Koi, a colourful variety of carp, are commonly kept in outdoor ponds in the UK. These fish can live for 20 years or more and grow to over 60 cm in length. Veterinary surgeons can readily apply their skills to provide a useful diagnostic service and offer constructive advice on the health and welfare of these and other ornamental fish

Taking the plunge: treating pet fish

WILLIAM WILDGOOSE

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THERE are more pet fish in the UK than dogs and cats combined. Fish keepers are increasingly approaching veterinary practices for professional help and a greater level of care can now be offered to them and their fascinating pets. There is not only scope for involvement with private hobbyists but also with breeders, importers, dealers and public aquaria. Using a logical approach and some basic equipment it is possible to treat many fish diseases and provide a useful service to fish keepers. This article presents a practical introduction to the subject and discusses some of the opportunities for practitioners with an interest in ornamental fish.

A LOGICAL APPROACH

The veterinary surgeon is often seen by the hobbyist (and sometimes by the vet himself) simply as a source of prescription-only medicines (eg, antibiotics, licensed anaesthetics and some pesticides). However, veterinary input can and should include constructive advice on general husbandry and disease management. While we may have limited training in aquatic diseases, we have a vast depth of knowledge and experience of health problems in other species and these principles can be applied directly to pet fish. As with health problems in terrestrial animals, fish disease investigations follow a standard approach – namely, investigation of the clinical history, the environment, the patient and laboratory samples.

CLINICAL HISTORY

A detailed case history will help to identify specific factors relevant to the investigation. For example, if all fish of all species are affected at the same time, this suggests an environmental problem. If a few fish exhibit signs of disease, with an increasing number becoming affected over a few days, then an infectious agent is more likely (see box below).

ENVIRONMENTAL INVESTIGATION

Examination of the environment requires some understanding of water quality and the fate of metabolic waste products. Ornamental fish usually live in facilities with a recirculating water system and at stocking densities greater than would exist in nature. Their health is so heavily dependent on the quality of the water in which they live that poor environmental conditions and stress are involved in at least 90 per cent of disease problems.

Ammonia is produced as the main waste product of nitrogen metabolism and is excreted by the gills. This is toxic to fish, particularly in water with a high pH and

Pointers that may be gleaned from the clinical history

A full clinical history may reveal a disease pattern which, in turn, will often give clues as to the nature of the problem. For example:

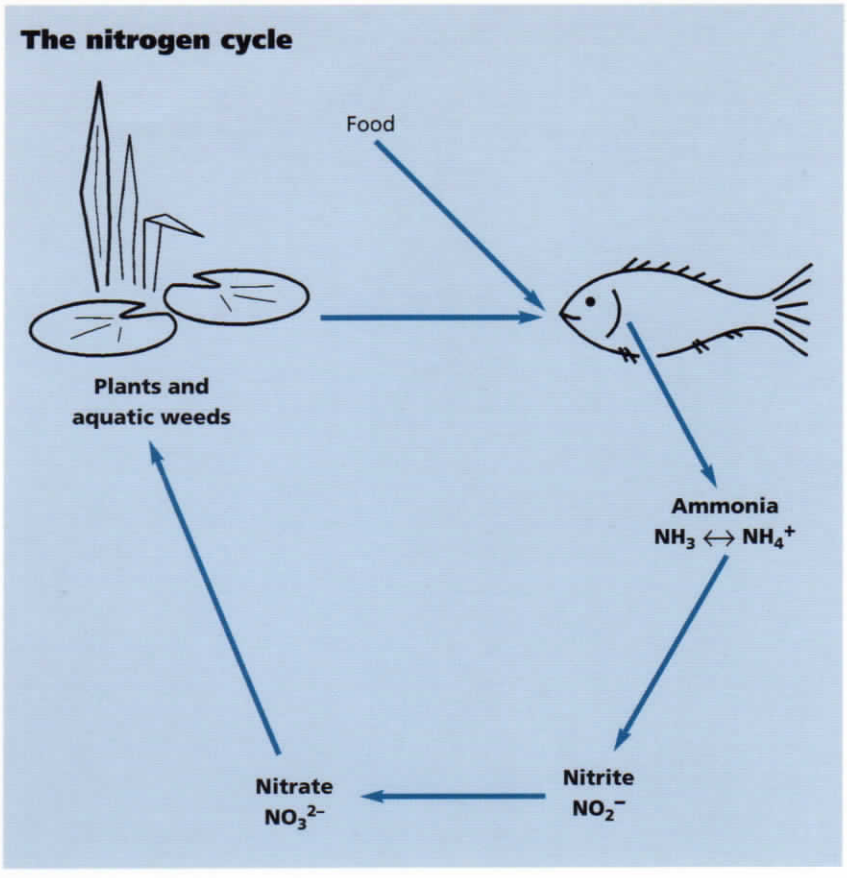
- Sudden illness + all species affected → Environmental problem (eg, poor water quality, poisoning)
- Gradual onset + increasing numbers of fish affected → Infectious disease (eg, bacteria, parasites)
- Isolated cases + small number of fish affected → Non-infectious disease (eg, tumours, physical trauma)

at high temperatures, when the unionised form exists (NH_3). At low temperatures, in acidic water and with increasing salinity, the less toxic ammonium ion (NH_4^{+}) dominates. These two forms of ammonia exist in equilibrium, the balance depending on the prevailing water conditions. Heterotrophic bacteria in the water and on the surface of filter media (where oxygenated water is constantly flowing) metabolise ammonia as an energy source. This is oxidised to nitrite (NO_2^{-}), which is also very toxic to fish. Other nitrifying bacteria further oxidise nitrite to nitrate (NO_3^{2-}); this accumulates in the water, where it is tolerated by most common species of fish, or is taken up by plants.

It takes several weeks for the bacterial flora to establish in new tanks and ponds and for the filter systems to mature and function efficiently. New facilities must therefore not be overstocked but fish numbers built up slowly. Metabolic wastes and their products should be monitored regularly (every two weeks, more frequently if water conditions are poor) and this is an essential part of fish husbandry. Simple and inexpensive test kits for measuring ammonia, nitrite, nitrate and pH levels are available from aquatic suppliers.

Knowledge of the various filtration systems used by hobbyists will help to identify the underlying cause of many water quality problems and enable practical solutions to be implemented. There are many types of filter units, varying in complexity, performance and cost. However, most employ a combination of mechanical, biological and/or chemical filtration principles to remove waste materials. Mechanical methods remove suspended solids such as faeces, silt and algae. Biological systems provide a large surface area to encourage the growth of organisms that remove ammonia and other organic wastes. Chemical filter media include activated carbon, ion-exchange resins and other synthetic media that adsorb various dissolved chemicals.

Poor water quality can be due to overstocking, overfeeding or poor design and maintenance of the filtration system. This produces physiological stress in the fish and reduces their ability to control many of the opportunist pathogens found in the aquatic environment. It is rarely possible to solve fish health problems without detailed information on the environment and general husbandry. This is best obtained by personal inspection, but time and expense often prohibit a visit to the facility



Water quality has a profound effect on the health of fish. Since most ornamental fish live in an enclosed body of water, the build up of metabolic waste products must be monitored. Various types of test kits are available. Most use colorimetric methodologies and involve adding measured amounts of reagents to the test solution, or the use of impregnated dip strips. Water quality tests must be performed regularly, regardless of the physical appearance of the water

Despite the large size of some fish ponds and the complexity of the filtration systems, a veterinary approach to koi ponds is the same as that used to inspect a small aquarium. The principles of water quality and disease management are similar. However, the effect of the immediate surroundings and climate on pond fish and their aquatic environment must also be considered

Anaesthesia

Anaesthesia of ornamental fish is relatively simple. Although several different chemicals produce safe anaesthesia in fish, it is recommended that MS222 (Thomson & Joseph, Norwich) – the only product licensed for use in fish – is used. Both the chemical and the volume of the water in which it is to be dissolved, should be accurately measured. Great care should be taken when anaesthetising uncommon species since there can be significant differences in their response to the agent. Brief immersion in the anaesthetic solution will produce sedation and permit the fish to be removed for examination and sampling. Minor surgical procedures necessitate deeper planes of anaesthesia, while longer operations may require a recirculating system that pumps fresh oxygenated solution over the gills.

A level quarter teaspoonful of MS222 in 4·5 litres of water produces an anaesthetic solution suitable for most coldwater species

Preparing an anaesthetic bath

MS222 is a dry powder which dissolves well in water and is often used at a concentration of 50 to 200 mg/litre. A stock solution (10 g/litre) can be used to prepare a working solution, although it is often more practical to use a small standard culinary measure. The author usually uses a level quarter teaspoonful of MS222 in 4·5 litres of water. This produces a working anaesthetic solution of about 170 mg/litre, which provides an effective dose for most coldwater species. Half this dose is used for tropical and marine fish. However it should be emphasised that great care and a low dose should be used for any unusual species. Owners should be instructed to bring a suitable quantity of water from the pond or tank in a separate container so that this can be used to prepare the anaesthetic bath.

Euthanasia

In some cases it will be necessary to kill fish humanely, either to avoid further suffering or to sacrifice a fish for postmortem examination. As with any animal, euthanasia must be handled sensitively and with compassion since the fish may be of great emotional value to the owner.

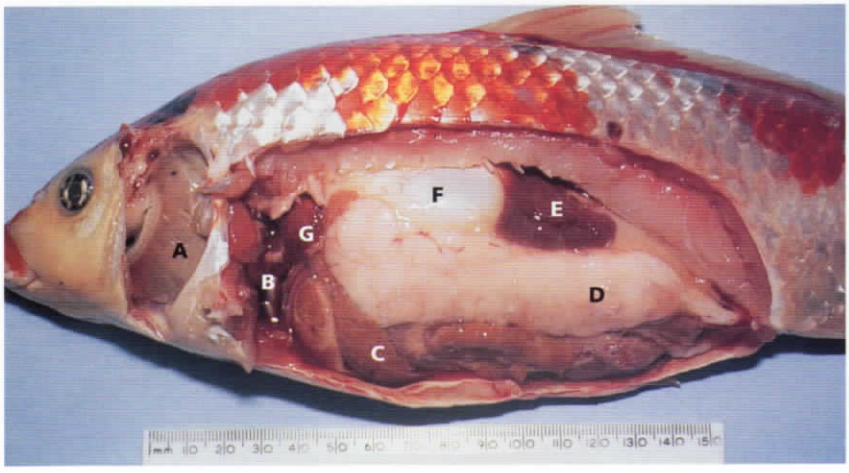
The most practical method is to use an anaesthetic overdose administered as a bath. A dose of five times the anaesthetic dose of MS222 will produce rapid and effective euthanasia. It is recommended that the fish remains in the solution for an hour to ensure that death has occurred, or that an intravenous or intracardiac injection of pentobarbitone is also administered. In the absence of MS222, 5 ml of isoflurane or 10 drops of 'oil of cloves' per litre of water can be used as an alternative agent for euthanasia. Oil of cloves, available from most pharmacies, contains the active ingredient eugenol.

LABORATORY INVESTIGATIONS

Laboratory investigations may include the examination of water quality, body mucus, tissue samples, bacterial swabs, blood and faeces. Water quality should always be tested in the investigation of a fish disease problem, even if only to confirm the results obtained by the owner. Examination of skin and gill mucus is a routine procedure that should be performed in most cases. Small numbers of pathogenic ectoparasites are found on most fish but, in healthy individuals, are kept in check by natural defence mechanisms. When the health of the fish is compromised, parasite numbers increase, leading to clinical signs of disease.

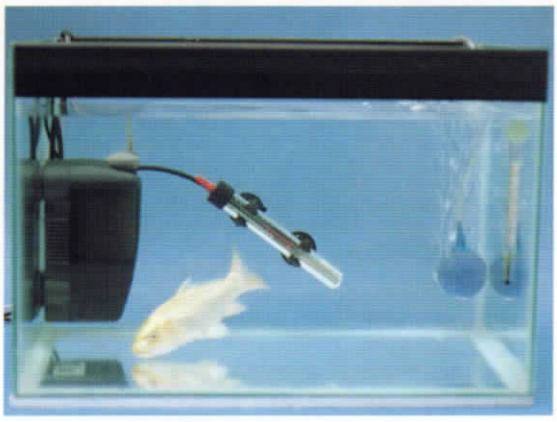
In some cases, mortality may be the first sign of a health problem. Postmortem examination is very useful

The examination of mucus samples from the skin and gills for the presence of ectoparasites and other pathogens is a routine investigative procedure. A small sample of mucus is obtained by lightly scraping the surface of the skin with a blunt scalpel blade or spatula. This is applied to a glass microscope slide with a drop of water from the tank or aquarium and a cover slip, and examined under low power magnification. Many parasites are refractile to light; their visibility can be enhanced by the use of phase contrast or by lowering the condenser



Postmortem examination of fish involves opening the body cavity with a midline incision from the pectoral fins to the vent. This is extended dorsally over the left flank to behind the operculum (gill cover) and the flap of tissue is removed. The organs visible are the (A) gill, (B) heart, (C) liver, (D) gonad (male), (E) posterior kidney, (F) swim bladder and (G) anterior kidney. Examination must be performed within an hour or two of death so that tissue autolysis is minimised. The gill, normally liver-red in colour, has become pale in this case and indicates that death occurred several hours earlier

but must be performed within one or two hours of death due to the rapid autolysis of fish tissues. Refrigeration may extend the interval by a few hours but the tissues are of little use after being frozen. Histopathology may provide useful information about a disease process but requires fresh tissue samples, preferably collected from sacrificed fish, for fixation. Routine samples are taken from the heart, gill, anterior and posterior kidney, liver, skin, muscle and any obvious lesions. Fish and fry that are too small to sample easily should be slit open and fixed in neutral buffered formol saline for histological examination of whole body sections. Samples for bacteriology and virology may occasionally be of value.



Only the bare essential equipment is required for an isolation facility or hospital tank, including a filter system, air stone, thermostat-controlled water heater and thermometer. This allows manipulation of the environment (heat can increase the rate of recovery in coldwater fish), and avoids any potential adverse effects of medication on healthy fish in the main facility

THERAPY

Following these examinations, it should be possible to form a diagnosis and suggest a line of treatment. Effective therapy involves not only curing the fish and removing any pathogens but also eliminating the predisposing stress factors. Often, there are several problems present at any one time. For example, poor water quality may stress the fish, precipitating an ectoparasite infestation that in turn produces damage to the skin and allows secondary bacterial and fungal infections to develop. All these factors must be eliminated for the fish to recover fully and to avoid a recurrence of the disease.

ENVIRONMENTAL IMPROVEMENT

Environmental improvement is often required and, in cases of emergency, it is recommended that substantial water changes (up to 50 per cent) are performed every 24 hours. Adding sodium chloride (salt) at 2 g/litre will also help freshwater fish to cope with poor water quality. Food should be withheld and the level of aeration increased until more detailed investigations can be carried out.

Measures to improve the environment

The following measures can also be used in cases of emergency before examination of the fish:

- Change 50% of the water, daily if necessary
- Add salt at 2 g/litre for freshwater fish
- Stop or reduce feeding until conditions improve
- Increase aeration with air stones or fountains
- Avoid the indiscriminate use of medications
- Monitor water quality regularly

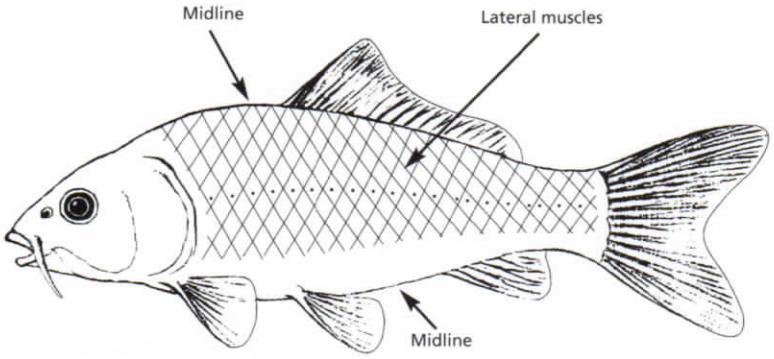
MEDICAL TREATMENT

The identification of any pathogens will enable an appropriate medication to be advised. There is a wide range of proprietary medications available from aquatic suppliers. These contain various chemical mixtures, and often include formalin and organic dyes. Most of them are only effective against external diseases and are administered as an in-water treatment. For details of proprietary products and other medicines used in ornamental fish, see the 'Further reading' list on page 227.

Bacterial diseases may be systemic and require antibiotic treatment given in the water, in food or by

Commercially produced medicated food is available following instruction to the manufacturer under a medicated feedingstuffs prescription. Currently, only one manufacturer in the UK (Sinclair Animal & Household Care, Bradford) is licensed to produce fish food that has oxolinic acid incorporated; both flake and pelleted formulations are available. Other antibacterial agents can be surface-coated onto the food together with vegetable oil, to act as a binding agent

Many proprietary medications are available without prescription and are packed in easy-to-use containers. Although these preparations have been used for years by the aquarist, most of the products do not have a market authorisation and the ingredients of some are not disclosed by the manufacturer. However, many have been shown to be safe and effective against some external bacterial diseases, ectoparasites and fungi. Therefore, following confirmation of the pathogen, owners should be advised to use one of these products as a first-line treatment



Injection sites used in ornamental fish depend on the size and species involved. The choice is often a personal one but include those shown here. Koi have extensive adhesions between the body wall and the viscera, which increases the risk of injecting a drug into the viscera or lumen of the intestine when using the intraperitoneal route. Therefore, intramuscular injection is preferred in this species and, depending on the size of the fish, the use of long hypodermic needles is advised so that the drug is not readily expelled from the injection site

injection (see table on the right). Many factors determine the route of administration and it is often necessary to use a combination approach that includes both environmental and systemic therapy.

The use of an isolation facility or hospital tank is only practical when a few individuals are affected. The water temperature can be raised to increase the metabolic rate in coldwater species and speed up their recovery.

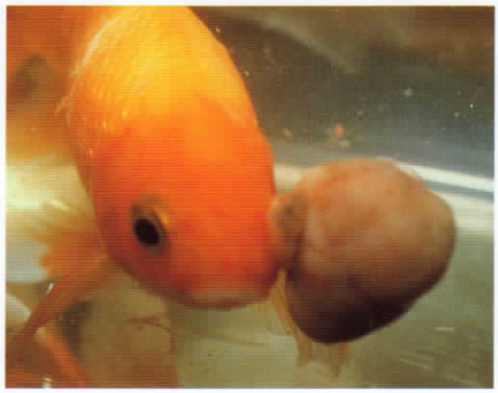
SURGERY

In addition to medical treatment, various surgical procedures can be performed on fish. The most common intervention is the topical treatment of ulcerations, which are frequently caused by bacterial infection (see box, below right). Many fish in captivity are old and present with age-related diseases, including neoplasia. Skin tumours are common in such fish and, although most cannot be removed completely, many can be debulked, particularly if they are causing obstruction around the mouth and gills. Internal surgery, such as laparotomy to investigate the cause of abdominal swelling or a buoyancy disorder, or tissue sampling/biopsy and removal of internal neoplasia, has been performed successfully; however, suitable cases are relatively uncommon.

DOSE RATES OF ANTIBACTERIALS COMMONLY USED IN ORNAMENTAL FISH

Antibacterial	*Dose rate*
Co-trimazine Tribrissen (Schering-Plough)	Oral: 30 mg/kg daily Injection: 30 mg/kg on alternate days
Borgal 7·5% (Intervet)	Injection: 75 mg/kg every 4 days
Enrofloxacin	Bath: 2·5 mg/litre for 5 hours daily Oral: 10 mg/kg daily Injection: 5-10 mg/kg on alternate days
Oxolinic acid	Oral: 10 mg/kg daily
Sarafloxacin	Oral: 10 mg/kg daily
Metronidazole	Bath: 7 mg/litre Oral: 10 mg per gram of feed for 5 days

NB Most treatments should be given for 10 days. Of the above antibacterials, only oxolinic acid is licensed for use in ornamental fish. Co-trimazine and sarafloxacin are licensed for use in salmon



Various surgical procedures can be successfully performed on fish. In many cases, this is for the removal of skin tumours and occasionally enucleation. This fish presented with a fibroma on the cornea which had become progressively larger over several months. The fish was anaesthetised and the abnormal eye was removed by excision. Haemorrhage was controlled by heat cauterisation and the socket was packed with waterproof paste. The fish was given systemic antibacterial treatment and made a successful recovery

VETERINARY OPPORTUNITIES

At present, most veterinary involvement in fish health relates to food-fish production. However, there is now a growing interest in pet fish and, with more opportunities

Body ulcerations are common in coldwater fish and are often due to infection with Gram-negative bacteria. Atypical *Aeromonas salmonicida* has been shown to be a primary cause of this disease in goldfish but frequently several species of bacteria are cultured from these lesions; secondary fungal infections may also develop. Lesions start as a localised area of inflammation, which later darkens and ulcerates, exposing the underlying tissue. Treatment with vigorous debridement and systemic antibacterial agents is required

Treatment of ulcerations

The author's approach to treating body ulcers in coldwater fish, such as koi or goldfish, is as follows:

- Anaesthetise the fish and remove from the water
- Debride the wound by removing necrotic tissue with dry cotton buds or gauze swabs and pluck out any damaged scales. The debridement is only performed once, unless there is persistent tissue necrosis, since epithelialisation will be impeded by further interference
- Apply diluted povidone-iodine surgical scrub topically and dry the site
- Apply a waterproof preparation to the lesion (eg, Orabase or Orahesive; Convatec)
- An antibacterial is given by injection and repeated at appropriate intervals or a suitable formulation is given as an in-feed preparation

In the commercial environment, the financial value of stock is considerable and the effects of infectious disease can be devastating. Commercial traders occasionally seek professional advice and assistance with investigations when it is economical to do so. The large size of their facilities and the high stocking densities can make treatment a challenge

to perform detailed investigations and procedures in these fish, knowledge of ornamental fish disease is expanding rapidly. Most cases presented in general practice are from private owners who keep fish as a hobby. Some keep solitary specimen fish whereas others may have large community tanks or ponds with expensive Japanese koi. A few experienced hobbyists breed valuable species for sale and occasionally require specialist services and advice on health matters.

Retail outlets and dealers occasionally require veterinary assistance for investigations and supply of prescription medications. Some laboratories use species, commonly regarded as pet fish, for various genetic studies and may require veterinary involvement under the Animals (Scientific Procedures) Act 1986. Public aquaria are now more popular, either as purpose-built facilities or as part of a zoological garden. Here, the role of the veterinary surgeon varies and may include routine health inspections, advising on health monitoring schemes, treating large fish such as sharks, and training staff in basic investigative methods.

From time to time, veterinarians may become involved in legal disputes and be requested to offer advice on fish matters as an expert witness.

Public aquaria are required to hold a licence under the Zoo Licensing Act 1981 and hence veterinary involvement is required in an advisory capacity; in addition, there is often an active role to be played in training staff and treating large fish. The specimens, which are frequently valuable due to their rarity or attraction to the public, are managed on an individual basis. They tend to develop age-related diseases, such as neoplasia or chronic organ failure, rather than problems associated with poor water quality and infectious diseases

SUMMARY

Although many pet fish have a low financial value, the investment in equipment and accessories is often considerable. The emotional value attached to fish varies considerably: some owners are passionate about their pet fish and owners often bond with large, long-lived specimens. Consequently, more ornamental fish are being presented for veterinary advice and treatment.

Treating pet fish is challenging and time-consuming work because there are so many important environmental aspects that must be considered. However, by using a logical approach similar to that in other species, it is possible to achieve success and this can prove to be an immensely rewarding experience.

Acknowledgements

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Further reading

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RCVS certificate and diploma

For readers with a greater interest in fish health, there is an RCVS Certificate and Diploma in Fish Health and Production. Further details can be obtained from the Royal College of Veterinary Surgeons.

Fish Veterinary Society

The Fish Veterinary Society has been established for over a decade. It provides a forum for veterinarians with an interest in fish, holds two scientific meetings a year and publishes the *Fish Veterinary Journal*. Details can be found on the society's website at www.fishvetsociety.org.uk