to be included in the fish's diet, as follows:-

- Structural – these are used for teeth and bones and include Calcium, Phosphorus, Fluorine and Magnesium.
- Respiratory – haemoglobin in the blood containing Iron, Copper and Cobalt.

- Metabolic – Sodium, Potassium, Iodine and Chlorine.
- Trace elements – Boron, Aluminium, Selenium etc.

Low levels of structural minerals will give poor bone structure; a classic example is the 'bent spine' (a distorted spine in fishes may also be due to disease, such as Fish Tuberculosis).

If respiratory minerals are deficient the fish will gasp at the surface as the Oxygen level in the blood falls below critical levels. Such behaviour could be blamed on the Oxygen levels in the water itself and aeration increased - with no effect on the symptoms.

Metabolic deficiencies are rare because most waters contain Sodium and Potassium. Chlorine is always present in water, indeed it is present in excess in tap waters and needs reducing anyway. Iodine deficiency gives goiter-like symptoms, just the same as in humans.

The trace elements are important but rarely absent in both diet and the water. Extra levels above naturally occurring ones can have beneficial effects. For example absence of Selenium inhibits spawning behaviour and so fish farmers use foods with extra Selenium for their breeding stock. Perhaps a Selenium-rich (among other things) fish food would help breeders of aquarium fish (but not yet seen in the aquarium trade).

The next article will be about those commercial foods and their benefits in "Feeding Aquarium Fishes"......

This is the Waltham Aquacentre. Based in Yorkshire, this unit has been used to study the needs and care of ornamental fishes for 30 years.

THE CHEMISTRY OF LIFE

By Les Holiday (Hagen)

In recent years the aquarist is becoming increasingly faced with a whole range of new products and processes which promise to keep aquarium water in perfect condition. No wonder many of us are becoming confused regarding the basics of the water chemistry in our aquariums and what we should regard as good water conditions for the inhabitants of our tank.

The fresh water tropical aquarium hobby involves keeping a wide range of aquatic subjects from around the world which live, often, in quite different conditions of water chemistry in the wild one from the other. Whilst it is very easy to exaggerate the complexities involved in trying to replicate the variety of conditions involved there are a few essential tried and proved rules for fish keeping that can easily be learned about aquarium water chemistry which can help you to be successful in solving problems related to this area of the hobby.

Most hobbyists learn an early lesson in aquarium water chemistry when first filling their brand new aquariums with tap water. If properly advised, when making their initial purchase of aquarium equipment, they will have learned that tap water direct from the mains is far from pure and can be considered poisonous to a wide range of aquarium fishes. Both chlorine and chloramine are added to tap water to kill bacteria and make it safe for human consumption and unfortunately both of these are harmful to fish and other aquarium inhabitants.

Quality water conditioners like Nutrafin Aqua Plus utilise Sodium Thiosulphate which is extremely safe, reliable and fast working in eliminating these toxins, in fact, effective in less than a minute. Nutrafin Aqua Plus also employs a compound called EDTA, a chelator used in most water conditioners to neutralise toxic heavy metal ions such as those of copper, iron, manganese and mercury.

The term water chemistry, meaning the chemical components of water, is often confused with water quality, which refers to the purity of the water. Water quality management, to most aquarists, involves dealing correctly with the effects of the organic wastes produced by living things in the aquarium through various filtration processes. Simply put, this is a process where harmful pollutants produced as wastes from fishes and the decomposition of dead plant material, uneaten food, etc., is reduced from highly toxic ammonia, and ammonium by nitrifying bacteria into less harmful nitrates. The rules concerned in making this process work effectively are well known. The bottom line, though, is that an aquarist must set up and maintain a tank as free as possible of these harmful organic

compounds. Organic substances decay in stages in the presence of oxygen, a process called oxidation, which progressively with the assistance of nitrifying bacteria reduces the ammonia and ammonium into nitrite and then finally into nitrate. A properly sized and effective filter to house the bacteria is therefore required and a maturation period to allow the bacteria to build up in the filter and handle the bioload of waste the aquarium inhabitants will produce. During these early maturation processes water treatments like Nutrafin Cycle which contains concentrations of nitrifying bacteria to quickly increase the biomass of bacteria in the filter will hasten the process and regular weekly dosing will help maintain a healthy biological balance. Keeping to the rules as far as stocking the tank is concerned to ensure the waste bioload does not exceed the capabilities of the filter plus good hygiene and tank management to ensure overfeeding does not take place and any uneaten food remains are quickly removed should be all that's needed to maintain stable, healthy water conditions. Where organic wastes are a major problem, like for example, in heavy duty aquariums housing subjects like large cichlids etc, Nutrafin Waste Control is also particularly useful as it contains six strains of heterotrophic bacteria which break down organic matter resulting from the by-products of decay such as film and sludge on the substrate, slime on the glass, protein film on the water surface, fish waste and decaying plant remains.

Another area where a little knowledge can be useful regards water hardness, the carbonate system and pH values, especially so if there is a desire to specialise in subjects which require specific levels of pH and water hardness. To understand this better let's see how variations occur in the wild. All spring and river water contains calcium and magnesium in varying quantities. The most important elements are calcium bicarbonate and calcium sulphate. Water rich in calcium salts is considered 'hard' with little it is called 'soft'. Hardness is measured in degrees of hardness one degree being equal to 10mg of calcium or magnesium oxide per litre of water. 'General hardness' (GH) is a term used to describe levels of calcium in the water whilst carbonate hardness (KH) carbonate levels. Each can be separately measured by test kit and the levels can be adjusted to suit the conditions required. African Cichlids and livebearer fishes, for example, require high levels of general hardness and conditioners like Nutrafin African Cichlid Conditioner safely increases general water hardness and creates an optimal mineral balance for these hard water loving fishes. Carbonate

hardness level adjustments are used to provide optimal conditions for fish health and plant growth and also assist in maintaining stable pH conditions. Nutrafin pH Stabiliser replenishes carbonate hardness safely and easily if dose levels are not allowed to produce changes in KH levels by more than 2° dKH per day. Greater changes can stress fish and create extreme pH levels.

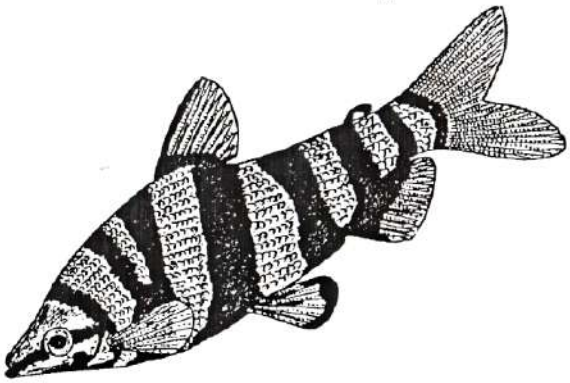
pH is a measurement of the degree of acidity in the water and indicates a change from a neutral point fixed at a pH of 7.0. Values above 7.0 indicate increasingly alkaline water those below increasingly acidic water. The optimum pH for aquarium plants and fishes lies between pH 5.0 and pH 9.0. Most freshwater fishes prefer a range between 6.0 and 7.5 whilst marine fish values between 8.0 and 8.5. pH adjustments can quite easily be made using a pH adjuster. Nutrafin pH Adjust Treatments Down safely reduces pH down to levels suitable for keeping fish species preferring more acidic environments such as tetras, barbs and South American Cichlids whilst Nutrafin pH Adjust Treatments Up safely raises pH to levels preferred by species liking alkaline conditions like guppies, mollies, swordtails and African Lake Cichlids. Both treatments are phosphate and nitrate free and are only for freshwater use.

One area of water chemistry management in the aquarium has not been mentioned. This is the build up of phosphates and nitrates over time, which is inevitable in most aquariums. Phosphates can originate from concentrations occurring in the mains water supply or due to using foods with a high phosphate content. Tiny amounts (less than 0.1 mg/l) can encourage unsightly growths of algae and therefore should be removed using a phosphate remover like Hagen Green-X, which traps phosphate within a chemical matrix. Feeding a food with a low phosphorus content can dramatically reduce the level of phosphates in the aquarium, thus reducing algae. Nutrafin Max foods are made with a unique manufacturing

process that ensures ash & phosphorus levels are at exactly the right level - high enough to provide the correct mineral levels but low enough to help prevent algae problems.

KNOW YOUR FISH

Marbled Headstander - *Abramites hypselonotus*



Common Name: Marbled Headstander

Scientific Name: *Abramites hypselonotus*

Where found: Amazon River and Orinoco Basin.

Characteristics: Body colouration variable, generally dark brown to yellowy brown with an irregular brown pattern resembling vertical bars. Finnage is yellowy with the anal fin possessing a broad black base and a thin black outer margin, the pectorals are blueish.

Remarks: This species was once considered to be a *Leporinus*. Upper and lower body contours are even and the fish assumes a head down stance at all times. It is considered by some that the *Abramites hypselonotus* and the almost identical *Abramites microcephalus* are one and the same, indeed, this is correct according to www.fishbase.org.

FBAS Show Class: 'C'

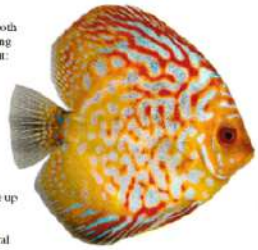
Festival of Fishkeeping & Water Gardening Weekend

October 14-16, 2005

New venue! Due to its continued growth, this year's Festival of Fishkeeping has been moved to Mill Pyth the Holiday Village, Hayling Island, Hampshire.

A host of exciting attractions for both residents and day visitors, including everything you need to know about:

- Freshwater tropicals
- Discus
- Marine fish
- Koi and goldfish
- Native freshwater fishes
- Filtration and lighting
- Water gardening



This year's events:

- 'Hagen Masters' Open Show (On Sunday – sponsored by Rolf C. Hagen)
- The Laguna Southern Koi Festival (Sponsored by Laguna)
- Goldfish Society of Great Britain Fish Show (On Saturday – sponsored by Aquarian)
- British Open Final (On Saturday – sponsored by Tetra)
- The FBAS 'Supreme Championship' Final (On Sunday – sponsored by Tetra)
- Catfish Show (On Saturday – sponsored by Aquarian; Southern Catfish Rescue Society Rules)
- 'Tancho Koi' – UK Rancho Specialist Goldfish (Sponsored by Aquarian)
- UK Discus Show (Sponsored by Tetra)
- Marine Display (Sponsored by Aqua Medic)
- Society-furnished aquaria
- Speakers from both the aquatic and water gardening worlds
- Furnished aquariums, pond and water garden displays, trade displays

Lectures

There will be an international line up of guest speakers, including:

- David Lim on Discus
- Geoffrey Tan speaking on general fishkeeping topics
- Heiko Bleher will also present a feature on Discus as well as a general fishkeeping topic.
- Dr David Ford will present his own very personal history of the 30 years of Aquarian aquarium foods and products.
- Rupert Bridges from Tetra will again give excellent advice in one of his own chosen aquatic themes.

This year's lectures are co-sponsored by Practical Fishkeeping magazine.

practical fishkeeping

Prices

Half-board

Two-night weekend £85
Three-night weekend £105
Lunch available both days
Cabaret entertainment, fancy dress competition and dancing on all three nights.

Hotline bookings: Please contact Grace Nethercell, 8 Acacia Avenue, Beenford, Middlesex TW8 8NK. Tel. 0208 847 3586.

Day visitors

Day visitors are welcome on Saturday, October 15, and Sunday, October 16, 10am-5pm. Entrance free, sponsored by Aquarian.

AQUARIAN QUIZ *HELD AT THE MIDDLESEX SHOW (3 July)*

Thanks to everyone who took part in this fun quiz. The first three correct answers drawn from the box were:

1st: Dave Lawrie, Southend, Leigh DAS 2nd: John Egan, Port Talbot AS
3rd: Nigel Attewell, Reigate and Redhill AS.

The winning prizes included the RENA iI internal filter (plus a RENA air pump for 1st and 2nd places), pots of AQUARIAN flake foods, and bottles of API's LeafZone product and Pimafix (Pimafix is the new herbal-based fungus remedy).

Printed below are the quiz questions, should you wish to have a go yourself. The answers will be printed in the next issue. Once you have got the 12 questions correct, you should be able to rearrange the first letter of each answer to form the first name of a well-known aquarium fish.

1. Popular livebearing fish, the males of which have an extension to the lower tail fin (9 letters).

Answer_____

2. From which country does the zebra danio originate? (5 letters)

Answer_____

3. Dr Ford is famous for developing AQUARIAN fish foods. What is his first name? (5 letters)

Answer_____

4. Scientific name of the fish louse parasite (7 letters)

Answer_____

5. Aspect of water quality measured by GH and KH (8 letters).

Answer_____

6. The harlequin and the scissortail are both a type of ..... ? (7 letters)

Answer_____

7. Toxic waste product excreted by fish (7 letters).

Answer_____

8. Buoyancy organ in fish (11 letters).

Answer_____

9. Name the new herbal-based fungus remedy from Aquarium Pharmaceuticals (7 letters):

Answer_____

10. Name of the dark fluid released by octopus and squid (3 letters)

Answer_____

11. Common name for the cotton wool - like growths caused by Saprolgenia (6 letters)

Answer_____

12. Florida home of the Pygmy sunfish (10 letters)

Answer_____

Now write down the FIRST letter of each answer here (= 12 letters):

_____

Assuming you have the right answers, you should be able to arrange the 12 letters above to form the common name of a well known aquarium fish (clue: the name is 8 and 4 letters):

_____

FISH BIOLOGY - SENSES

From the Tetra Club Website - January 2002

Just like other animals, fish have a well developed set of senses to enable them to survive in their environment. The range of senses and their capabilities vary between different types of fish but they generally include hearing, taste, smell, vision, touch, and, in some fish, electroreception and magnetic reception.

Mechanoreception

The process of hearing in fish is generally referred to as mechanoreception, meaning the physical detection of pressure waves in the water. This is because sound travels through water as waves of pressure and fish have developed different methods of picking this up.

The inner ear of fish is the principal organ involved in sound detection, although it also provides the fish with information regarding it's orientation and position in the water. Chambers within the ear contain structures called otoliths and are lined with sensory hair cells. Because most of the fish's body is the same density as the surrounding water, sound waves will generally travel through it without being detected. However, the otoliths are more dense than the rest of the fish's tissues and when sound waves hit them they vibrate at a different rate to the other tissues. This difference in vibration frequency is picked up by the sensory cells, causing them to fire off nervous signals to the brain. Hence the principal behind sound detection in fish.

In addition to the otoliths, the swimbladder also vibrates at a different frequency to the rest of the body, as it is filled with gas. Many freshwater fishes, including tetras, barbs, carp, loach and catfish, have a series of specially modified back bones that connect the swimbladder to the inner ear. This increases their sensitivity to sound. This series of bones are called the Weberian ossicles. The elephant fishes of Africa have gone one step further and actually have a gas bubble in their head which connects to the inner ear and improves hearing.

Further mechanoreception, or 'hearing', is achieved through the lateral line system. This consists of a series of sensory pits running along the flanks and around the head, which are lined with sensory hair cells. Water displacement around the fish, caused by prey items or predators for instance, causes the sensory hairs to move, triggering nervous signals to be sent to the brain.

The combination of these structures, sometimes referred to as the acousto-lateralis system, enables fish to efficiently pick up pressure waves caused by sound and movement. This helps them to avoid predators, capture prey and navigate around obstacles.

Vision

The eyes of fish are similar in structure to other land-dwelling animals. Light passes through a cornea and is focused on the retina by a lens. Just like us, certain fish (e.g. plecostomus) use an iris to control the amount of light entering the eye. Other fish simply alter the position of the light absorbing cells in the retina. Some fish (e.g. sturgeon and sharks) also have a 'tapetum lucidum', which consists of a layer of reflective crystals at the back of the eye that help to enhance vision in dim light.

Light is absorbed in the retina by light absorbing cells called photoreceptors, which then pass messages along the optic nerve to the brain. There are two types of photoreceptor found in fish, called 'cones' and 'rods'. Rods are good at absorbing light in dimly light conditions and are therefore predominant in fish that hunt at night or that live in areas where light is scarce, e.g. in the depths of the sea. Cones are used for absorbing bright light and can distinguish colours. There are four types of cone cell, each one specialised for detecting different colours namely red, green, blue and ultra-violet. Fish that feed during the day and rely on vision for finding food tend to have the best colour vision.

Because the eye requires a lot of energy for functioning properly, many species have a special 'choroid' gland surrounding the optic nerve which serves to supply extra oxygen to it. This gland receives oxygen from the 'pseudobranch', a special gill-like structure on the inside of the gill covers.

There are a multitude of different specialisations and adaptations amongst the eyes of fish species, which serve to give a particular fish the best chance of surviving in its natural habitat. Perhaps one of the strangest eyes belongs to the four-eyed fish, *Anableps anableps*, from South America. Each of its two eyes is effectively divided in two, with two pupils and a retina split in halve. This allows it to float at the water's surface, with its eyes half submerged, and see above and below the water at the same time.

Chemoreception

Chemoreception refers to the detection of chemical signals in the water through smell and taste. The distinction between the two is a little vague in aquatic environments as all chemical signals tend to be carried in the water in much the same way.

Fish have structures called 'nares' on the front of their heads which are basically openings leading into two nasal sacs, one on each side of the head. They may have one or two nares for each nasal sac. Unlike our nostrils, in most species the nasal sacs do not lead to the throat and cannot be used for breathing. Instead, they are lined with a highly folded sensory surface, or 'epithelium', which is covered in cells that are receptive to various chemical signals. These signals are drawn into the nostrils as molecules which then

attach to the receptor cells, causing signals to be sent to the brain. Smell is not just used to detect food, but also for finding mates and in some cases for navigation. Salmon have such a good sense of smell that after going to sea to feed and grow they can home in on the river in which they were born just by its unique "odour".

Fish "taste" food in the water through special taste buds in the mouth, throat, gill arches, gill rakers, barbels and fins. Some catfish even have taste buds all over their bodies. The taste buds are coated with "gustatory" sensory cells that can pick up molecules in the water in a similar way to the nasal sacs, causing messages to be sent to the brain.

Electroreception

All living things emit very weak electrical fields, through muscle movements such as the beating of the heart. In addition, aquatic organisms create very weak electrical fields caused by the difference in the concentration of ions (salts) between their body tissues and the surrounding water.

Many fish have the ability to detect these weak electrical fields, using the information to help them locate prey. Species such as sharks, rays, sturgeon and catfish are able to pick up these weak signals, using special electroreceptive organs. When they encounter an electric field it changes the rate at which calcium ions pass over the membranes of the cells in these organs, stimulating nervous signals to the brain.

More developed electroreceptive fish can actually generate their own specific electric field and use it for navigation, communication, prey capture and so on. As these species, which include the knife-fishes and elephant fishes, move through the water they get information about their environment sent back to them via disturbances in their electric field. This gives them a particular advantage when navigating murky waters.

Magnetic reception

Certain species of fish appear to be able to detect magnetic fields to help them navigate. There are two ways in which they are able to do this. Sharks and some other electroreceptive fish can detect such weak electrical signals that they could theoretically pick up changes in electric fields caused by their movement through the earth's magnetic field. Others, such as some salmon and tuna, appear to be able to directly detect the earth's magnetic field and magnetite has been found in the brains of some of these species.

It is clear that fish have an armoury of senses that allow them to be supremely adapted to the environments in which they live. It is quite impressive to consider all of the environmental signals being picked up and processed by our fish as they go about their day to day lives in our tanks and ponds.