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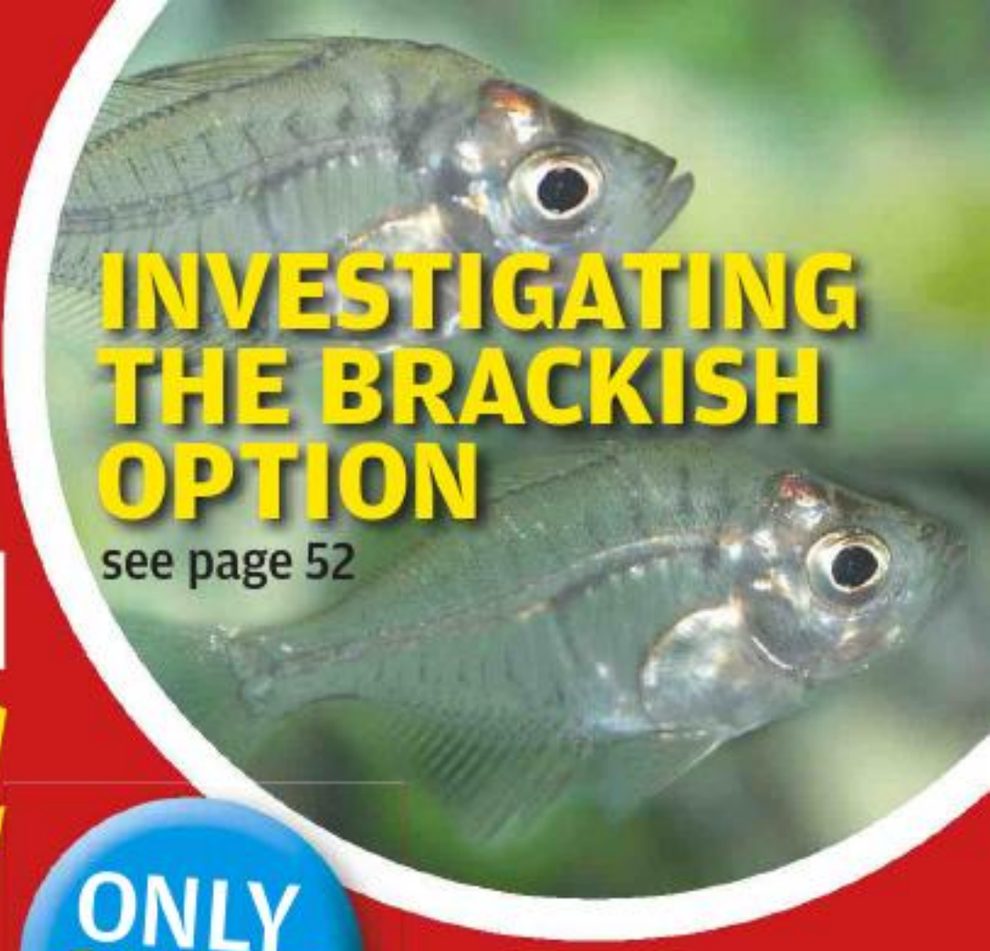

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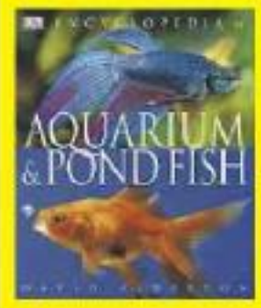
hello

Welcome to the latest issue of *Popular Fish Keeping*! It is now only a few weeks until the elections for the European Parliament, with the UK voting on 22nd May. In all honesty, I would guess that this probably isn't a date encircled in your diary, unless you're something of political diehard. Barely one in three of us who are entitled to vote make it to the polls to elect our Euro MPs, which is considerably below the European average.

"So what?" you may say. "It doesn't make any difference to me, and I've got other, more significant things in my life, like fish keeping." Unfortunately though, that may not be the case, if the Eurogroup for Animals has its way. This powerful Brussels-based organisation is currently seeking to persuade prospective Members of the European Parliament (MEPs) to sign up to a series of pledges.



David has kept fish for many years, and his books include the *Encyclopaedia of Aquarium & Pond Fish* (Dorling Kindersley, £16.99) - a comprehensive guide to the care of over 800 species. His website can be found at www.petinfoclub.com

Keith Davenport, of the Ornamental Aquatic Trade Association (OATA), is warning that keeping fish and other aquatic creatures, plus all other types of pets (apart from cats and dogs) could be under threat if Eurogroup is successful in its #votes4animals lobbying campaign in the run-up to the European elections.

OATA – which is lobbying MEPs to make sure they hear the other side of the argument – is also calling on people power to help to stand up for pet keeping. They are urging everyone with pets that fall within Eurogroup's definition to support OATA's #handsoffmyhobby campaign.

"We think it's time that the more representative views of the millions of people who enjoy keeping fish, birds and other pets right across Europe should also be brought to the attention of prospective MEPs," explains Keith.

Please, get involved and help to build the case. We've listed what you can do here.

HOW YOU CAN HELP

Contact MEPs who have already signed up to the Eurogroup for Animals' manifesto to let them know how much you enjoy your hobby and what it means to you, and ask why they support this document. Explain that you are unlikely to vote for them as a result. You can find the details of those British MEPs who have signed up to the Eurogroup for Animals' pledge at www.ornamentalfish.org/hands-off-my-hobby

Contact candidates for the European Parliament in your area to let them know about the #handsoffourhobby campaign and why you support this initiative. You can find the contact details of your local MEP at www.europarl.org.uk/en/home.html

Like OATA's Facebook page, follow them on Twitter or follow their LinkedIn page to keep up-to-date with the latest news on this campaign – and share updates with your pet-keeping friends across groups, forums and communities. This is really important, to get the message behind this threat out there, both to fellow enthusiasts in the UK and in other EU countries too.

Use the #handsoffmyhobby hashtag on Facebook, Twitter and Google+ to share what a ban would mean to you.

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SEE PAGE 36

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David Alderton, Editor
pf.ed@kelsey.co.uk

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Summer 2014

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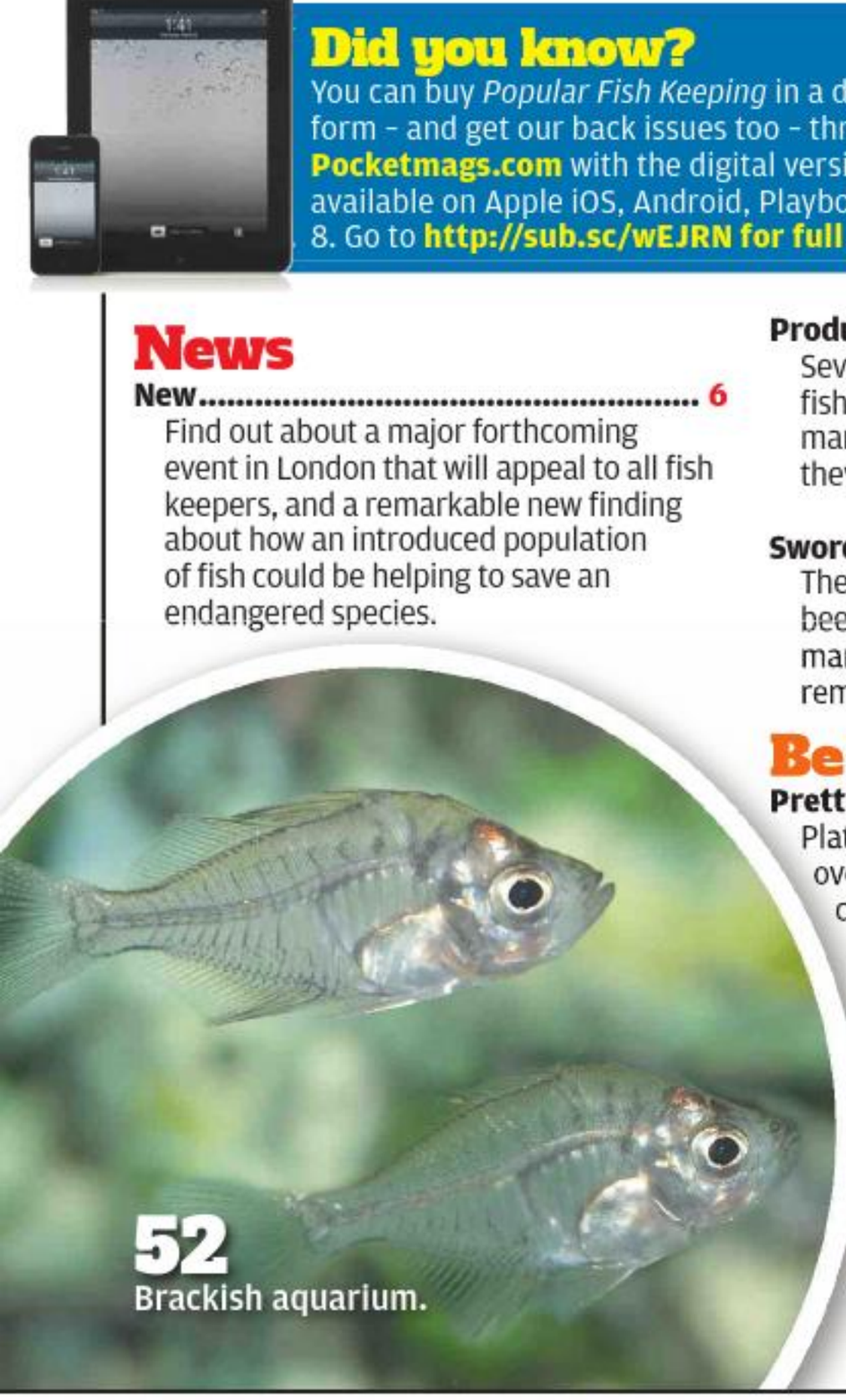
You can buy *Popular Fish Keeping* in a digital form – and get our back issues too – through **Pocketmags.com** with the digital version being available on Apple iOS, Android, Playbook and Windows 8. Go to **http://sub.sc/wEJRN for full details**.

News



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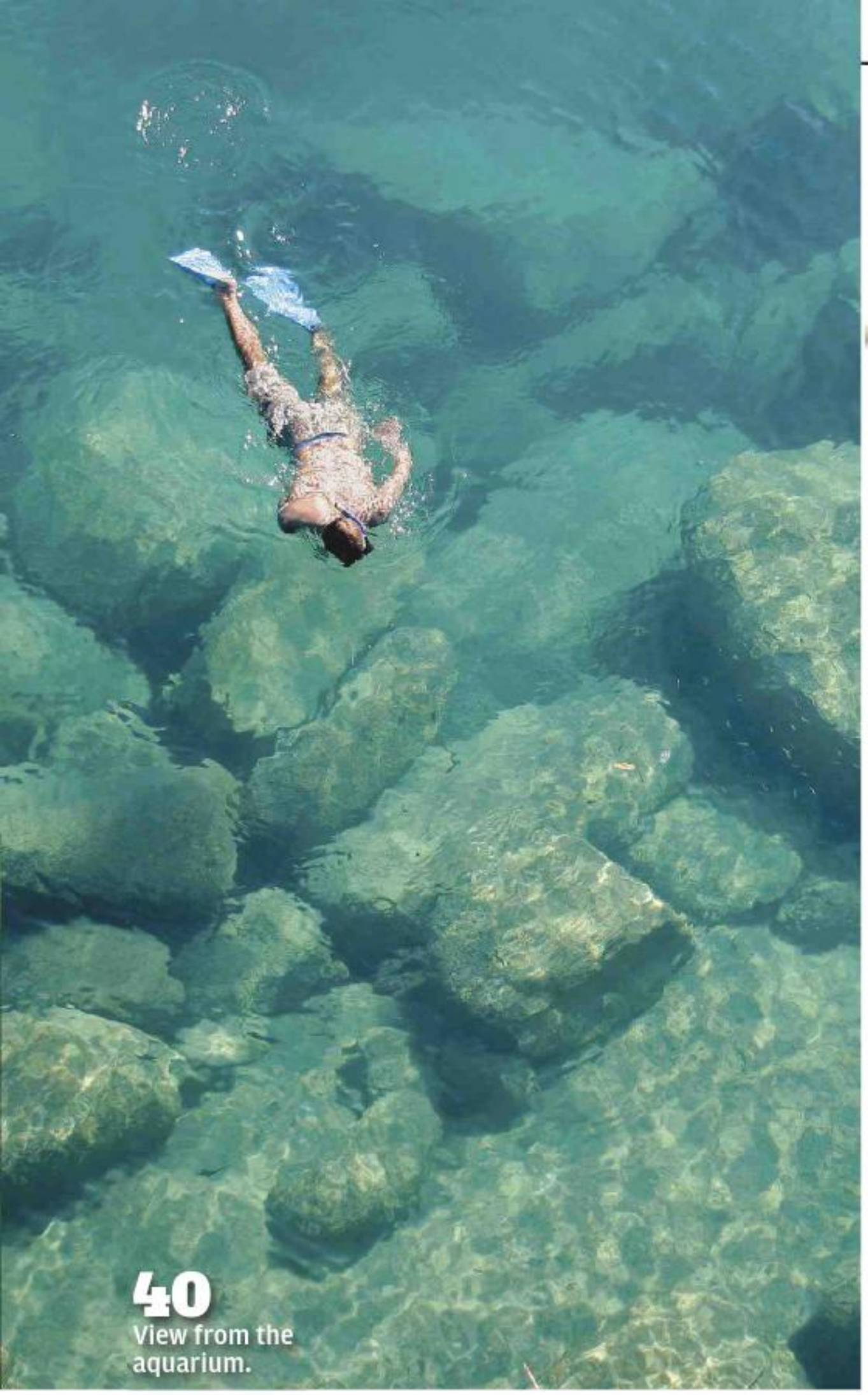

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News & views

Keep up-to-date with events in the world of aquatics.

Share your views and opinions by Emailing us: pf.ed@kelsey.co.uk

Head to the London Pet Show for a fun-filled day out with the fish!

From starting your first aquarium to those looking for more in-depth information, the London Pet Show, sponsored by MyPetonline, features beautiful fish and aquatic set ups and information for fish keepers of all levels of experience.

Fluval, the world leader in quality aquatic products and sponsors of the Discover Aquatics & Reptiles zone, will be displaying a wide array of colourful and eye-catching fish housed in their beautiful aquarium surroundings as well as a sneak peak at some of the brand's new products.

Their display will lead you through a perfect recreation of the wild environment of a fish, as the aquarium splits into three wild biotope areas. Marvel at the Malawian tank, full of cichlids, be amazed at the Amazonian stream and watch piranhas prowl the Brackish Mangrove are of the display as you learn more about these habitats and inhabitants.

The modern Fluval Fresh and Reef aquariums will be on display as well, full of bright and colourful species. Have a go at spotting 'Nemo' the clown fish in the reef environment or some of his fishy friends.

If you are just starting out, the colourful Betta splendens, better known simply as the betta or Siamese fighting fish, will be on display in the brand new Marina Betta Kit. These fish are full of character, style and fun and an excellent pet choice for people who have little to no prior experience with fish or aquariums, as long as they are kept away from their own kind.

You can also check out the breeding area, where members of the Federation of British Aquatic Societies will talk you through how fish breed, and how the process takes place. Keep your eyes open and you may even catch a glimpse of fish fry hatching before your eyes!

And if you want to try your hand at aquascaping an aquarium, why not try the Fluval aquascaping challenge in association with the UK Aquatic Plant Society, for your chance to win a prize!

With other amazing attractions including presentations by TV presenters Steve Backshall and Chris Packham, the SuperDogs Live show, hosted by Ben Fogle, rabbit show jumping, magnificent displays of parrots and birds of prey and racing micro pigs, London Pet Show offers a fun and educational Spring day out and you will leave inspired, with everything you need to give your pet the best care possible.

GETTING THERE

The venue is served by excellent transport links and is easily accessible by tube, bus, car or train, offering with straightforward connections to various mainline stations.

By tube

Nearest stations: Earls Court (Piccadilly and District lines) and West Brompton (District line). Earls Court One is directly opposite Earls Court Station on Warwick Road (Exhibition exit) which is on the District line.

By national rail

Nearest station: West Brompton. Southern trains run direct services to West Brompton station. Direct services run from Clapham Junction, Gatwick Airport, East Croydon, Watford Junction, Willesden Junction and Stratford.

By bus

Nearest stops: Warwick Road (for Earls Court One): 74, 328, C1, C3.

By car

From M1/A1/M11/ A10, take the A406 westbound to A4. Continue on A4 over Hammersmith Flyover until A4 becomes West Cromwell Road and follow signs.

From M4/A4, follow directions as above.

From A3/M3, follow signs for central London, take Wandsworth or Putney Bridges.

From Wandsworth Bridge, turn left onto New Kings Road, turn right onto Fulham High Street, which becomes Fulham Palace Road, turn right onto Lillie Road and follow signs.

From Putney Bridge, turn left onto Fulham Palace Road and follow directions as above.

From M2/M20/ A2, follow signs to central London, take Blackfriars, London, Waterloo, Vauxhall, Southwark, Chelsea or Battersea Bridges, turn left along Embankment and follow signs.

From A12/A13, follow signs for central London towards Tower or London Bridge. Do not cross the bridge, but instead, continue along Embankment and follow the signs.

At a glance

When: 9.30am-5.00pm, Saturday 17th and Sunday 18th May 2014.

Where: Earls Court One, Warwick Road, Earls Court, London SW5 9TA.

Admission: Advance ticket costs: Children £12 (under 5s go free), adults £17, seniors £14, family £54. Visit the website at: www.londonpetshow.co.uk or call 0844 873 7332 and quote FURRY for 10% off.

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A remarkable new relationship

In areas where they are present, these small American fish can multiply rapidly and reach large numbers. *PHOTO COURTESY HUNTER DESPORTES.*

Scientists investigating the plight of the now critically endangered long-fingered bat (Myotis capaccinii) have made an amazing and totally unexpected discovery, involving fish. Ostaizka Aizpurua-Arrieta is a researcher in the Ecology and Behaviour Evolution group of the UPV/EHU-University of the Basque Country in northern Spain.

During a routine study into the habits of this bat, the researchers found scales in the droppings of one colony. "That detail drew our attention, because until then the species had been thought to be insectivorous, eating only insects," recalls Ostaizka.

Many questions were prompted by those scales: did these fish represent an unusual part of the diet of long-fingered bats, or were they hunted regularly on a routine basis? Ostaizka Aizpurua and the UPV/EHU research group began to seek answers to these questions.

ABOVE The team at work, preparing for the bats to start fishing as darkness falls. *PHOTO COURTESY JAKE ABOTT.*

Changing behaviour?

"It was a special challenge for me because we didn't think fishing was among the habits of the long-fingered bat," she explains. "Bats normally hunt by echolocation; but that means they can't detect what's under the water, because the surface reflects the sound waves emitted. Also, the long-fingered bat is very small; it weighs no more than 10g (0.3oz) and that is another reason why it is difficult to imagine it fishing.

But could this represent a change in behaviour by the bats? "You have to remember that the whole of the Mediterranean has undergone significant changes in recent years and these changes have had an effect on the bat population. The science of phenology looks at how the seasons and climate influence living creatures, and we suspected that these factors could have been significant in the case of these particular bats."

Specifically, according to one of the hypotheses put forward by the researchers, the bats probably came to take advantage of the large concentration of fish that had accumulated in the small ponds in the area during the dry seasons, and this had encouraged them to start fishing.

Which fish?

So the scientists gathered samples of the droppings from a bat colony in Denia (Alicante) for a period of two years, to see whether remains of more scales appeared, and at what point this happened. As a result of these findings, they reached the conclusion that eating fish was not an isolated occurrence in long-fingered bats and also, that this consumption was not linked to a specific season. "Although the fish remains were more abundant in August and September, we found remains throughout the year," adds Ostaizka Aizpurua.

Apart from the scales, they also studied the fish's otoliths. "Otoliths are a type of small bone in the ear; they are specific to each species, and that is why they are used to identify species," Ostaizka explains. The study of the otoliths enabled them to reach the conclusion that the fish consumed by the long-fingered bats are eastern mosquitofish (*Gambusia holbrooki*).

This is an exotic species. It is an insectivore and was introduced into the Mediterranean region during the 1920s to tackle the plagues of insects. Eastern mosquitofish were also more widely introduced around the world at that stage in the hope of controlling malaria. The plan was that they would eat the developing mosquitos, but they proved to be less effective in this role than had been hoped.

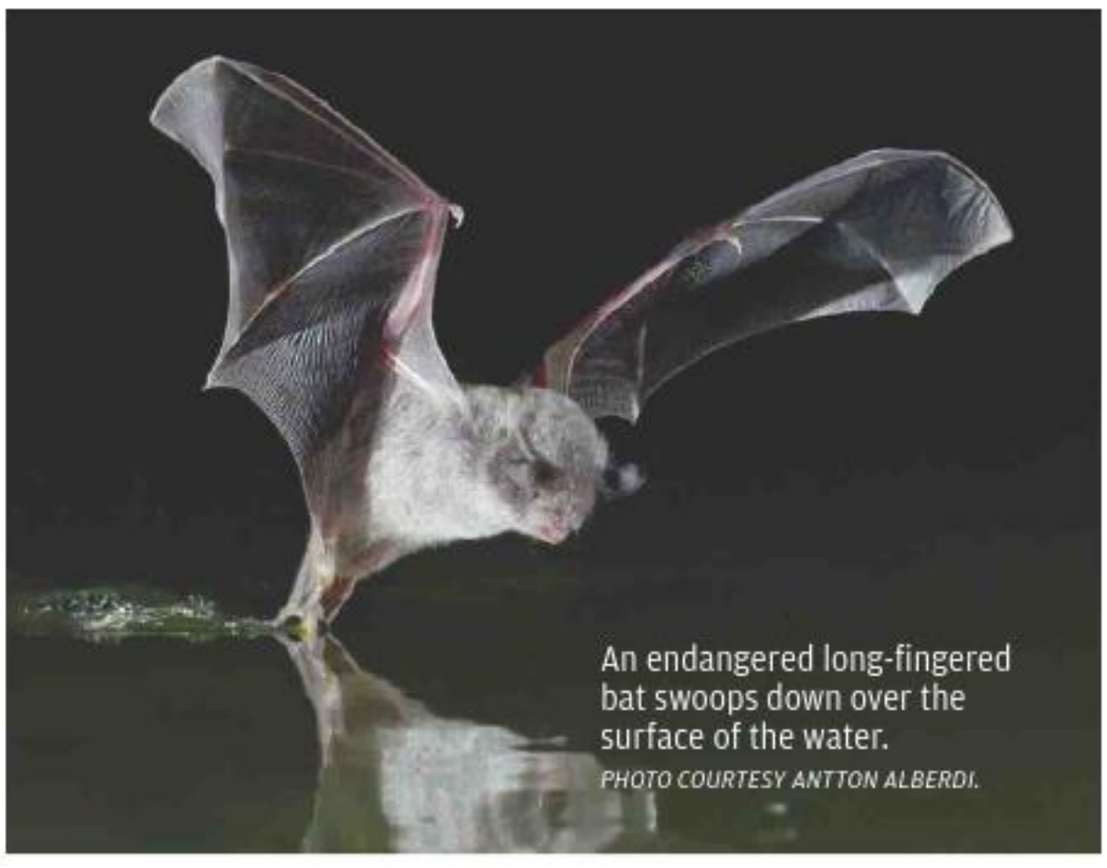
Today, the eastern mosquitofish features as one of the one hundred most important invasive species on the peninsula. The researchers also measured the individual fish eaten by the bats. They found that the bats chose the smallest fish from those that they had available, presumably as these were easier for them to lift out of the water.

Caught on camera

Finally, to confirm their findings, the scientists managed to film the bats while they were actually fishing: "We fitted radio transmitters to the four bats that had the most fish remains in their droppings; that enabled us to see exactly where they fished. It was a large pond with a great density of fish. On the next occasion, we had the video camera set up and we filmed them while they were fishing," says Ostaizka Aizpurua.

There are still intriguing questions that the team of researchers have not yet been able to answer, such as, for example, whether the bats used to fish before the eastern mosquitofish was introduced and, if so, what species they consumed. But Aizpurua and her colleagues have at least now demonstrated that the long-fingered bat is capable of fishing and that it is not an unusual activity for the members of a colony.

With such a plentiful supply of food available, at least this gives hope for the future survival of these endangered bats. The relationship between these bats and the introduced mosquitofish shows just how remarkably adaptable nature can prove to be on occasions!



An endangered long-fingered bat swoops down over the surface of the water. *PHOTO COURTESY ANTTON ALBERDI.*

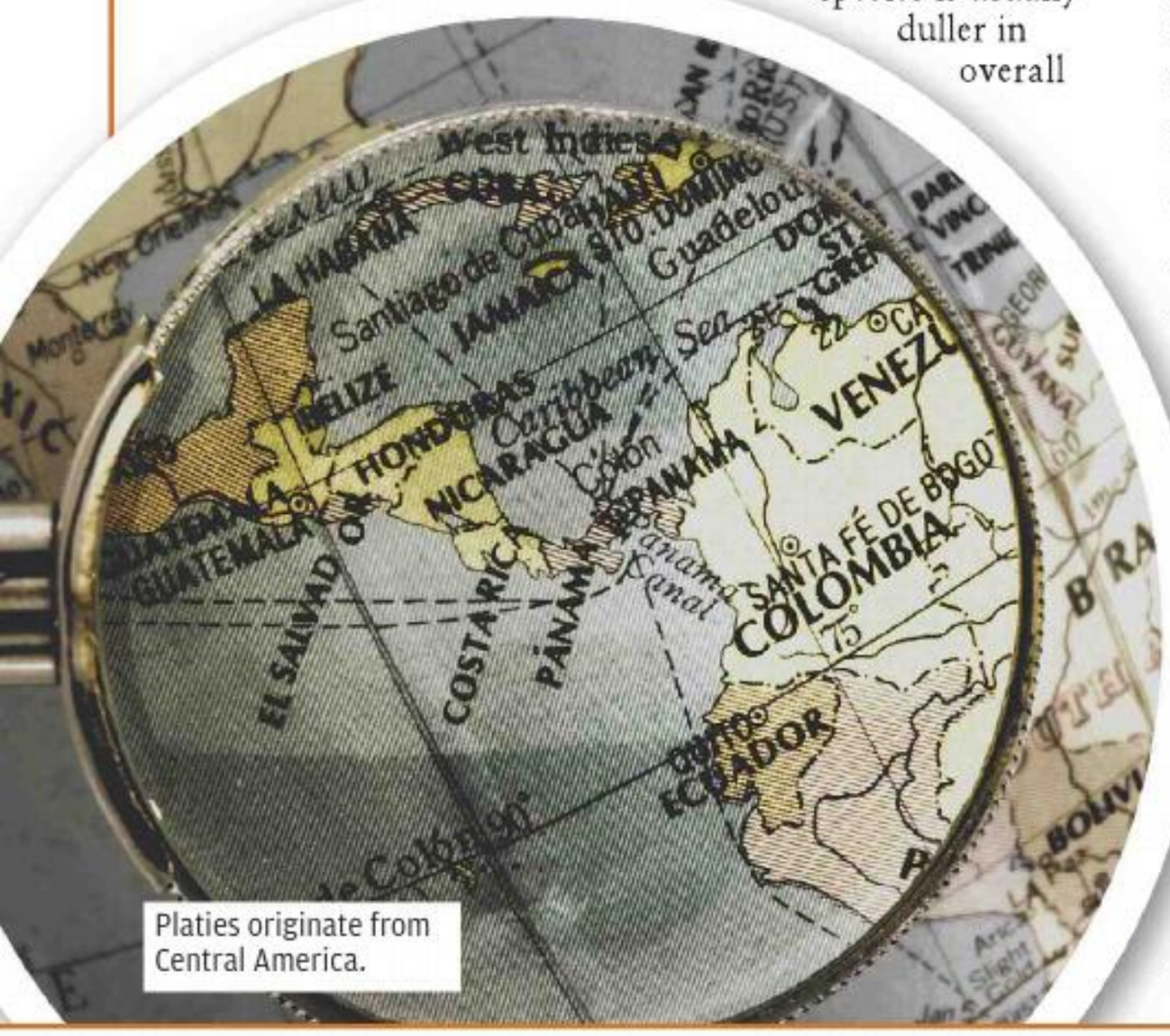
FURTHER INFORMATION

Ostaizka Aizpurua, Inazio Garin, Antton Alberdi, Egoitz Salsamendi, Hans Baagøe, Joxerra Aihartza. **Fishing Long-Fingered Bats (*Myotis capaccinii*) Prey Regularly upon Exotic Fish.** PLoS ONE, 2013; 8 (11): e80163 DOI:10.1371/journal.pone.0080163

Pretty platies

Platies always seem to be rather overlooked, as far as livebearers are concerned, but they are attractive, easy to keep and available in a stunning array of colours. They are ideal to enliven a community aquarium, and offer great scope for the specialist breeder, as **Don Harper** explains.

There are two recognised species of platy as far as the aquarium hobby is concerned, both of which are found in central America. The platy (*Xiphophorus maculatus*) itself originates from southern Mexico, extending southwards to parts of Guatemala and Honduras along the Atlantic side of the peninsula. Individual populations may display considerable variation in appearance through this extensive range.



Platies originate from Central America.

The potential

The wild form of this species is usually duller in overall appearance than today's domesticated strains, generally being olive-brown in colour. Populations can be very localised however, and are often distinctly coloured. A naturally occurring red population of platies is known to exist in the Rio Coatzacoalcos in Mexico as an example, and there is also a neighbouring but different greyish-brown population living in the same river, which flows into the Gulf of Mexico.

These different colours from the wild provide a hint of what has since been achieved by breeders. In any population though, it is usually possible to recognise the males at a glance, because they are typically more brightly coloured.

Platies rank amongst one of the earliest fish kept by pioneering fish keepers back in the late 1800s. There are even records of them being brought back to America on a boat that set sail from Germany in 1899. They were transported in cans, with the water being changed regularly, to ensure that they arrived safely at their destination several weeks later.

Colours and varieties

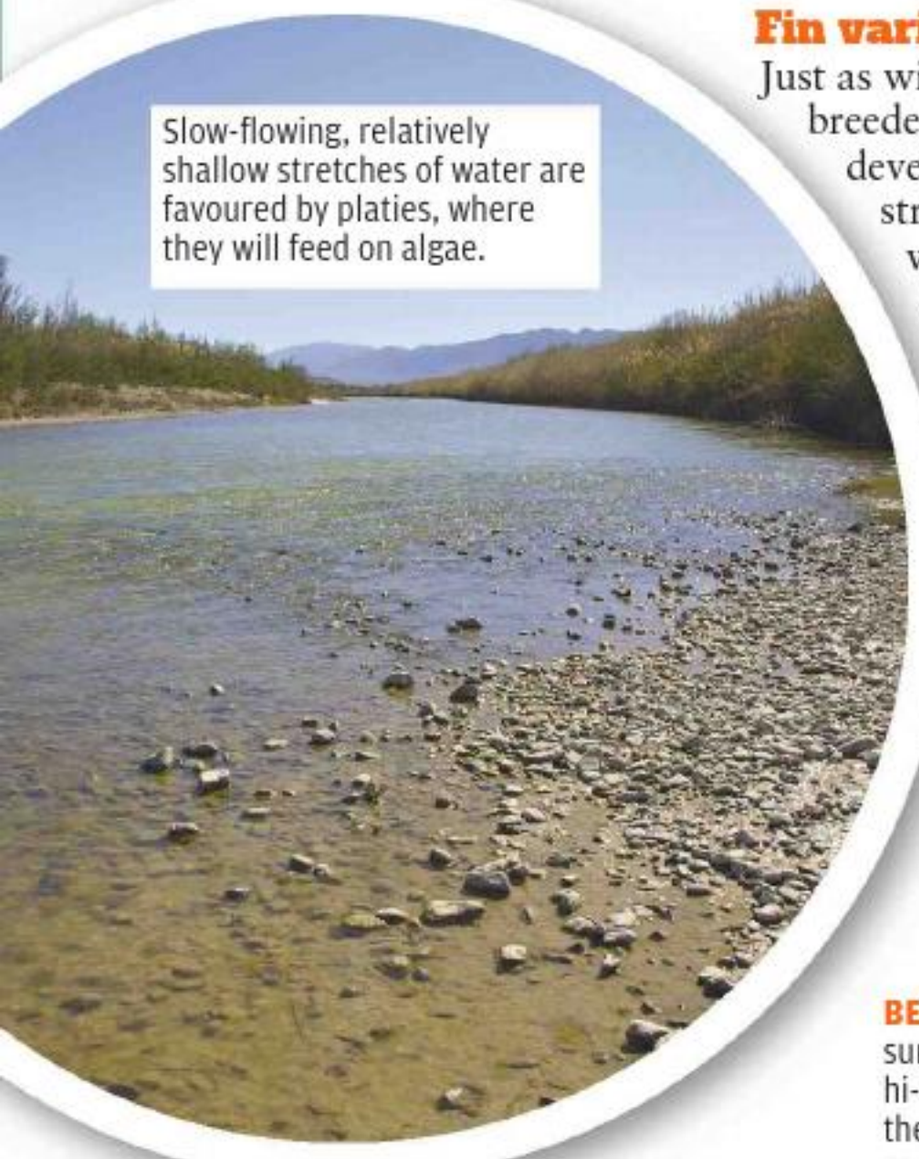
Subsequently, when the new yellowish variety grabbed the imagination of fish keepers, platies acquired the name of moonfish, which is still used by some people to describe them today. Shades of red, orange and yellow still remain popular as well, although, the range of options has grown dramatically. There are now more than 30 recognised varieties of ornamental platy. The basic colours range from white through yellow and red to blue and green, with or without black patterning.

Amongst the distinctive forms are the tuxedo platies, with black colouring on the lower part of the body, offset against coloured areas elsewhere. Then there is the wagtail group too, with a dark mouth and fins, contrasting with a brighter, often reddish

body colour. One of the most unusual patterned forms is the so-called Mickey Mouse, named after the popular cartoon character. The distinguishing feature in this case is the presence of two dark markings, evident top and bottom of the caudal peduncle (the area that connects with the tail or caudal fin). These are said to resemble Mickey Mouse's ears, while in front, there is another distinct, dark area that could be likened to his head, in the case of a well-marked specimen. Other patterns are easier to explain, such as the Dalmatian, named after the popular dog of that name and displaying variable black spotting on a white background.

A red-backed golden Mickey Mouse platy. *PHOTO COURTESY PHOTOMAX AT THE GOLDFISH BOWL.*

A hi-fin golden moon Mickey Mouse platy. *PHOTO COURTESY PHOTOMAX AT THE GOLDFISH BOWL.*



Slow-flowing, relatively shallow stretches of water are favoured by platies, where they will feed on algae.

Fin variants

Just as with other livebearers, breeders concentrate on developing particular strains of these fish, when it comes to establishing colours and patterns, and these can be combined with other characteristics. There are also some variations in terms of fin shape for example, most notably perhaps hi-finned varieties, where the dorsal fin on the back is elongated in appearance.

Display considerations

There is a wide range of colours now established in the case of domesticated platies, leaving aside the popular red variety, which is still stunning and has retained its popularity. Take care with choosing the substrate when keeping these fish though, because the impact of their colouration can be lost to some extent if you chose a single coloured gravel such as red or white. It will be better in this instance to use a neutral colour, such as natural gravel.

Although it obviously again a matter of personal preference, the overall impact in the tank can be more striking if you select a group of platies of the same colour, rather than picking individual fish of many different colours. This tends not to result in the desired rainbow effect.

Cross-breeding

The platies that you see for sale in aquatic outlets today are unlikely to be simple descendants of the ordinary platy though. This is because over the years, these fish have been hybridised with the closely related variegated platy (*X. variatus*), whose distribution is restricted to southern Mexico. It looks quite similar, but is bigger, and has a more elongated body. There has also been some past hybridisation with swordtails (*X. helleri*), to which platies are closely related.

There are the typical differences in size between the sexes, as is the case with other widely-kept members of their family Poecilidae, such as Guppies (*Poecilia reticulata*). Females can grow to nearly 3in (7.5cm), with males

CONTINUES ON THE NEXT PAGE »

BELOW A male sunset marigold hi-fin platy. Note the shape of the anal fin.

Platies are easy to cater for, eating a wide variety of foods.
PHOTO COURTESY MARRABBIO2.

A hi-fin green platy.
PHOTO COURTESY PHOTOMAX AT THE GOLDFISH BOWL.

reaching about half this length.

As a further point of distinction, males also possess a modified anal fin, which has a rod-like appearance, and serves as a copulatory organ during mating.

Fertilisation in this case is internal, with the female platy producing live young in due course, rather than eggs. These simply develop in the relative safety of her body, rather than forming any placental attachment here.

Lifestyle

In the wild, platies favour quiet, slow-moving surroundings, rather than fast-flowing stretches of water. They are also more likely to be encountered in the shallows, sometimes in marshy areas where the water level can be as low as 5cm (2in). Living close to the Equator, this therefore means that the habitat where these fish are likely to be found warms up very quickly indeed during the day under the hot sun, and can easily top 30°C (86°F) or more.

Although quite adaptable, and certainly suited to a community-style of tank, platies do appreciate a slightly higher water temperature, averaging around 25°C (77°F), which may mean a slight adjustment to a pre-set heaterstat. Platies are not aggressive fish, either if kept in a group on their own or as part of a mixed collection. Their feeding is also very straightforward and they are well-equipped to eat a quality flake food, thanks to their upwardly directed jaws. Nevertheless, variety in their diet is to be recommended, as

A wagtail tiger stripe platy.
PHOTO COURTESY PHOTOMAX AT THE GOLDFISH BOWL.

they are omnivorous nature.

Platies are instinctively inclined to feed on small insects, so dry bloodworm can be provided in small amounts as ever, and should prove to be a useful breeding conditioner. They will also browse on the algal growth that develops in the shallow stretches of water where they occur in the wild, under the bright sun. If there is no algae available in their tank therefore, occasional offerings of other types of greenfood such as blanched lettuce leaves given in small quantities can be recommended.

Breeding platies

These fish rank amongst the easiest of all aquarium fish to breed, and in fact, you are likely to find that young are produced almost routinely. Even females on their own can give birth, if they have mated previously. They are able to store the male's sperm and use this to fertilise future batches of eggs, giving rise to more offspring.

Provided that they are kept well-fed, female platies can produce broods consisting of anywhere from 20-80 fry, beginning a month after the initial mating. The number of fry appears to be influenced by the size of the female, with larger fish having correspondingly bigger broods. The frequency of mating can also have an impact. The male that most recently mated with the female is likely to have the greatest impact on the paternity of the young, but not all the young will necessarily be related to him.

A festival blue wagtail platy. *PHOTO COURTESY PHOTOMAX AT THE GOLDFISH BOWL.*

A young platy, at three days of age. It measures just 7mm (0.3in). *PHOTO COURTESY UDE.*

In a well-planted tank, provided that the adult fish are fed small amounts of food frequently, many of the young platies should survive, although there is always a risk that some will be snapped up by larger occupants in the aquarium – possibly even their own parents. Female platies do not display any sense of parental care, failing to recognise their offspring after they have been produced.

There are various methods that can be used to maximise the number of offspring from a particular brood that can be reared. These can entail moving the female once signs of developing young within her body become apparent, and keeping her on her own until she gives birth in a tank set up where the young can swim out of her reach, incorporating a suitable divider here for this purpose.

Alternatively, the young can be removed from a community tank and raised separately. They are easily reared, using a livebearer fry food, and will benefit from being offered a high quality powdered flake food as well. Brine shrimp nauplii can also be recommended, helping to ensure that the young fish have good, intensive colouration.

If you are serious about creating your own bloodlines and selectively breeding your platies, then do bear in mind that you will need far more than one tank! The sexes need to be separated while they are young, to prevent unwanted matings. This will then enable you to be certain of the parentage of particular broods in the future, which is a key part of breeding these fish selectively. You will also need a rearing tank too, and a pair of aquariums for your adult stock, so they also can be split into males and females.

The young platies will themselves be mature by the time they are about five

CONTINUES ON THE NEXT PAGE »

months of age, but females may initially produce relatively small broods. This is quite normal. The lifespan of platies can be anywhere from 3-5 years, and on occasions, even older individuals have been documented.

The genus *Xiphophorus*

There are approximately 28 different species in this genus, which includes not just platies, but swordtails too. All are confined to central America, in terms of their distribution, with the majority being found in Mexico. Their scientific name translates from the Greek literally as 'dagger bearer'. This is a reference to the appearance of the gonopodium, which is present in males of all species.

The common names of platy and swordtail may be used somewhat interchangeably, not overlooking the so-called swordtail platy (*X. xiphidium*). Some species are virtually undocumented in the aquarium hobby, including the northern platy (*X. gordoni*), which is named after Dr Myron Gordon (1899-1959), who pioneered the use of these fish in cancer research, creating pure bloodlines for this purpose in 1939, which still exist today, 75 years later. He also wrote some of the earliest information about platies for fish keeping enthusiasts as well.

Unfortunately, it is currently unclear if the platy that bears his name is still thriving, following its discovery during 1961. Its area of distribution is a hot spring, heated by underground volcanic activity, located in Santa Tecla, Mexico.

The water temperature in this locality ranges typically from around 29-36°C (85-96°F), making it considerably hotter than the waters in which most fish would be found. The water here was described as having an unmistakable sulphurous smell associated with it, being shallow in depth and choked with vegetation.

Unfortunately, the spring has subsequently been linked into a canal, and it is currently unclear if the northern platy still survives. On the other hand, there is the optimistic hope that it might have expanded its range as a result of this development. However, it is currently listed as being officially Endangered on the IUCN's Red List, with the annotation that updating on its status is required.

Coffee & ink platies. *PHOTO COURTESY PHOTOMAX AT THE GOLDFISH BOWL.*

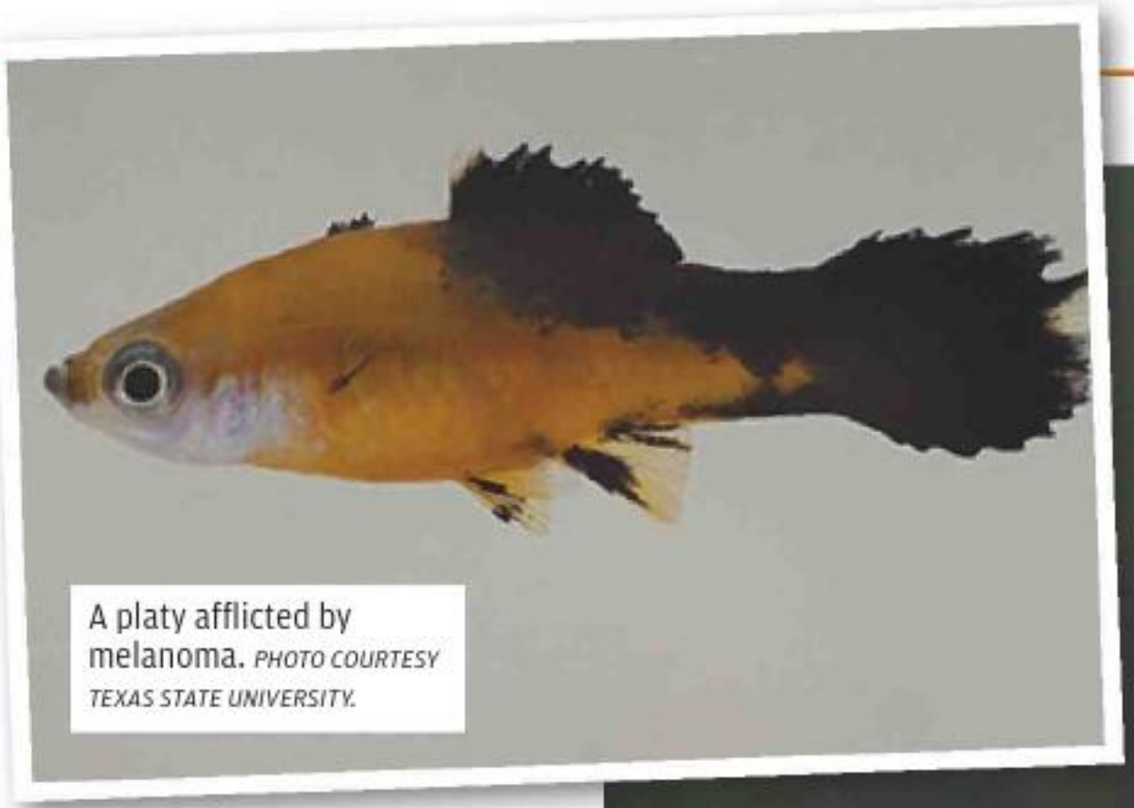
"The number of these fish surviving in the wild is now estimated to consist of no more than 250 individuals"

Spotted golden platies. *PHOTO COURTESY PHOTOMAX AT THE GOLDFISH BOWL.*

Golden green parrot platies. *PHOTO COURTESY PHOTOMAX AT THE GOLDFISH BOWL.*

On the edge

The most endangered of the platies is, however, considered to be another Mexican species, called the Monterrey platy (*Xiphophorus couchianus*). It is restricted to this area in north-east of the



A platy afflicted by melanoma. *PHOTO COURTESY TEXAS STATE UNIVERSITY.*

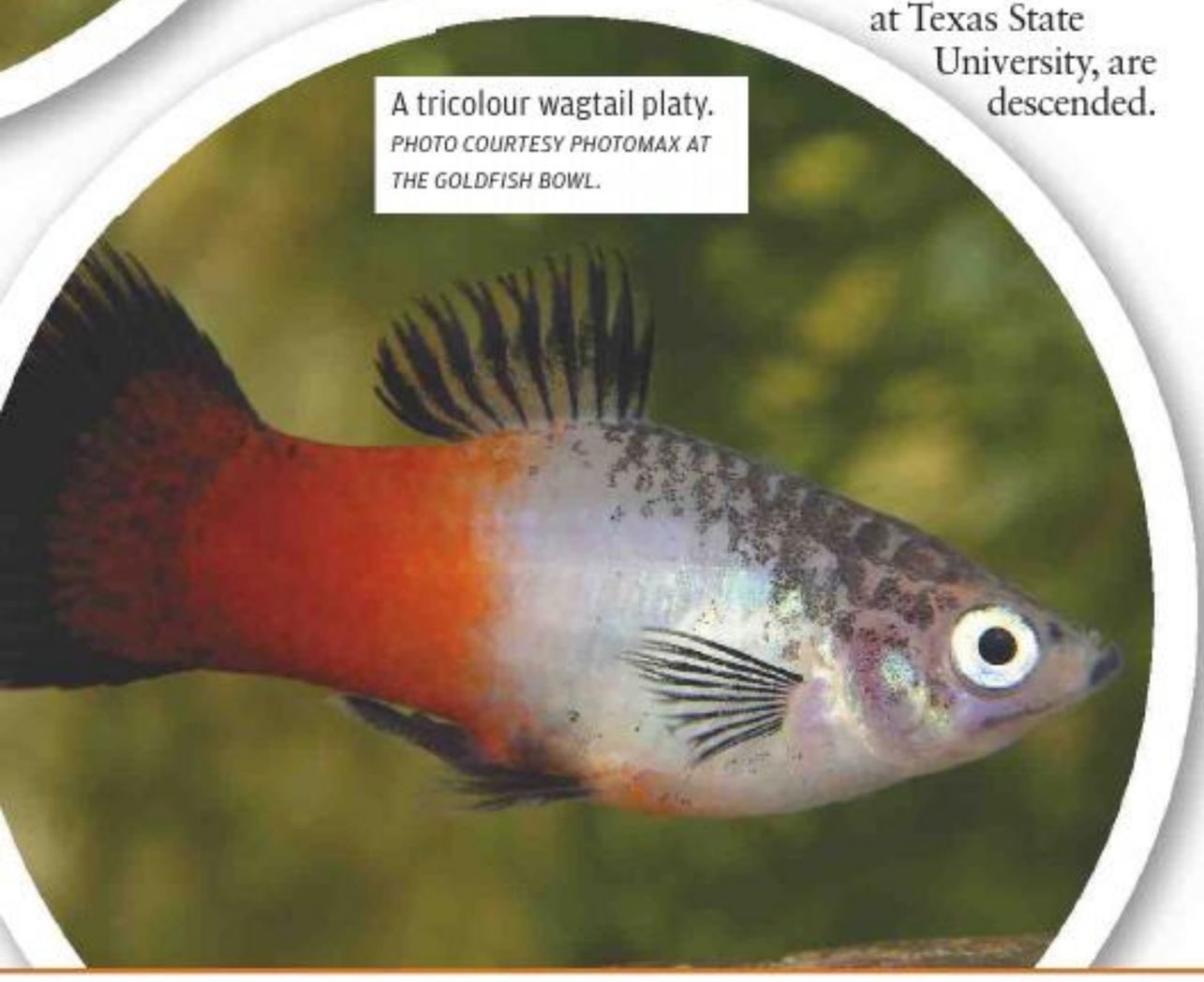
Blue colouration is evident in some platies.

country, where it is associated with the Río San Juan. Rapid development in the region has been fragmenting its remaining habitat, causing populations to become smaller and more isolated.

The number of these fish surviving in the wild is now estimated to consist of no more than 250 individuals in total. It was actually the second member of the genus to be classified, in 1859, with its name commemorating that of its discoverer, who was Major General D.N. Crouch.

As a result of its status, this particular species has been chosen as a target species by the American Livebearer Association's Species Maintenance Program. It is hoped that it will be possible to increase the captive numbers of this fish significantly, thereby ensuring its continued survival, although it has not proved to be particularly easy to keep, even in the hands of experienced enthusiasts.

Dr Myron Gordon obtained Monterrey platies on several occasions, from 1930 through until the 1950s, and a subsequent collection was made in 1961, from which today's captive strains, maintained partly at the *Xiphophorus* Genetic Stock Center (XGSC), located at Texas State University, are descended.



A tricolour wagtail platy. *PHOTO COURTESY PHOTOMAX AT THE GOLDFISH BOWL.*

DNA studies

Platies have also attracted the attention of scientists, particularly because of the fact that they are susceptible to the skin tumours known as melanomas. This form of cancer is very apparent in these fish, manifesting itself as black blotches along the tail and often affecting the fins.

As part of this work, an international team of scientists recently investigated the genome – the genetic code - of *Xiphophorus maculatus*, with a view to gaining further insights into this cancer. They found that the platy genome was made up of some 20,000 genes – roughly the same as the human genome. Yet there was a key difference too, in that the chromosomes of the platy, like those in other fish, have remained remarkably intact over some 200 million years of evolution, unlike the situation in mammals.

In spite of being livebearers, these platies have retained some genes that are normally seen in egg-laying species, and the scientists also spotted that the genes related to both egg fertilisation and placental functions were unique in some respects. Furthermore, it emerged that platies possess similar genes to mammals, which may helping to explain their social behaviours such as schooling, and their fairly complex means of communication, in terms of their breeding display as an example. Clearly however, much still remains to be learnt about these fascinating fish.

Further information

You can read about the genetic study in more detail online:
Manfred Schartl, Ronald B Walter, Yingjia Shen, Tzintzuni Garcia, Julian Catchen, Angel Amores, Ingo Braasch, Domitille Chalopin, Jean-Nicolas Volff, Klaus-Peter Lesch, Angelo Bisazza, Pat Minx, LaDeana Hillier, Richard K Wilson, Susan Fuerstenberg, Jeffrey Boore, Steve Searle, John H Postlethwait, Wesley C Warren. **The genome of the platyfish, *Xiphophorus maculatus*, provides insights into evolutionary adaptation and several complex traits.** *Nature Genetics*, 2013; DOI: 10.1038/ng.2604

LIGHTING FOR PLANTS

Keen aquarium keeper and professional lighting expert **John Courteney-Smith**, who works for Arcadia, explains what you need to consider, when it comes to setting up a successful planted aquarium.

Paler arowanas can develop a noticeable tan.

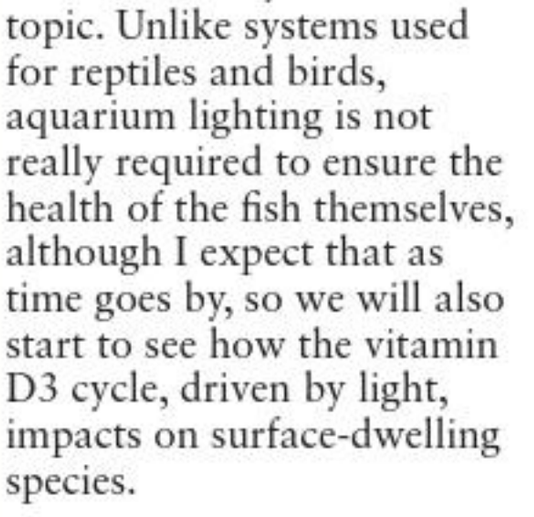
The correct provision of light for aquariums is still a very controversial topic. Unlike systems used for reptiles and birds, aquarium lighting is not really required to ensure the health of the fish themselves, although I expect that as time goes by, so we will also start to see how the vitamin D3 cycle, driven by light, impacts on surface-dwelling species.

New discoveries

We already know that some fish like the Asian arowana (*Scleropages formosus*), which is widely kept as a symbol of good fortune in that part of the world, can develop a natural tan in the wild. Furthermore, these large and highly distinctive fish have a modified form of tetrachromatic vision. This means they can see ultraviolet light, which provides them with more sensitive colour vision, as well as enabling them to find food and, of course, basking areas.

I anticipate that discoveries like this will continue to hit the aquatic news quite frequently, now that we are starting to understand the sun and its effects on life in general much better. But if light is not essential to sustaining life in most aquariums accommodating tropical fish, then what use does it have in our aquariums and why is there so much choice of lighting in aquatic shops now?

Firstly, there is the obvious answer. We want to see our fish in the best possible light! Good lighting can also help to highlight health problems in fish as well. It is worth bearing in mind that there are massive differences between standard household lamps and those that are produced for aquariums.



LEFT Snails and shrimp can both have vital roles to play in an aquarium, but check they are suitable. Photo courtesy Lucas Witte-Vermeulen/Sharnbrook Shrimp.

Different technologies

Household lamps are fundamentally designed to light a room and there is a huge variety of colours and colour variations of these lamps on the market today. Aquatic lamps, however, have to have a lot more thought put into their design, taking into account the lighting spectrum.

Firstly, manufacturers in this field need to be able to produce a lamp that not only shows off the colours of tropical fish in the best possible way, but also, at the same time, will not encourage nuisance algae growth. If you have ever used a household lamp over an aquarium, you will notice that fine brown algae will grow very quickly.

Aquatic lamps should be produced with the same guarantee of quality as associated with those sold for reptiles, and unfortunately, there is no single "wonder lamp" for aquarium use as yet that will do everything that you require. There are some fantastic compromises for fish-only systems though, where the choice of fish purchased can be attuned with your choice of lamp.

Most systems, however, incorporating both fish and plants, will require a minimum of two lamps. One will serve to sustain and encourage plant growth, while the other

The eggs of this angelfish were laid on the leaf of an aquarium plant.

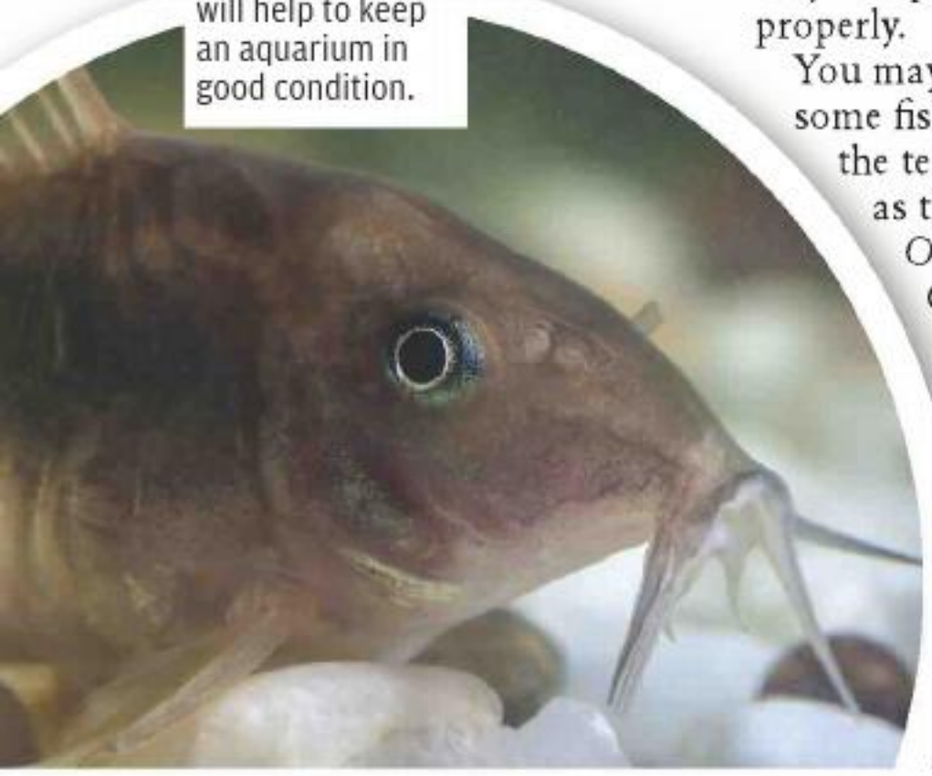
will display the colours of your fish in the best possible way, without increasing the risk of unwanted algal growth, which will spoil the appearance of the tank.

Clean-up crews

In all systems, of course there has to be a harmony between fish, plants and aquarium maintenance crews. It is not just marine keepers that need "clean-up crews". It is just as vital to have shrimps and snails and maybe even crabs in a freshwater aquarium that will not be preyed on by the other occupants, nor will they harm the plants themselves.

These invertebrates will help to keep on top of any dead plant matter and of course, deal with any small pieces of food that the fish have missed, as well as their waste, thereby lightening the burden on the filtration system. Snails can help greatly in the fight against the accumulation of algae, and shrimps can also help to manage the plants so that they can photosynthesise properly.

You may also like to add some fish themselves into the team. Fish such as the coolie loach, *Otocinclus* and *Corydoras* catfish, plus, of course, the traditional *Plecostomus* species are all worth considering. But beware in the latter case, because plecs can become very large quite quickly, so ask your retailer to advise you on the right species for your particular set-up.



Corydoras catfish will help to keep an aquarium in good condition.

Invest in a good range of home water tests and read up well so that you understand the biological process that removes and breaks down fish waste via the nitrogen cycle before you really begin to stock your aquarium. It is also a matter of considering the filtration system and water quality, in terms of plant growth. Most aquariums come complete with a filter now, but it is important to keep up with your filter maintenance so that everything is working well, both mechanically and biologically.

The importance of plants

Do not forget that living plants play a vital role in maintaining a healthily aquatic habitat. They can help to reduce the phosphates and nitrates in the water that may otherwise cause nuisance algae, and they will of course turn carbon dioxide into oxygen.

Aquatic plants also provide shade and cover for your fish, being used for spawning purposes too, and they can even play an important part in the diet of some aquarium fish. This is another aspect to bear in mind when choosing fish for your tank.

Plants need carbon dioxide and light to survive and photosynthesise, which enables them to produce their own food. What we as fish keepers want is for our plants to look vibrant and to keep growing well with the minimum of fuss. Dead and dying brown plants that just add to the biological load of a system are a serious problem, because as they break down in the tank, so this provides more food for the algae themselves.

Light plays a vital role in plant growth. Plants must have light supplied at an energy level that allows them to reproduce at a cellular level. They also need light to be provided across both the red and blue ends of the light spectrum. You may have seen some of the new hydroponic plant growth systems for growing vegetables in the home. Many of these simply use a rake of blue and red LED (light emitting Diode) lights. These may not look attractive, but the plants will thrive under them.

What is required

The aim with aquatic lighting is for manufacturers to provide both a light source that has peak output within the red and blue areas of the lighting spectrum, and to ensure that these wavelengths are hidden in the actual output of a lamp. It needs to operate in such a way that not only will its output meet the plants' growth requirements, but also, it must ensure that the light emphasises the attractive colouration of the fish themselves for the onlooker.

This is achieved with very clever phosphor science.

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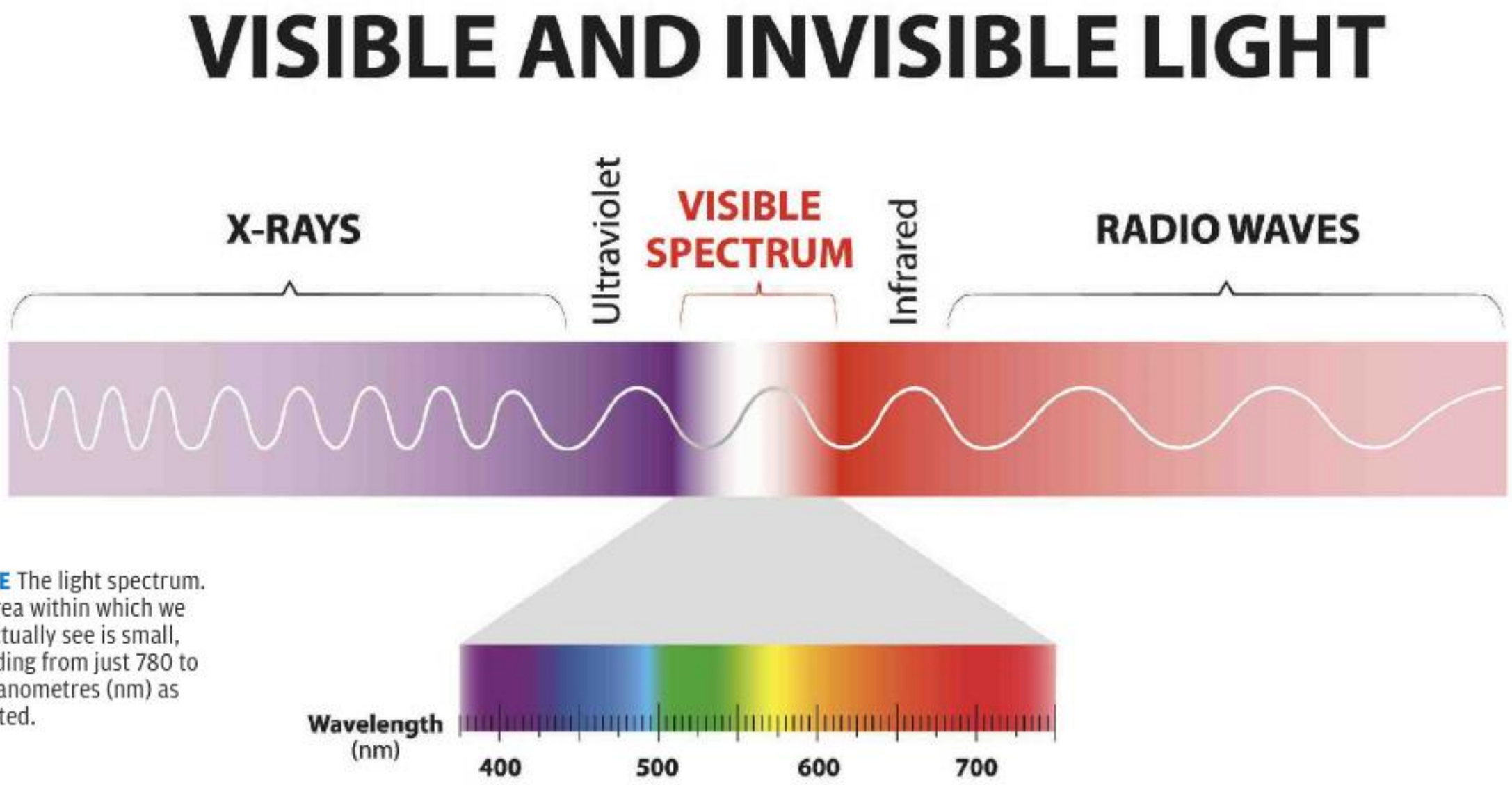


ABOVE The light spectrum. The area within which we can actually see is small, extending from just 780 to 380 nanometres (nm) as indicated.

Expensive phosphors are required to disguise the red and blue wavelengths with a full spectrum output. I can speak for our brand in terms of our freshwater lamp. This well-designed lamp has a wonderful full spectrum colour but it also has peaks in the spectrum at 420-480nm and 600+nm. It does seem that the perfect wavelengths for encouraging plant growth are 420nm and 680nm.

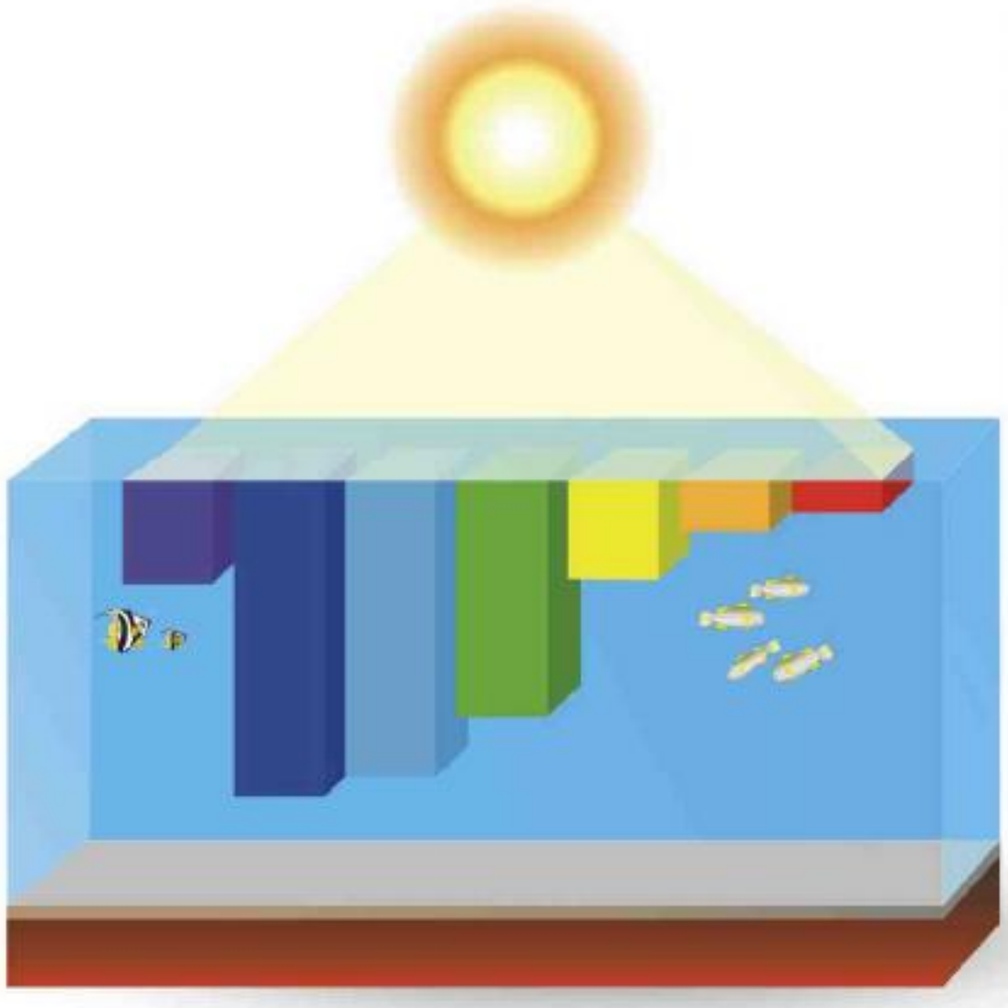
Yet your choice of lamp, as mentioned already, is very much dependant on your choice of fish. If you were to keep an aquarium of tropical or coldwater fish where the majority of fish are red and blue, then you would require a lamp like the original tropical range.

This lamp focuses on stimulating plant growth, but also has more in the way of red in the mix. The increase in emphasis on red then allows the vibrant colours of the fish to reflect back at you in a way that maximises such shades. If you had an aquarium housing fish that are mainly green and yellow in colour, then may be the freshwater range is right for you. The shop can advise you.

But what about those systems that are bigger, and accommodate a wider range of fish and plants? Well, then this is where a multi lamp system is required. For freshwater fish, this is usually a combination of just two lamps.

Most keepers will use one freshwater lamp and one original tropical lamp with reflectors, with the lamps

More than one lamp may be required, depending partly on the size of your set-up.



ABOVE The different colours within light penetrate water to varying depths. Blue extends furthest, explaining why the sea and other stretches of water typically appear blue.

ABOVE Good lighting is essential for a healthy, planted aquarium.

being positioned alongside each other. This combination of lamps then allows the plants to grow well and for all of the fish to show off their best colours.

As your system increases in technology, so more lamps can be added. I personally steer clear of "blue moon" type lamps though, based on my experiences with them. These in my mind do nothing for the colours of freshwater fish, and simply seem to increase the risk of nuisance algae colonising the tank.

Depth considerations

You must also keep in mind that light loses power the further that it has to travel from its source. This applies to all forms of lighting, and especially when light has to travel through a restricting media like water. The deeper your tank therefore, so the more powerful the lighting that will be required.

As a guide, let's say that you have a communal tropical tank that is 45cm (18in) deep, and that you have some red and green plants. A standard output T8 lamp could be used as a sole light source, or perhaps a twin system may be needed if you require higher and brighter light levels.

Should your aquarium be over 45cm (18in) deep, then you should really be starting to look at high output T5 systems. T5 is a revolutionary advance in the aquatics field, as it produces vastly more visible light per watt used than a T8, and as such, less power is required to produce more light.

The "PlantPro" range is great for T5 and can be coupled together with the freshwater and original tropical range. You can almost play with your tube mix with these three groups, in order to get the result that you require, with the assurances that you will not be increasing the risk of algae and that your fish will look great.

Know your plants

In addition though, research the species of aquatic plants that are available in store, and do not simply pick those that look nice to you! Many of the aquatic plant species that are available are not true underwater aquatic plants at all, and so they are likely to break down and die quickly if kept under these conditions, compared with true aquatic plants.

Research is the key to success. The more research that you can do now, before you start to plant up your aquarium, then the more you will know and the easier that the whole experience will be, both in the short and longer terms. Seek out good quality test kits and water additives, and consider helping to remove toxins with products like the Polyfilter, as well as setting up a dedicated plant feeding system.

Carbon dioxide systems

In the more professional systems, carbon dioxide can be added to the aquarium to help the plants become well-established and grow better, but please read up on this first, so you understand what is involved. You need to appreciate that firstly, carbon dioxide can be deadly to fish when present in excess, with the benefits of using this gas and feeding the plants being totally dependent on getting the lighting right first.

The need for plants to photosynthesise effectively is the key to success. As is common in nature, the different aspects must work together in harmony to get the desired result. Always remember that your aim is to create an environment that thrives rather than simply just survives!

The growing needs of plants, including their lighting requirements, do differ.

Fish Doctor

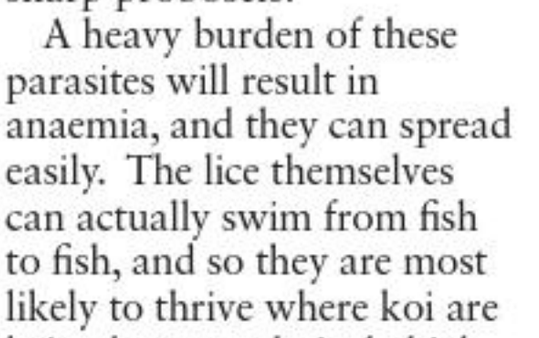
Tackling the health problems that you want answered.
Why not email us with yours to pf.ed@kelsey.co.uk?

Q Can you please give me some advice about fish parasites please?

A While it is often easy to see whether fish appear healthy in general terms, it can be much harder to detect whether there are parasites on them, especially if these are located not on the body itself, but concealed within the gills. You therefore need to be constantly alert to the threat of parasites, particularly when buying fish to add alongside established stock. Parasitic problems are most likely to become evident at this stage, with the parasites themselves multiplying rapidly when fish are under stress and/or weakened.

New fish should always be kept separate for a period therefore, rather than being introduced directly to an established aquarium or pond. Always aim to inspect fish both when you purchase them, and also when you get home, before releasing them into their quarters. It is generally easier to spot external parasites on larger individuals, although the coloration of the fish can sometimes serve to disguise them.

Fish may also succumb to microscopic protozoal parasites as well, including *Ichthyophthirius multifiliis*, which is the cause of white spot. Any sliminess evident on the body is a characteristic sign of protozoal disease in fish, resulting from excessive production of the mucus which provides a protective coating over its surface.



ABOVE A fish louse on a stickleback. *PHOTO BY MICHAL GRABOWSKI.*

Q I want to buy some small koi for a large indoor tank, before transferring them as they grow bigger to a pond. What do I need to look for?

A One of the most likely parasites which you may potentially find on recently imported koi are fish lice (*Argulus*). In spite of their name, these are actually crustaceans. Fish lice measure up to 1.2cm (0.5in) in diameter, and anchor themselves to the fish's body by means of suckers. They feed on the blood, piercing the fish's body with their sharp proboscis.

A heavy burden of these parasites will result in anaemia, and they can spread easily. The lice themselves can actually swim from fish to fish, and so they are most likely to thrive where koi are being kept at relatively high stocking densities, making them a particular danger in holding facilities.

It is obviously possible to treat an infected individual separately, but if you detect these parasites, then more than one fish in the group is clearly likely to be infected. Having dislodged a louse, so it will be important to treat the site of the bite, as the wound is otherwise likely to become infected by fungus or bacteria.

A red swelling usually forms in this area too, because the parasite releases a toxin as it feeds, which causes local irritation. Affected fish may appear to be more active than usual, rubbing against any items in their enclosure, in a bid to lessen this discomfort. This is a fairly typical sign of an external parasitic problem, rather than a specific indicator of the presence of fish lice. A treatment added in the correct proportions to the water will be needed to overcome these particular parasites.

The risk of external parasites spreading is greatest when fish are being housed together in relative large numbers.

Q Can you give me some information about anchor worms?

A Anchor worm is another example of a parasite with a confusing name, because it is actually classified as a crustacean. It has a unique life-cycle, with only the mature females being found on the sides of fish such as koi. Their shape changes, becoming worm-like as they bore into the fish's flanks, and they produce an extensive tentacle-like growth to anchor themselves firmly in position in the skin. They then release digestive juices, consuming the fish's body tissue.

The presence of two egg

Anchor worm – note the surrounding red inflamed areas associated with this parasite. *PHOTO COURTESY DNATHEIST*

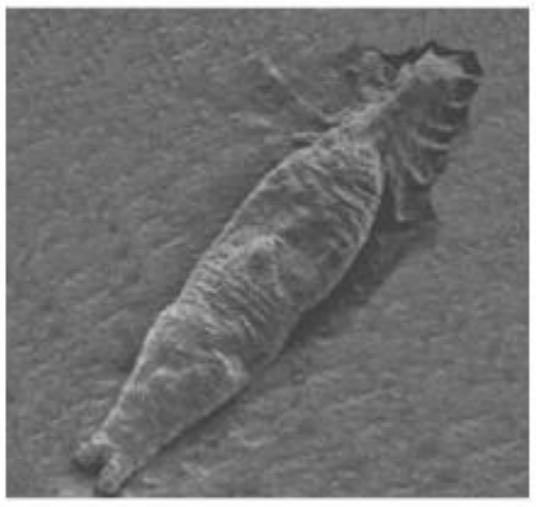
ABOVE Inspect young koi closely after they have been caught and bagged, for any sign of external parasites. Don't forget to look at both sides of the body!

sacs at the end of the body enables anchor worms to be identified easily. Each female anchor worm (*Lernaea* species) can produce thousands of eggs. These then hatch, with the young, called *nauplii*, being free-swimming at this stage.

After two further moults, the crustacean assumes a longer body shape and will then attach itself to a fish, localising in the gills. Here mating takes place, with the male anchor worms then reverting to a free-living existence. Measuring just under 2.5cm (1in) long, the adult females may be hard to spot, but the damage that they can cause will soon become apparent, resulting in ulcers developing on the sides of the fish. These will need rapid treatment if the fish is to survive. If anchor worms themselves are discovered, they must be removed very carefully, so as to minimise the extent of the injury, bearing in mind that they will be firmly attached in the fish's body. Proprietary treatments added to the water will destroy the free-living stages in the lifecycle.

Q What about flukes?

A These parasites are more common than anchor worms, but harder to spot. The skin fluke



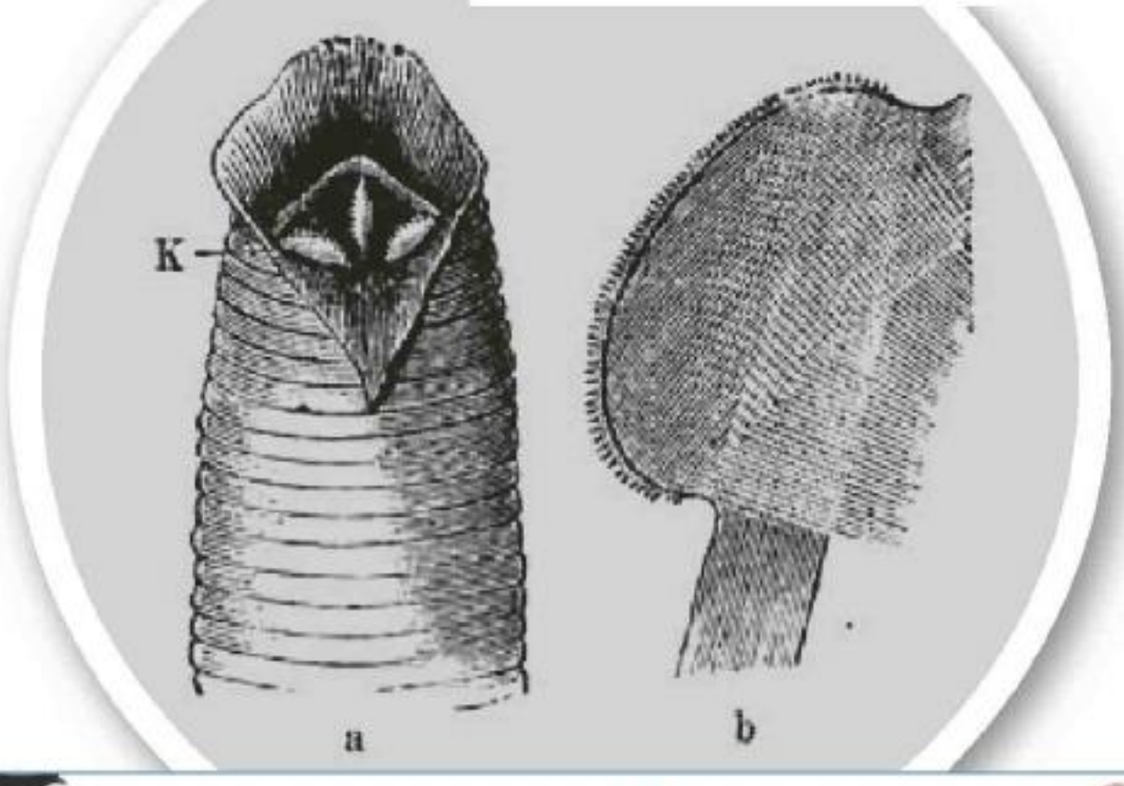
ABOVE A magnified view of a *Gyrodactylus* fluke attached to a fish. *PHOTO THE SCOTTISH GOVERNMENT, CROWN COPYRIGHT.*

(*Gyrodactylus*) can be distinguished from the gill fluke (*Dactylogyrus*) by the lack of any eyes. This difference will be obvious under a magnifying lens. In spite of their names however, these flukes may afflict either part of the body.

Healthy koi can expel gill flukes by a gesture which looks like yawning, but in the case of weakened individuals, the gill tissue which the fish depend on for respiratory purposes can be damaged by large numbers of these parasites.

Flukes tend to be most prevalent during the spring in temperate areas. They can multiply rapidly at this stage, while the resistance of fish that have been housed outdoors will still be relatively low after the winter period. There is, however, a key difference between these two flukes in terms of their reproductive habits. *Gryodactylus* gives birth to live offspring, whereas *Dactylogryus* produces eggs. These hatch into free-swimming larvae, and so can be transferred more easily from fish to fish. Various treatments for these parasites are available.

BELOW The powerful mouthparts of a leech allow it to attach to the fish's body. *SOURCE PD.*



Q Are there any other parasites to worry about?

A The fish leech (*Piscicola geometra*) can attack koi and other fish. It has strong mouthparts, enabling it to anchor on to their sides. These parasites are quite obvious though, measuring about 5cm (2in) in length, and look rather like a piece of thread dangling down here. Fish leeches congregate around the more vulnerable parts of the fish's body, where it will be easier for them to reach soft tissue. They suck

ABOVE External parasites are less likely to emerge as a problem in an established pond, where no other fish are present.

blood, and can also infect the koi with harmful protozoa and other diseases. Although the leeches themselves can be treated quite easily, their eggs represent a much tougher proposition, being thick-shelled. The most effective way of destroying them is to remove the fish, and treat their quarters with calcium hydroxide, which will wipe out any of these parasites that are hatching, as well as killing the eggs themselves.

Look very carefully for leeches if you are obtaining koi from large natural ponds in your area. These parasites are most likely to be introduced to your pond by this route, being associated with wild plants and other types of fish that may have been living alongside them in these surroundings.

From here to there

This is the time of year when many people's thoughts turn to their garden, and either reinvigorating or building a pond. **Greg Jennings** provides some practical advice to help you transfer fish that have been living in aquarium surroundings here safely.

A number of goldfish keepers like to bring their fish indoors over the winter, before returning them to a pond for the summer months. This will be essential if you have any of what are often generally described as fancy goldfish. These are varieties such as the pearl scale or oranda, which have corpulent bodies.

Such varieties are ill-equipped to survive in freezing water, being vulnerable to swim bladder disorders, and they can only be allowed out into a pond during the warmer months of the year. It is equally important to remember this if you are looking to buy goldfish primarily for a pond. The typical single-finned ornamental fish will be the best choice for this environment.

It is worth remembering that although shubunkins, with their shades of blue, black, white and red in their bodies can look striking in an aquarium, those with predominantly dark colouration are likely to merge into the background, especially in a planted pond. They will be far less conspicuous here than a typical goldfish.

The same applies in the case of the Moor, with its characteristic black appearance – these fish are also not hardy, and those with telescope-eyed may suffer eye injuries and infections in pond surroundings. Equally, bubble-eyes with their jelly-filled sacs under their eyes are also not suited to pond life, because they can easily injure their sacs in such surroundings. Even in a tank, they should not be kept with any rockwork or similar décor that may have sharp edges attached to it.

Two lionheads – a typical, short-bodied fancy variety.

TOP TIP

Be sure to obtain a robust pair of pond gloves before you start working on the pond. Wearing these will then protect you again the slight risk of Weil's disease – a rat-borne bacterial infection that could possibly be fatal. It will also prevent the risk of acquiring other infections, particularly if you have any cuts on your hands.

A good spring clean

Assuming that your pond has been empty of fish over the winter, it will be a good idea to clean it up, before putting goldfish. There may be old waterlily leaves for example, that have not rotted away. The plants can be lifted and cleaned as required. Now they are growing again though, do not leave them out of the water for longer than strictly necessary.

Oxygenators such as Elodea that have grown leggy and lost their leaves along with much of their stems should be pulled out of the water and trimmed as necessary, with the growing ends of the plants being thrown back in. They will soon re-establish themselves and start to spread again, providing a relatively safe refuge for any young fry that hatch out in the pond. The old growth should be composted.

Temperature

You should also invest in a pond thermometer, so you can take reading of the water temperature. This needs to be compared with the temperature reading in the tank where the fish are currently being housed indoors. Depending where you are in the country, as well as the location of the pond in

Goldfish with long, flowing fins are vulnerable to minor infections here over the winter if left in a pond, with the immune systems functioning less effectively at this stage.

A typical goldfish – sleek and able to swim much faster than fancy strains.

your garden and the current weather conditions, you may need to be patient before putting the fish back outdoors.

Meanwhile, now is a good time to buy any further goldfish that you want to add to the pond. Find out if these have been housed outdoors through the winter, or if they have been recently imported. Well-acclimatised specimens are to be preferred, even if they are slightly more costly. Depending on the size of the goldfish, it may be possible to sex them (see page 34) as well, if you are hoping to breed from them.

Should you acquire new fish though, it is important to ensure that they are healthy, before releasing them into your pond. It is much easier to deal with an outbreak of disease in a tank rather than in a larger volume of water. By housing the newcomers in an aquarium briefly, so you will also safeguard the health of existing fish.

As a general guide, it is probably best to keep the newcomers in an aquarium, perhaps in a shed or summerhouse for two or three weeks. This will give time for them to settle and you can be sure they are eating well at this stage. Do be sure to keep a close check on water quality through this time though, and carry out partial water changes as necessary.

It obviously helps to have access to a power point for filtration purposes, but avoid placing the tank in a conservatory, where the temperature will typically rise to a much higher figure here than outdoors, bearing in mind that the fish are housed in a glass tank. This means that there is likely to be a major hike in the temperature of their water too in these surroundings.

It will be also be helpful to transfer goldfish that have been housed indoors into a shed or similar outbuilding for a couple of weeks, before returning them to the pond. This will allow them to adjust to cooler conditions, in advance of finally being moved outdoors.

Catch the goldfish and initially transfer them into a plastic bucket, while draining down the tank, so that this can be transferred outdoors easily. Do not throw the water away, but simply refill the tank again once it is in its new location, having put the filtration system back in place. Once everything is working, the fish can then be returned here temporarily, with the water quality in their tank being unaffected.

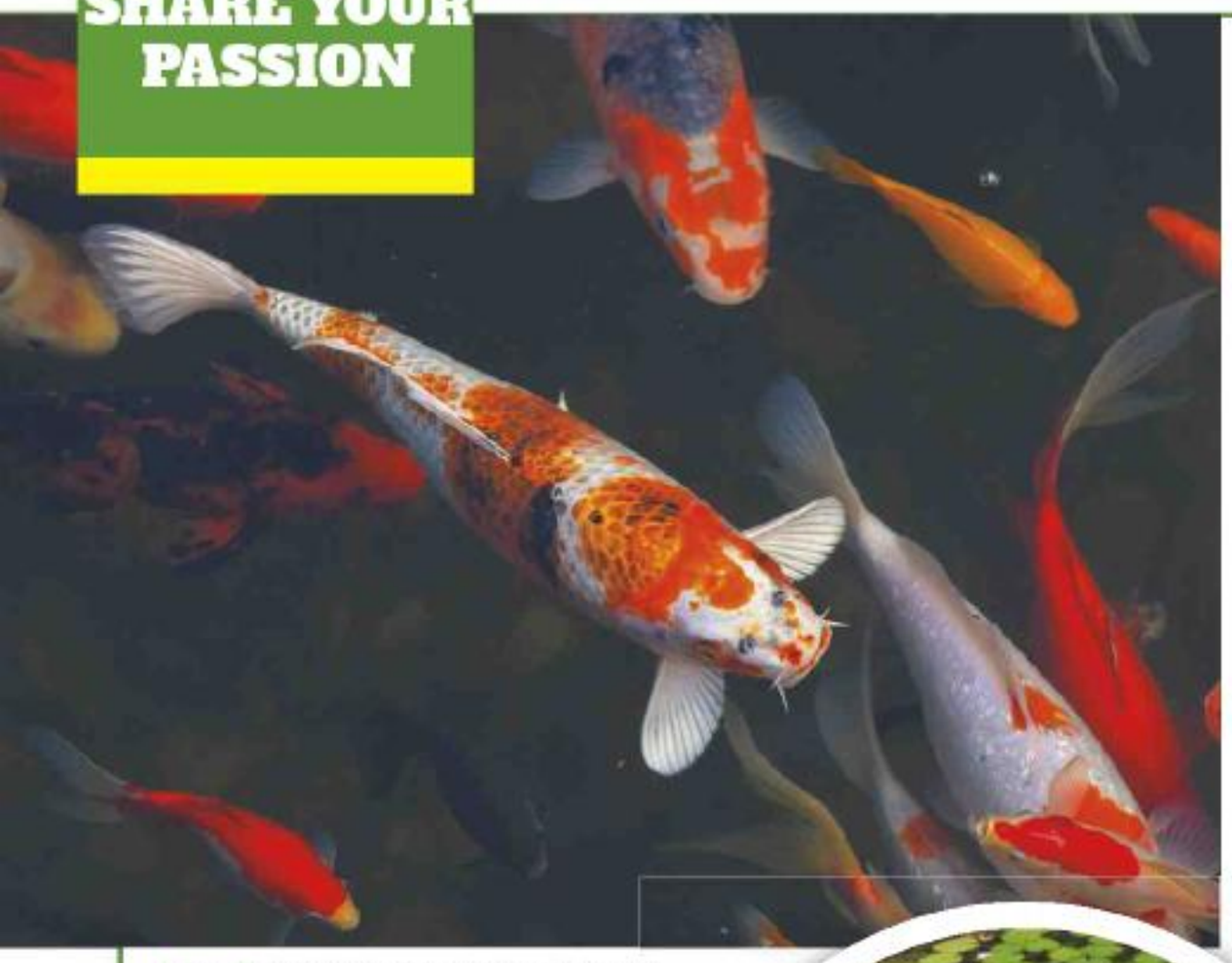
Placing the fish into the pond

You will need a need and carrying bucket for this purpose. It will be safer to choose a bucket with a lid, so if you do slip over, then there should be no risk of the fish ending up on the grass or a path, from where it will need to be retrieved. Fish should never be handled directly if at all possible, certainly with dry hands, because this will damage the protective mucus layer covering the surface of the body.

It is a good idea to wait until a weekend when you will be around before placing the fish in the pond. If you do so relatively early on a Saturday morning, then you will be able to keep a check on them and see that all is hopefully well. The fact that the fish are likely to disappear for a time is quite usual, although offering a little food when the temperature warms up might draw them up to the surface.

At this time of year, the vegetation in the pond is only starting to grow though, so it

TURN OVER FOR MORE ABOUT MOVING FISH »



ABOVE Goldfish are sometimes kept in the company of koi. Although these fish will agree, their requirements are slightly different. You also need to be sure the smaller goldfish are obtaining their share of the food.

Young goldfish can soon adapt to life outdoors.

ABOVE The oxygenators here are well-established. Never allow young children near the pond unsupervised though. They could fall in.

ABOVE Herons can be a particular danger to goldfish in some areas. Netting of some other form of protection will be needed.

will be easier to see them than subsequently, once the waterlilies are spreading over the surface. The relatively high visibility of the fish can be a drawback though, with a number of aerial predators keen to take advantage.

Herons, for example, can help themselves to a lot of fish, rapidly acquiring the taste for goldfish. These birds are most likely to be encountered in rural areas, especially if you live reasonably close to rivers. Being large in size, herons tend to need a relatively big area in which to land and fly off, so that small gardens are less likely to attract their attention.

Seagulls are much more of a threat though, particularly in coastal areas, as they can swoop down easily and seize fish, even when access is restricted. The solution is to use a pond net at first, at least until the vegetation has grown, so the fish will be less conspicuous.

Feeding

Obtain a good quality goldfish food, appropriate for the size of the fish, starting perhaps on a wheat germ product that will be easier for the fish to digest at cooler water temperatures. When it comes to selecting a food for longer-term use, bear in mind the size of your goldfish, and choose one of appropriate size. Flake products can be used, but I prefer floating pellets for my pond goldfish, simply because I feel it is easier to assess what they are eating.

Watch their appetite, and it really is important to feed a little and often. Cut back on the food that you provide when the weather is relatively cold, as the goldfish will be less inclined to eat under these circumstances.

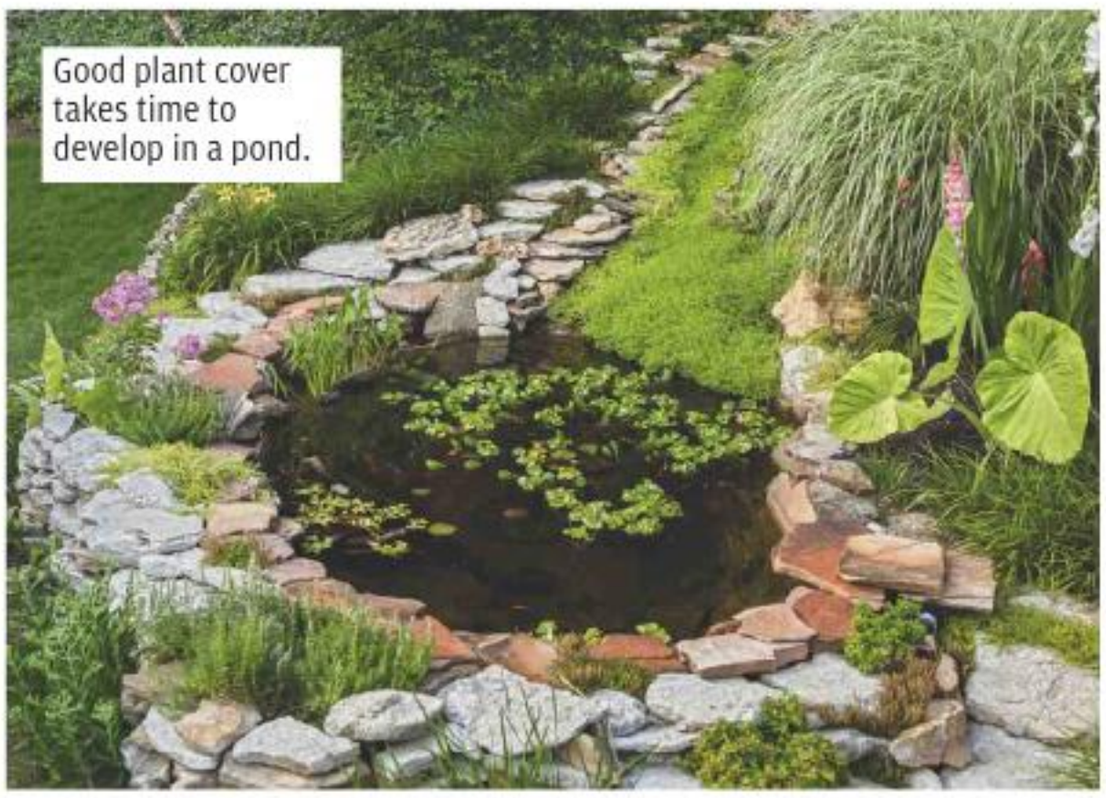
Spawning

Before long, however, you may observe the start of the spawning period. The most obvious sign will be a disturbance in the pond, with the males chasing the females around here. This may occur for a couple of days or so beforehand, after which tranquillity will be restored again. If you want to try hatching some of the eggs yourself, you may be able to retrieve some that have become attached to oxygenators, but bear in mind that the most visible eggs are likely to be eaten by the pond occupants.

Provided that they are kept well-fed though, the goldfish will not consume all their eggs, and some are likely to hatch and ultimately give rise to young fish, particularly if there is a good covering of oxygenators in the pond. These plants will provide an invaluable retreat for the developing goldfish in the early stages of their lives.

Do not anticipate seeing them in the pond for some months though. The first sightings are likely to be when they come up to the surface to feed alongside the older fish, once they are several months old. The young goldfish are not easy to see though, being matt black in colour at this stage. You are more likely to spot the disturbance at the water surface as they dart around taking pieces of food here.

The rate at which they change colour varies considerably, depending on the individual. Some may already be displaying brighter colouration by the autumn, whereas others may retain their dark colouration through until next year. Young goldfish should be able to survive in the pond over the winter, but you may decide to bring them indoors and enjoy watching their development here instead. Certainly, they will grow faster in these surroundings than in a pond.



Good plant cover takes time to develop in a pond.

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Austrolebias nigripinnis.
PHOTO © HRISTO HRISTOV.

South American annual Killifish

Killifish are often stunningly beautiful, only grow to a small size, and yet you are unlikely to find them for sale in most aquatic shops. But don't let this put you off! They're generally quite easy to keep, and you even can obtain their eggs to hatch yourself. **Steve White** of the British Killifish Association continues his series of articles about these fish.

Introduction

The last article looked specifically at non-annual killifish, species whose lifespan is not dependent upon the seasonal conditions that occur in the environment in which they have evolved. Annual killifish occur on the continents of Africa and South America. The extremely colourful *Nothobranchius* species are found in eastern and southern Africa, whilst the more diverse and varied annual killifish species, many often referred to as 'pearl killifish', covering several genera, occur in eastern parts of South America. This article looks specifically at these annual killifish from this continent, highlighting some of the more common and interesting species.

Awonder of the natural world

The lifecycle and evolution of the annual killifish is one of the true wonders of the natural world and probably one of its greatest secrets. Annual killifish are found in temporary bodies of water and in most cases, they have a very short and frenetic lifestyle in the wild, governed entirely by extremes of climate.

From the egg onwards, they face a battle for survival. As soon as they hatch, the race is on for the fry to eat as much as possible, allowing them to grow as quickly as possible. Under optimal conditions, many species are sexually mature in as little as 5-6 weeks. Their priority then becomes breeding, producing as many eggs as possible, which are deposited deep in the substrate at the bottom of their temporary homes.

These pools gradually dry out with the changing of the seasons, with all the killifish perishing as the water evaporates. Their eggs, however, deposited in the substrate remain safely concealed here, out of reach of predators that may have taken the adult fish as the water level fell.

The dry season often lasts for many months, but eventually the season changes and the rains come. The first real rains trigger some of the eggs to hatch, and the cycle and the race for life and survival commences again. The challenge for the the killifish enthusiast is to maintain and breed such fish under aquarium conditions, recreating an environment similar to that found in the wild, then collecting and storing the eggs, before eventually trying to hatch and raise the next generation.

Before looking at a selection of species in greater detail though, it is interesting to consider the natural phenomenon that enables the eggs of these annual killifish to

survive, in what is effectively a stated of suspended animation. This phase in their lifecycle is known as the diapause.

Diapause

It always seems incredible, almost miraculous, that some species of fish have managed to adapt and evolve to survive in this manner, effectively taking on nature and winning against all the odds!

The eggs of annual species of killifish undergo three stages during diapause. This is quite an involved process and there is much that is still not fully understood about what exactly controls and triggers the various stages of the process. In brief, the eggs develop to a certain point, and then stop for a period of time. They then develop further and stop again, creating a second resting period.

After this, the egg develops to a stage where it is ready to hatch, and finally, a third period of diapause occurs. The slowing of development of the egg is enough to ensure viable eggs are available at the time of the next rainy season.

Not all eggs hatch upon wetting by the first rains; if this was to happen, it could be a disaster for the survival of the species, as if these first rains were only brief, they may prove insufficient to create and fill the temporary pools for long enough, in order to support the fry though to adulthood. The eggs are therefore programmed not to hatch all at the same time. For this reason, killifish breeders of annual species wet the spawning medium with the eggs on several different occasions, with the result that more fry often appear on each occasion that it is soaked.

The phenomenon of diapause also occurs in some plants and mammals. Some seeds need to be exposed to the cold before they germinate, while kangaroos and wallabies have the ability to pause the development of embryos until such times as food becomes plentiful again.

Diapause and the built-in delay of not all eggs hatching

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DID YOU KNOW?

Diapause sometimes occurs in non-annual killifish; eggs can be collected and develop in the usual way but then on occasion, they pause for several weeks, before hatching, despite being maintained in water, and under what appears to be ideal conditions. Sometimes all that is needed under these circumstances is a change of water, which should be at a slightly lower temperature, mimicking the effect of rainwater. This is usually sufficient to trigger hatching.

ABOVE The puddles in which these fish are found are only temporary.

Hypsolebias sp. aff. antenori - Amontada.
PHOTO © HRISTO HRISTOV.

Nematolebias whitei, a species that can be recommended for those new to keeping killifish.
PHOTO © HRISTO HRISTOV.

upon the first rains is natures insurance policy to give the species every chance of continued survival in these environments of great seasonal variation. There is still much to learn and understand about diapause. The sudden appearance of fish following the first rains at the end of the dry season, led some communities to believe 'that it rained fishes'; what other explanation could there be?

Location

South American annual killifish are found in Brazil, Argentina and Uruguay, a vast area with a varied geography resulting in a differing range of climatic conditions. Represented by species of the genera *Austrolebias, Simpsonichthys, Hypsolebias, Ophthalmolebias, Spectrolebias* and *Nematolebias,* there is a tremendous range of species, many of which have adapted to specific biotopes.

Several species face an uncertain future in the wild, particular those found on the coastal region of Brazil, as a resulting of the rapidly increasing human population and the associated development of area. Many biotopes have been lost in recent times. In the last 30 years, numerous new species have also been found and identified, but it is unclear how many may have been lost.

All these killifish are carnivorous, living on water insects, as well as mosquitos and their larvae, although some species in aquarium surroundings will take flake food. In some instances, research has identified species specialising in a particular food source.

Some of the *Austrolebias* species, such as *Austrolebias elongatus,* are quite large reaching 22cm (9in) in length making them unsuitable for the average home aquaria. The majority of species in these genera average around 4–5cm (1.5–2in), and tend to be the more colourful and attractive, making them more appealing and practical for the killifish hobbyist.

Nematolebias whitei

First described in 1942 and being found in Brazil, this is a common species in the killifish hobby and an ideal choice for a beginner to keep, being a colourful and easy-to-breed species. This species grows very quickly, with males attaining a length of 7.5–8.5cm (3-3.5in); females are much smaller only growing to 5cm (2in). This is one of the South American annual killifish that will keenly feed on flake food.

"The challenge when it comes to breeding and maintaining this fish, along with other annual killifish, is to recreate similar conditions to those that exist in the wild."

There is only one other species currently described in this genera and that is *Nematolebias papilliferus*. Visually and virtually the same as *Nematolebias whitei,* it can be maintained and bred in the same way.

Nematolebias whitei males are particularly attractive fish, as their brown body colour is peppered with yellowish dots. It is the large fins with their iridescent markings, which show as blue or gold on a red background according to the light, together with the black bar through the eye, which make this species very appealing. Females lack these vivid colours though, and are light brown with a large black spot on the sides of the body.

Collecting eggs

The challenge when it comes to breeding and maintaining this fish, along with other annual killifish, is to recreate similar conditions to those that exist in the wild. Peat moss that has been boiled and then rinsed is favoured by many breeders as a spawning medium in their tanks. Others prefer coir instead of peat. Care must be taken as some peat on the market does contain additives, which are harmful to fish.

Some breeders use deep containers in which they place the spawning medium, which may be 7.5cm (3in) or more in depth, dependent upon the species, It must always be sufficiently deep to allow the breeding fish to dive into the peat and spawn. The use of a container does help to keep the spawning medium largely in one place, and facilitates easier collection of eggs contained within the peat. This can be carried out every week or two by carefully removing the container and changing the spawning medium.

The peat that has been

a temperature of 22–25°C (72–77°F) and need to be checked every few weeks to ensure they do not dry out. Opening the bag to check is also considered beneficial as this allows oxygen in, which aids egg development.

Hatching eggs and raising fry

Nematolebias whitei eggs are normally ready to hatch after around three months, although these can continue to be stored a little longer and moistened at a time convenient to the breeder. Some species have a short incubation period though; this can be as short as two months in the case of *Simpsonichthys zonatus*, whereas it is longer in other cases.

The stored substrate removed then needs to be drained through a net or a pair of old tights. The peat is left to dry on kitchen roll until it is slightly damp, and then it can be checked for eggs. Those of many species can be easily seen, looking rather like little golden pearls, but in a few cases, they are more difficult to spot, as the eggs are slightly adhesive, causing the peat to stick to them. The eggs need to be labelled with the species' and variant names as appropriate and the date of collection, before being stored.

They should be kept at a temperature of 22–25°C (72–77°F) and need to be checked every few weeks to ensure they do not dry out. Opening the bag to check is also considered beneficial as this allows oxygen in, which aids egg development.

All being well, the fry should appear in a matter of hours and often continue to hatch over the course of several days. After a few days, the fry can be carefully removed to larger accommodation and the substrate dried again, stored for a few more weeks then the wetting process can be repeated. Often, more fry will hatch under these circumstances.

The size of the fry does vary from species to species, with the smaller young being unable to consume newly-hatched brine shrimp, and so necessitating the use of micro worms and liquid fry food for the first few days. The young killifish grow rapidly though, containing the eggs needs to be placed in the hatching tank or container, and water with a temperature of around 16°C (61°F) is added. A mixture of part rainwater and part aged tapwater is ideal. A water level of 5cm (2in) is sufficient, although some breeders favour a slightly greater depth of water. The addition of an oxygenating tablet can also be beneficial.

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Larger foods such as frozen bloodworm can be offered once the young fish are big enough to eat them. Care needs to be exercised so as not to overfeed them, as uneaten food with contaminate the water, threatening the survival of the fry.

Some other species

Austrolebias nigripinnis

First described in 1912 by Regan, *Austrolebias nigripinnis* is a popular and widely kept fish in the killifish hobby, as well as being the emblem of the British Killifish Association.

The first specimens described were found in La Plata in Argentina. Its black body, distinctive spots and fin markings of iridescent blue ranging through to white depend upon its location in the wild. Commonly referred to as the Argentinean pearl fish, it is one of the most easily recognised killifish species.

Now discovered in numerous other locations in the wild, fish from each population differ slightly in colouration and markings, emphasising the need to keep strains pure. They are often

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Austrolebias nigripinnis. PHOTO © HRISTO HRISTOV.

Austrolebias nigripinnis showing the variation in appearance, compared with the individual above. PHOTO © HRISTO HRISTOV

Simpsonichthys virgulatus - Unai.
PHOTO © HRISTO HRISTOV.

Simpsonichthys punctulatus - Goias. PHOTO © HRISTO HRISTOV.

given a locality name or a collection reference, alongside their scientific description.

Eggs of *Austrolebias nigripinnis* are normally ready for wetting after 3-4 months. Growing to around 5cm (2in) males are stunning fish, particularly when displaying to the females. This is a species which will thrive at lower temperatures of around 20°C (68°F).

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Simpsonichthys boitonei
This killifish has a fascinating history; its discovery in 1959 was unusual to say the least. It was subsequently described

Simpsonichthys notatus - Alvorada do Norte. PHOTO © HRISTO HRISTOV.

again in 2007. Occasionally seen in the hobby, these days it makes a colourful and interesting species to keep. *Simpsonicthtys boitonei* is considered a vulnerable species in the wild.

The way in which *Simpsonichthys boitonei* was discovered has to be one of the most unusual ways that a new species of killifish has ever been found. At a new zoo being constructed in the then new capital city of Brazil, Brasilia, a zoo official named Saturnino Marciel de Carvalho was responsible for collecting live fish to feed to the aquatic birds at the zoo.

During one of these collections in 1959, he noticed the beautiful appearance of five of the specimens that he had caught. He brought these to Sr. Jose Boitone, the head of Zoological Services at the zoo. Sr. Boitone, not being familiar with the fish, then took it upon himself to send specimens to the renowned scientist and ichthyologist Dr Antenor de Calvalho, in Rio de Janeiro. Dr Carvalho described and classified this new species in 1959, giving it the name of *Simpsonichthys boitonei*. The species name was in honour of Sr. Boitone for having sent the specimens for classification.

This original location, a temporary pool within the Zoo, was lost as were the other seasonal pools in the area as the city developed. A few other locations close to Brasilia seem to have contained *Simpsonichthys boitonei* at times during the 1970s but there have been fears that the species has become extinct in the wild.

Measuring around 3cm (1.75in), this is another species that thrives at around 20°C (68°F). It is slightly shy by nature and benefits from plenty of plant cover in its tank. This also provides a refuge for the females when in the company of persistent

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Simpsonichthys myersi - Goias. PHOTO © HRISTO HRISTOV.

"*Simpsonicthtys boitonei* is considered a vulnerable species in the wild."


Hypsolebias magnificus - Itacarambi. PHOTO © HRISTO HRISTOV.

males. Good results often occur from wetting stored eggs after eight weeks.

Hypsolebias magnificus

A stunning fish, as the species description of '*magnificus*' suggests, this Brazilian species was first discovered during 1991, when it was believed to be a member of the *Simpsonicthtys* genus. Males grow to around 5cm (2in).

This was a much sought after species when it first became available in the killifish hobby. A species that thrives at temperatures of 23-24°C (73-75°F), eggs require a longer incubation period of 4-5 months.

Other species

There is a wealth of colourful species within the genera mentioned in this article,


Astrolebias alexanderi. PHOTO © HRISTO HRISTOV.


Simpsonichthys santanae. PHOTO © HRISTO HRISTOV.


Hypsolebias picturatus. PHOTO © HRISTO HRISTOV.

many of which are available within the killifish hobby, and additional new species are being described every year. Some other species of note, which demonstrate this variety, are *Austrolebias alexanderi, Simpsonichthys santanae, Hypsolebias picturatus, Ophthalmolebias constanciae* and *Spectrolebias costai*.

Summary

For the aquarist who wishes to maintain and breed colourful and interesting species of fish, South American annual killifish are challenging but very rewarding subjects. There is something very special and even magical about recreating the conditions and successfully propagating these subjects. Even after many years of fish keeping there is still a sense of achievement when fry appear in the hatching tanks.

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Popular Fish Keeping has teamed up with the British Killifish Association to offer an exclusive 50% off the cost of the first year's BKA membership, helping to put you in touch with fellow enthusiasts, obtain stock and benefit from experienced advice. New members will also receive the BKA's bi-monthly club journal, posted to U.K. residents only. All this will cost just £10, instead of £20.

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Spectrolebias semiocellatus. PHOTO © HRISTO HRISTOV.

Next time...

The next and concluding part in this current series of articles, will look at the extremely colourful African annual killifish, *Nothobranchius*, and a few other less known genera from around the world.

Further info

The Internet offers much information on killifish with several sites covering South American annual fish; one site in particular aptly named 'It Rains Fishes' has a wealth of information and images solely relating to South American killifish. You can find this at www.itrainsfishes.net/content/

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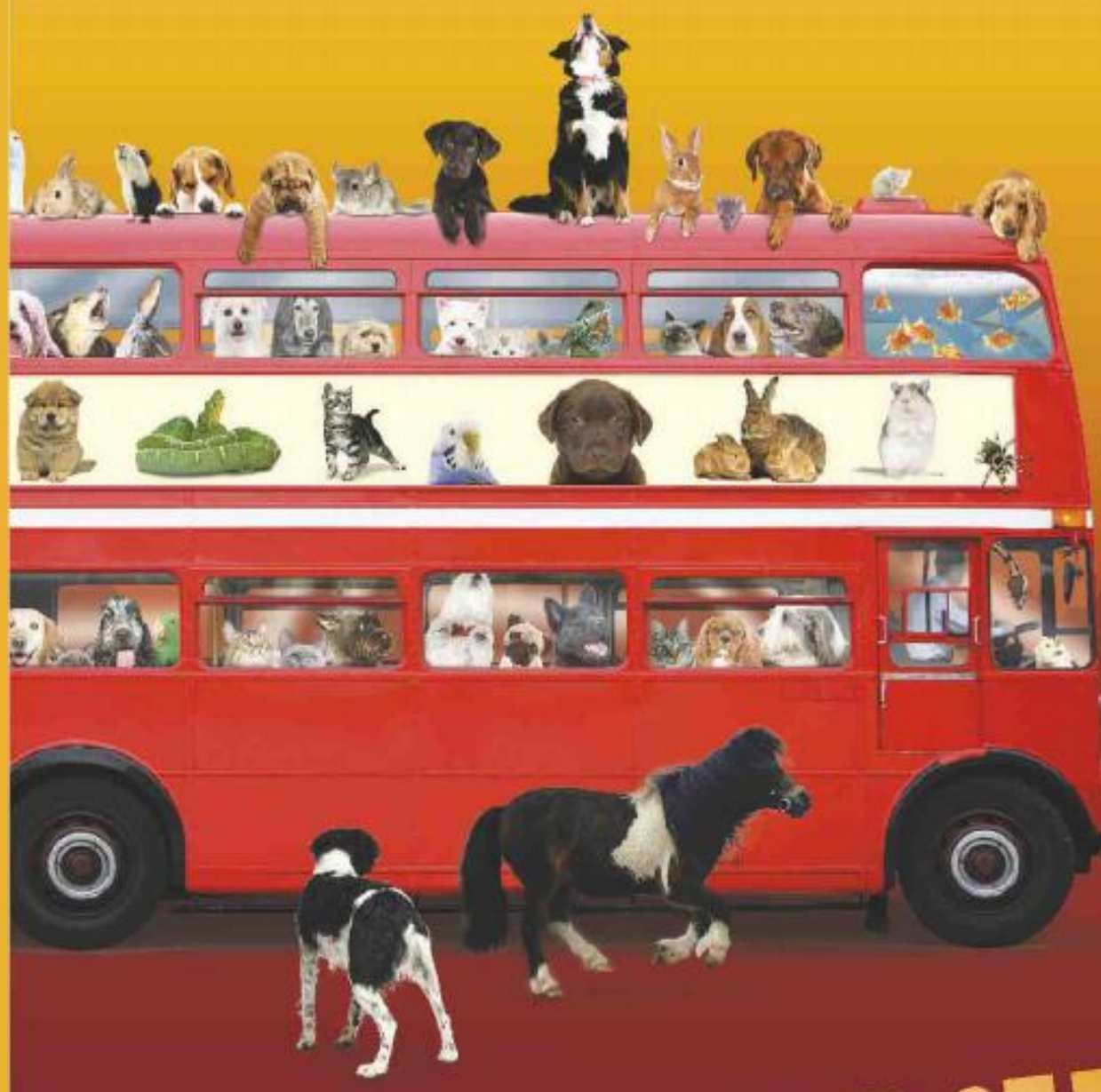

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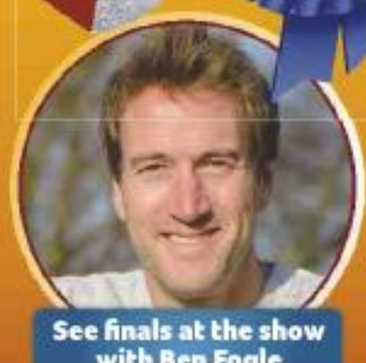

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Both sides of the same coin

Fish as a group have proved to be remarkably adaptable creatures, having been faced with a wide range of different environmental conditions – particularly in terms of the type of water in which they live. **David Alderton** explains more about how this is achieved in practice.

Think about what happens when you pour water on to a teabag – the clear water in the cup darkens, starting to become tea-coloured and the previously dry tea in the bag becomes saturated with water. Although perhaps a rather exaggerated way to describe the basic principle of osmosis, this is a good visual representation of how differing concentrations of salts on either side of a porous membrane naturally tend to even out, ending up in equilibrium. In this case, the water in the tea bag will end up being the same colour as that in the cup itself.

Different challenges

Fish have adapted to counter this natural process though, depending on the water conditions in which they live, because as far as they are concerned, it would be deadly. For example, osmosis would put fish that live in the marine environment at risk of absorbing too much salt from the sea, and consequently losing water from their own bodies, leading to dehydration and ultimately death. Marine fish have therefore adapted to curb this potentially fatal water loss from their bodies by producing very little urine.

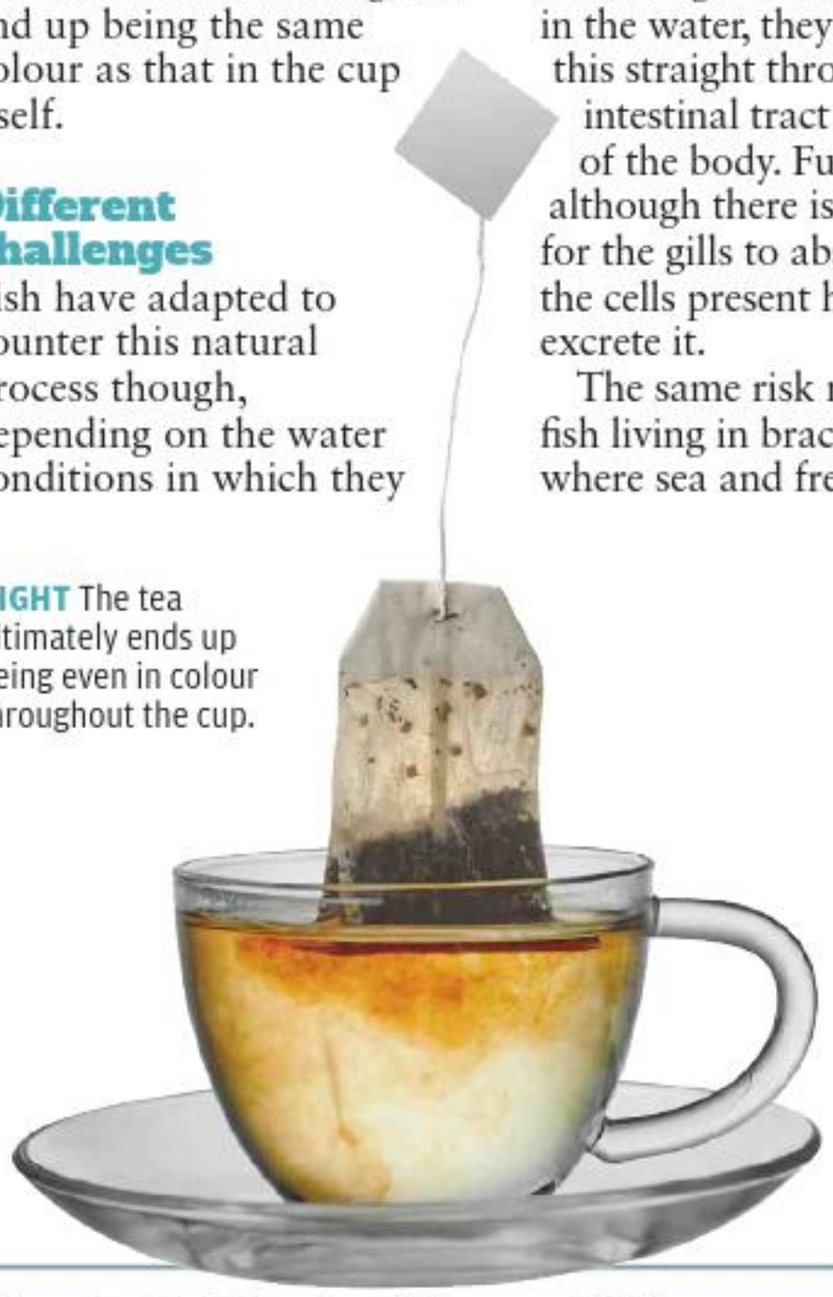
Although they drink large volumes of water, rather than absorbing the dissolved salt in the water, they can pass this straight through their intestinal tract and out of the body. Furthermore, although there is a tendency for the gills to absorb salt, the cells present here actively excrete it.

The same risk may affect fish living in brackish water, where sea and freshwater mix, as in estuaries (see our article on pages 52-53 - *Ed*), but they are generally able to adapt, depending on the conditions. When buying such fish though, always ascertain the water conditions under which they are being kept, so that you can replicate these in your own aquarium. For example, mollies are sometimes accommodated in freshwater, although they often tend to do better under the brackish conditions in which they are frequently to be found in the wild.

Adaptability

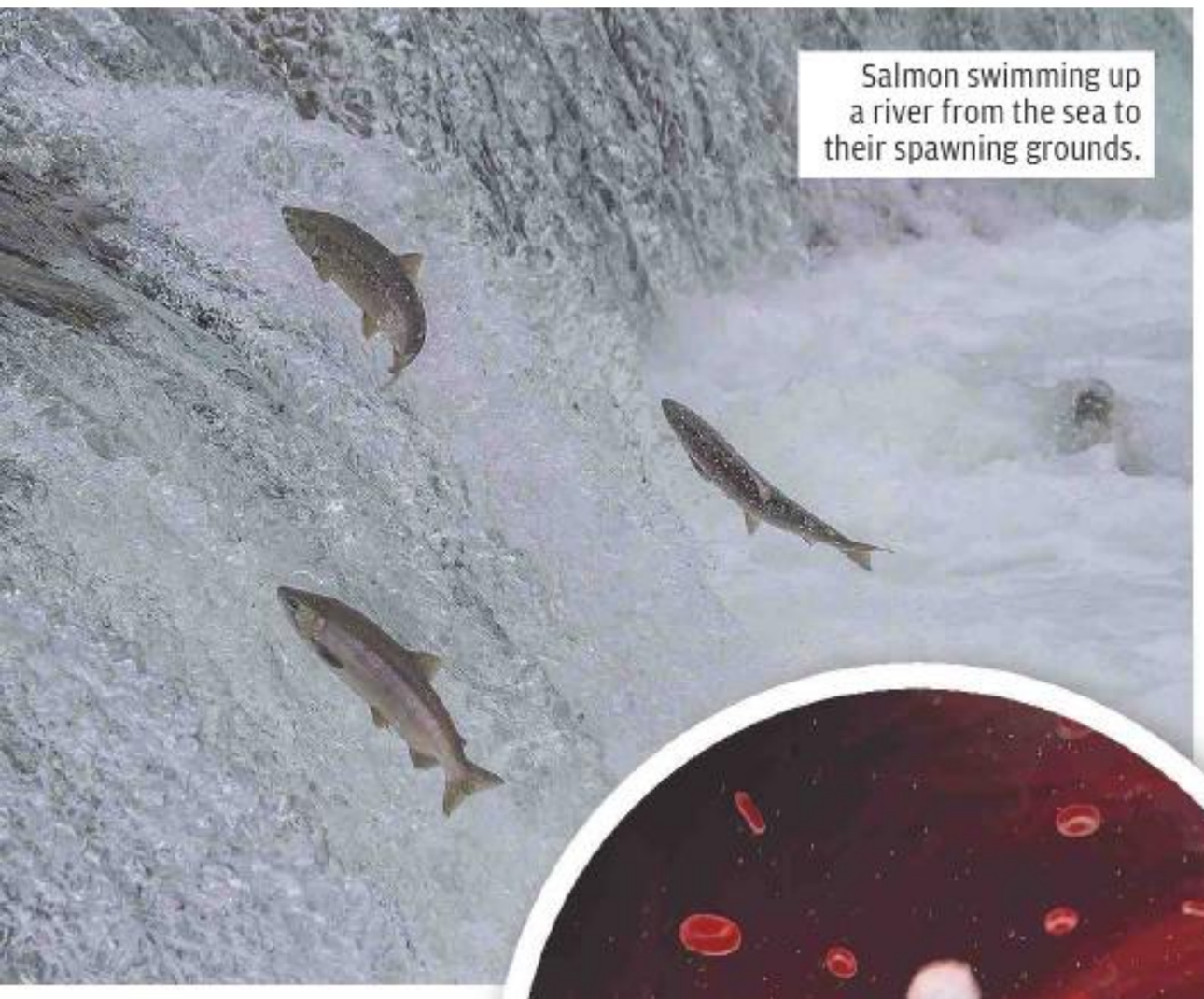
The risk of problems will be greater in the case of fish that have been imported, rather than having been tank-bred for many generations. If the water conditions are sub-optimal, fish are more likely to succumb to opportunistic infections such as fungus. Those moved from brackish conditions to freshwater are particularly vulnerable to this problem, as their bodies will not have been able to adapt gradually to a shift in salinity.

ABOVE Most pufferfish, such as this white-spotted, are marine species.

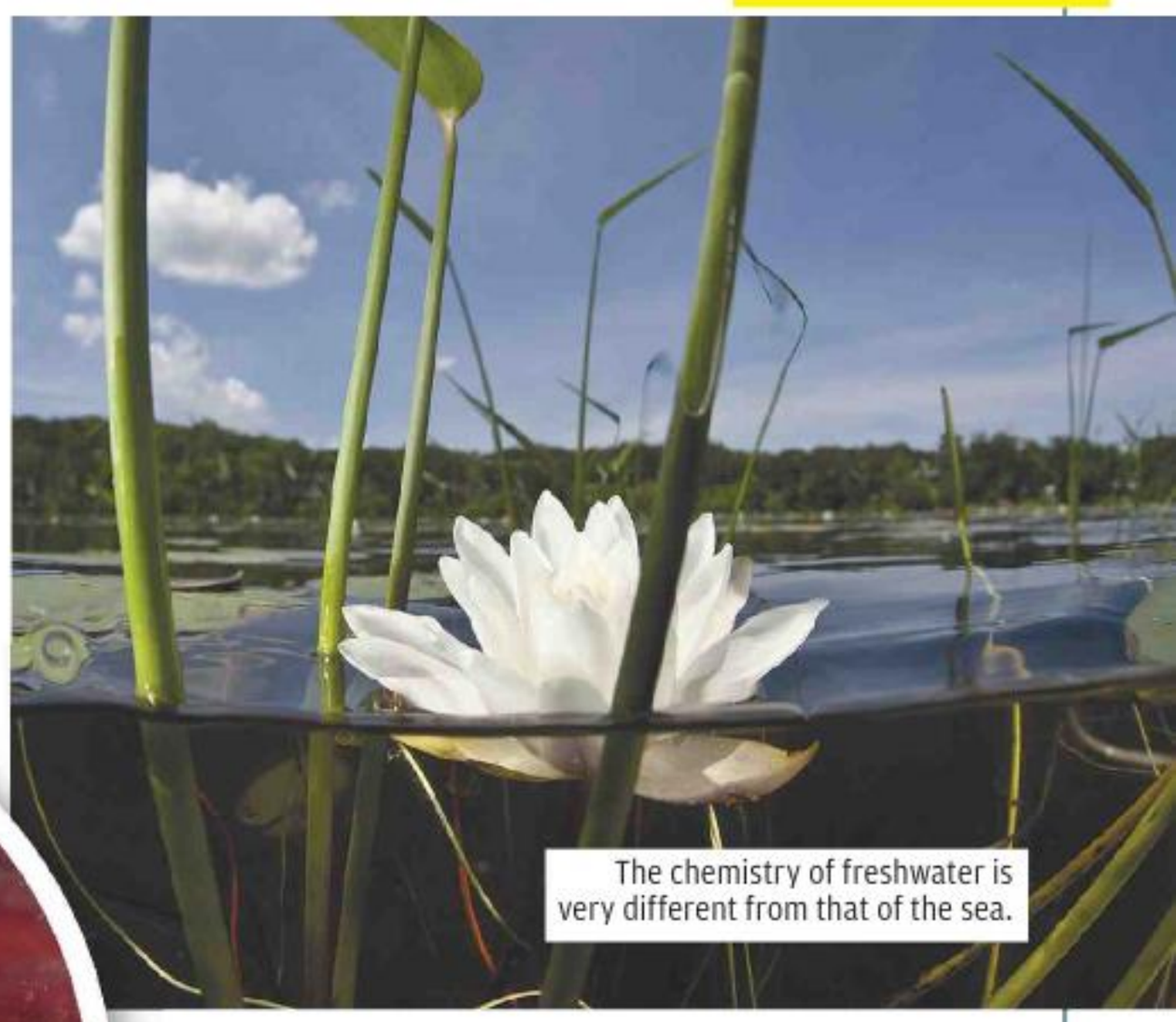


RIGHT The tea ultimately ends up being even in colour throughout the cup.

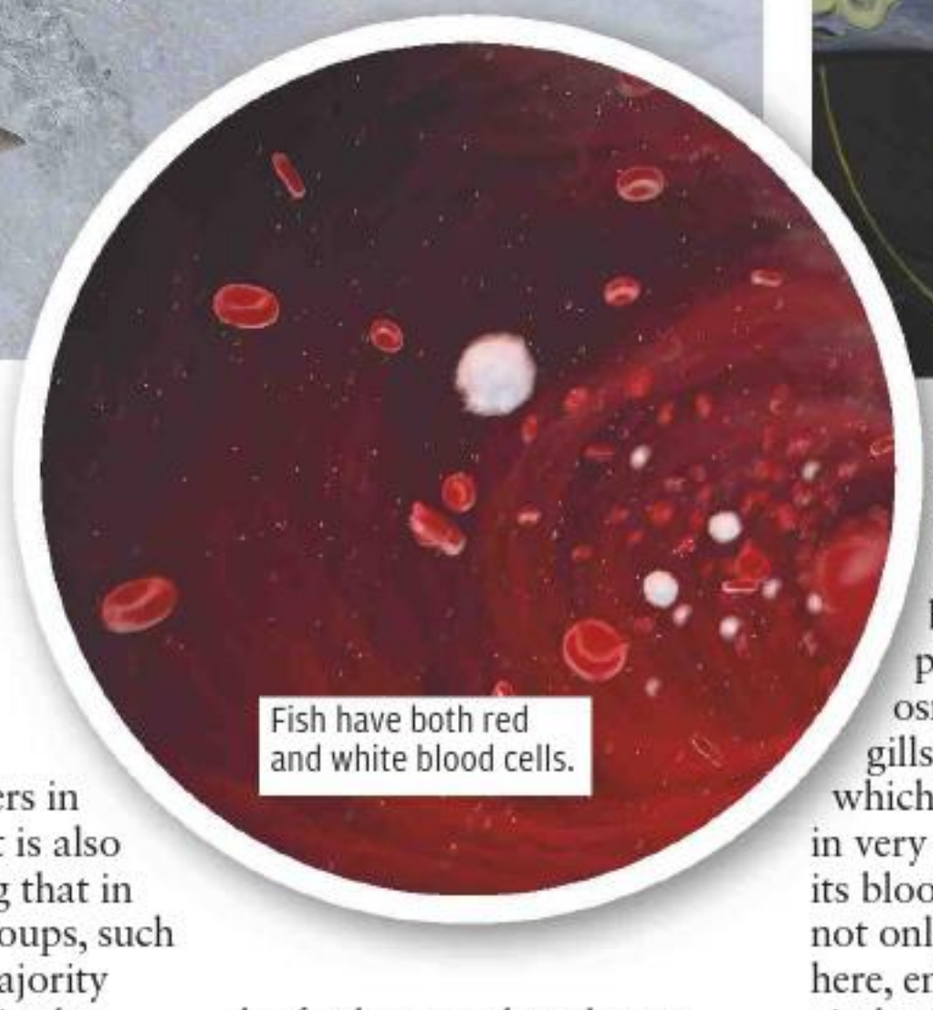
Reef fish face a very different challenge from their freshwater counterparts.



Salmon swimming up a river from the sea to their spawning grounds.



The chemistry of freshwater is very different from that of the sea.



Fish have both red and white blood cells.

At the other extreme, fish found on the world's coral reefs have evolved to live within a relatively narrow band of water chemistry parameters in this environment. It is also worth remembering that in the case of some groups, such as pufferfish, the majority of species may live in the marine environment, but a number can be encountered in estuarine waters and a few, such as the green pufferfish (*Tetraodon fluviatilis*) inhabit freshwater.

The freshwater situation

The challenge that freshwater fish face is essentially the opposite problem, compared with marine species. The relatively high concentration of salts in their bodies, compared with the lower level present in the water in which they swim, means that their body salts would tend to be depleted by osmosis, with freshwater entering the body to dilute the higher level of salt.

This exchange would ultimately have fatal consequences. In order to overcome the problem, freshwater fish produce large amounts of dilute urine, preventing the tendency of water to build up within their bodies. Although surrounded by freshwater, they do not increase their fluid load by drinking.

Key systems

The circulatory and urinary systems both have key roles to play in maintaining the balance within the body. Perhaps surprisingly though, the basic structure of the fish's urinary system does not differ greatly from that of mammals. It includes a pair of kidneys which remove unwanted products from the blood, and urine is stored in a bladder until excreted.

In terms of the fish's kidney, often referred to as the opisthonephros, this is quite different in structure from those of mammals. It is narrow and elongated in shape, and relatively large. The anatomy varies somewhat as well, between bony fish and cartilaginous species, such as rays and sharks.

Freshwater fish need to retain salts in their bodies, and so these chemicals are actively reabsorbed through the walls of the kidney tubules. Despite this, the fish's body still loses salts, partly as the result of osmosis occurring in the gills, where the water in which the fish is swimming in very close contact with its blood. This means that not only is water taken up here, entering the blood, but vital salts also diffuse out. In order to maintain the correct balance within the body, freshwater fish therefore have to have an active uptake of salt from the water.

The blood and heart

A fish's circulatory system includes the heart and blood vessels, and operates in a similar way to that of mammal, although it is simpler in structure. As in our own blood, there are both red and white cells present which function in a parallel way to our own. This means that the red blood cells carry oxygen around the body and transport carbon dioxide back to the gills, while white blood cells help to protect against infections.

The blood is pumped around the body by the heart, which is located in the lower half of the fish's body between the gills and pectoral fin. A fish's heart is less powerful than that of higher vertebrates, and has a relatively simple structure, being in the shape of an S-bend.

Deoxygenated blood returns from the body via the veins, flowing into the first chamber of the heart, known as the atrium, and then enters the thick walled, muscular ventricle. The contractions here force the deoxygenated blood back into the arterial system, via the gill arch arteries, and so through the gills where the blood is reoxygenated, before continuing its passage back around the body.

Lifestyle changes

A small number of species of fish, notably salmon and certain eels, are exposed to changing water conditions at different stages in their life cycle. Salmon return to freshwater to breed once they are mature, and then their young ultimately head to the sea, whereas the European eel, for example, undertakes what is in effect the reverse journey. The young eels, known as elvers, migrate up freshwater rivers from the sea, and spend their lives there, before returning back to the marine environment in due course in order to spawn.

Q&A

In each issue, our team of fish-keeping experts will be answering the questions that you want answered. **Why not email us with yours to pf.ed@kelsey.co.uk?**

Male goldfish, showing their distinctive white pimples. *PHOTO BY ADAM HOUGH.*

Q Can you tell me how to sex goldfish?

A You should be able to make out the line of white spots running down the leading edge of the pectoral fins, at the front of the male fish's body, extending over the gill plates just behind the head. These markings are only visible when male goldfish are mature and in breeding condition, so unfortunately, it is not always easy to distinguish the sexes when simply looking to buy goldfish.

But now onwards is a good time of year, as goldfish tend to come into breeding condition in the spring, particularly when housed in ponds. These pimples can be easily distinguished from the parasitic disease called 'white spot' since they are very localised and do not occur over the rest of the body.

Females usually start to appear more swollen, in terms of their body shape, when their eggs develop in their bodies. Male fish then start to show more interest in them as potential partners, nudging females enthusiastically on their flanks as a prelude to mating.

If you have not kept goldfish before, do remember that some varieties have a naturally more rotund body shape though, and this is not a sign that the fish is necessary a female full of spawn when making your choice! Some potentially serious medical conditions, including tumours, can also cause goldfish to develop a swollen body, irrespective of their gender, which is something else to bear in mind.

Q We've had a mixed collection of fish since Christmas, but they haven't shown any signs of breeeding yet. We would really like to have some young fish. Any tips?

A Firstly, be prepared to invest in further tanks if you want breeding is to be successful. Many species of fish can be described as bad parents, because they will eat their spawn and fry, if allowed to remain in the same aquarium. Even those such as guppies that give birth to live young may consume their offspring while they are small.

Females in this case can be transferred to a breeding trap in a separate tank prior to giving birth, while most egg-laying fish should be moved once signs of spawning are imminent. Then as soon as eggs have resulted, the fish can be transferred back to the main tank. It is a big help if everything is set up in advance, but do read up more about the specific breeding requirements of your fish.

Obviously, you need to be sure that you have a pair of fish. As the time for spawning approaches, so males become more colourful in many cases, while females swell with eggs.

ABOVE Daphnia (seen here highly magnified) and other livefoods are very useful conditioners to encourage breeding behaviour in many types of fish.

The level of activity in the aquarium rises, as the males pursue their intended mates. In some cases, they can become quite vicious, to the point that the fish may have to be separated, to prevent any fatalities. Take out the male, and reintroduce him at a later stage, once the female is likely to be closer to spawning.

There are a number of factors that may influence spawning activity, but increasing the level of live food such as water fleas in the diet is likely to be a significant factor. Changes in the water level, or more frequent water changes, mimicking the effects of flooding in the wild, can also trigger breeding activity. Lowering the water temperature slightly will also serve to duplicate the effects of a large influx of fresh water into rivers and streams following heavy rain.

Q What about rearing the young fish ?

A Commercial fry foods have simplified the rearing process for many smaller fry, although it is possible to set up cultures of infusoria (microscopic water creatures) quite easily. A tank outside partially filled with some hay or other vegetable matter should be sufficient. Very hot water should be poured into the container, which should then be

Mixed tanks in the home are great to look at, but they do not provide an ideal breeding environment for the fish.

The structure of a goldfish's digestive tract influences its feeding habits.

"The front part of the goldfish's small intestine has become swollen into a sac-like structure"

left to stand in a warm place.

Watch the water as it turns cloudy and then clears, over a period of perhaps 5-7 days, depending on the temperature. This then is the stage at which infusoria will be present. Bale out portions of the water containing the microscopic infusorians and then tip this into the rearing tank for the fry.

Another possibility as an early food can be cooked egg yolk, grated to a very fine consistency through muslin, but this is likely to pollute the water quite rapidly, so it is vital not to add too much to the tank at a single feed. Young fish need access to an almost constant supply of food, however, so they can eat and grow quickly and you need to be prepared to meet their needs.

The food offered to the fry depends on their size. Cichlids generally are relatively large on hatching, whereas labyrinth fish are very much smaller. One of the most widely used rearing foods for larger fry is brine shrimp nauplii. Eggs can be purchased from aquarist stores, and hatched in accordance with the pack instructions without great difficulty.

Hatching will take at least 12 hours or so, and sequential batches will be required to guarantee a supply of food for the young fry. Keep the brine shrimp eggs dry and away from moisture in an airtight vessel, because otherwise their hatchability could be badly affected. There are also commercial fry foods available that have been used as a food for young fish for many years.

Since hundreds of fry may result from a single spawning, you will need to have additional tanks available, so you can separate the young fish into groups as they become larger. Otherwise, not only will their development be curtailed, but also, the risk of disease will be significantly increased by overcrowding.

LEFT Discus actually produce a special secretion on their bodies, known as 'discus milk', which their fry feed on at first.

Q Why has one of my fish been swimming around with what appears to be part of its intestinal tract hanging out, which then disappeared?

A The likelihood in this case is not that your fish suffered a prolapse, but instead, what you saw was simply a sign that it is constipated! This is not that uncommon, particularly when you first acquire fish, and it can be a reflection of a change in diet. It can also afflict older individuals.

The problem usually resolves itself, as you found, but if it persists, try offering your fish an occasional slice of cucumber, or peas with their skin removed, which should act as a laxative. Depending on the normal diet of your fish, so the occasional use of fresh live food can be beneficial too. Also, be prepared to change the food through the week, not offering the same brand every day.

Age may be a factor in some instances. Sometimes, elderly fish that have been in your collection for a long time can prove to be more susceptible to this problem. Check the water temperature too, so as to ensure that the temperature is not too cold.

This guppy is showing obvious signs of constipation.

Q Is it true that goldfish do not have a stomach?

A Yes and no! Instead of a stomach, the front part of the goldfish's small intestine has become swollen into a sac-like structure. Food will accumulate here before it starts to pass through the intestinal tract, where it is digested.

Goldfish will naturally eat frequently and often, but if you overfeed them, the uneaten food will simply pollute the water in the aquarium. Only offer as much as they will consume within two or three minutes, several times every day.

Healthy goldfish are invariably hungry, being ready "snackers", eating at almost every opportunity. If you feed them at the same times every day, it will not take long until they come to recognise when a meal is imminent, and will be there waiting for their food.

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FISH FOCUS

Tetra

German blue ram
Mikrogeophagus ramirezi

As domestication of aquarium fish has taken place, so strains of different colours and even various fin types have been created. This is especially evident in the case of those fish that are most frequently bred, such as livebearers, but is also apparent in the case of other groups too, such as cichlids.

The blue ram is one such variant, being a colour form of Ramirez's dwarf cichlid. This species is found in the wild in the Orinoco river in the extreme north-west of South America. These fish, like many cichlids, are often quite boisterous and can definitely be rather aggressive on occasions too, in spite of their relatively small size. Adult pairs are best kept separately, and they are likely to spawn on flat rocks, subsequently guarding their eggs and also their offspring for a time once they hatch.

Divide the aquarium with plenty of plants, as well as rocks and other decor, creating suitable retreats for these cichlids. Water quality is vital, as they are very intolerant of dissolved pollutants, including nitrate. They require soft water conditions, with a pH around 5 and a water temperature between 25.5-29.5°C (78-85F).

Key info:

Grows to:
7.5cm (3in)

Water chemistry:
pH 5

Water temp:
25.5-29.5°C (78-85°F)

"Adult pairs are best kept separately, and they are likely to spawn on flat rocks, subsequently guarding their eggs and also their offspring for a time once they hatch."

The checkerboard lamprologus (*Neomanprologus caudopunctatus*) – a Lake Tanganyikan species.

Rift Valley cichlids

Having worked for many years as the curator of a zoological collection in Scotland, **Bill Lowe** has long been fascinated by the beauty of the many species of cichlid originating from Africa's Rift Valley.

This amazingly diverse group of cichlids originates from the lakes of the Rift Valley in East Africa, which were formed as a result of a huge tectonic fault in the Earth's crust; this area was torn apart about 40 million years ago by the separation of the geological plates in this part of the world.

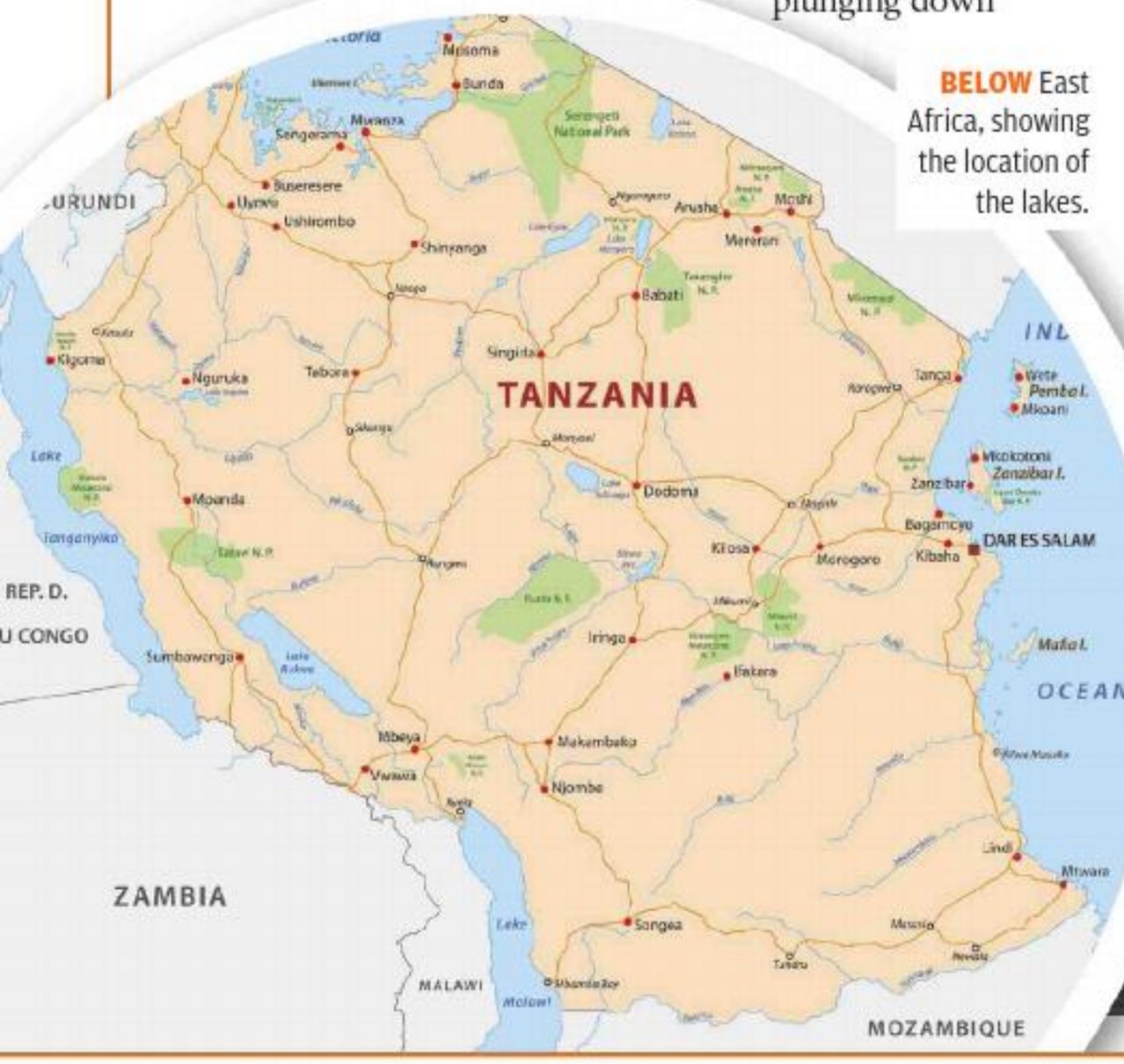
Unique environments

In the resulting depressions, a series of more than 20 different lakes ultimately formed, of which the largest are Lake Malawi and Lake Tanganyika. Lake Tanganyika formed first, around six million years ago, followed by Lake Malawi about four million years later. Both of these lakes are very deep, plunging down to some 1500m (nearly 5000ft) in the case of Lake Tanganyika, which is also the longest lake in the world, stretching for a distance of about 660km (410ml).

The species of cichlid that are found within each of these lakes are totally different, having evolved in isolation from each other. No-one knows how many species exist in these lakes, but what is beyond doubt is that there are many more yet to be discovered. As an example, Lake Malawi is home to some 500 recognised species, with scientists estimating that there could be anywhere from 1000-1500 in total resident there.

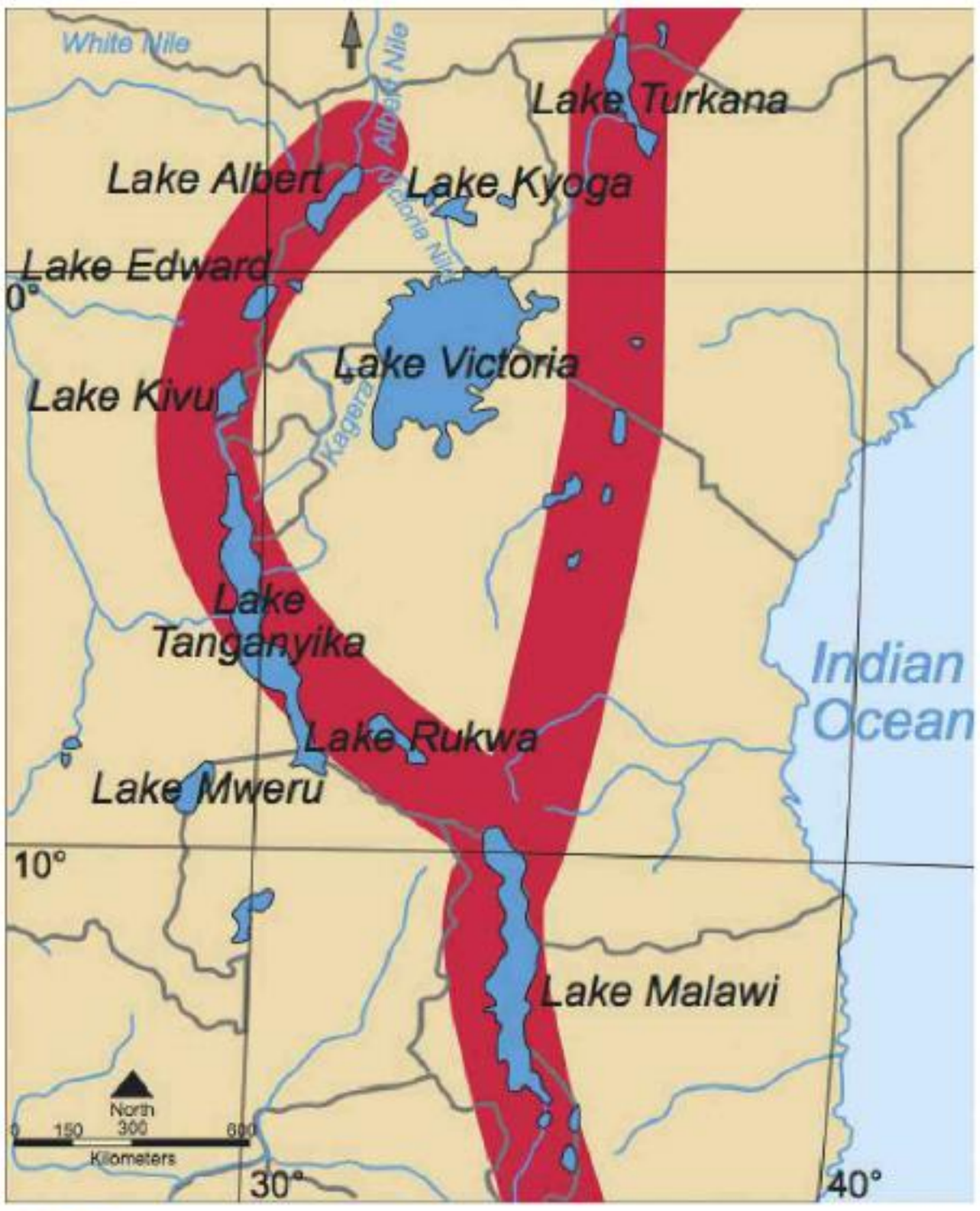
Lake Victoria is different from these other two lakes, being much shallower as it is not located in a deep trough. In fact, it has been suggested that it may even have dried up completely some 12-15,000 years ago, which would mean that its cichlid population is very recent. These fish are less commonly kept.

Aside from the diversity in their cichlid populations, which are the dominant group of fish, what makes these lakes unique is their strongly alkaline pH levels – in the case



BELOW East Africa, showing the location of the lakes.

BELOW The bigger lakes in the Rift Valley, such as Lake Malawi seen here, are like inland seas, such is their size.



ABOVE Lakes lying in the deep western and eastern troughs of the Rift Valley, highlighted in red, with Lake Victoria, located in-between them. *MAP COURTESY KIMDIME69.*

A photograph of the Rift Valley lakes, taken from space. *PHOTO COURTESY NASA.*

Lake Malawi cichlids represent some of the most colourful of all freshwater aquarium fish. Their beautiful colours are almost as dazzling as those of many marine species. Strangely enough, many of the Rift Valley cichlids fill the same niches as similar species such as the damselfish, that are to be found on coral reefs. The activity of the damselfish serves to maintain the cleanliness and general health of the coral by removing particles of algae. Many cichlids graze on the algae growing on the rocks in the clear water around the edge of the lakes.

Likewise, there are certain species of cichlids which act very much like cleaner fish, helping to rid other species of parasites.

This latter behaviour is something which is almost unknown in other freshwater environments, but again, is not uncommon in a reef environment.

The algal-covered rocky areas – an example being seen here - provide a key habitat and food source for cichlids inhabiting the shallower areas of Lake Malawi. Rockwork needs to feature prominently in their tank design.

of Lake Malawi, this figure is 7.7-8.6; Lake Tanganyika has a pH of 8.6-9.2 and that of the water of Lake Victoria registers in the range between 7.1-9.0. It is essential that you should replicate these figures as closely as possible in your aquarium so that cichlids originating in these localities will hopefully thrive.

There are many different species of cichlid in each lake occupying the varying habitats, adapting to virtually every possible ecological niche. The huge diversity includes bottom-dwelling fish, those occuping the mid-water areas and surface dwellers. Those found near the surface in open water tend to be larger and often highly predatory. They are therefore not really as suitable for the aquarium enthusiast as others from different areas of the lake.

Suitable choices

Bottom-dwelling species that naturally inhabit the shallower waters are the most colourful and commonly-kept. However, you might also want to include some of the mid-water species in order to add interest as these cichlids will utilise this space, just as they do in the lake itself. If you are interested in breeding your fish though, then you need to be prepared to specialise, and this is also likely to entail having extra tanks and equipment available, as always.

There are similarities between damselfish like these sergeant majors associated with a coral reef, and African lake cichlids.

CONTINUES ON THE NEXT PAGE »

ABOVE Cichlids seen swimming near the surface in Lake Malawi.

Temperature

I would aimed to maintain the temperature of the water in the park's aquariums housing Malawi cichlids at around 26°C (78°F). This figure should always be in the range of 22°C (72°F) up to a maximum of 29°C (85°F). As is the case with all aquariums used for housing tropical fish, check both your heaterstat and your thermometer. I think it is always a sensible investment to have a spare heaterstat available, in case one breaks down or you need to set up another tank for some reason.

If chilled, fish become stressed and, consequentally they are susceptible to all manner of diseases, some of which can prove to be fatal – this rule applies to all tropical fish. Just make it a simple rule to check your thermometer readings at least once a day.

Some of the larger cichlids from this part of the world, as elsewhere, can be disruptive in an aquarium, and so it is is a good idea to invest in one the unbreakable style of heaterstats now on the market, rather than the more traditional glass design.

Water chemistry

Given the right conditions and by providing the largest tank you can accommodate, the maintenance of these cichlids should be quite straightforward, but bear in mind that you need to be prepared to specialise in these fish. The water chemistry that they require is such that they cannot be housed as part of a typical mixed aquarium.

As the pH levels of the each of the lakes are different, it is advisable to stick to keeping species which originate from one particular lake on their own, rather than trying to mix them. However, it is quite possible – with care – to keep different species of cichlid from the same lake in a single tank, provided that there is sufficient space, and they are compatible with each other.

Maintaining the pH levels at the correct level should not present any real problem, as there are now commercial alkaline buffer products available, as powders or in liquid form, so you can establish and maintain the correct pH level, if your

What's in a name?

- The names of lake cichlids can appear rather confusing, especially when you are starting out. The example seen here is a blue regal peacock cichlid "Mbenji", with the scientific name of *Aulonocara stuartgranti*. This description of "Mbenji" refers to the island of this name located in the southern part of Lake Malawi, and is used to signify that this is the area of where this particular variety originated.

- Designations of this type are important, because members of the same species from elsewhere in the lake can look very different, with the individual populations being quite localised. As far as the scientific name is concerned, this relates to Stuart Grant (1937-2007), a man who helped to pioneer the study and breeding of African lake cichlids, and supplied many different species to fishkeepers overseas.

A group of frontosa blue Zaire "Moba".

Java fern. SOURCE PD.

tapwater is unsuitable. Generally, if you live in hard water areas of the country where your kettle furs up, then this suggests that your water is likely to be suited to these fish, but obviously, you will need to check this with a test kit.

Be prepared to leave this to stand for 24 hours, so any carbon dioxide picked up as it passes through the pipework can come out of solution. This will give you a more accurate reading, as you are likely to find that after this period, the pH will actually be higher, and so buffering may not be required.

Set up the tank correctly from the outset, in terms of pH, based on the conditions where the fish are being kept, and you should have no problems when it comes to settling them in to their new home. What you should never do is add a pH buffer direct to the aquarium where the fish are being kept, as this could easily be fatal for them. Even a smaller adjustment on the pH scale marks a significant biological change.

The choice of plants that will grow in this type of environment is somewhat restricted, partly because some of these cichlids will uproot plants as well. But Java fern (*Microsorum pteropus*) is a good choice for these surroundings, proving to be both tough and hardy.

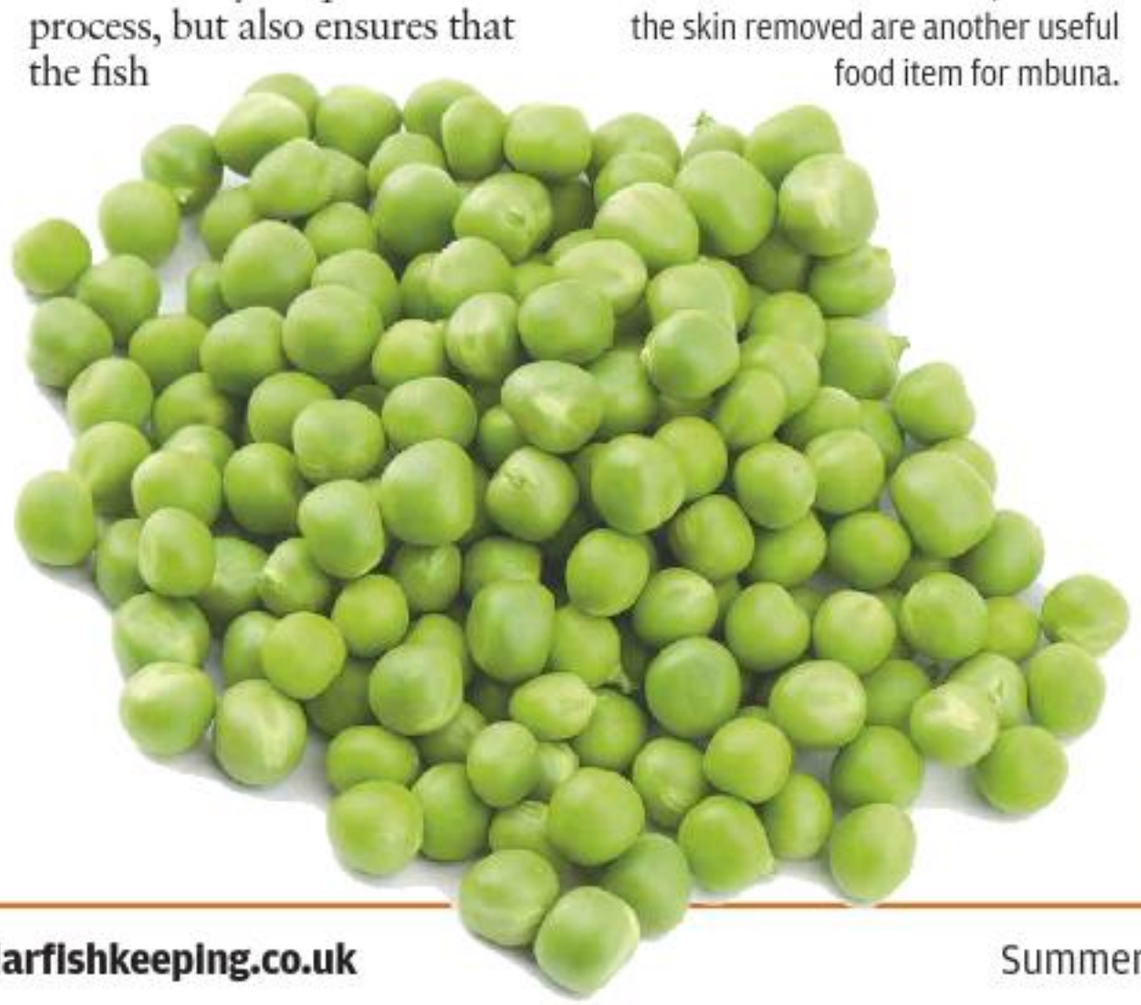
Water changes

It is also sensible to invest in a suitable container where you can prepare water in advance for a weekly water change. This not only simplifies the process, but also ensures that the fish will be subjected to minimal stress, if the fresh replacement water corresponds in terms of its temperature and pH to that which is being replaced.

It is worth bearing in mind that tank-bred African lake cichlids are more adaptable than those which have been wild-caught - but only up to a point. The small quantity of water in an aquarium is quite different from the huge volume in the lakes where these fish occur in the wild. As a result, just like marine fish living on a coral reef, Rift Valley cichlids are not adapted to survive any build-up of pollutants – even nitrate – in their tank water, and so water quality is paramount.

It is often recommended to use coral sand in the aquarium of these cichlids, along with limestone rocks, to help the buffering of the water. However, what is often overlooked is that this only works under acidic conditions, where the pH is below 7. This will not apply in the case of tanks for Rift Valley cichlids however, as the pH has to be higher.

BELOW Fresh or defrosted peas with the skin removed are another useful food item for mbuna.



Feeding

Feeding these cichlids is quite easy, as they live quite happily on the various proprietary brands of specialist foods available, which are adapted to meet the requirements of such fish. A certain amount of greenfood should be offered and a good growth of algae within the tank will be most beneficial, for mbuna cichlids in particular. Defrosted peas (without the skin) and even pieces of lettuce will be eaten as treats.

Foods with spirulina should help to enhance the colouration of these fish naturally, but variety in the

CONTINUES ON THE NEXT PAGE »

LEFT A group of Rift Valley cichlids can make an impressive display in a spacious tank in a public aquarium.

BELOW Compatibility can be a problem, as shown by these zebra cichlids.

diet is also important. You can also acquire specifically-formulated pellets designed to enchance specific colours, such as red or green in these fish.

Bear in mind that the feeding habits of Rift Valley cichlids are quite diverse, allowing members of the group to utilise different sources of food within the lakes where they live, and thus avoid competing with each other. Some are carnivorous and need to be fed accordingly, taking both fresh items such as shrimp, and also suitable cichlid pellets.

Correct feeding is vital with these fish, because they can be vulnerable to bloat, which is often fatal, causing them to swell up and lose their ability to swim normally. Stick to tried and tested foods, and feed them little and often – ideally a couple of times a day. Flaked variants are particularly useful for fry, as this type of food crumbles up very easily, to make a useful rearing food.

On a cautionary note, where most people go wrong initially with fish keeping, after setting up their tank carefully, is to overfeed the occupants. A little and often is the answer. Your fish should always be alert and looking for food; it is much better to underfeed than to overfeed. Several small feeds a day are to be recommended – and never one large meal! Fish are not like dogs. Any food which remains uneaten in the tank will quickly pollute the water and overwhelm the filtration system, often with disastrous consequences.

Reducing the risk of aggression

As aggression can be a problem with most of these cichlids, it is probably best to purchase at least three or five members of the same species at the same time. This lowers the risk of one fish constantly picking on another, particularly if you have an odd number.

Being persistently harassed will lead to a fish becoming stressed and its immune system will be threatened. As with all creatures, stress can kill, so try to miminise the risk to fish in your aquarium at all times. If a certain individual is proving to be particularly aggressive towards its companions, transfer it to another tank. It may be possible to reintroduce it successfully to the group at a later stage, as some individuals do become more aggressive if they are keen to spawn.

"Correct feeding is vital with these fish, because they can be vulnerable to bloat, which is often fatal"

Aggressive tendencies can also be further reduced if the aquarium is designed with strategically placed rockwork that allows the fish to escape out of sight of each other at times.

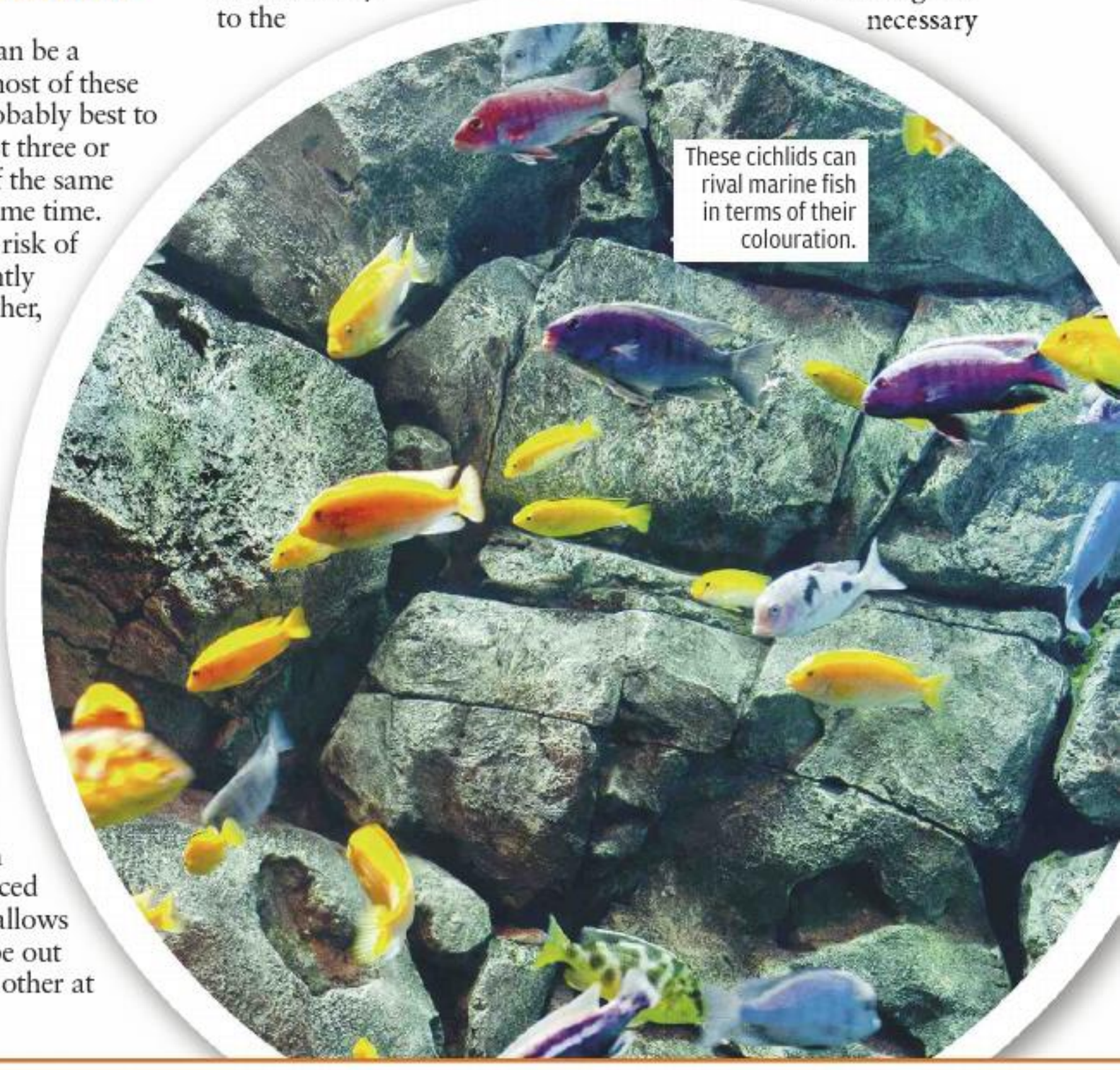
People's misplaced perceptions

Working in a public aquarium, I had to be aware that the fish tanks needed to be kept in immaculate condition. This was not essentially for the benefit of the fish, which would be quite happy in cloudy water because, in the wild, the water is hardly ever crystal clear.

However, from the point of view of the general public wishing to gain a good view of the occupants of each tank, it was important to maintain the water in the aquariums so they could see the occupants easily.

Many Rift Valley cichlids will browse on algae, which serves as an important food source for them. I remember allowing one tank to become slightly overgrown with algae to allow fry to develop, but the complaints rolled in from members of the general public visting the establishment.

I was subsequently taken to task by the director of leisure and recreation for not maintaining the necessary



These cichlids can rival marine fish in terms of their colouration.

Bear in mind the size of your aquarium, before selecting your cichlids. Some will grow much bigger than others. Always research a particular species carefuilly at the outset, before deciding that it is the right choice for you.

DID YOU KNOW?

There are two main reproductive methods evident amongst the different cichlids to be found in the lakes - there are mouthbrooders and substrate-spawners. The former mainly originate from Lake Malawi and Lake Victoria, while the latter hail, in the most part, from Lake Tanganiyka, although there are representatives of both groups to be found in each of the lakes.

levels of cleanliness which were expected by the general public. I would always try to explain to enquiring visitors why I had allowed this to happen, but frequently my explanations were only met with disbelief!

For some reason, many people imagine that water in its natural state is always crystal clear. As to why they should think so, I have no idea. Have they never had the opportunity to look into a local river, or pond and see for themselves just how murky the water will often appear? Also of course, clear water is not the same as clean water – invisible pollutants such as ammonia and nitrite can kill fish, even though the water itself may appear sparkingly clean.

In the public aquarium, I also had the problem of people banging on the glass fronts of the aquarium and so, with many species I was wishing to breed, I had to keep them out of sight of the general public, in off-display localities.

I remember one visitor explaining to his wife and children, as they were marvelling at the colours of the fish in one particular tank, as to how they were saltwater species and lived in the coral seas around the Equator. Yes, they do indeed live in this part of the world - he got that bit right. However, the tank that he and his family were looking at was one which was 12ft (3.6m) in length, 4ft (1.2m) high and 4ft (1.2m) wide. It contained an assortment of Malawi cichlids and certainly no tropical marine species!

I did not want to make the man feel foolish in front of his family, so I did not have the heart to correct him – although perhaps I could have drawn his attention to the tank label!

Points to consider

Rift Valley cichlids only became available to hobbyists from about the 1970s onwards, and knowledge about them has increased significantly over recent years. Things have changed dramatically since those days when I was working in a public aquarium.

Now you can purchase everything you need to keep these cichlids healthy and in peak condition but, in my day, you often had to improvise. However, one advantage I did possess was the sheer size of the aquariums that I had to work with. In general, large tanks make everything so much easier - the larger the volume of water you have to work with, the better.

I was extremely fortunate to have such large tanks at my disposal, so I could keep many species together that normally could not be housed in close proximity to one another, if I only had much smaller tanks for them to occupy.

In a typical small aquarium measuring, say, only 61cm (2ft) in length, it would certainly not be advisable to mix so many different specimens together. In my opinion, you should not try to keep a variety of Malawis in anything smaller than an aquarium measuring 122cm (4ft) in length – otherwise, you are simply asking for trouble. Disagreements will be almost inevitable. However, if all you can accommodate is a 61cm (2ft) tank, restrict the occupants to just a few small individuals that are likely to prove to be compatible.

ABOVE The young frontosa fry can just be seen here in their mother's mouth. *PHOTO COURTESY MATTHEW MILLER.*

Breeding observations

I always found that is was interesting to listen to members of the general public discussing the parenting skills of the mouthbrooders, especially as the majority of visitors to the aquarium had no idea as to what was really happening. When a member of the public noticed a cichlid seemingly swallowing a large school of fry, the comments ranged from the likes of "Oh,

CONTINUES ON THE NEXT PAGE »

LEFT The diversity of colours existing in the case of this species are reflected here.

its feeding habits, eating algae which grows on the rockwork here. Active by nature, the cichlids grow to about 15cm (6in), and tend not to be aggressive by nature.

This is a mouth-brooding species, and a single male should be kept with several females for breeding purposes. The yellow egg spots on the anal fin of the male tend to be brighter in colour than those of females, allowing the sexes to be distinguished.

Changing colour

Their colouration can be influenced by their surroundings as well, and they can change colour. I remember the first time that I saw this many years ago. I thought that I had lost a couple of fish, only to discover that I had gained two corrresponding individuals but with completely different colouring.

that's disgusting!" to "These fish must be starving as they are eating their own babies!".

Once again, I would explain exactly what was happening and that this was quite normal behaviour. The vast majority of members of the public were happy with the explanation I offered but, on certain occasions, I was told that I did not know what I was talking about.

Nevertheless, at times working so closely with the general public was extremely entertaining. I never ceased to be amused by some of the comments which I overheard from the service passage behind the tanks, especially as most visitors had no idea of my presence in their midst.

Apart from the unusual parenting methods of the mouthbrooders, the substrate-spawners are just as interesting, especially when you watch them constructing their nest, or cleaning the surface of a large rock for spawning purposes.

Some suggestions

There are so many different species suitable for the aquarium that it is impossible to list them all in one article, quite apart from all the different natural colour variations of species that exist. There are some fish stores that tend to specialise in Rift Valley cichlids, and it is worth seeking these out, in order to gain a better insight into the range of different species that are available.

Here I will stick to some of my personal favourites:

Variations in zebras

The zebra Malawi cichlid (*Pseudotropheus zebra*) occurs in many natural colour morphs, ranging from electric blue, through mottled yellow and brown, via orange to a pale yellow. Blue individuals appear to be most common. This species is found along the western side of the lake, and is predominantly vegetarian in

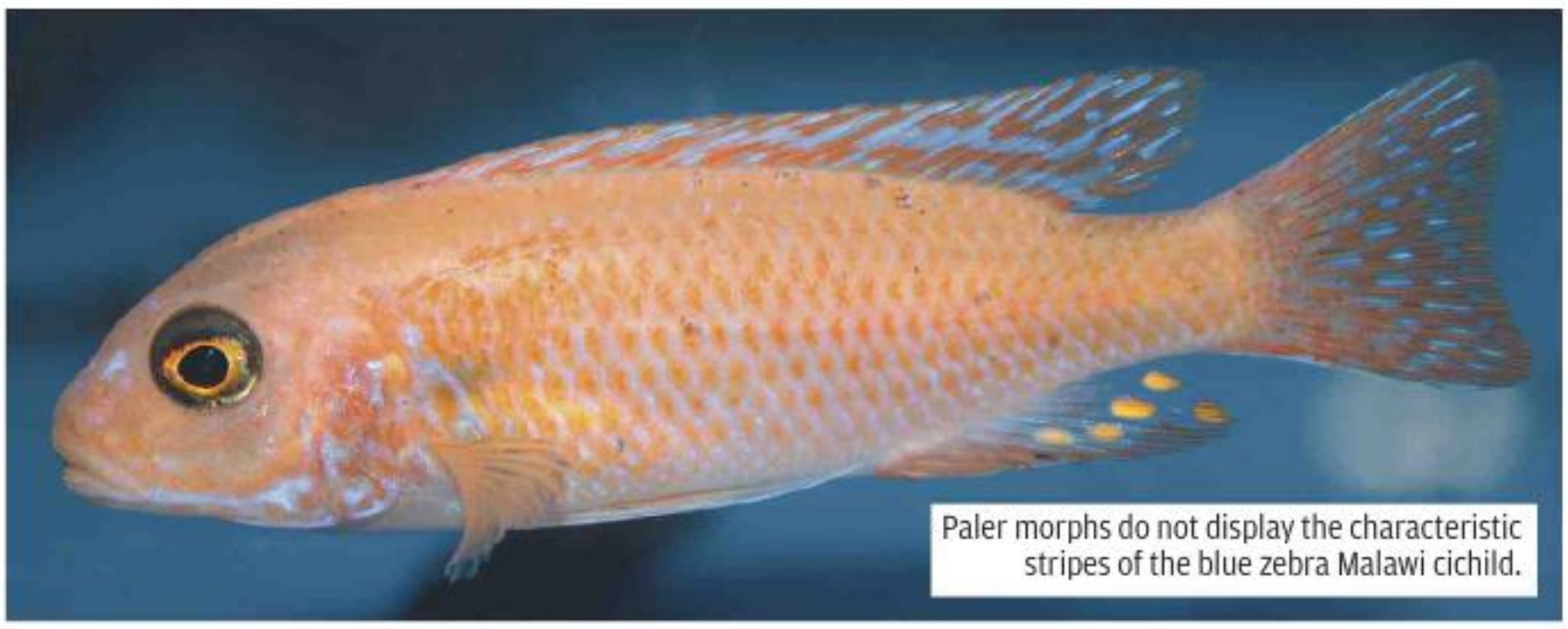
Brichard's lamprotogus (*Lamprologus brichardii*). PHOTO COURTESY PHOTOMAX AT THE GOLDFISH BOWL

LEFT The Malawi golden cichlid (*Melanochromis auratus*) is a stunning smaller cichlid, found in the shallow waters around the edge of Lake Malawi. Males range in colour from gold with black stripes to almost black with an irridescent blue line on their bodies.

Flowing fins

Brichard's lamprologus (*Lamprologus brichardii*) is an extremely elegant species, although its coloration is perhaps not as spectacular as many other species. What it lacks in colour, however, it more than makes up for in sheer elegance. It has long flowing fins that make it a most wonderful addition to any aquarium. Those with the most highly developed fins will be males; females tend to have slightly less elaborate fins.

They live in groups outside the spawning period, but then become territorial, and will



Paler morphs do not display the characteristic stripes of the blue zebra Malawi cichlid.

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Local Retailer Guide

The lemon cichlid (*Lamprologus leleupi*), *PHOTO COURTESY PHOTOMAX AT THE GOLDFISH BOWL*

LEFT Trewavas' cichlid (*Labeotropheus trewavasae*) *PHOTO COURTESY PHOTOMAX AT THE GOLDFISH BOWL*

probably probably require separate accommodation at this stage, unless their tank is very large. Again, this species is a cave spawner, and so items such as clean flowerpots should be provided for this purpose. It is perhaps a little more delicate than some species, and more difficult to maintain in good condition, but is well-worth the extra effort.

What are mbuna?

This is a common description used for a group of haplochromine cichlids that are found in Lake Malawi. The word comes from a local dialect, and is pronounced as *em-boon-na*, which literally means 'rockfish'. It does not refer to a specific species therefore, but the habits of those species of cichlid that live in association with rocks, and tend to be quite territorial by nature.

Beautiful and golden

The lemon cichlid (*Lamprologus leleupi*), originating from Lake Tanganyika, is a truly stunning golden-coloured fish, growing to a length of about 10cm (4in) long. There are sometimes traces of dark markings on the dorsal and other fins. It is unusual in that it has eyes that are rather larger than normal in size, as well as large lips. It is a superb addition to any aquarium.

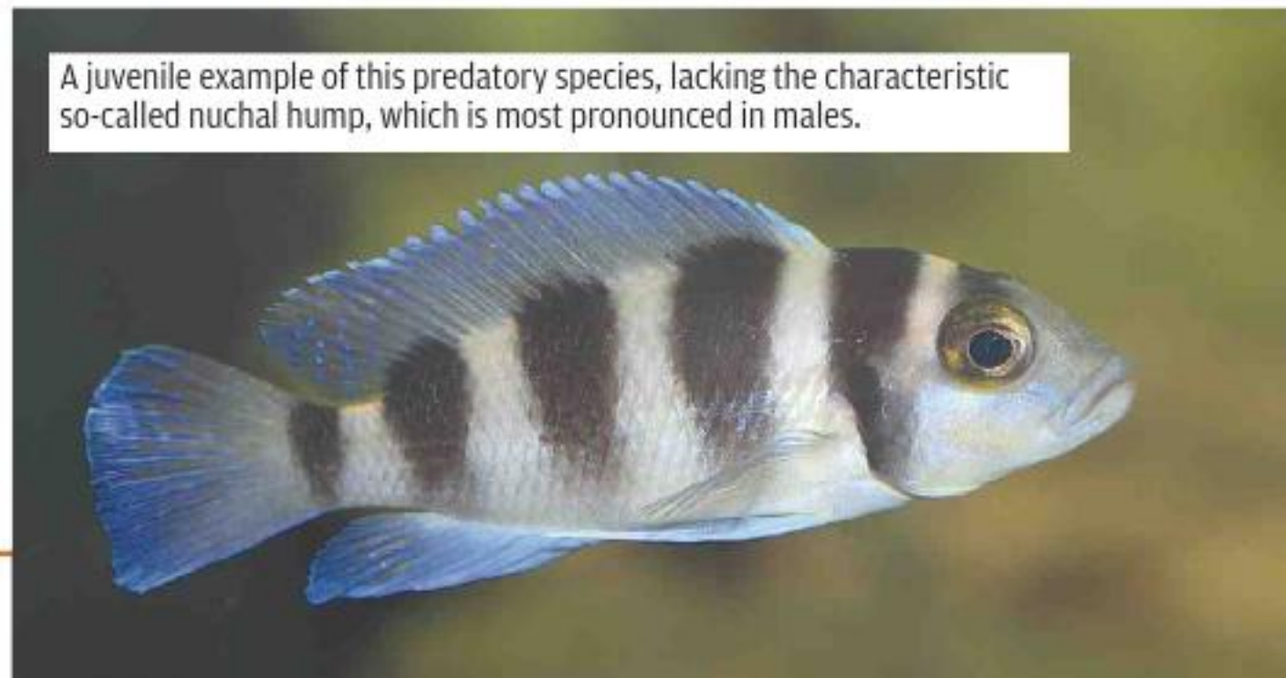
Males have longer pelvic fins than females, and they should be kept in pairs. They will often spawn within a flowerpot. Be sure to remove the young by the time they are six weeks old, because these cichlids are predatory by nature.

Trewavas' cichlid (*Labeotropheus trewavasae*) gives some idea of the difficulties inherent in identifying and classifying Rift Valley cichlids, as it occurs in more than 40 different geographical and colour forms. It tends to be a glorious blue coloured fish with darker bars and a reddish dorsal fin, in the case of the "Red Top" variant. The mixture of these colours is quite wonderful. It has a protruding upper lip, giving the fish a somewhat comical appearance.

No easy names!

Many Rift Valley cichlids are unusual in not having common names, and instead, they are often referred to under an Anglicised form of their scientific name. They include *Cyphotilapia frontosa*, better known in the hobby simply as frontosa. This is a rather strange-looking fish, developing the typical swelling associated with mature cichlids from other parts of the world as well, known as a nuchal hump.

Adults are slightly less colourful than youngsters, being greyish-brown, with off-white stripes. This is one of the larger species of Rift Valley cichlid though, and so should only be chosen if you have a large tank, of at least 550l (150gal) as they can easily



A juvenile example of this predatory species, lacking the characteristic so-called nuchal hump, which is most pronounced in males.

An adult example of *Cyphotilapia frontosa*.

ABOVE *Julidochromis marlieri*, displaying the narrow and relatively elongated body shape that typifies this particular genus of cichlid.

Julidochromis cichlids. *PHOTO COURTESY PHOTOMAX AT THE GOLDFISH BOWL*

grow to 35cm (14in). They should be kept in groups of at least three individuals, as they are natural shoalers.

It is particularly important to make sure that all tank décor is securely positioned as well, and heaters should be protected using a special heater guard to minimise the risk of damage. Alternatively, a better option these days – for these and similarly large fish – is to use one of the unbreakable heater-stats that are now being marketed, as mentioned previously.

Julies

Julidochromis cichlids are restricted exclusively to Lake Tanganyika, with the Julie (*Julidochromis ornatus*) itself being one of the more colourful members of the group. It is yellow with dark brown and white stripes. Do not rely on differences in colouration when it comes to determining pairs of this species though. Unfortunately, as in the case with many Rift Valley cichlids, colour differences in this case tend to be caused by the distribution of the fish, rather than being a reflection of their gender. Those from southern areas are paler, with yellow areas tending to be replaced by ivory markings.

Julies belong to the cave-spawning cichlids, seeking out suitable underwater retreats for this purpose, so again, artificial caves or clay flowerpots should be provided for this purpose. The females only lay batches of around 50 eggs at a time, but will do so quite frequently, if they are well-fed. They will eat both flake and livefoods, with the latter being particularly helpful when it comes to triggering spawning behaviour.

Other species that you may encounter include *Julidochromis dickfeldi* which is similar to ornatus, but with bluish fins, while the southern form of this species is a rather beautifully spotted fish. There is also *Julidochromis marlieri* which is a combination of dark brown with yellow and whitish markings.

Shell-dwellers

One of the smaller and very interesting cichlids that you can include in your aquarium is a shell-dwelling species from Lake Tanganiyka. *Neolamprologus brevis* is not one of the most brightly coloured of the Rift Valley cichlids, but its habit of nesting in shells makes it fascinating to watch.

Unlike most of the other shell-dwellers, this species is often to be found living in areas with low shell densities, so individuals have come up with a living arrangement that is quite unique – both the male and the female share the same shell! Males can be easily identified by their larger size.

In summary

The list of cichlids from these lakes is endless and provided your aquarium is large enough, you can mix a number of the species with ease, but take care not to include any of the more aggressive species with those which are relatively non-aggressive.

Your aquarium for these cichlids needs to have plenty of large rocks and a gravel base. If you can arrange the rocks into different caves and hiding holes, this will make your fish feel more at home and secure. However, be careful to make sure that the rocks are secure, especially in an aquarium housing large species, so they cannot fall down and injure any of the occupants of your aquarium.

Malawi cichlids come in a vast variety of different colours and, in my opinion, a group housed in a suitably-sized aquarium can look quite stunning. Maintain the correct water conditions and provide your fish with suitable surroundings, and they will reward you with a display almost comparable to any coral reef. They offer the advantage that, in general, they are much easier to maintain than marine species too, and with the additional positive point that you may be able to achieve breeding success with them as well.

Neolamprologus brevis. *PHOTO COURTESY PHOTOMAX AT THE GOLDFISH BOWL*

You can also see the critically endangered Mekong giant catfish (*Pangasianodon gigas*). Is a herbivore, which lacks both teeth and the barbels, which are characteristic of most catfish species. It can grow up to 3.2m (10.5ft) long and currently is regarded as the world's largest freshwater fish.

ALL PHOTOS BY THE AUTHOR.

Asia's first "River Safari"

In recent years, almost every self-respecting city seems to have opened a public aquarium, if it did not have one already! However, now the city-state of Singapore has gone one step further, by creating a so-called "River Safari" that is devoted entirely to freshwater ecosystems. **Victoria Neblik** reports.

Singapore Zoo has long had a reputation as being home to one of the world's more impressive, innovative and more animal-friendly zoos. In 1994, the zoo expanded its activities to open a "Night Safari", which was billed as the world's first night time zoo, and it rapidly became one of the country's leading tourist destinations. So, when the zoo unveiled a new park – called the "River Safari" – which was opened officially at the end of February this year, *Popular Fish Keeping* naturally took an interest: would the new attraction rival the zoo's past successes?

Freshwater fish often seem to get overlooked in favour of their often more colourful marine cousins, so it is great, at last, to be able to visit an "aquarium" devoted solely to freshwater ecosystems. By way of introduction, the River Safari is themed around eight of the world's great rivers. It features the Mississippi and the Amazon, reflecting the New World; Africa's Nile and Congo; the Ganges, Mekong, and Yangtze, to be found in Asia, and Australia's Murray River.

Exhibits are organised around a broadly circular path, with the second half of the exhibition being devoted to the Amazon. As you might expect for a big budget attraction at a world famous zoo, a lot of thought and money has clearly been invested in the display layout, to the point of exhibits being embellished with set design. There are enormous models of a freshwater stingray and giant carp suspended from the roof at one point, beside a tank with live specimens that are nearly as large.

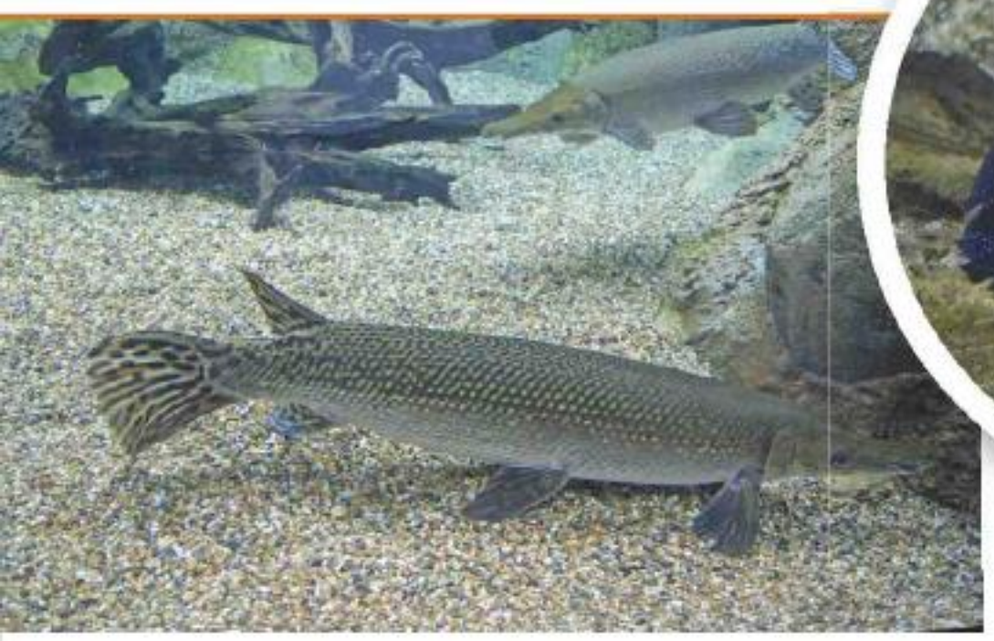
Fish exhibits

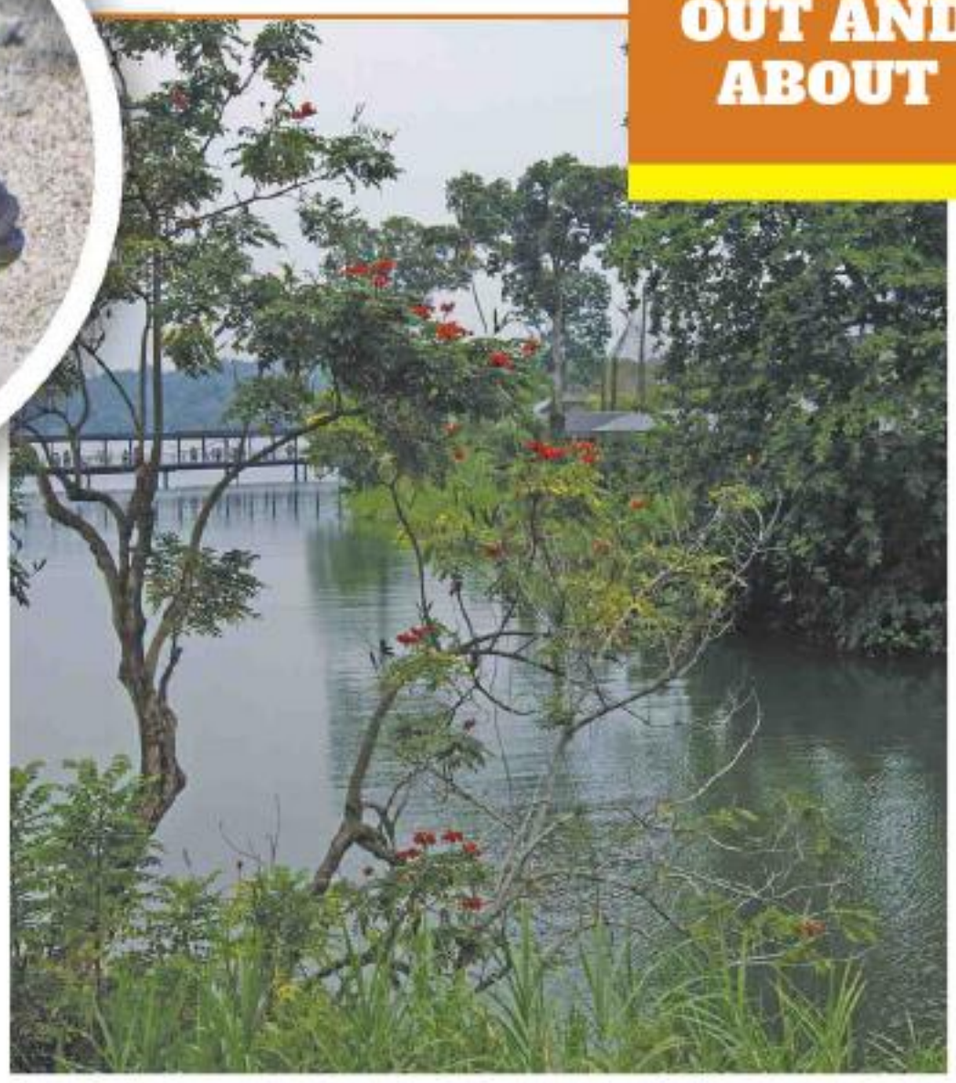
Spectacular live fish on view as part of the exhibit include the highly distinctive and endangered Mississippi paddlefish (*Polyodon spathula*), plus, on a smaller scale, the Chinese high fin banded loach (*Myxocyprinus asiaticus*) and various attractive cichlids, such as Uaru species, and a number of jewel cichlids (*Hemichromis species*).

Over the course of recent decades, zoos have been under great pressure to stress their conservation aims and to play a role in public education about wildlife. It is fitting, therefore, that the River Safari opens with an audiovisual display video with music and the words "Our survival is linked to freshwater habitats", combined with the rather alarming statistic that "freshwater animals are disappearing six times faster than land animals".

Other animals too

You might expect a river safari to be overwhelmingly about fish, yet there were perhaps fewer fish on view than might be anticipated. Not that there is a shortage of creatures to see, and this reflects the ecosystem aspect of the attraction, revealing just how many species live inter-dependent lives. They include





CLOCKWISE FROM TOP LEFT
The alligator gar originates from the Mississippi River.

There are a number of large and spectacular fish to be seen.

The central lake and walkway of the River Safari.

One of the giant models, showing a carp.

reptiles like the enormous Asian gharial (*Gavialis gangeticus*), a narrow-snouted, fish-eating crocodile, and the endearingly small African dwarf crocodile, (*Osteolaemus tetraspis*), which, as one tourist noted "is barely large enough to make a handbag!". There are also crab-eating macaques (*Macaca fascicularis*), giant otters (*Pteronura brasiliensis*) and wading birds such as the lesser adjutant stork (*Leptoptilos javanicus*).

In these cases, the connection with water ecosystems is obvious, however, the safari also includes some inexplicable non-freshwater creatures - toucans, squirrel monkeys and giant pandas, for example. This is slightly strange – especially with regard to the pandas – but the net result is that there is something for everyone, which is surely what the non-committed visitor to a family tourist park hopes to see on a visit.

Speaking as someone with what I have been told is an unhealthy fondness for insects, it was also good to see a few aquatic invertebrates on display. Specifically, there were water stick insects (*Ranatra sp.*), water scorpions (*Nepidae sp.*) and the giant water bug (*Lethocerus indicus*). In total, this river-themed wildlife park houses over 6000 creatures, belonging to more than 200 species.

Highly popular!

In several ways, the River Safari is already proving to be a victim of its own success. On the day that I was there, for example, what was billed as the advertised high point of the visit - the boat trip past a section of exhibits - was sold out due to high demand. Furthermore, the crowds were several deep, surrounding many of the tanks, making it hard to get a clear view of some of the exhibits.

Nevertheless, the River Safari has some worthy highlights. For me, one was simply the bridge over the lake with its views of wild fauna: creatures such as painted storks, purple herons and some freshwater turtles. As part of the Malay archipelago, Singapore is right in the middle of one of the world's mega-biodiversity "hotspots", so in this regard, the setting for the Safari couldn't be better.

An interesting choice

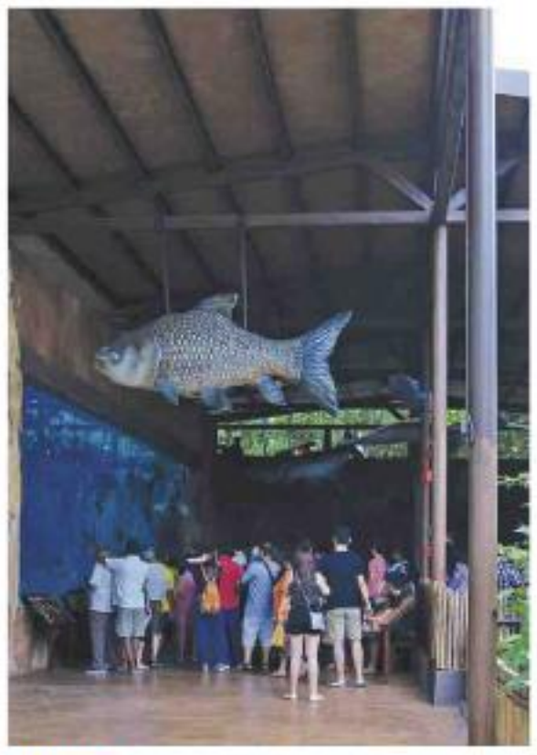
In terms of exhibits, the large manatee tank close to the end of the displays struck me as one of the best and most innovative displays. In many public aquaria, "the big tank" is often given over to sharks, and so it was refreshing to see pride-of-place in the River Safari being devoted to something very different that most people will never have seen before.

Multiple viewing windows allow for close-up vistas of the manatees. It is one thing to know that manatees are mammals, but quite another to see their seal-like movement and to stand close enough to one to glimpse the unexpected, pig-like hairs on their backs and tails.

Even the most devoted manatee fan could not honestly describe them as beautiful, but they certainly have a charm about them. They provided further proof of just how important it is to conserve the diversity of creatures to be found within our major rivers – and by default, our small waterways too, right down to local streams.

Further information

Details of Singapore's "River Safari" can be found online at www.riversafari.com.sg/



ABOVE This is already a popular attraction.

ABOVE The lesser adjutant stork - one of the birds to be seen.

ABOVE Some of the exhibit buildings, overlooking the lake.

ABOVE One of the open air tank in the Amazon section.

ABOVE Boats moored on the central lake, with buildings housing displays in the background.

Mangrove roots provide a dense and safe environment for young fish, some of which may later head out further to sea.

Why not consider a brackish aquarium?

When it comes to starting out, the obvious choice is between a freshwater or marine set-up. But in fact, there is a third option - a brackish aquarium. A range of fish have adapted to live in this type of habitat, on the borders between sea water and fresh water, close to the mouths of rivers and often in mangrove swamps in tropical areas. **Sue Reid** outlines some of the possibilities.

Some suitable choices

An unusual fish that can thrive in brackish water is the glassfish (*Parambassis ranga*). It has a transparent body, enabling you to see its skeleton very clearly. Unfortunately, they are not brightly coloured and this has resulted in the unpleasant and cruel practice of injecting them with dyes which show up through their bodies. Although reputable aquatic stores usually refuse to stock dyed glassfish, they are still occasionally seen for sale.

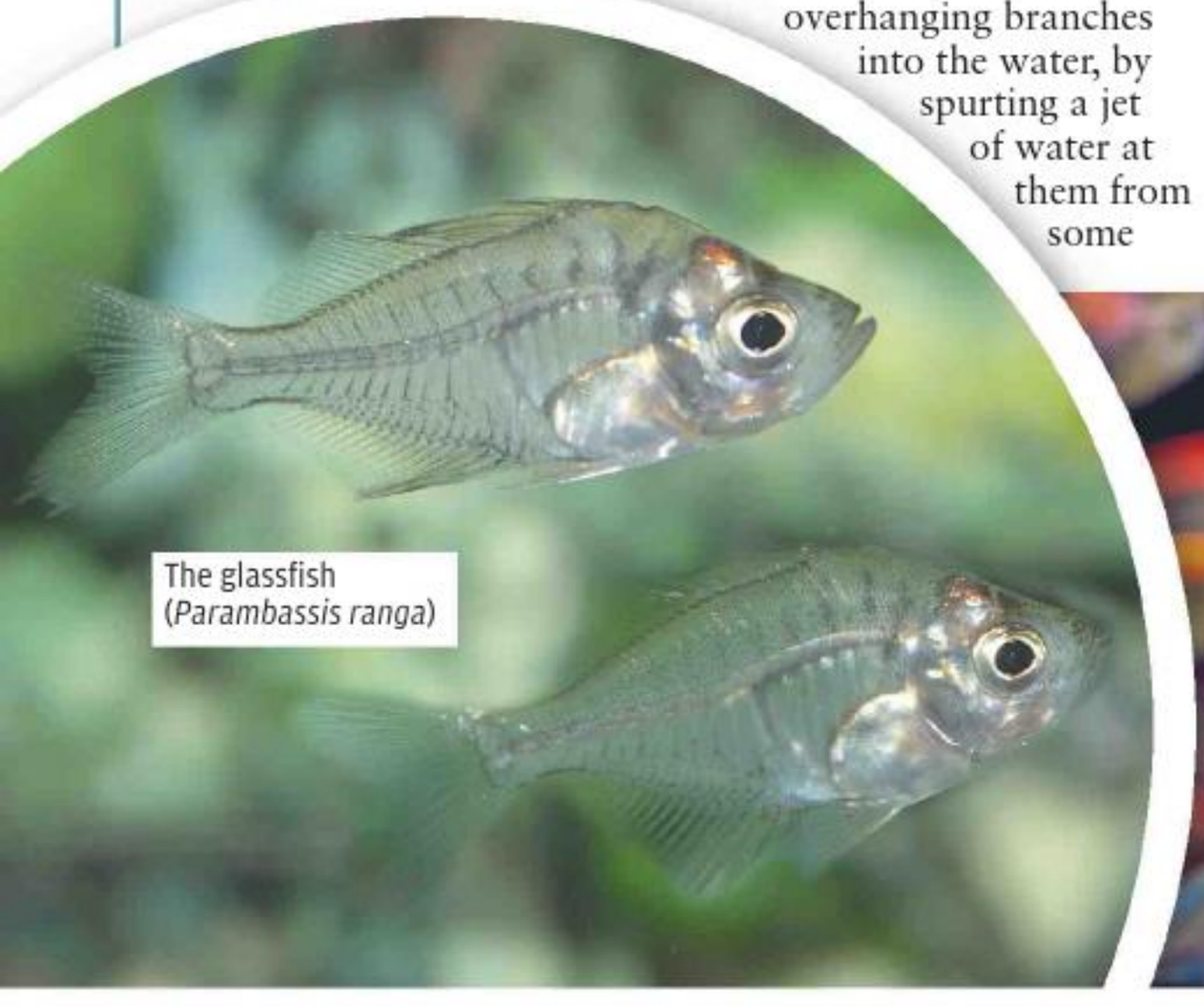
Archers take aim

Another interesting choice can be the archerfish (*Toxotes* species), so-called because of their ability to shoot down insects from overhanging branches into the water, by spurting a jet of water at them from some distance away. In the aquarium, archerfish can be persuaded to display this skill with a high degree of accuracy, aiming at food located on the sides of the tank above the water level.

Other possibilities

Some brackish water fish have a much more variable appearance in terms of their coloration. Scats (*Scatophagus argus*) may range in colour from silver through shades of red to gold, while their markings can vary from spots to stripes. They thrive if kept in small shoals of about five fish. Scats will grow to about 15cm (6in) long in aquarium surroundings. Be careful if handling them, as they do have venomous spikes on the front area of their bodies.

The mono (*Monodactylus argenteus*) has a flattened body shape and is silvery, with yellowish fins. Black stripes run through the eyes and also across its gill covers. They can get quite large as they grow, however, reaching up to 25cm (10in) or more in length, and live in shoals. They are predatory by nature, and must not therefore be



The glassfish (*Parambassis ranga*)

The glassfish: the practice of dying them is not only cruel, but shortens their lives

Bumblebee goby – males tend to be more brightly coloured, with a slimmer profile. *PHOTO COURTESY CITRON.*

housed with fish significantly smaller than themselves.

Various species of boxfish are another possibility to consider for a brackish aquarium, although they can be quite aggressive and are best kept on their own. They have a rather square, box-like shape as their name suggests.

More peaceful by nature is the bumblebee goby (*Brachygobius xanthozona*), which only grows to about 3.75cm (1.5in) long. This species can be shy though and will appreciate somewhere to hide away on occasions, usually spawning in caves as well. It is so-called because of its black and yellow markings.

None of these fish is difficult to look after and they will thrive on the range of foods stocked by aquarist stores. As with all aquarium fish, it is important to feed them two or three times daily rather than just providing one large meal.

Housing

The corrosive effects of salt means that it is important to use an all glass aquarium rather than one of the old-style metal frame tanks. Similarly, choose a plastic rather than a metal hood for the aquarium. Covering the tank is important, not just to provide the aquarium with lighting but also to prevent evaporation of water that can occur at a fast rate in centrally heated homes. This in turn will cause the salt content of the remaining volume of water to increase.

It is quite easy to make up the water for a brackish aquarium. You can use one of the special blends of marine salts now available. But it is always advisable to treat the water with a dechlorinator prior to adding the marine salt. This is because these chemicals will often not work as effectively in salt water, which could then have fatal consequences for the fish.

Instructions for mixing the salt will be given on the packaging. You will need to stir a specific quantity of the salt in with ordinary tap water, ensuring that it has dissolved completely. Carrying this out in a bucket before adding water to the aquarium is to be recommended.

Measurement of the salt content of the water is carried out using an instrument called a hydrometer, which will give you a specific gravity reading. You can buy a hydrometer from aquarist outlets, along with the sea salts. In the case of a brackish aquarium, a specific gravity figure between 1.005 and 1.015 is required.

Planting

It will probably be better to aim for the lower end of this scale if you want to include plants in the aquarium, as most aquatic plants will not grow in salty water. There are a few, however, which can prove sufficiently adaptable to thrive for a brackish environment. These include Java fern, which will root on submerged objects including rocks. Tie this plant in place first so as to anchor it down in position until it has established itself on the rockwork. You can then cut off the support later.

Java fern will also grow well on bogwood, which is available from aquarist stores. But it is vital if you use this wood, either in a brackish or freshwater aquarium, to treat it first. Otherwise it will turn the water a dirty shade of yellowish-brown. Soaking the bogwood in a bucket of water and changing the water regularly will help to leach out this unwanted colour over perhaps a week or so.

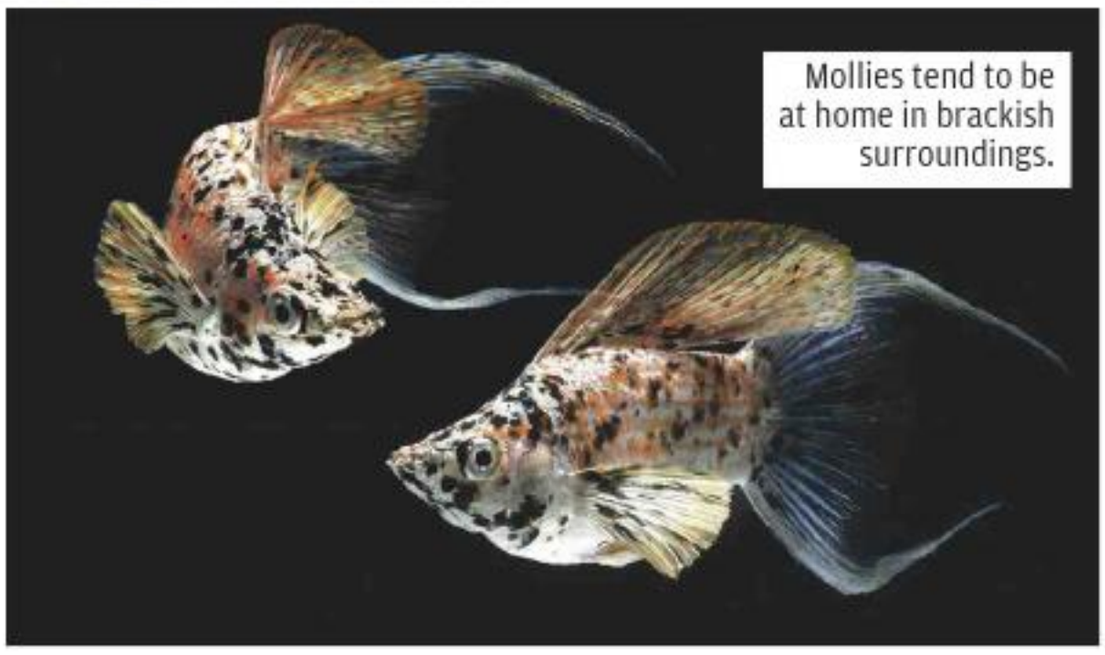
The other alternative is to paint the bogwood carefully with polyurethane varnish. This will seal the surface but you will need to wait until it has dried thoroughly before submerging the wood in the aquarium. Several coats of varnish may be required to achieve a complete seal.

Vallisnerias can also prove sufficiently robust to survive in brackish surroundings but these particular plants will rarely grow as well here as they would in fresh water. You can of course simply add plastic substitutes as an alternative but including at least some live plants will help to utilise the nitrate produced from the fishes' waste in the aquarium. It is also possible to obtain young mangrove plants which can be incorporated, certainly while they are small. These can be found on eBay, but they are less commonly available from aquatic retailers. You may also be able to obtain mangrove roots as well, as decor.

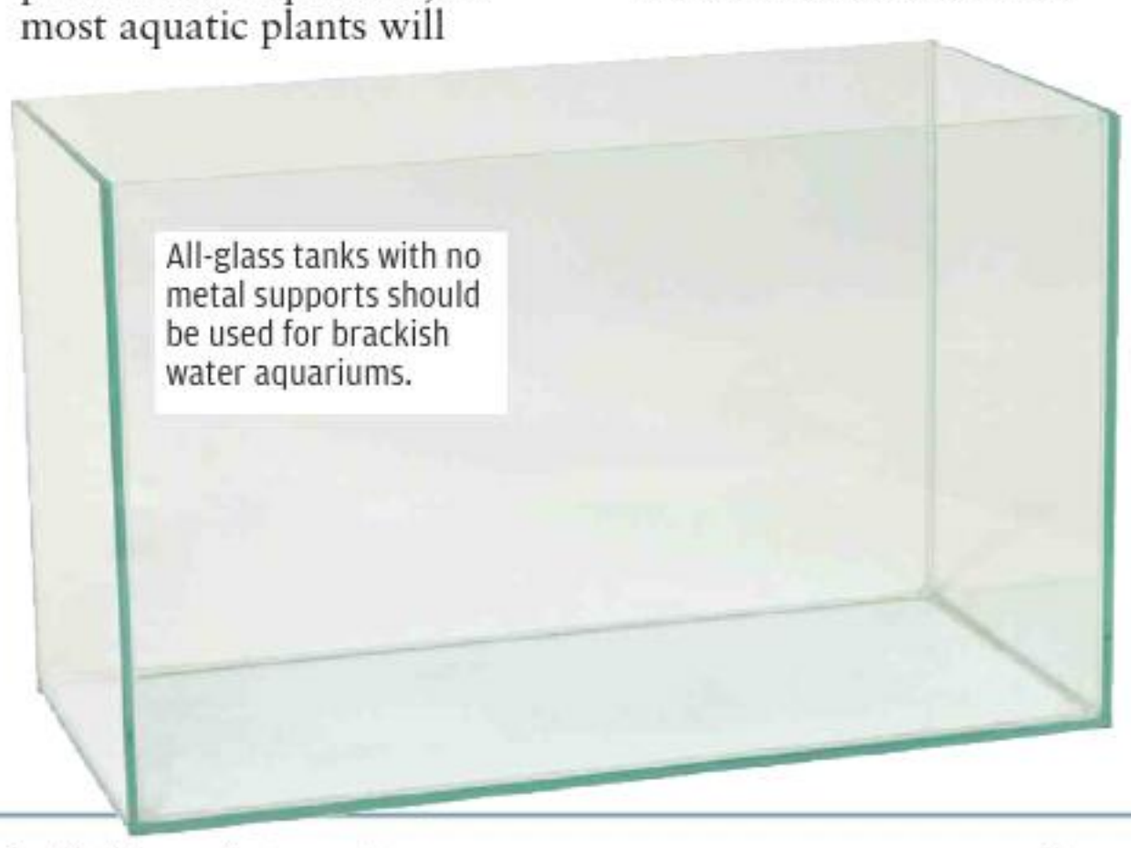
The floor covering can be made up using a mixture of gravel and sand. The large pieces of gravel will help to keep the sand from clogging up together, which is especially important if you have an undergravel filter. Otherwise the filter bed will become blocked and the filter will fail to work effectively.

Brackish water aquariums are probably underestimated – they can be fascinating, allowing you to decorate them in a very unique way. A set-up of this type also increases the range of fish that you can consider keeping, while some established favourites such as mollies will tend to thrive better if kept in slightly brackish water rather than in freshwater.

Vallisneria is sometimes known as eel grass, because of the way it moves in the water. When seen from above in clumps, it can also look like grass.



Mollies tend to be at home in brackish surroundings.



All-glass tanks with no metal supports should be used for brackish water aquariums.

Feeding aquarium fish

DAVID POOL
Fish scientist

With an ever-increasing range of fish foods available, what factors do you need to consider, when selecting the best food for your fish? Fish scientist **Dr David Pool** who has spent many years researching in this area, and has just launched his own range of fish food under the Fish Science label, provides vital guidance.

A quick search of the internet or flicking through an aquarium book will quickly reveal the large number of different fish species which can be kept in a tropical freshwater aquarium, each of which may have differing nutritional requirements.

In the wild, these fish feed on a very wide selection of food items, ranging from microscopic algae to whole fish and even pieces bitten out of land animals in a few cases! In their natural surroundings, fish tend to congregate where there is abundant food (given that other conditions such as water conditions are suitable). If there is insufficient food, or if it is of the wrong type, the fish move to another area, or if this is not possible, then they are likely to starve.

In the confines of an aquarium, the situation is very different. Fish rely on us to provide the correct food and in suitable quantities. Fortunately, a wide range of

Even in an aquarium, fish soon learn where food is provided.

Plant-eaters

Herbivorous fish are those that consume mainly or exclusively plant material and include species such as the flying foxes, otocinchlus catfish, tinfoil barbs, plecostomus catfish and Malawi cichlids.

These fish have a number of characteristics that allow them to feed on plant material. One of these is their specially-adapted intestinal tract, which may be 2-3 times as long as their body and which has no recognisable stomach. The length of the intestine allows the fish to make maximum use of plant and algal material, which is very difficult to digest.

Despite their long intestinal tract, herbivores need to feed regularly if they are to obtain sufficient nutrition to survive. This behaviour can be seen by anyone who keeps mollies or plecs, for example. These fish can be seen to graze continually on any patches of algae that are growing in the aquarium.

In order to keep herbivorous fish successfully, it is important to provide a diet that is rich in vegetable material. There are a number of flake, stick, pellet and tablet foods available which provide an ideal basis for their diet. This can be supplemented by algal-based treat tablets and fresh vegetables, such as slices of cucumber or peas.

Since digesting plant material is relatively inefficient, herbivorous fish tend to produce a lot of waste – but fortunately, it has a relatively low protein content and so does not pollute the water too badly.

ABOVE The freshwater barracuda (*Ctenolucius hujeta*) is a highly predatory species, reflected in part by its prominent teeth and streamlined shape, which is somewhat reminiscent of a pike. Always discover the habits as well as the requirements of fish before buying them.

Carnivores

Carnivorous fish are those that do not necessarily feed on flesh, but seek out animal protein. They can be subdivided into piscivores, which feed largely on fish (such as pike cichlids and pike top livebearers) and insectivores, which feed on insects and their larvae, with this latter group including both hatchetfish and archer fish, which actually shoot down prey by spurting a jet of water at it.

Compared with herbivores, these fish have very short intestines, often only being as long as their body. They also have a muscular stomach, which can expand to accommodate a large meal. This short intestine is all that is required to digest and absorb a diet that is rich in animal proteins.

Unlike herbivores, carnivorous fish do not feed continually. Instead they hunt for short periods and then remain inactive for several hours or even days, while their meal is digested.

It is relatively easy to identify a piscivorous fish just by looking at it. These species are adapted to catch fish, with large mouths and teeth to stop their prey escaping. They also tend to have lots of their fins towards the back of the body, allowing them to suddenly accelerate and catch their prey.

Insectivorous fish also have teeth (even neon tetras do!), but these tend to be less well developed and less obvious than in the piscivores. However, these are still important to ensure that the living food items do not escape from their grasp.

Carnivorous fish require a diet that is rich in protein so that it can be digested in their

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Most aquarium fish are invariably on the lookout for feeding opportunities.

ABOVE Piranhas are the most notorious of all carnivorous fish.

specialised intestinal tract. Again, there are a range of flakes, sticks, pellets and frozen foods specially formulated for these fish. The foods are often in bigger pieces to replicate the size of food eaten naturally.

For some of the more specialised species, manufactured diets are often ignored – particularly when you first acquire such fish. They need to see something that moves to trigger the feeding response. For these fish, live foods such as bloodworms or shrimp may be needed, but it is important to try to wean them on to prepared foods, which offer a more balanced diet, particularly with regard to their vitamin and mineral content.

Omnivores

The majority of fish kept in a tropical aquarium are classed as omnivores. These tend to be opportunistic feeders that will eat whatever food they come across, basically taking anything that they can fit in their mouths, whether of plant or animal origins, including fish eggs, fry, insects and plant matter.

These opportunistic feeders tend to be easier to feed within an aquarium, as they will eat most foods, providing it is of a suitable size and is present at the same level within the tank where they are to be found.

Offering small amounts of food regularly is to be recommended.

Food size

In selecting a suitable diet for fish, it is important to consider not only what type of food they would eat in the wild, but also what they can consume, and where they normally seek their food in the water.

The size of food particles that a fish requires is largely determined by that of its mouth. If the food offered is too big, the fish will either break it up by biting out chunks, or simply show no interest in it. At the other end of the scale, large fish will ignore small particles of food, or simply scoop up a few of them, with the majority sinking to the bottom of the aquarium where they will remain uneaten. In either scenario, wasted food here is likely to decompose and pollute the water.

Flaked foods, either crumbled or fed whole, are ideal for small and medium sized fish. The flakes may be eaten at the water surface, as they sink or even on the bottom, depending on the fish species concerned. Sinking granules offer the same possibilities, though they do not stay at the surface for very long, being heavier.

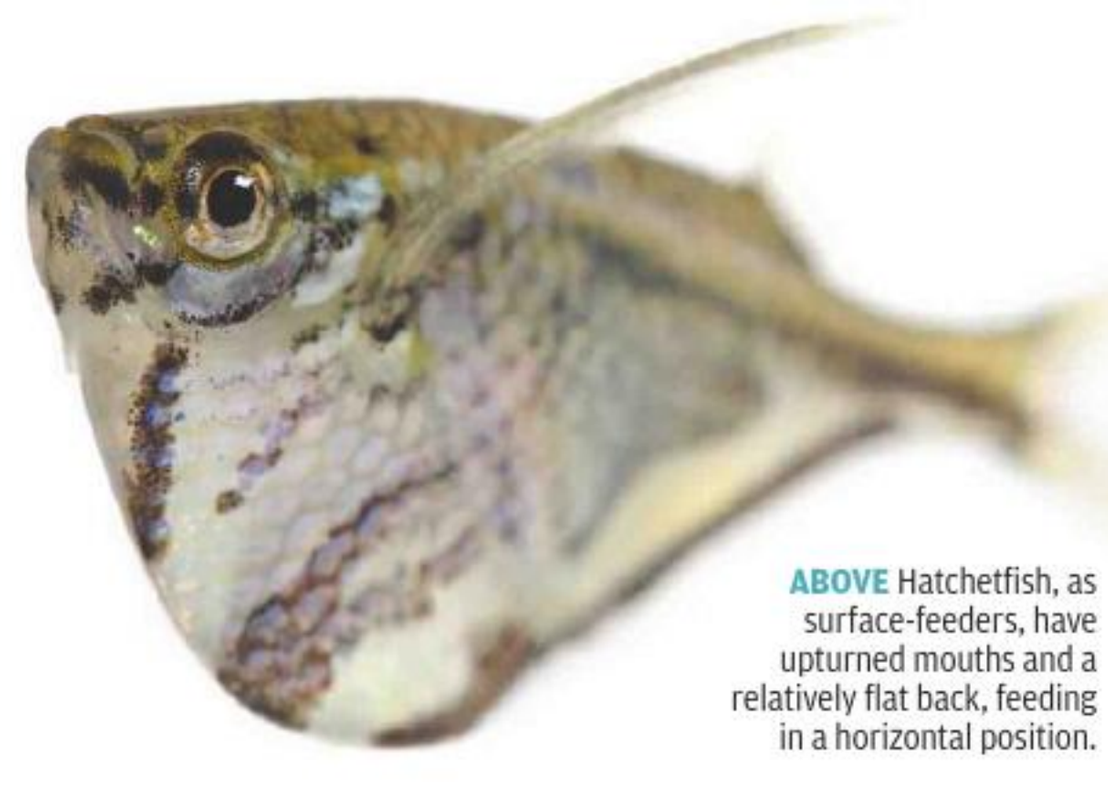
Larger fish, measuring more than 10cm (4in) overall, are best offered food sticks or a pelleted food. These come in bite-sized pieces, with no small particles to remain uneaten and pollute the water, as they will be swallowed whole.

Position in the water

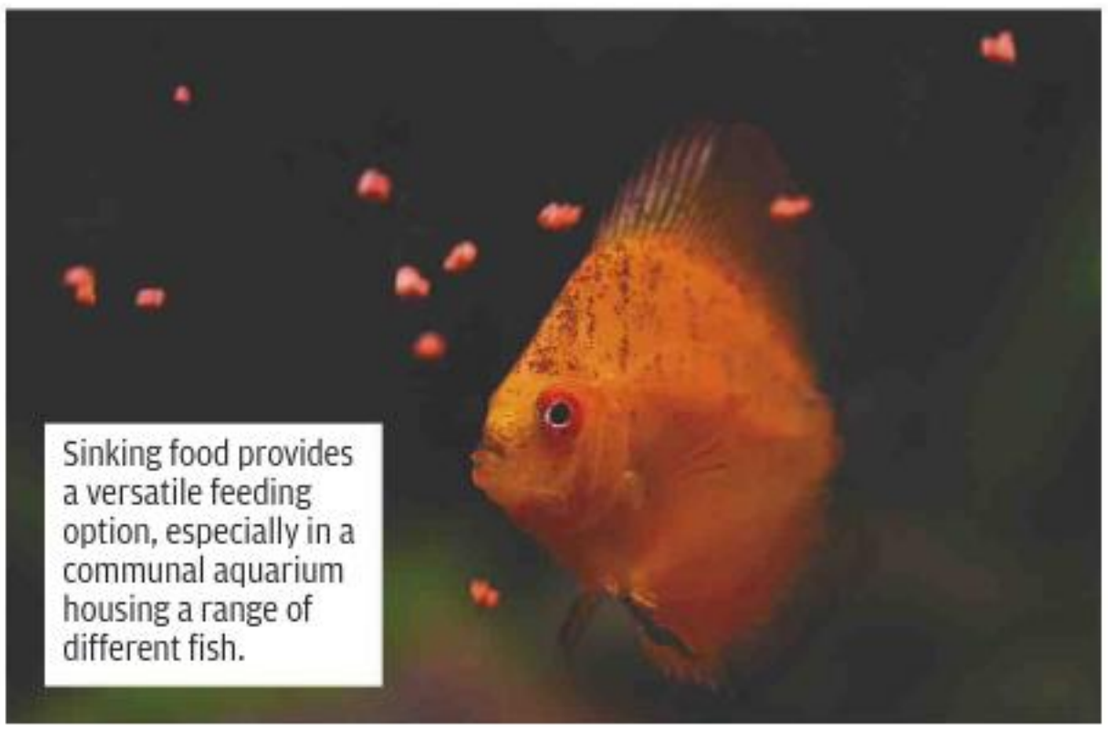
The fish that we keep in our aquariums will naturally feed at different levels in the water. Fish that prefer to feed at the surface such as swordtails, mollies and hatchetfish, have upturned mouths. This allows them to eat whilst remaining almost horizontal in the water. Such behaviour provides an obvious advantage if danger threatens, allowing them to swim away quickly without having to straighten up first. Floating foods such as flakes, sticks and pellets are the best choice for these fish.

Bottom-feeding fish tend to have downturned mouths for the same reason as the surface feeders, with many catfish such as corydoras being in this category. Tablet foods, sunken flakes or sinking pellets are required for these species.

Other fish feed in the midwater zone, but they can also take food from the surface or substrate. These species tend to have forward-facing mouths and have to point up or down when feeding at the surface or bottom. All types of food can be given to these fish, although those that float and then gradually sink, such as flaked food and granules of this type are perhaps the best.



ABOVE Hatchetfish, as surface-feeders, have upturned mouths and a relatively flat back, feeding in a horizontal position.



Sinking food provides a versatile feeding option, especially in a communal aquarium housing a range of different fish.

Quality versus quantity

With so many foods to choose from now on the market, it is difficult to know what constitutes a good food and what is not so good. Unfortunately, the fish themselves do not help here, as in many cases, they will eat whatever you give them, assuming that they are hungry. However, it is what they do with the food that is important.

Poor quality foods may be eaten, but little will be digested by the fish, resulting in a lot of waste. This needs to be removed from the water before it decomposes and results in raised levels of potentially dangerous pollutants, in the guise of ammonia and nitrite, which can overwhelm the filtration system. In addition, the waste can cloud the water and/or encourage unsightly algal growth.

Developing a good fish food costs money, as do high quality ingredients, so it will come as no surprise to learn that a good quality food costs more per gram than one of lesser quality. Do not be mislead into thinking that an 'inexpensive food' is better value than a higher priced option. The food conversion ratio (FCR) is a measure of the amount of fish tissue (in grams) that is formed by every gram of food eaten.

Good quality foods will have a low FCR of between 1 and 2, meaning that most of the food is used by the fish to form tissue. As a result, there is very little waste. A poor quality food, by contrast, may have a FCR of 4 or more – meaning that if 4g of food is given, only 1g is formed into fish tissue and approximately 3g passes through the body of the fish as waste.

The exact figure is actually slightly less than 3g of waste, because some of the food will be used for energy production, allowing the fish to swim and breathe for example. The 3g of waste in this example needs to be removed by the filter or manually, in order to avoid it decomposing and polluting the water.

Continuing with our example – to get your fish to grow by 1g, you would need to add 1-2g of a good quality food, or 4g of a poor quality food. It is worth asking yourself - is that good quality food twice as expensive as the poor quality one?

Assuming you are using a good quality food, you will only need to feed your fish once or twice a day, providing as much as they will eat within a minute. This may not seem very much, but commercially produced foods are very concentrated.

Look at the moisture content, and you will see that it is between just 6-10% in a flake or granular food. Natural foods are around 90% water – that is 10 times less nutrition per gram of food, which is a significant amount.

Adding colour

The colouration of a fish is produced by three colour pigments that are present within cells called chromatophores. These pigments are erythrin (red), melanin (black), and xanthin (yellow), with each occurring

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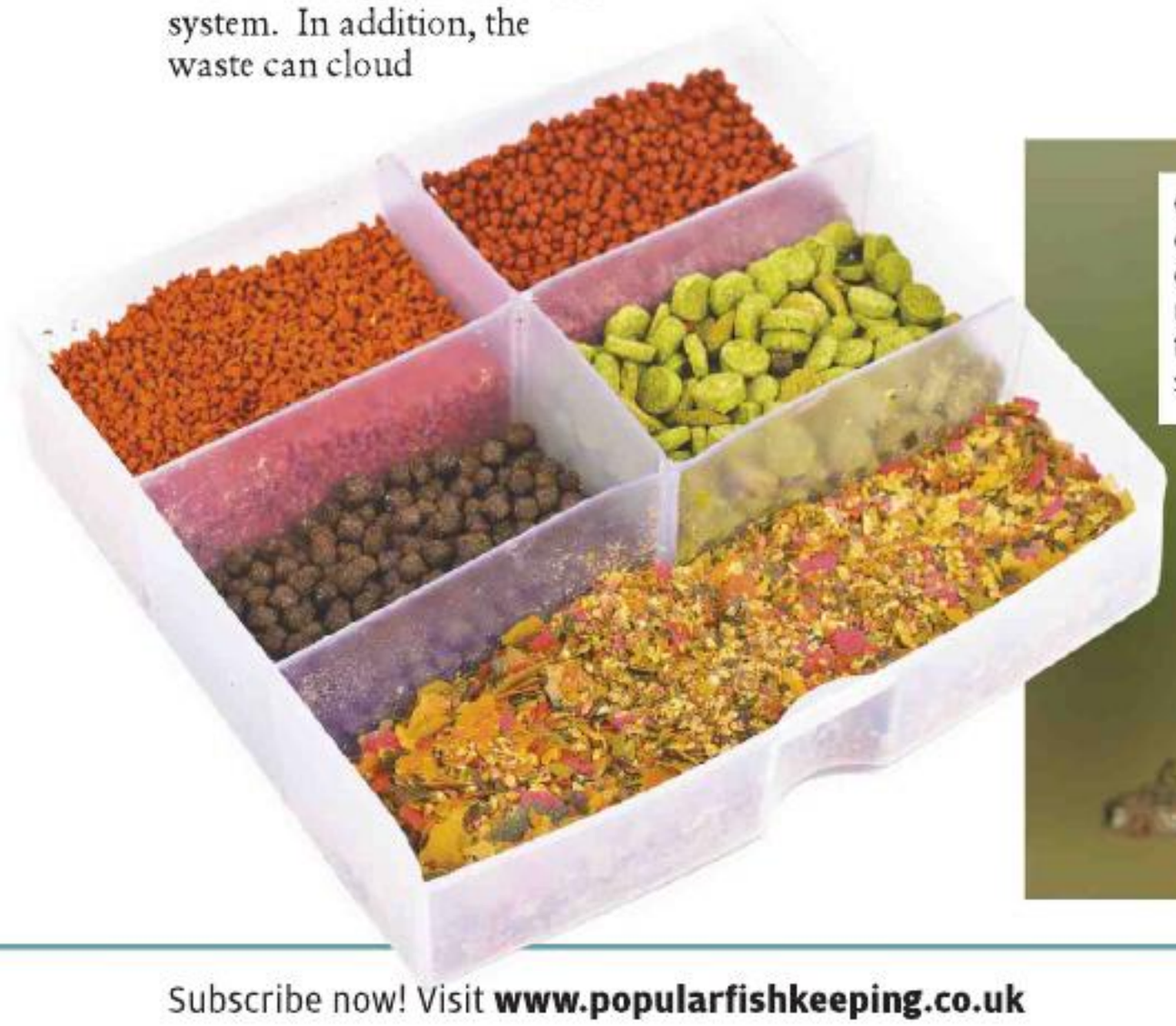
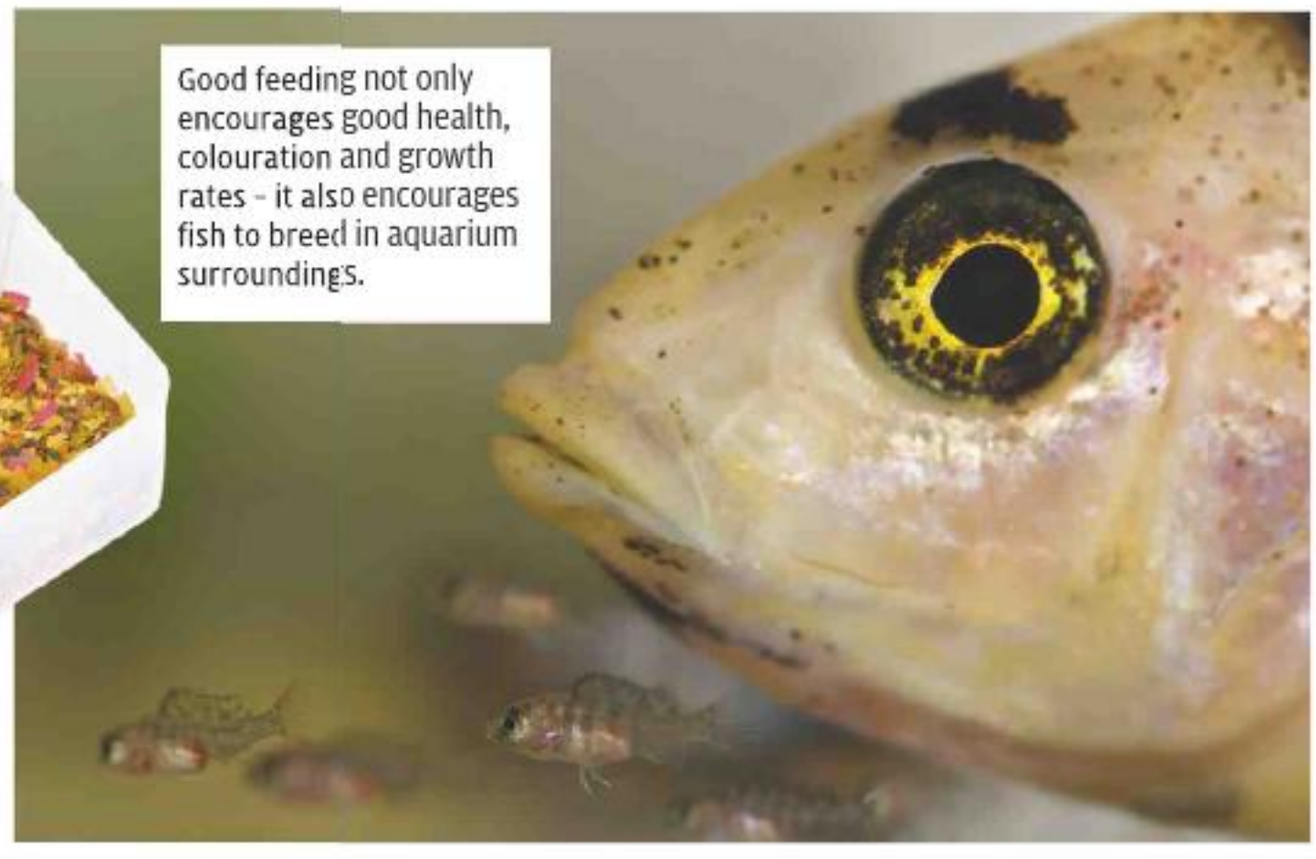
BELOW Fish food today comes in many different forms. It is generally impossible to distinguish the best by sight - but price is a useful guide.





Good feeding not only encourages good health, colouration and growth rates - it also encourages fish to breed in aquarium surroundings.

ABOVE Spirulina powder is derived from algae, and has become a valuable natural colouring agent in prepared aquarium fish food.

ABOVE The fish's colouration, as well as its health, can be improved in an aquarium by good feeding.

Angelfish enjoy a treat food.
PHOTO COURTESY DAVID POOL/FISH SCIENCE.

in different chromatophores. Complementing the colour pigments are iridocytes, which are best described as tiny reflective spheres within the skin.

All of the colours we see in freshwater fish are a mixture of these components. For example, orange is a combination of red and yellow chromatophores; brown is a mixture of black and yellow, while red is the result of just the red chromatophores. If there are no chromatophores, the fish will appear white due to the presence of the iridocytes, or the background colour of the skin and muscle will show through.

In general, fish cannot make their own colour pigments, and therefore, they have to consume them in their diet. In the wild, these pigments would originate from eating algae, shrimps, snails and similar items.

Within the confines of an aquarium, there is not enough algae or other natural sources of such pigments, so it has to be included in the food that you provide. As with all foods, it is important that the colour-enhancing food given is of high quality, so as to ensure that the pigments are in a form that the fish can absorb effectively into its body.

The colour-enhancing ingredients in fish food can be either natural or artificial, but all are a source of the pigments mentioned previously. Natural ingredients that are rich in colour pigments that can be utilised by fish include krill, spinach, spirulina algae and carrot. It is worth looking for these ingredients in your fish food if you wish to optimise their colouration.

An occasional treat

Many of the commercially available foods are described as 'complete foods' on the packaging. This means that they have been formulated to provide all of the nutrients that fish require. However, there is a growing trend to add a complementary or treat food to the aquarium, in order to create some variation in the fish's diet, bring them to the front of the tank, with a view perhaps to conditioning them to get them ready to breed, or aiding their recovery from illness. Treat foods come in a range of formats, from live foods to living organisms. Tablet foods that stick on the aquarium glass are a great treat as they bring the fish right to the front of the aquarium where you can view them. Feed such treat foods 2-3 times per week, using them instead of the normal food on that day.

A practical solution

The choice of foods for your aquarium fish is therefore a large and increasing one, which can be confusing for fishkeepers. I would suggest using a selection of two or three different food types to ensure that all of the fish in your aquarium get a good diet. But do not use the same types of food at each feed – alternate the foods, and, most importantly, take great care not to overfeed the fish.

You can find out more about the FishScience range at http://www.fishscience.co.uk/

Product news

Several exciting new products of value to fish keepers have recently come on to the market. Here is a round-up from **Don Harper**.

iQuatics' hanging bars

When it comes to innovation, iQuatics have established an enviable reputation amongst fish keepers, which will doubtless be further enhanced by their recent introductions. As an example, this ground-breaking design is set to revolutionise the way that people incorporate suspended aquarium lighting, making it far easier for the average hobbyist to install hanging lights above a tank.

iQuatics' hanging bars represent a brand new concept, with the company's design team having managed to come up with a brilliantly simple and yet effective solution to address the common problems surrounding suspended lighting.

For many hobbyists, installing hanging lights has caused serious difficulties in the past, mainly owing to the usual method of securing them, which entails drilling into ceiling joists. iQuatics' hanging bars make this unnecessary by utilising a cleverly designed attachment bolt.

This means that it is now possible to connect hanging bars directly to an aquarium stand or cabinet, rather than having to attach them to the ceiling. Furthermore, they can be adjusted for attachment to a wall too, if required! No more drilling into ceilings… with iQuatics' brand new approach, it is possible to benefit from hanging bars and keep all of the equipment in one place without the need to cause permanent damage to your property.

Not only are these hanging bars innovative, but they are also priced extremely competitively, making them an affordable solution for most hobbyists. But there is no economy in design terms. They are made from sleek, durable and long-lasting stainless steel and are intended to fit smoothly into any set-up without spoiling the lines of the aquarium.

iQuatics hanging bars are available in a range of sizes from 600-1200mm (24-47in), being supplied in the form of a kit containing everything that the customer needs to use them. Prices start from £69.99, with the largest 1200mm (47in) wide kit costing £79.99. These hanging bars will make a professional standard set-up into a reality for many people, by greatly simplifying the process of lighting an aquarium with new technology.

A new space-saving T5 controller from iQuatics too!

Fish keepers have traditionally been limited to having just two tubes operating with an external controller system. This has meant the addition of more tubes required the purchase of extra lighting controllers. The iQuatics' AquaLumi T5 controller changes things drastically, by allowing you to operate as many as six T5 tubes through just one, sleek, stylish and high quality black aluminium control box. The system can be mounted to the side of the aquarium using the included mounting rail, or rested on rubber feet, which are also provided. So no matter what your situation, the controller will adapt to your aquarium! iQuatics have also designed and manufactured their own T5 lamp leads to accompany their controller systems. These IP67 rated cables provide complete peace of mind, and are supplied with a generous 2m(6.5ft) of cable. The cabling is attached to the aquarium using high quality stainless steel mounting clips; no longer do you have to battle with brittle plastic clips for this purpose. Emphasising the flexibility of the system, the AquaLumi T5 controller can be purchased on its own, or as part of a complete aquarium lighting system, including T5 tubes and reflectors.

** iQuatics currently sell directly to the public through their e-commerce store at www.iquaticsonline.co.uk and iQuatics products can also be found in many specialist aquarium retailers throughout the UK and worldwide.*

Fish net news

Trying to catch fish in a deeper aquarium with a standard net can be problematic, but not any longer, thanks to Wacky Practicals' Collapsible Fishing Net. This adjustable and yet solidly constructed net is also suitable for pond use too, when it comes to catching smaller goldfish or koi in these surroundings.

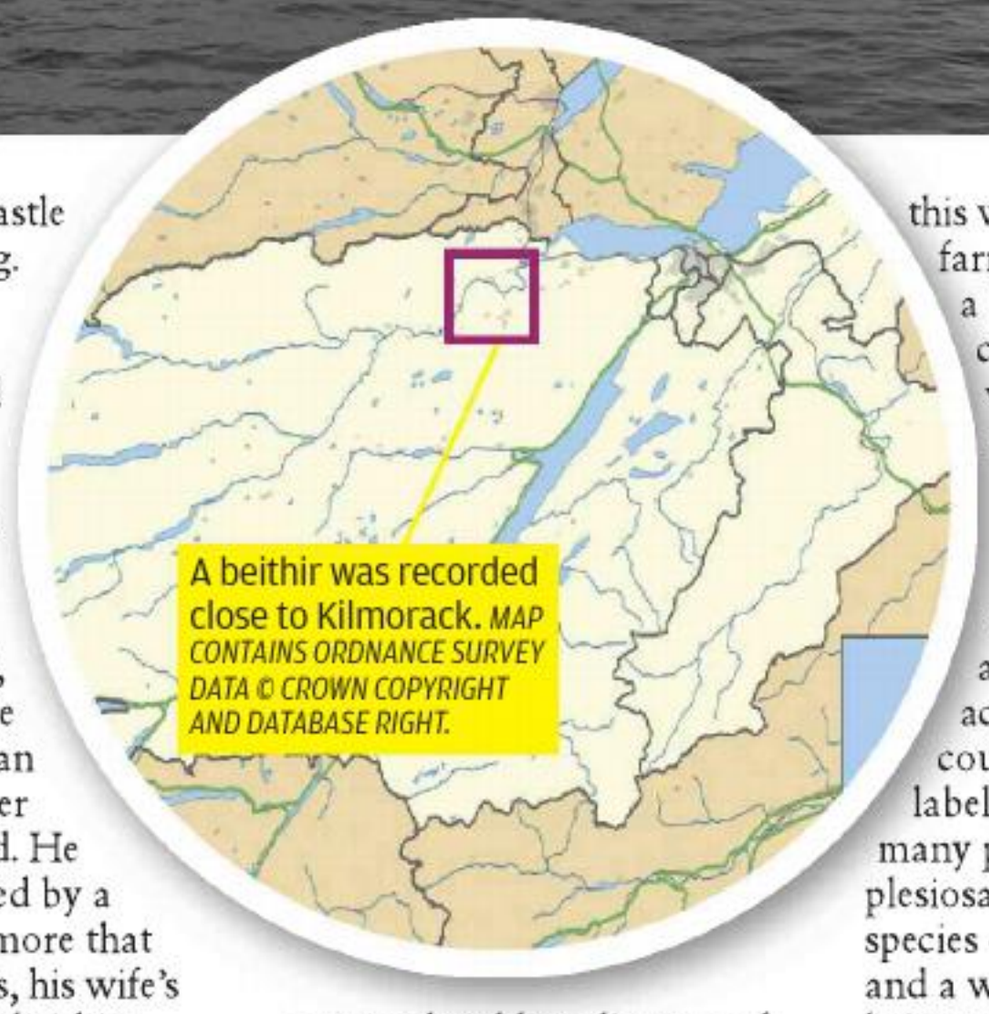
The stainless steel handle of the net is easily and securely extended, from 17cm (7in) up to a length of 66cm (26in), with the net itself having a diameter of 20cm (8in). It's also ideal for general pond dipping, and taking to the seaside, so why not buy two? Available in a choice of red or navy blue, these nets cost £5.99 each, plus delivery. Trade enquiries are welcome.

** For further information and to order, see www.wackypracticals.com or call 0800-599 9458.*

Bothersome beithirs and other freshwater mystery eels

A number of mystery creatures reported from areas of freshwater in Britain and elsewhere in the world could conceivably be unusually large eels – with this rather scary possibility being explored in the following selection of eye-opening examples by **Dr Karl Shuker**.

Strange water beasts have reported for centuries from Scotland.



Never bother a beithir!

The Loch Ness monster may well be Scotland's best known freshwater mystery beast, but it is not this country's only one. Far less familiar yet no less intriguing in its own way is the beithir. This is a description that comes from ancient Scottish Gaelic language, describing a savage creature that is often regarded as having a serpentine appearance.

In 1994, a correspondent to the English magazine *Athene* published two fascinating articles containing various modern-day beithir sightings. The first account related to a meeting between the writer and a fisherman that had taken place early during 1975.

The man claimed that he and four others had once sighted a beithir lying coiled in shallow water close to the edge of a deep gorge upstream of the Falls of Kilmorack. When it was disturbed by their presence, however, it began thrashing about wildly, before finally swimming up the gorge near Beaufort Castle and disappearing. The fishermen estimated its length at around 3m (10ft).

Four months later, the *Athene* correspondent learnt of another sighting, this time offshore of Eilean Aigas, an island in the River Beauly, Highland. He was also informed by a keeper at Strathmore that during the 1930s, his wife's parents had seen beithirs moving overland at Loch a' Mhuillidh, near Glen Strathfarrar and the mountain of Sgurr na Lapaich.

After discussing these reports with various zoological colleagues, the author of the articles considered that the beithir was probably an extra-large variety of eel. Such fish are well known for their ability to leave the water and move overland to forage when circumstances necessitate, and even to be able to live out of water for protracted periods.

Indeed, the *Athene* correspondent was informed by a Devon farmer that during the extremely harsh winter of 1947, his mother had been badly frightened to discover a number of eels alive and well in the farm's hayloft, where they had evidently been sheltering since the freezing over of the nearby river some time earlier. The rest of the family came to see this wonder, including the farmer himself (then still a boy), and his father confirmed that they were indeed eels, and not snakes (as his mother had initially assumed).

The Loch Ness monster (always assuming that it actually exists, of course!) has been labelled as many things by many people – a surviving plesiosaur, an unknown species of long-necked seal, and a wayward sturgeon being among the most popular identities proposed over the years. However, some eyewitnesses and zoological authorities – notably the late Dr Maurice Burton – have favoured the suggestion of a giant eel, possibly up to 10m (33ft) long.

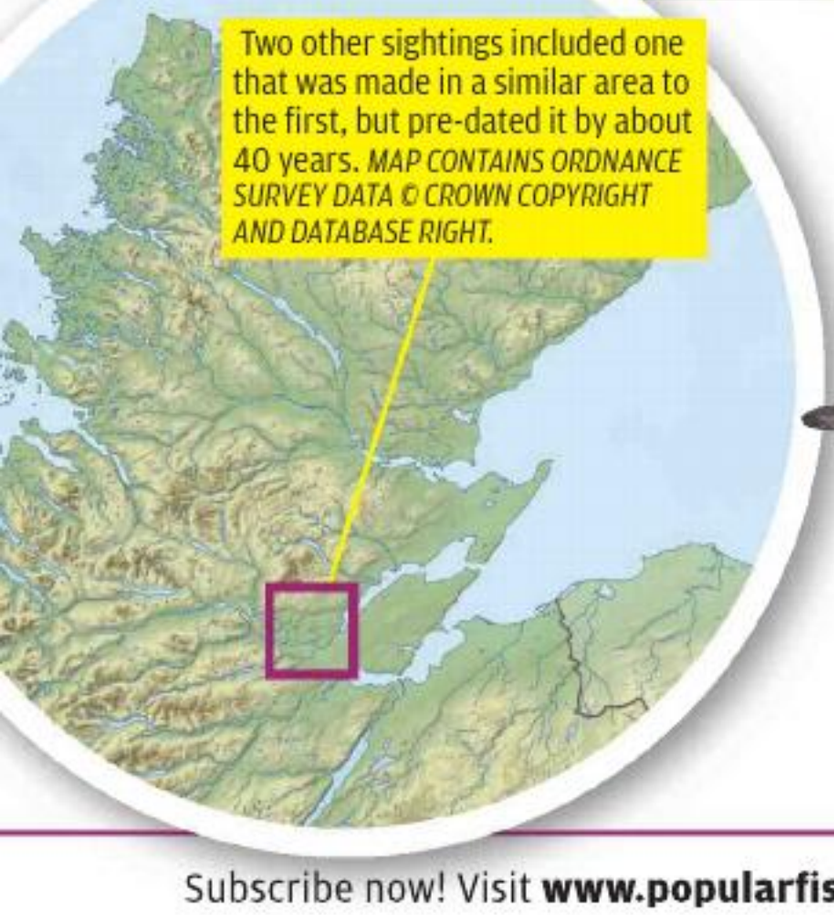
Under normal circumstances, the common or European eel (*Anguilla anguilla*) does not exceed 2m (6.5ft), and even the conger eel (*Conger conger*), which is

Loch Ness – looking southwards down the lake, giving some idea of what a huge body of water is contained here in the loch.

DID YOU KNOW?

A mountain which lies south of the entrance to Glencoe in West Scotland is called Ben Vehir, with local tradition stating that this name commemorates a beithir which lived in a water-filled corrie (lake) there, and was ultimately killed by the local people.

Could Nessie be a population of giant eels?



the world's largest species of eel, rarely exceeds 3m (10ft). However, ichthyological researchers have revealed that growth in eels is more rapid in confined bodies of water, (such as a loch), in water that is not subjected to seasonal temperature changes (a condition met with in the deeper portions of a deep lake, like Loch Ness), and it is not uniform (with some individuals growing much faster than others belonging to the same species).

Collectively, therefore, these factors support the possibility that abnormally large eels do indeed exist in Loch Ness. Moreover, sightings of such fish have been reported by divers. Also of significance is the fact that eels will sometimes swim on their sides, at or near the water surface, yielding the familiar humped profile that has often been described by Nessie eyewitnesses. And an eel measuring 6-10m (20-33ft) long could certainly produce the sizeable wakes and other water disturbances often reported for this most famous – and infamous – of all aquatic monsters.

I would not be at all surprised if the presence of extra-large eels in Loch Ness is conclusively demonstrated one day. However, I cannot reconcile any kind of eel with the oft-reported vertical head-and-neck (sometimes described as the 'periscope') category of Loch Ness monster sightings, nor with those land encounters

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BELOW Common eels are fish that move between salt and freshwater at different stages in their lifecycle.

Some eels may grow much larger than others. Their growth rate is not uniform. *SOURCE PD.*

reported adjacent to the loch that describe a creature with four limbs, a long neck and a long tail.

Yet regardless of what creature these latter observations feature (assuming once again their validity), there is no reason as to why Loch Ness should not contain some extra-large eels too. After all, any loch that can boast a volume of roughly 7.4 cubic km (nearly 2 cubic miles) of water must surely have sufficient room for more than one type of monster!

A eunuch eel?

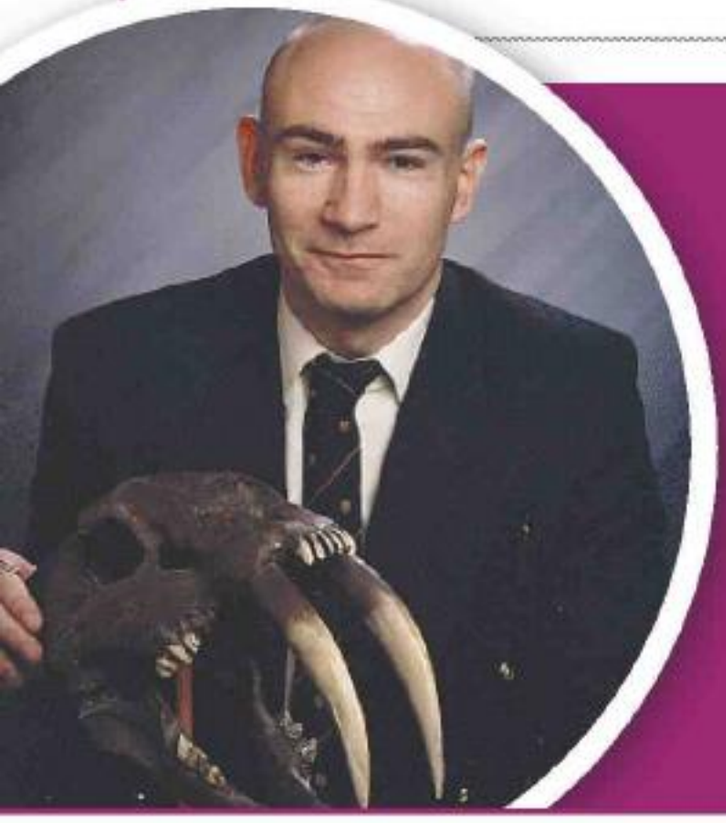
In recent years, the giant eel identity proposed for Nessie has been modified by some cryptozoological researchers. This theory has been transformed to yield a creature as remarkable in itself as any genuine monster – namely, a giant eunuch eel.

It has been suggested that Nessie may be a gigantic, sterile or 'eunuch' specimen of the common eel – one that did not swim out to sea and spawn but instead stayed in the loch, grew exceptionally long (8-9 m/26-29.5ft), lived to a much greater age than normal, and was rendered sterile by some currently-undetermined factor present in this and other deep, cold, northern lakes where similar sightings have been made. This is undeniably a fascinating, thought-provoking theory, but Dr Scott McNaught, Professor of Lake Biology at Central Michigan University, has stated that even if such eels did arise, they would tend to grow thicker rather than longer. Nevertheless, giant eels remain a distinct possibility in relation to explaining sightings of some of the world's more serpentiform lake monsters, and especially in northern latitudes.

The conger eel is currently recognised as the world's largest species.

Monster eels on Réunion

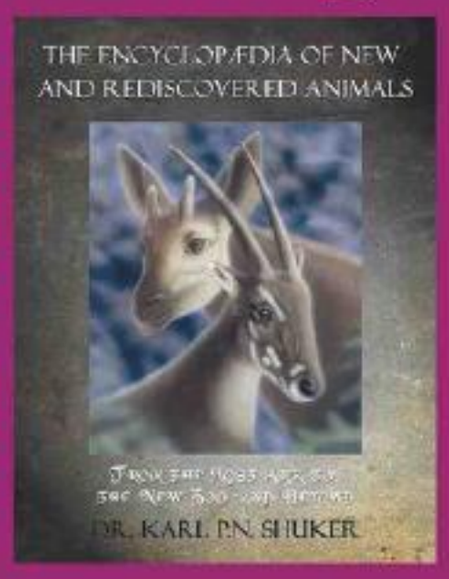
The concept of giant freshwater eels is by no means limited to Britain. For example, some of the deep



Read up on more fish mysteries

Expert in new species

Dr Karl Shuker BSc PhD FRES FZS is a zoologist, author and broadcaster who is pre-eminent in the field of both newly-discovered species and cryptozoology – the study of animals whose existence is not proven. Read his regular column in each issue, delving into the mysteries surrounding the discovery of various freshwater fish.

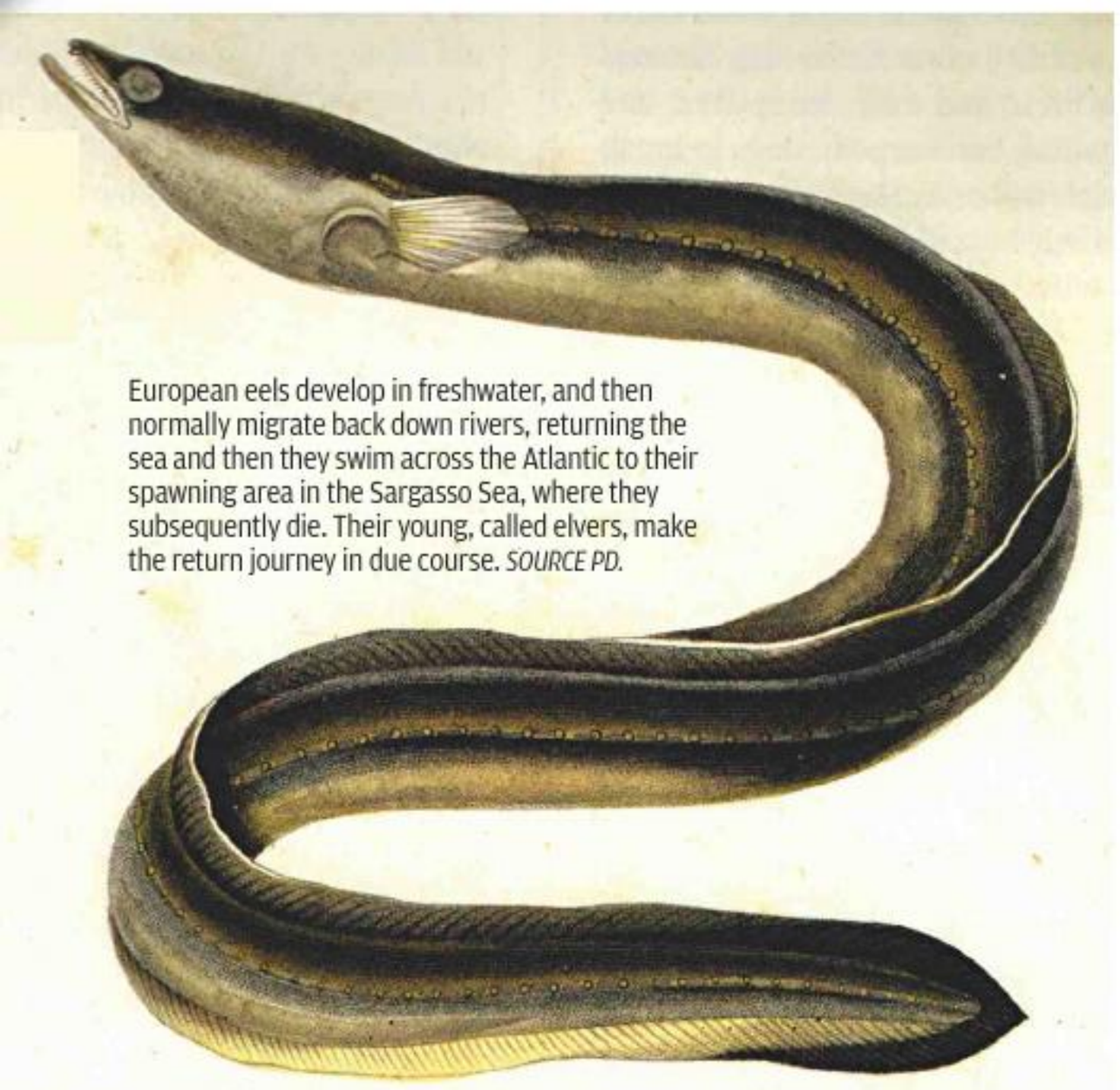


A great read

Karl's latest book - *The Encyclopaedia of New and Rediscovered Animals* (Coachwhip Publications: Landisville, 2012) extends to 370 pages long and is packed throughout with rare colour and b/w photographs. It costs £24.95, is available in hardback from Amazon and can also be ordered through all good bookshops.

TOP The island of Réunion lies between Madagascar and Mauritius.

pools on the Mascarene island of Réunion in the Indian Ocean are supposedly inhabited by gigantic, landlocked eels. In a letter to *The Field* magazine, published on 10th February 1934, Courtenay Bennett recalled seeing a dead specimen that had been caught in one such pool called the Mare à Poule d'Eaux, which is said to be very deep in places, during his time as a Consul on the island during the 1890s. He described this eel as being so immense that it was subsequently sliced into "steaks as thick as a man's thighs".



European eels develop in freshwater, and then normally migrate back down rivers, returning the sea and then they swim across the Atlantic to their spawning area in the Sargasso Sea, where they subsequently die. Their young, called elvers, make the return journey in due course. *SOURCE PD.*

BELOW The supposed appearance of the giant blue eel. *SOURCE PD.*

ABOVE Deep stretches of water on the island are – or at least were – inhabited by gigantic eels.

According to native testimony, moreover, during the heavy winter rains, similar giant eels could apparently be seen circling along the sides of this lake, searching for a way out. Being so exposed, however, they were prime targets for local hunters, who would catch them using a harpoon and a rope hitched round a tree. The flesh of these fish would then be sold as food in a neighbouring village.

Could the explanation be in Borneo?

Having said that, however, in recent times I made an interesting discovery that may perhaps constitute the original core of zoological truth from which the yarn of the giant blue, elephant-engulfing, worm-like Ganges eel was subsequently elaborated and exaggerated.

I discovered that Mount Kinabalu, on the island of Borneo, is home to a sizeable species of earthworm,

BELOW Mount Kinabalu is home to many strange creatures.

Giant blue eels of the Ganges

Finally, what can we say about the giant worm-like eels with vivid blue bodies that were soberly claimed by Ctesias, Solinus, Philostratus, Aelian, Pliny, and several other famous ancient scholars to dwell amid the dank riverbed ooze of the Ganges and other major rivers in India? According to Solinus, these amazing creatures were 10m (33ft) long. However, their dimensions grew ever larger with repeated retellings by later writers, until they eventually acquired sufficient stature – up to 100m (330ft) long now - to emerge from their muddy seclusion beneath the dark cloak of evening and prey upon oxen, camels, and even elephants! Not surprisingly, this spectacular species of giant eel has never been brought to scientific attention. In best angling traditions, it is no doubt a classic case of "the one that got away"!

measuring up to 70cm (28in) when fully stretched out, which is bright blue in colour. It is called the Kinabalu giant earthworm and known scientifically as *Pheretima darnleiensis*. It is not just confined to Borneo, however, as it also exists on several other nearby southeast Asian islands as well as New Guinea.

Moreover, it is such a familiar creature in this region of southern Asia that it is not beyond the realms of possibility that travellers journeying from here to India in bygone times mentioned this eye-catching worm there, and by so doing, they sowed the seeds for the stories that subsequently grew up around it. These ultimately resulted in a non-existent monster that was not so much a worm-like eel as just a worm, albeit one with highly unusual, memorable colouration. Thus, however, are legends often born!

It began with guppies!

Reflecting the international nature of the hobby, Charles Grima is a keen fish keeper who lives in Fgura, Malta, with his wife Marion, and his two sons, Christopher and Saviour. He has been actively involved with fish for most of his life, and is the current President of the Malta Aquarist Society. Here he talks with **Susie Kearley** about his love for the hobby and his work in the society.

SUSIE KEARLEY
Aquarium writer

Early days

When did you start keeping fish for a hobby?

When I was ten years old, my father's work colleague gave him a pair of guppies, which Dad passed on to me. I was completely fascinated by these colourful fish, although I really knew nothing about them! They were so beautiful. I put them into a large jar full of tap water, although it had no filter, no heater and nothing else, such as lighting – I was really breaking all the rules. In Malta of course though, it tends to be a lot warmer than in the UK, so the lack of heating was less of an issue.

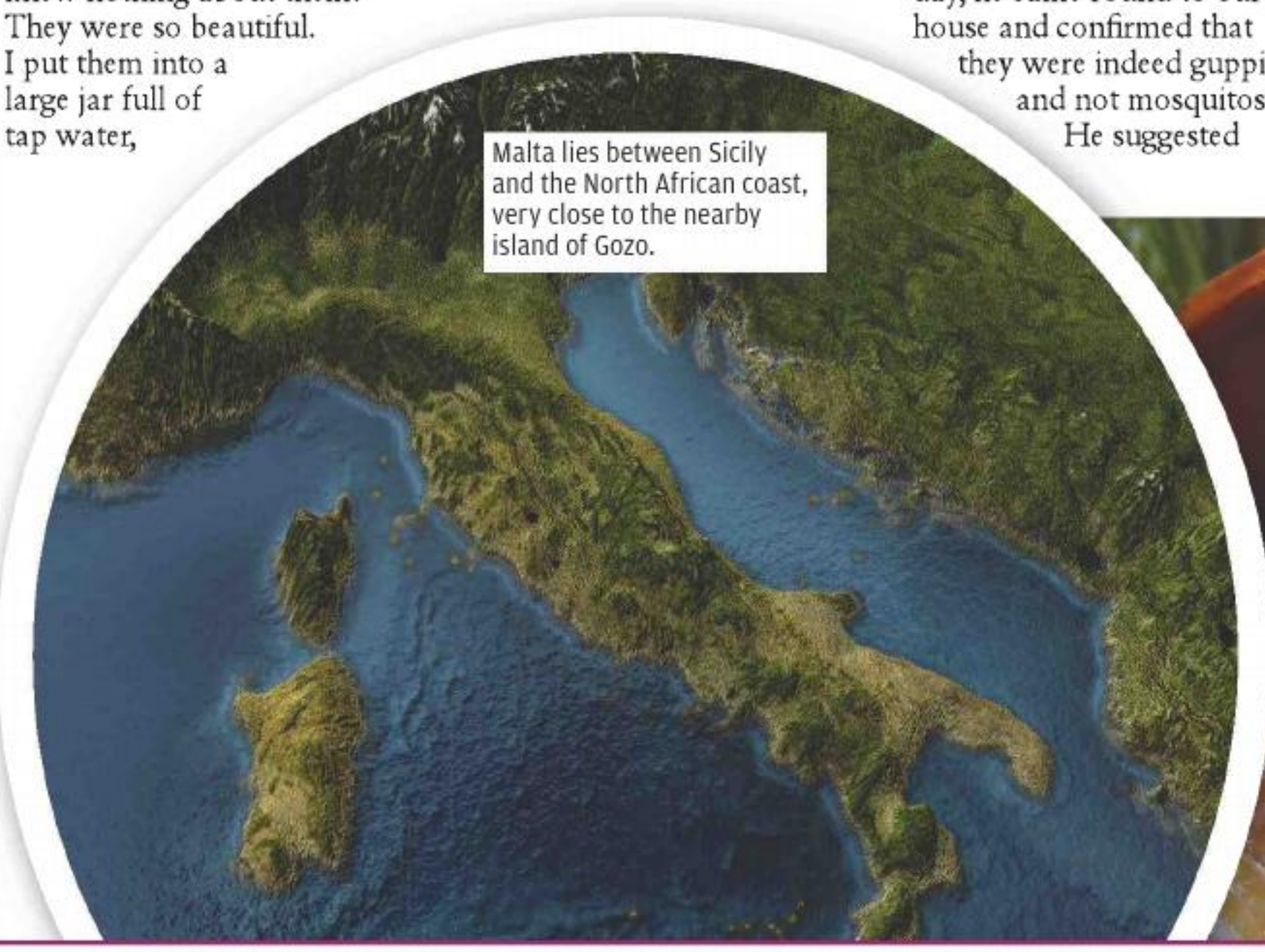
Every day when I came in from school, I went straight to see these fish, and always spent time just looking at them. One day, I noticed some small fish swimming around in the jar, and I was so excited. I can remember screaming out to the rest of the family that my fish had had babies!

Everyone came to look at them, but my father was unconvinced when he came home from work. He thought they were young mosquitos that had bred in the water, and he told me to change the water and throw them away!

I was sure that they were young guppies though, and asked him to check with his fish keeping friend. The next day, he came round to our house and confirmed that they were indeed guppies, and not mosquitos! He suggested that my father bought me an aquarium, and Dad promised to do so if I passed my forthcoming exams. That was the start of my involvement in the fish keeping hobby.

While the number of tanks that I could have was limited while I lived with my parents, my collection really grew

BELOW Baby guppies are tiny and lack the colours of adult fish. They are liable to be eaten by other tank occupants at first. This one is a week old. PHOTO © NEVIT DILMEN.



Malta lies between Sicily and the North African coast, very close to the nearby island of Gozo.

PHOTO COURTESY CHARLES GRIMA.

A spectacular male fancy goldfish kept by Charles.

ABOVE Charles Grima

when I left home. Mum and Dad wanted me to focus on my studies, and not become too distracted with fish keeping. However, by the time I left home, I'd managed to persuade them to let me keep six 1.2m (4ft) tanks and some smaller ones. My hobby had developed a long way since I was ten years old with a large jar of guppies!

A growing interest

How did you make the transition to breeder and exhibitor?

After several years of keeping livebearers such as swordtails, platies, guppies and mollies, I became aware of a new fish keeping club that was being launched on the island. It was being called the Malta Aquarist Society, and the year was 1970. I was very interested in their activities and signed up. The club celebrated its 40th anniversary in 2010, and it is still going strong!

The society was founded by a small group of aquarists who wanted to expand the hobby here on the Maltese islands. The first few meetings took place at members' homes, and things grew from there, with the group eventually being recognised as the national society for aquarists in Malta.

We started to associate ourselves with foreign clubs, which in turn helped us as a group to gain a greater knowledge about aquatics, and we have joined the Association of Aquarists and the Federation of British Aquatic Societies. This has certainly contributed to the club's growth and development. As the membership started to increase, we found a better location for our purposes, at Mount Carmel Hospital, where we now hold meetings, committee elections and discussions about fish keeping. Members can also trade and exchange fish that they breed at such events.

The society has now grown to almost 160 members and we are delighted. Within the membership, we have two groups: a junior section and the seniors. We have a monthly general meeting where everyone is welcome to come along, discuss fish keeping and socialise.

"However, by the time I left home, I'd managed to persuade them to let me keep six 1.2m (4ft) tanks and some smaller ones."

A pearlscale goldfish in Charles's collection.

Which species of fish do you breed now?

Today I have a purpose-built fish room, which accommodates 32 aquariums. Many of these I use for breeding purposes. I breed lots of species including black widow tetras, serpea tetras, lemon tetras, zebra danios, rosy barbs, tiger barbs, and the cichlid *Lamprologus brichardi*. Other cichlids in my collection include severums and golden severums, angelfish, convicts, burtoni, moori, red devils and frontosa.

I also keep galaxy rasboras, scissor-tail rasboras, and several others. As far as guppies are concerned, I now tend to specialise in Moscow blacks. I also have a large pond in my garden, with a built-in homemade biological filter, and have various types of goldfish, including fantails and single tails, as well as koi.

Being part of the society

How does the society operate?

We have a table show for members where they can display their best fish, and I sometimes take part. It's good fun seeing everyone's favourite fish, and it gives us plenty to talk about as well. The table show encourages members to attend and to display some of their most prized fish. The way that it works is that a panel of judges then selects the best three fish for that month's table show.

There are also many homebred species for sale. Fish breeding is something I like to encourage, because it adds to interest in the hobby and can help to make us independent if it becomes difficult to obtain aquarium fish in the future.

It means that as a club, we have the potential to become self-sufficient in some cases, breeding and supplying certain fish to all our members who want them. Members also benefit though from a 10 per cent discount on fish purchased from local aquatic outlets.

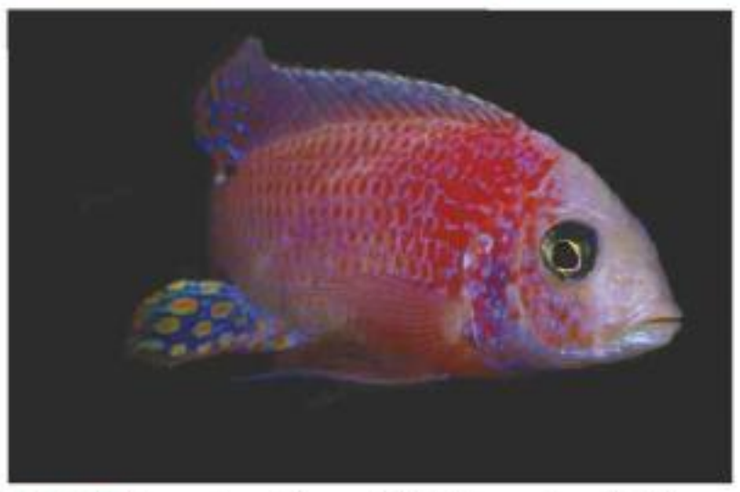
CONTINUES ON THE NEXT PAGE »

African cichlids are well-represented in Charles's collection.

One of Charles's black Moscow guppies.

RIGHT This particular cichlid, called frontosa, needs to be kept in small groups. It comes from Lake Tanganyika.

ABOVE Part of the appeal of fish keeping is the range in appearance of the fish themselves.



ABOVE The colouration of cichlids can be vivid, as shown by this Malawian individual.

ABOVE The moori cichlid comes in various forms.

PHOTOS COURTESY CHARLES GRIMA.

I'm putting a lot of my energy into the upkeep of our club at the moment. Last year, we changed all 300 of the club aquariums that we use for shows.

What else do your meetings offer to members?

There is a monthly talk given by a specialist fish keeper, and we share our fish photos, video clips, tips, and information online. We also sometimes watch DVDs on fish keeping topics. The Malta Aquarist Society's website has tutorials for anyone who is struggling to get to grips with the club's technology. We also have our own library of aquatic books and magazines.

We started meeting with aquarists from our sister island, Gozo, three years ago. Maltese aquarists were able to share their experiences with Gozitan aquarists and the attendance was encouraging. A relatively large number of aquarists joined in a fairly short period of time.

All our members are kept updated through our monthly newsletter called *Ilma Car*, which means "clear water". As a society, we are really keen to pass on and share knowledge and experiences with each other, helping members to develop their hobby successfully. We are constantly searching for fresh information - new ways to keep our fish fit and healthy, and in a suitable environment that corresponds to their natural habitat.

With adequate knowledge available, both fish keepers and their fish will be happy. It is very nice to have an aquarium, but actually to understand what is best for your fish, knowing their history, and most of all, being certain that they are healthy and well-cared for, is another thing.

ABOVE Charles Grima presenting trophies, as President of the Malta Aquarist Society.

ABOVE Charles Grima talking about the society and fish keeping in general at a local radio station.

MAS logos

What's the highlight of your fish keeping year?

The most highly anticipated event here is undoubtedly our annual Tropical Fish Show. Every aquarium hobbyist gets his fish in great condition for this competition. Thanks to the hard work of the members, this show has always been a success.

It brings a great sense of satisfaction to all those who help with arranging the show, as well as those who enter their fish for the competition. The winning members are presented with trophies and certificates on a later date at an organised lunch, so it is not just a one-off event either, but forms an important part of the social side of the society's activities as well.

Further information

Maltese Aquarist Society
www.maltaaquarist.com
Maltese Aquarist Society
Facebook www.facebook.com/groups/183670600050

A lungfish in aquarium surroundings.

The difficulties of breathing in water

We are all familiar with fish generally not being able to breath atmospheric air, but did you know they have a hard time breathing in water as well? **Paul Donovan** explains.

Respiration is the process by which an animal extracts oxygen from its environment in order to perform normal body functions, and gets rid of carbon dioxide produced in the body as a result of metabolism. In order to extract oxygen from the water, which contains only about 3% of the total amount found in atmospheric air, fish rely on their specialised breathing organs, called gills. The oxygen level in atmospheric air itself is quite low in the first place, consisting of about 21% oxygen, with the rest being made up mainly of nitrogen.

The gills resemble feather-like structures and are located behind the head. They are protected on each side by a large bony covering called the operculum. As water is drawn through the mouth, it passes over the feather-like filaments where carbon dioxide is exchanged for oxygen along the thin membranous coatings. A high diffusion rate is achieved here, ensuring this gaseous transfer is very efficient.

Of course, this all sounds very simple; just open your mouth, take in a load of water, pass it over the gill filaments where oxygen and carbon dioxide are exchanged, and expel it through the gills. But things are not quite that straightforward as there are many factors that affect this process.

LEFT The fish's feathery gills are normally covered by a flap on each side of the head called the operculum.

Different factors

One aspect that must be taken into account is temperature. The amount of free oxygen in water decreases with an increase in temperature, and conversely, rises with a fall in temperature. The fish is then put at something of a disadvantage, because, being cold-blooded, so its metabolic rate must increase correspondingly to compensate for a rise in water temperature, at a time when oxygen levels in the water are becoming lower.

This is why on a hot day, as the water temperature begins to rise, so fish may gather at the surface, apparently gasping for air. The same thing can happen if the aquarium thermostat fails, leading to an increase in water temperature in the tank.

The concentration, or saturation level, of oxygen held in the water is also affected by pressure. All things being equal, the deeper you were to go down in the ocean, so the greater the availability of oxygen. And the higher you go, the thinner the air becomes. Think of it this way; the farther up Mount Everest you were to climb, the thinner the air is, so there is less oxygen available to breathe. This brings about a condition known as altitude sickness, where the body is essentially being starved of oxygen.

CONTINUES ON THE NEXT PAGE

ABOVE Still water is often stagnant, and contains little oxygen, because there is no movement to bring the water into contact with the air. Fish may struggle to breathe under these conditions, especially if they are active. An aquarium air pump helps to raise the oxygen content of the water in a tank.

Gouramis, like this dwarf gourami, are part of the group of so-called labyrinth fish, thanks to the organs that allow them to breathe atmospheric air directly.

ABOVE Corydoras catfish will dart up to the surface to breathe atmospheric air, storing this in their intestinal tract. They may occur in stretches of water where there is little oxygen available. This is the peppered corydoras (*C. paleatus*).

BELOW Lungfish represent a very old group of fish. *Dipterus macrolepidotus*, an extinct species that lived in parts of present day Europe and Australia during the Devonian period, some 400 million years ago, is portrayed here.

There is another element that is significant too, as far as fish are concerned. This is salt. It makes it even more difficult for a fish to extract oxygen, because there will be less of it available. In other words, at the same pressure and temperature, the solubility of oxygen in freshwater is greater than that of saltwater at the same parameters. This means that a marine fish therefore has to work a lot harder to extract oxygen from water than its freshwater cousin.

The simple fact that fish live in water means that they require a lot more energy to extract free oxygen from their environment, compared with an air-breathing mammal. Water is a thousand times denser than air, and at 20°C (68°F), it only contains 3% of the oxygen as the same volume of air. Therefore, in order to extract the oxygen, a fish uses about 20% of its energy for respiration, in order to extract 80% of the oxygen from the water that flows over the gills.

In comparison, a human can only take up 25% of oxygen passing through the lungs expending an equivalent of 2% of its energy for this purpose. Unsurprisingly though, on the other side of the coin, it is far easier for a fish to give up its carbon dioxide back into the water rather than it is to extract oxygen. This is simply because carbon dioxide is much more soluble in water.

Structure of the gills

Bony fish have four gill arches on either side of the head, whereas sharks have five. Each of these arches resembles a hairy "comb" whose function is to increase the surface area through which gaseous exchange can take place. The surface area is increased still further by the presence of secondary lamellae, and it is through these that the exchange takes place. This design ensures that the largest available surface area of the gills that can be used for gaseous exchange comes into contact with the water, confined within the smallest possible amount of space. Also, as the filaments are so close together, much of the water that passes over them is involved in the gas-exchange process.

In fish, blood exits the heart via the blood vessel known as the ventral aorta, and then enters the gills where it eventually finds its way into the capillaries of the second lamellae. As the oxygen-rich water meets the blood saturated with carbon dioxide, so oxygen diffusion takes place. Carbon dioxide leaves the blood, to be replaced by oxygen. The re-oxygenated blood then returns to the heart via the dorsal aorta, from where it is then transported to the various organs.

Respiratory movements

The physical act of pumping water over the gills is achieved by a number of actions. Firstly, the gills are closed and the fish opens its mouth. Water is then sucked into the buccal cavity. Once full, the mouth is then closed and muscular contractions force the water across the gill filaments and out through the opercula. This entire process works cohesively, as part of a continuous cycle.

As the water contains such a small amount of available oxygen for the fish to extract, this must pass through the mouth and exit via the opercula so as to ensure an on-going sufficient uptake is sustained. If it were to pass back through the fish's mouth, as air does after it has been taken into the lungs of a human for example, insufficient oxygen would be taken up.

The rate at which respiration occurs is described as the respiratory rate and this can speed up or slow down, according to the fish's level of activity, metabolic rate and water temperature for example. Stress too is also likely to impact on the respiratory rate.

While it is widely accepted that respiration occurs through the gills, there are some freshwater fish such as gouramis and bettas that possess an accessory breathing organ called the labyrinth organ, located in close proximity to the gills. This enables them to breathe atmospheric air directly, and so survive in shallow and/or poorly-oxygenated water. A similar structure also exists in snakeheads and some catfish. Others such as corydoras catfish may have the ability to gulp air and absorb it through the lining of the gut.

Air-breathing fish

Further still, there are fishes with the ability to gulp air and absorb it through primitive lungs. One such example are the lungfish. There are six species alive today. They all possess two lungs, with the exception of the Australian lungfish (*Neoceratodus forsteri*) which has only one.

In the African and South American species, the gills are rudimentary or atrophied and so serve no useful function for respiratory purposes. In the Australian species, however, the lung is more developed, thereby giving the fish the ability to breathe both in water and air. The lungs are connected to the pharynx and extend into the ventral surface of the oesophagus and alimentary (digestive) tract. The inner surfaces of the lungs are lined with a honeycomb-like structure supplied with a rich network of blood vessels. When it requires oxygen, the lungfish will rise to the surface, open its mouth and gulp air. Gaseous exchange then takes place in tiny air vessels.

In the Australian species, the mouth is often kept closed and air is drawn through the nasal openings where an opening called the choana then links the nasal passage to the mouth. A single gulp of air can last the lungfish for 30-40 minutes or so.

It is believed that the Australian lungfish relies on gill respiration when water levels and oxygen levels are favourable. When water levels fall, as the result of evaporation and its habitat becomes little more than a muddy bath, the lungfish then reverts to breathing oxygen. This is an ideal survival strategy, because being unable to obtain oxygen from their gills, other fish are likely to end up perishing in these conditions. A second lineage of fishes with air breathing abilities are the bichirs. These have lungs similar to the lungfishes. Essentially, air-breathing fish can be classified either as obligate air breathers, meaning that they routinely rely on breathing atmospheric air, or facultative air breathers, only doing so when the need arises.

ABOVE A Senegal bichir. These represent an ancient lineage of fish, and have primitive lungs.

Breathing though the skin

A number of fish such as mudskippers belonging to the family Gobidae have the ability to leave the water, and then live and move around on land for some quite extended periods of time. They can also live in stagnant pools or ponds where oxygen levels are severely depleted. These fish, as with frogs, have the ability to absorb oxygen through the skin.

The link between fish and amphibians is reinforced by the fact that juvenile bichirs possess external gills, which are a primitive feature shared with tadpoles, representing the larval stage in the lifecycle of amphibians, and may show some evolutionary connection. Oxygen absorption through the skin can also be seen in anguillid eels, and this allows them to move overland, out of the water when necessary.

ABOVE Mudskippers are well adapted to breathe and live out of water.

Shark respiration

Sharks have a slightly different means of respiration. Although it is similar to that of bony fishes, it is not brought about by a "pumping" action, but by movement. The shark must keep moving in order for water to pass freely over the gills and gaseous exchange take place.

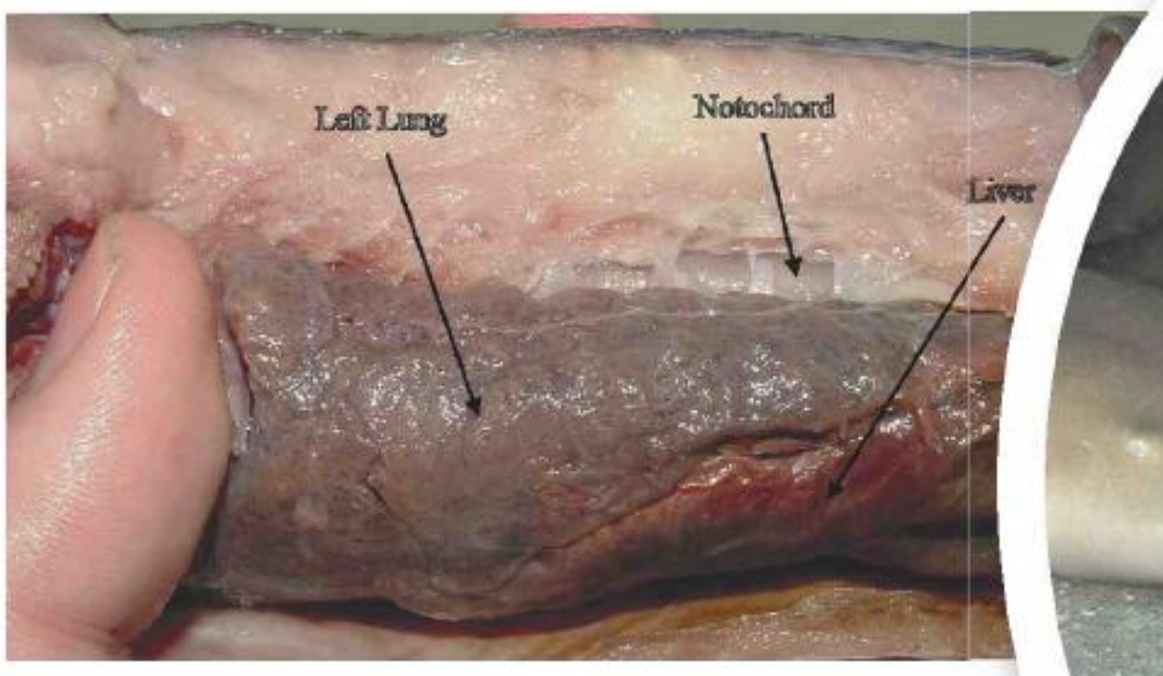
If it were to remain motionless, this exchange would not take place and the individual would die from oxygen starvation. Having said that, there are a few exceptions to this rule. The nurse shark (*Ginglymostoma cirratum*) can remain motionless on the seabed where it relies on passing currents to ensure that water continues to flow over its gills.

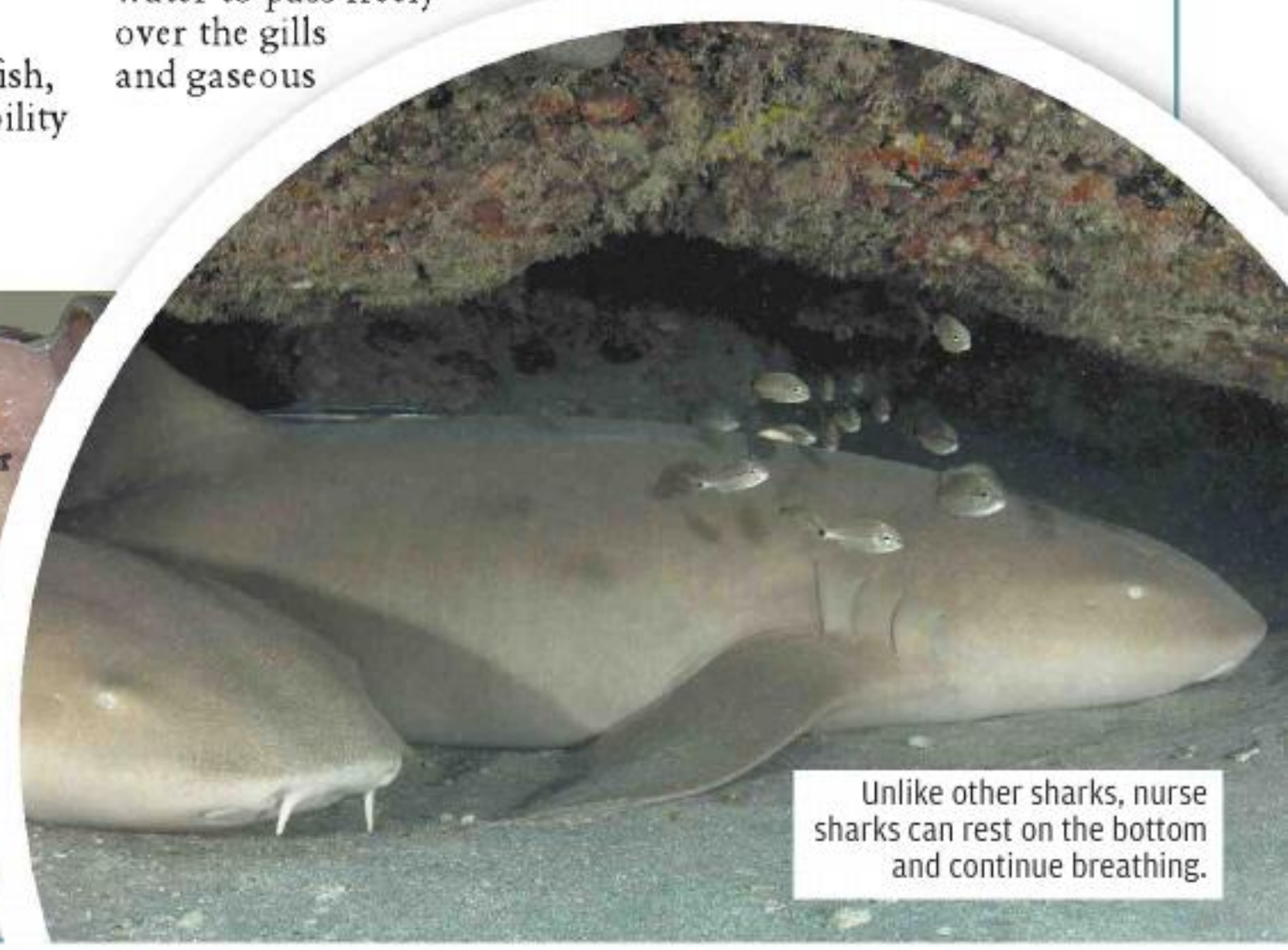
Coldwater versus tropical

An increase in temperature or activity will mean that the fish requires more oxygen to cope with the corresponding rise in its metabolic rate. This will see an increase in the respiratory rate and heart rate as the fish tries to push more blood through the gills in the attempt to secure oxygen. But of course, there will come a point at which a blood flow threshold is reached and this then limits the amount of oxygen absorption that is possible.

Each group of fish has adapted to live with a specific temperature range, and to place a coldwater fish in a tropical set-up would lead to its premature death because it would be unable to extract enough oxygen to maintain its normal bodily functions. It is therefore important to keep the fish within their correct temperature range. A fish may indeed be adapted to living in water, but it has a hard time doing so!

BELOW The lung of the spotted African lungfish (*Protopterus dolloi*). Photo courtesy Mokele at en.wikipedia.





Unlike other sharks, nurse sharks can rest on the bottom and continue breathing.

Puzzle page

See if you can solve the puzzles here! You can find all the answers on page 74.

ANATOMICAL

Fifteen of the external parts of a fish's anatomy (listed below) have been hidden - up, down, diagonally, back and forth - in the wordsearch grid. which one is missing?

BARBELS, BELLY, EYES, FINS, GILLS, HEAD, LATERAL LINE, MOUTH, OPERCLES, PLATES, RAYS, SCALES, SNOUT, SPINES, SWIM BLADDER, TAIL.

PUZZLE IT OUT

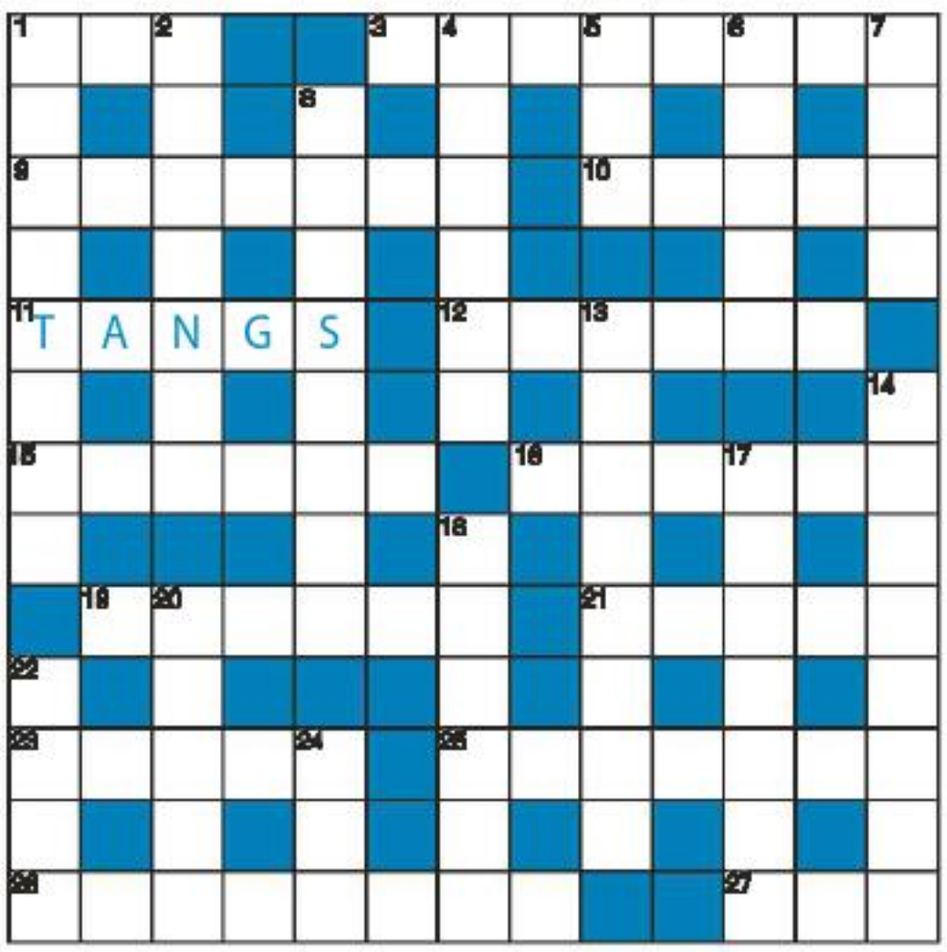
Solve the crossword in the usual way except that where a clue is represented by asterisks, you must enter a word that has some connection with the solution already given - TANGS.

ACROSS

1 Item for sale at auction (3)
3 Large bounding Australian marsupial (8)
9 Joanna player (7)
10 Sorcery (5)
11 TANGS
12 Puzzle, conundrum (6)
15 Small red stone fruit (6)
16 Hanging spike of frozen water (6)
19 * * * * * * (6)
21 Sturdy alloy of iron and carbon (5)
23 Pinafore (5)
25 Young hare (7)
26 * * * * * * * * (8)
27 Bob head in agreement (3)

DOWN

1 * * * * * * * * (8)
2 Apprentice, cadet (7)
4 Thespians (6)
5 * * * (3)
6 * * * * * (5)
7 On a single occasion (4)
8 Troubadour, mediaeval musician (8)
13 Sharp and determined in judgement (8)
14 Released the air out of (8)
17 * * * * * * * (7)
18 Number in a dozen (6)
20 Third planet from the Sun (5)
22 Flowing volcanic material (4)
24 Nought, no score (3)



ID PARADE

Can you identify this fish and its continent of origin?

TETRA PUZZLE

Here are five different tetras. Can you recognise them?

A green swordtail (*Xiphophorus hellerii*).

Swordtail discoveries

They are highly popular fish that have been bred in aquarium surroundings for many years, and yet still we are making remarkable discoveries about swordtails, even today.

If you are having trouble breeding swordtails, this may be an indication that your filtration system is highly efficient! Thanks to research funded by the National Science Foundation and the American Livebearer Association, it is now known that the urine of male swordtails contains chemical messengers called pheromones that serve to attract female fish.

The study was based on wild sheepshead swordtails (*Xiphophorus birchmanni*), from the Rio Atempa in Huitznopala, Mexico. By administering a fluorescein dye that is visible under ultraviolet light, so it was possible to see when the male fish urinated in aquarium surroundings.

It became clear that they strategically release pheromone-packed urine in the presence of females, as a hidden aspect of their courtship display. This indicates that male swordtails have developed both time and location controls when it comes to releasing their pheromones.

A new area of investigation

The research, led by Texas A & M biologists Dr Gil Rosenthal and Dr Heidi Fisher, with assistance from colleagues at Centro de Investigaciones Cientificas de las Huastecas in Hidalgo, Mexico, and Boston University, opens up a new and exciting field of study. In the past, it had been assumed that fish simply released pheromones indiscriminately, but it is now clear that this is not the case. It is a carefully coordinated process. In the wild, male swordtails were observed swimming upstream, from where their urine would be carried downstream by the water current to the females. "Our findings show that aquatic species and vertebrates, in particular, can have fine control over their release of chemical cues in the same manner as mammals that mark their territories or advertise their reproductive state," explains Dr Fisher, who is now based at Harvard University's Department of Organismic and Evolutionary Biology.

ABOVE Research using swordtails is providing vital clues in terms of their reproductive biology.

Impact on wild populations

Swordtails serve as a popular choice amongst scientists for investigating animal communication subjects, and they are commonly used in female mate-choice research. But while numerous studies have addressed the role of cues ranging from olfactory to visual on the behaviour of these fish, none has previously investigated exactly how and when chemical cues are released.

"For the first time, we have now shown that male swordtails use chemicals in their urine as mating signals," Dr Rosenthal says. "There's been relatively little work on how pheromones shape the lives of aquatic creatures".

The outcomes

Dr Rosenthal adds that studying the chemical signals of swordtails is vital not only to understanding how they and similar species communicate, but also because the information could be indicative of several environmental factors that could prove useful in the future. For example, he says, any amount of pollution might disrupt the communication within a species, thereby interfering with the courting and mating process and ultimately affecting the population.

"Since these chemicals are rich in information and because they're transmitted through the water at very low concentrations, any change in the environment has the potential to shut down communication," he explains. "The silver lining is that we might be able to use communication behaviour in a way that enables local communities to detect pollutants in the water."

Male swordtails can be recognised easily by the presence of the so-called sword, which describes the elongated area on the dorsal fin.

Further information

You can see the full findings online here: www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0016994>

Could swordtails have a role in making us aware of pollution in the future?

ALL SHRIMP AND EQUIPMENT PHOTOS BY LUCAS WITTE-VERMEULEN, SHARNBROOK SHRIMP.

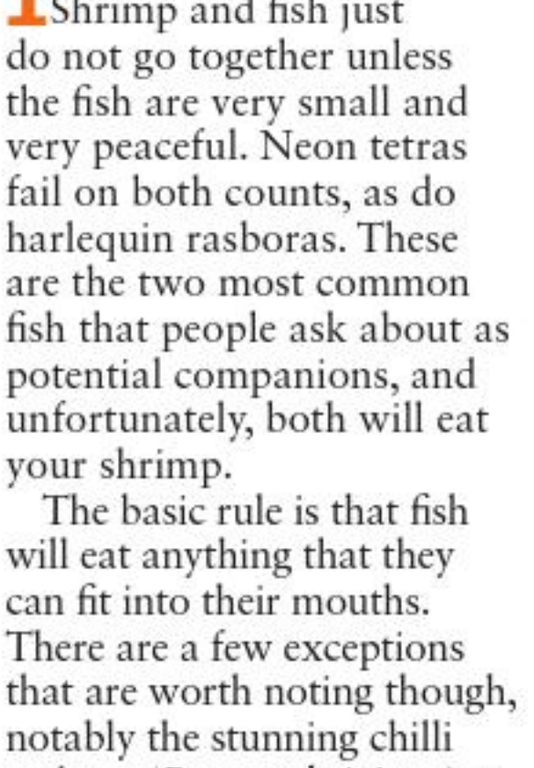
Shrimp require a tank with natural planting.

Top ten tips for shrimp enthusiasts

Keeping shrimp is becoming very popular, and here **Lucas Witte-Vermeulen** of Sharnbrook Shrimp outlines the key aspects to consider, when on a quest to set up shrimp successfully.

1 Firstly, the bad news! Shrimp and fish just do not go together unless the fish are very small and very peaceful. Neon tetras fail on both counts, as do harlequin rasboras. These are the two most common fish that people ask about as potential companions, and unfortunately, both will eat your shrimp.

The basic rule is that fish will eat anything that they can fit into their mouths. There are a few exceptions that are worth noting though, notably the stunning chilli rasbora (*Boraras brigittae*) or the equally attractive galaxy rasbora (also known as celestial pearl danio – *Danio margaritatus*), plus any other very small fish. These should be safe to keep with shrimp.



ABOVE Otocinclus will prove useful in a shrimp tank. *PHOTO COURTESY RAINER SCHMITT, 2004.*

One particular group of fish can be considered almost ideal shrimp companions though. Members of the genus *Otocinclus*, which are a type of armoured catfish, will not bother even the tiniest bay shrimp. Otos, as they are sometimes known, have the added advantage of being voracious eaters of brown diatom algae, preventing these from taking over a tank.

2 Decide what shrimp you want to keep before setting up your tank, as there are important differences in their care that must be considered. Two main types of shrimp are available in the UK: *Caridina* shrimp, including the popular crystal bee shrimp along with other, more exotic colour and pattern variations, and *Neocaridina*, as represented by the red cherry shrimp and its colour variants, which include yellow, orange and even blue.

LEFT A 15 litre nanotank is ideal for shrimp.

Caridina shrimp thrive in relatively soft water with a lower pH reading, and so using reverse osmosis (R.O.) water and an active shrimp soil substrate is recommended in this case. You can buy R.O. water at many specialist aquatic shops, if you do not have an R.O. unit yourself.

Members of the *Neocaridina* group, however, prefer water conditions that are harder, with the pH being higher. If you want to keep these particular shrimp, then an inert sand or gravel substrate, and tap water treated with a suitable water conditioner/dechlorinator should be suitable. By deciding beforehand, so you will not be disappointed when the shrimp you decide that you want to keep are not suitable for the tank that you spent ages preparing for them! Always do your research first.

3 If your tank is not purpose-designed for shrimp, then you need something to cover your filter or filter intake You can use fine sponges to cover the intakes on canister filters, or even cut down tights for this purpose. Air-driven sponge filters are the safest option for shrimp, even if they are a little noisy.

4 Neither *Caridina* nor *Neocaridina* shrimp need much heat. In fact, heaters are not necessary if your shrimp tank is kept around room temperature. It is recommended to set a temperature of less than 23°C (73°F) if you decide to incorporate a heater into their quarters.

Orange sakura shrimp – as a *Neocaridina* species, it needs different water conditions to *Cardinia* species.

Indian almond leaves, and the skeleton that is left after they have been nibbled away.

Too much food will simply pollute the water.

5 Acclimatise your shrimps slowly using the drip method, and never rush. This method relies on a tub and a length of airline, with a knot or clamp at one end and a suction cup at the other. Using the airline as a siphon, the water from your tank will slowly drip into the tub of newly purchased shrimp until the parameters are the same. Floating the bag of shrimp in the tank is fine to allow them to adjust in terms of temperature, but remember that this will do nothing to acclimatise them to the actual water parameters within the tank.

6 When buying shrimp, always make sure that they are from a reputable shop or breeder. Look for feedback and reviews from past customers on the web. The growing interest in shrimp means that there are many new online shrimp shops popping up all the time, so again, do your research carefully.

It is always a good idea to pick up the phone and speak to the shop, or call in and ask any questions that you may have before you purchase anything. Speaking on the phone is a good way of establishing if a shop knows what they are talking about, especially if you are going to rely on having the shrimps delivered, rather than being able to pick them up yourself.

7 Live plants should be used in a tank for shrimp - please do not use plastic plants! They have no benefit whatsoever for these crustaceans, and contribute nothing in terms of the natural tank cycle. You need live plants to utilise the nitrates resulting from the breakdown of waste, and these will also serve to oxygenate the water. You need lights too: I would recommend low energy LED lights. Many are waterproof and last for five years or more, and will highlight the tank occupants very effectively.

8 Make sure your tank is cycled! Never set up a tank and then go out and buy shrimp straightaway. Cycle your tank for around four weeks at a minimum, and test your water for nitrites and ammonia levels before heading off to your local shrimp shop. Get advice from the shop about their water parameters too, as it will save you a lot of worry and potential headaches when starting out. This is the time that problems are most likely to arise.

9 Always keep a couple of Indian almond leaves in your shrimp tank. These will slowly rot away, and as they do so, a bio film will form on the surface of the leaf. The shrimps will constantly graze away on this and help to consume the leaf too, until there is just an outline skeleton left. The leaf will also release chemicals called tannins that have anti-fungal properties. These leaves were initially used in Asia for breeding bettas, and they have proved very useful in the shrimp hobby too, as well as being beneficial as a long-lasting food source that will not pollute the water.

10 Better to underfed than overfed if you are in doubt, as overfeeding will be a disaster. Shrimp do not have access to a constant food source in the wild, other than rotting leaf litter, and it is important to avoid excessive food. If you overfeed, you will get algal blooms occurring, and fungus is also likely to become a problem, threatening the tank occupants. The water quality will rapidly deteriorate and your shrimps will die. There is no need to feed shrimps every day. Offer food no more than every second day and only then as much as the shrimp can eat in a couple of hours. They can obtain food from an almond leaf if they wish.

Want to know more?

Lucas has opened the first shrimp-only retail store in the UK: Sharnbrook Shrimp, 3 West Street, Rushden, Northamptonshire, NN10 ORT.
Tel: 01933-317107
Website: www.sharnbrookshrimp.co.uk

Next issue

ON SALE FRIDAY, 18TH JULY

Seasonal changes

Discover how warmer weather may impact on the care of your fish, and why it is necessary to plan ahead if you are setting off on holiday, to ensure that all is well with them.

Striking a pose

Swordtails are very attractive fish, and now exist in a wide range of varieties. These livebearers can make a great introduction to the hobby. Discover more about them, including their remarkable biology and care.

Are you a winner?

Find out if you were successful in our competitions to win a top of the range Fluval Fresh F-60 Aquarium set, comprising an 85l tank and an integral cabinet, courtesy of Rolf C. Hagen, or a stylish biOrb LIFE 15 Aquarium, courtesy of Reef One.

Puzzle page

HEADS UP

Pictured below are close-ups of the heads of five different fish. Can you identify them?

1. Black neon tetra (*Hyphessobrycon herbertaxelrodi*)
2. Silverlip tetra (*Hasemania nana*)
3. Glowlight tetra (*Hemigrammus erythrozonus*)
4. Black phantom tetra (*Hyphessobrycon megalopterus*)
5. Rummy-nose tetra (*Hemigrammus rhodostomus*)

PUZZLE IT OUT SOLUTION

Across: 1 Legs, 3 GOLDFISH, 9 Oceania, 10 Comet, 11 Hinge, 12 Desert, 14 Agreed, 16 Friend, 19 Ranchu, 21 Uncle, 24 Alive, 25 Thimble, 26 Fighters, 27 Mars.
Down: 1 Lionhead, 2 Green, 4 Oranda, 5 Ducks, 6 Immerse, 7 Hate, 8 Sneeze, 13 Idleness, 15 Reading, 17 Ryukin, 18 Guitar, 20 Chest, 22 Cobra, 23 Half.

ID PARADE ANSWER

Ram cichlid (*Mikrogeophagus ramirezi*)

STAR FISH

Missing name is: OPERCLES

Popular Fish Keeping

Visit: www.popularfishkeeping.co.uk

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