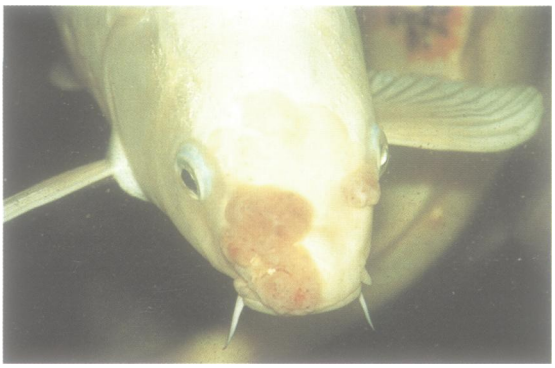


Cold water pond fish, such as koi and goldfish, are commonly seen in practice in the UK

Skin disease in ornamental fish: identifying common problems

WILLIAM WILDGOOSE

William Wildgoose graduated from Glasgow veterinary school in 1977 and has been in small animal practice in London since then. He has a special interest in exotic pets, and ornamental fish in particular, and holds the certificate in fish health and production.

OWNERS of ornamental fish are increasingly approaching veterinary surgeons for assistance with disease diagnosis and treatment. Although some veterinarians may be unfamiliar with fish health, our training provides us with a unique understanding of disease processes and comparative medicine which can be applied directly to fish. Many cases seen in veterinary practice are those which do not appear to respond to proprietary medicines and these often require simple investigations in order to reach a diagnosis. The aims of this article are to assist in the recognition of the common skin diseases in ornamental fish and to act as a guide to disease investigation. A problem-orientated approach is used, reflecting the way in which fish diseases are generally presented in the practice situation.

A SYSTEMATIC APPROACH TO SKIN DISEASE

The skin of fish provides a barrier and first line of defence against infection, osmotic pressure and mechanical injury. Being the most visible part of the fish, it is where disease is first seen.

Fish diseases usually arise from a complex interaction of a variety of factors. The majority of problems affecting ornamental fish involve stress as a result of poor husbandry. Although some diseases may initially appear to be uncomplicated, the knowledge and experience of fish-keepers varies considerably and hence the management of new establishments should always be thoroughly inspected; this may reveal other underlying problems which will need to be resolved in order to achieve a successful outcome and avoid relapse of the disease. Skin lesions may reflect more general disease processes and therefore a complete assessment of the case history, the environment, the fish and a range of

Approach to the clinical investigation

Case history

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

- sudden illness + all species affected = environmental problem (eg, poor water quality or poisoning)
- gradual onset + increasing numbers of fish affected = infectious disease (eg, bacteria or parasites)
- isolated cases + small number of fish affected = non-infectious disease (eg, tumours or physical trauma)

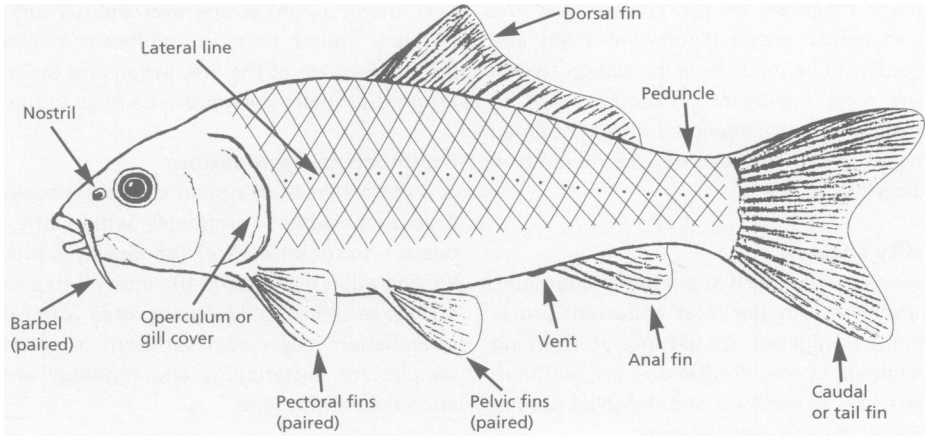
Environment

A basic understanding of the aquatic environment is required, and readers are referred to some of the texts available (eg, Butcher 1992, Noga 1996). Water quality is the most important factor affecting the health of fish and routine testing of the levels of ammonia, nitrite, nitrates and pH must be performed regularly by owners; simple chemistry kits are available commercially. This should be one of the first procedures to be performed in a veterinary investigation, even if only to confirm the owner's results. The effects of environmental factors such as high levels of nitrite and extremes of pH can cause skin irritation and damage with increased mucus production.

Fish

A detailed clinical examination should be performed but it is important to know the normal features of the

External anatomy of fish



laboratory samples is essential (see boxes below and overleaf).

It is difficult to categorise all skin diseases into a simple list and so, for the purposes of this article, a systematic approach has been adopted based on the following presenting clinical signs:

- Colour change
- Visible pathogens
- Spots
- Swellings
- Ulcerations
- Texture changes
- Fin lesions

Inevitably, there is a certain degree of overlap and the distinction between some groups may not always be particularly clear. One disease will often result in a multitude of secondary infections because the effects of stress produce a general depression in the natural defence mechanisms. In these cases it is not uncommon to find several pathogens, all of which may require treatment. Therefore, it is possible that an initial problem such as poor water quality will stress the fish and allow parasite numbers to increase, producing physical damage to the skin which may then become further infected by bacteria and fungi.

COLOUR CHANGE

Changes in the coloration of fish can sometimes be due to normal camouflage behaviour or sexual responses. Pigment cells in the dermis (see box, page 229) are under neurological control and therefore any damage or irritation to the nerve supply may cause colour changes (Fig 1). Pigment cell tumours may present as a discrete plaque or raised mass of abnormal coloration (see Figs 19 and 20).

FIG 1. This fish, a characin, developed a discrete purple-blue coloration on its peduncle following a local injection of antibiotic to treat the ulceration between its anal and caudal fins. The dramatic colour change developed in seconds and is due to the irritant effect of the injection on the nerves supplying the pigment cells in that area. The purple colour is produced by the refraction and reflection of light by the melanophores. It took several weeks for the normal coloration to return in this case. Similar reactions have been reported as a result of damage to the cutaneous nerve supply by local neoplasms

species under investigation. Colour changes and other features can develop during normal breeding activity (eg, nuptial tubercles on goldfish). Some exotic varieties of goldfish, such as orandas, are deliberately bred with verrucose masses around the head.

Skin disease may affect single or multiple fish, can be irritant or non-irritant and often (but not always) compromises the health of the patient. Observation of abnormal behaviour such as 'flashing' may suggest irritation of the skin (the fish swim rapidly in an arc to rub their flank against a rough surface). Irritant diseases can result from infestation with ectoparasites or from environmental chemicals and pollutants. Some species may jump more frequently, although this can be a normal behaviour in certain pond fish.

Laboratory samples

Hobbyists usually treat fish diseases symptomatically without establishing a diagnosis. By offering a simple laboratory service (see overleaf), veterinary surgeons can confirm and diagnose fish diseases and hence advise on the correct treatment and course of action required. Many fish pathogens are opportunists and these may complicate primary disease. Low numbers of parasites are normal and tolerated by fish but stress factors and illness allow multiplication to a level where signs of disease are seen. Therefore, improving environmental conditions is an essential part of therapy. Where many fish are affected with a similar disease the sacrifice of suitable moribund fish may be required for detailed investigations. Histological examination of fish tissues plays an important role in routine disease investigations. Biopsy samples can be taken from proliferative lesions but this procedure is more invasive and may predispose the patient to secondary wound infections.

Laboratory tests used in ornamental fish

The laboratory diagnosis of fish disease was the subject of an earlier article (Southgate 1994) and brief comments will be made here in relation to skin diseases. The most important procedures used to investigate disease in ornamental fish are outlined below; some or all of these tests may be required to confirm a diagnosis.

Water quality analysis

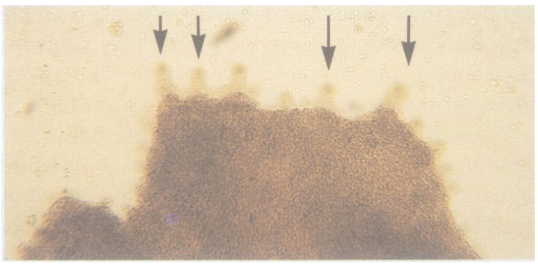
In a closed water system, such as a pond or aquarium, water quality analysis is the most important procedure. Routine investigation should involve checking levels of ammonia, nitrite, nitrates and pH; additional parameters such as hardness and dissolved oxygen may be required in some circumstances.

Skin scrape examination

Scrapings of body mucus are usually taken using a blunt scalpel blade from behind a pectoral fin or from the operculum – sites where parasites are most likely to be found. This may necessitate an anaesthetic, and readers should consult the relevant texts for information on their use (eg, Butcher 1992, Noga 1996). Alternatively, light manual restraint may allow a scraping to be taken from near the dorsal fin.

A drop of water from the tank or pond should be used to mount the coverslip. The sample should then be examined as soon as possible before any mobile parasites become inactive and die. Dying fish can become overwhelmed with high numbers of ectoparasites and therefore samples taken from several live fish will give a better overall impression of the level of parasite infestation.

Most ectoparasites can be seen under low power magnification (x 40) but, since many are refractile, they are more visible using phase contrast or with the condenser racked down. Small protozoans such as *Ichthyobodo* species are better seen at medium power magnification (x 100), as are the 'haystack' formations of *Flexibacter (Cytophaga) columnaris* colonies (see below). The latter are most visible at the edge of the mucus sample where they are silhouetted against a plain background.



The 'haystack' formation of *Flexibacter (Cytophaga) columnaris* colonies (arrows) (x 100 magnification). Infection with this bacteria causes 'fin rot', 'mouth rot' and 'peduncle disease'. The organism is best identified by examination of a fresh scraping from the lesion since it is difficult to culture without specialised media

Gill sample examination

Under light anaesthesia, mucus and the tips of a few gill lamellae can be sampled for microscopy by performing a light scrape over the gill surface. Skin parasites found here in significant numbers may reflect the scale of the infestation and can affect the prognosis if there is extensive damage to the gill.

Postmortem examination

A postmortem examination should be performed as soon as possible – preferably within one hour of death – since autolysis of fish tissues is often rapid. Refrigeration may extend the interval to a few hours but the results should be interpreted with care. Gross examination may reveal sufficient information but samples for bacteriology and histology are usually also taken at this time.

Bacteriology

Swabs of superficial lesions are invariably contaminated with environmental bacteria. Swabs taken from the kidney at postmortem examination therefore provide a better source of samples in cases where there is a systemic bacterial infection. The culture and identification of pathogens and interpretation of the results is best performed by laboratories familiar with fish diseases. However, as discussed above, some species of bacteria can be difficult to culture and diagnosis of *F columnaris* infections is best achieved by microscopic examination of a scraping from the lesion.

Other bacteria associated with skin disease in fish include Gram-negative species, such as *Aeromonas*, *Pseudomonas*, *Flavobacterium* and *Vibrio* species, and occasionally *Mycobacterium* and *Nocardia* species.

Histopathology

Only samples from freshly killed moribund fish should be used for histopathological examination since tissue autolysis can start prior to death. Fish may be euthanased by using an overdose of anaesthetic (eg, MS222 [Thomson & Joseph] or benzocaine), although it is claimed that this may reduce the numbers of ectoparasites. To hasten euthanasia, larger fish can be given intravenous pentobarbitone into the caudal vein (which can be located ventral to the vertebrae of the peduncle) or the superficial blood vessels on the medial aspect of the operculum.

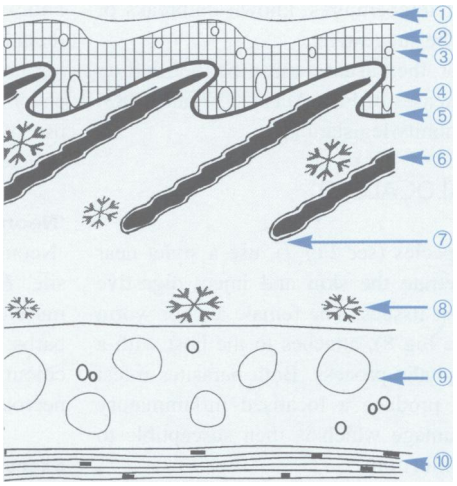
Gill, heart, liver, spleen, bowel and anterior and posterior kidney are routinely sampled at postmortem examination and a section of skin and underlying muscle containing both red and white muscle fibres is usually taken from near to the lateral line. Other obvious lesions such as tumours and ulcers should also be sampled at the junction with normal tissues. Samples, which must be no more than 1 cm^3 in size, are fixed in an adequate volume of chilled 10 per cent neutral buffered formalin (generally 20 times the volume of the tissue is used). All tissues should be sampled because there may be considerable histological change even in the absence of any gross pathology. Certainly it is always preferable to be able to discard unwanted samples than not to have any samples at all. Tissue pathology should be interpreted by a pathologist who is familiar with a range of fish diseases.

Histological structure of the skin of fish

Appreciation of the histological structure of fish skin allows a better understanding of many diseases. Examination of skin scrapings by light microscopy is a routine procedure in fish health management.

A diagrammatic cross section of the skin of fish is shown on the right. The cuticle ①, the outermost layer, allows the fish to move smoothly through water. It is about 1 µm thick and consists of mucus and cell debris. It also contains antibodies (IgM) and lysozymes which have antibacterial and antifungal properties. This layer is usually lost during the routine processing of samples for histopathology.

The epidermis ② consists mainly of fibrous malpighian cells and, together with the cuticle, forms a waterproof barrier. The thickness of the epidermis varies with species, age and site on the body. Mucus-secreting 'goblet cells' ③ are located in the epidermis and, in some species, 'club cells' ④ secrete a potent alarm substance when the skin is damaged. Unlike mammals, the epidermal cells at all levels are capable of mitotic division, although most occurs at the deepest level near the basement membrane ⑤. During wound healing there is a loss of the intercellular attachments and the cells migrate rapidly to cover the defect and



provide some waterproof integrity. This leads to a reduction in the thickness of the surrounding epidermis and produces a thin layer of epidermis at least one cell thick over the wound. This process occurs independent of water temperature but is inhibited by the presence of pathogens and necrotic tissue. Later, these malpighian cells undergo cell division to restore the epidermal layer. This is a slower process and is dependent on ambient temperature.

The dermis consists of two layers. The upper layer contains collagen and reticulin, which form a supportive network. The lower, deeper layer of the dermis is a more compact mass of collagen fibres which provides the main structural strength of the skin. The scales ⑥ are flexible bony plates which develop in scale pockets ⑦ in the upper loose connective tissue; they are not shed regularly but grow with the rest of the body. Some fish do not have scales and the epidermis is often thicker in these species. The dermis may also contain pigment cells called chromatophores ⑧. These produce different colorations when acting individually or in combination, and by the reflection and refraction of light.

The hypodermis ⑨ is the deepest layer of the skin and consists of loose fatty tissue connecting the skin to the underlying structures ⑩. Due to its design and good blood supply, bacterial diseases spread rapidly along this layer.

Pigment cells found in fish

- Melanophore (black)
- Xanthophore (yellow)
- Erythrophore (orange/red)
- Leucophore (white)
- Iridophore (reflective/iridescent)

FIG 2. Petechiation and ecchymosis is most visible on the ventral surface and pale or white areas of fish. The generalised septicaemia in this koi was confirmed by isolation of *Aeromonas* species from an ulcer near its mouth, as well as from the rectum and kidney

INFLAMMATION (GENERALISED)

Septicaemia

Septicaemia may result in a widespread reddening, visible as hyperaemia of the fins and other non-pigmented areas of the body (Fig 2). Many cases are caused by Gram-negative bacteria such as *Aeromonas*, *Pseudomonas* and *Vibrio* species. Goldfish may also develop patches of brown pigmentation (Fig 3) which disappear with successful antibiotic treatment.

FIG 3. Septicaemia in goldfish often produces focal patches of brown pigmentation in the skin which may be localised or widespread. These disappear and the gold coloration returns following successful antibiotic treatment. This fish, which lived on its own in a tank, recovered and was seen six years later (see Fig 5)

Spring viraemia of carp

Spring viraemia of carp (SVC) is caused by *Rhabdovirus carpio* which affects carp, goldfish, orfe, pike, roach, rudd, tench and Wels catfish, producing various clinical signs including abdominal swelling, exophthalmos,

petechial haemorrhages and darkening of the skin. There are no pathognomonic signs for the disease, which is notifiable, although a history of recent introductions, rising springtime water temperatures, known outbreaks or multiple deaths may be suggestive.

Any suspicion of the disease must be notified to MAFF under the Diseases of Fish Acts (1937 and 1983) and European Community legislation.

INFLAMMATION (LOCALISED)

Parasites

Fish lice, *Argulus* species (see Fig 7), use a stylet near their mouth to penetrate the skin and inject digestive enzymes into the host tissues. The female anchor worm *Lernaea* species (see Fig 8), attaches to the host with a large penetrating cephalic process. Both parasites infest freshwater fish and produce a localised inflammatory reaction and skin damage which is then susceptible to secondary bacterial infection.

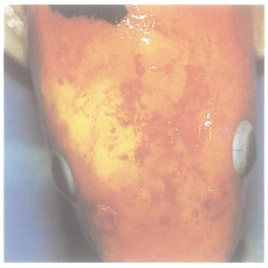


FIG 4. Localised ecchymosis and petechiation on the head of a koi, which was assumed to be due to bacteraemia since the fish also had a small body ulcer. An injectable antibiotic was administered and the cranial discoloration resolved within seven days

Bacteria

Petechiation and ecchymosis can result from bacteraemia, producing localised areas of redness (Fig 4).

Sunburn

Sunburn causes petechiation and patches of erythema on white and non-pigmented dorsal surfaces of exposed fish. This can be a problem in shallow ponds where there is no shade and the water is exceptionally clear.

LOSS OF COLOUR

Management problems

Poor water quality can affect the colour of delicate aquarium fish, such as discus, which require very specific water conditions. A lack of dietary pigments and chronic nutritional deficiencies can also result in dull coloration of some species. Indoor fish which are not exposed to natural sunlight or specific fluorescent lighting tend to be pale and less vibrant in colour.

Tuberculosis

It is thought that there may be a high incidence of tuberculosis (Fig 5) in aquarium fish which goes undetected. Care should be taken when advising clients about the implications of this mycobacterial disease following its confirmation by histopathology and bacteriology: it is a professional responsibility to alert owners to the zoonotic risk and give appropriate advice. This should include attention to hygiene and a warning against priming tank siphons by mouth. Clients should be advised to cover any skin wounds with waterproof plasters and to use rubber gloves of an adequate length when cleaning infected tanks.

FIG 5. This is the same goldfish, as pictured in Fig 3, on presentation six years later when it had abdominal swelling and body ulcers with a caseous discharge. Its original gold colour had disappeared completely except for a small localised area on its peduncle. Postmortem examination revealed extensive internal lesions and granulomata due to *Mycobacterium* species. An area of inflammation above its pelvic fin is the early stage of ulceration due to an underlying tuberculous lesion

'Neon tetra disease'

'Neon tetra disease' is caused by a microsporidian parasite, *Pleistophora hyphessobryconis*, which infects the muscle tissue of various aquarium fish such as tetras, barbs, danios and goldfish. It produces focal areas of colour loss and grey or white patches due to muscle necrosis, particularly along the dorsum.

Excess mucus

Excess mucus production is caused by various factors (see later under 'texture changes') and is sometimes called 'slime disease'. The associated thickening of the cuticle dulls the colours of fish and gives the skin a light grey appearance.

Epidermal hyperplasia

Epidermal hyperplasia is common, particularly in pond fish. In some species it is due to a viral infection of epidermal cells and may be associated with *Herpesvirus cyprini* infection, the causative agent of carp pox (see later) in koi. Lesions appear as smooth milky white plaques, about 1 mm thick and up to several centimetres in size (Fig 6).

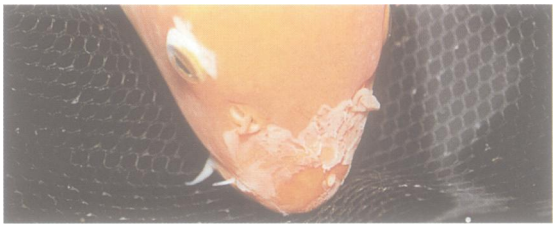


FIG 6. Epidermal hyperplasia is common in koi and seen as discrete smooth milky white patches which are more visible on dark areas of the body. It can be differentiated from diseases producing excess mucus by the fact that the lesions cannot be scraped off easily. Some areas of epidermal hyperplasia are associated with localised papillomas. The hyperplastic tissue will slough periodically after several months, as was the case with the lesion on this koi's snout

BRUISING

Trauma

Damage to the skin as a result of poor handling and netting may produce bruising. Predatory birds such as herons can cause a range of lesions including bruises, lacerations and deep puncture wounds (see Fig 26). Frogs are reported to grip on to the head and operculae of pond fish during the frog breeding season in early spring, causing bruises to the neck or even death by preventing normal gill function.

Bacteria

Prior to ulceration, infection with Gram-negative species (eg, *Aeromonas* or *Pseudomonas* species) can produce a localised area of inflammation which may then darken like a bruise due to the enzymatic effect of bacterial toxins in the dermal tissues.

PARASITES

Some microscopic ectoparasites and the tissue reaction that they produce may be grossly visible as small spots (see later). Larger parasites which are visible to the naked eye include the fish louse, *Argulus* species (Fig 7), anchor worm, *Lernaea* species (Fig 8), and leech, *Piscicola* species (Fig 9). Large flabelliferan isopods (up to 6 cm) can occasionally be found on the skin or in the buccal cavity of marine fish. Although not a skin parasite, the intestinal nematode, *Camallanus* species, is a red thread-like worm which can be seen protruding from the anus of some tropical aquarium fish such as mollies and platys.

FIG 7. The crustacean parasite, *Argulus* species, is commonly called the fish louse. Adults can measure up to 7 mm in size; examples of both adult and immature fish lice are seen here (x 2 magnification). The parasites move over the surface of the fish and can swim freely in the water, laying eggs in the environment. Successful treatment requires medication of the pond; this may need to be repeated over several months in order to eradicate the parasite completely

FIG 8. *Lernaea* species is a freshwater copepod which attaches to the host with a large cephalic process which it embeds in the dermis and underlying tissues – hence its common name, the anchor worm. This can produce a marked inflammatory reaction or even penetrate into the abdominal cavity. Only the female is parasitic and is identified by a pair of trailing egg sacs. Adults can measure up to 15 mm in length; their characteristic shape is more easily recognised while in water. Treatment often involves manual removal of the parasite under general anaesthesia and the use of an appropriate chemical in the environment

FIG 9. Leeches attach to the host by a large suction pad and move around with a characteristic contractile action. A common leech, *Piscicola geometra*, can measure up to 4 cm in length when relaxed. While not an important parasite, leeches are unsightly and cause some damage to the skin when feeding on the host's blood. They can also act as vectors and transmit bacteria and viruses. These freshwater parasites lay eggs in the environment which are very persistent and can be difficult to eradicate

FUNGUS

Saprolegnia species

Saprolegnia species resembles white cotton-wool (Fig 10), though may appear green in pond fish due to trapped algae. It is important to distinguish this organism from 'mouth fungus' and 'peduncle disease' which look similar but are caused by *Flexibacter* (*Cytophaga*) *columnaris*, a bacterium which usually infects the mouth and root of the tail, respectively (see Fig 29).

Dermocystidium koi

Dermocystidium koi infects the dermal tissues in koi, producing a smooth raised swelling which later ulcerates to reveal a mass of hyphae (see Fig 21 and later under 'swellings').

FIG 10. *Saprolegnia* species is a fungus or water mould which commonly infects damaged skin and the gills of freshwater fish. The delicate fungal structure resembles cotton-wool but collapses into a slimy mass when removed from the water. *Saprolegnia* is often a secondary invader of skin wounds and infects fish with concurrent diseases. It is a reflection of serious underlying husbandry problems and poor water quality. Fish with extensive lesions, such as this black moor goldfish, are unlikely to recover due to loss of osmoregulatory control

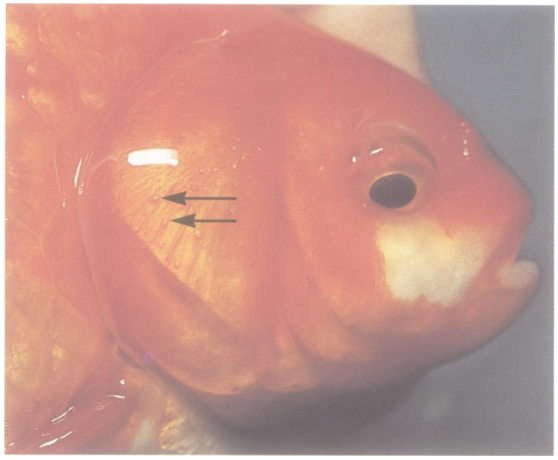


FIG 11. Nuptial tubercles are multicellular keratinous nodules, visible as spots on the operculum of this male goldfish (arrows). During the breeding season they become larger (up to 2 mm), raised and more prominent. Although they resemble 'white spot' parasites, they are not dislodged by routine scraping. They are also found on the pectoral fins (see Fig 30)

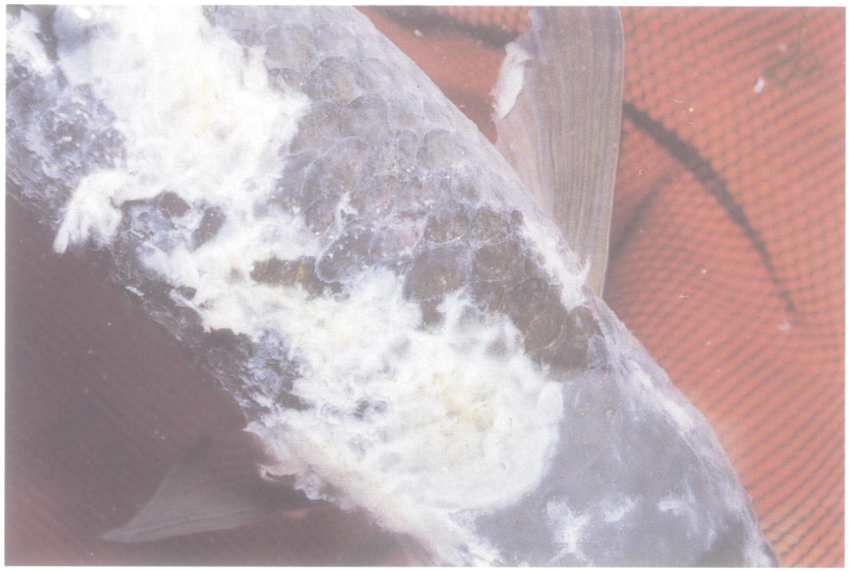


FIG 12. 'White spot' is caused by a protozoan, *Ichthyophthirius multifiliis*. The small white parasites are more easily seen on the dark areas of the body. In large pond fish, such as this koi, it can be difficult to see these parasites until considerable damage has been done to the skin. Initially there may be an excess of mucus and thickening of the epithelium, producing a grey sheen to the skin. As the disease progresses, fungi can invade infected sites producing large white areas of disintegrating skin. Here, the green coloration is due to algae trapped between the fungal filaments

SPOTS

Spots which form part of the natural coloration of some fish are usually bilaterally symmetrical and should be differentiated from pathological lesions. In this article the distinction between large spots and small swellings is based on size and both sections may apply to the same lesion.

Nuptial tubercles

Raised multicellular keratinous nodules (1 to 2 mm in diameter) – so-called 'nuptial tubercles' – are usually found on the opercula (Fig 11) and leading edge of the pectoral fins (see Fig 30) of male goldfish and are more visible in the breeding season.

'White spot'

'White spot' is a protozoan parasite infection which in freshwater fish is caused by *Ichthyophthirius multifiliis* (Fig 12). Also known as 'ich', the mature parasites can measure up to 1 mm in size. Although this common disease is often regarded as a minor problem since it is easily treated with proprietary medicines, these parasites can cause devastation to gill tissue if treatment is delayed. Only the free-living stage (theront) is susceptible to treatment since the visible stage (trophont) on the fish feeds inside the epidermis and is protected from external medications. Repeated courses of treatment are required to eliminate these ectoparasites.

Cryptocaryon irritans produces a similar disease in marine fish (Fig 13).

'Velvet'

A dinoflagellate, *Piscinoodinium* species, is the cause of 'velvet' (alternatively known as 'rust disease' or 'gold dust disease') in tropical freshwater fish. The parasites can be seen as very fine spots on the skin and produce a gold- or rust-coloured velvet-like layer over affected areas. The organisms sometimes cluster together to form larger spots.

The marine counterpart, also called 'coral fish disease', is caused by *Amyloodinium* species.

'Black spot'

Metacercariae of digenean flukes, *Neascus* species, migrate to the skin and cause a reaction in the dermis, stimulating melanocytes around the parasitic cyst to produce 'black spot' (Fig 14). Affected fish are intermediate hosts in the life-cycle and the lesions can measure up to 0·5 mm.

Epitheliocystis

Epitheliocystis is caused by a chlamydia-like organism which infects epithelial cells of the gills and, less commonly, the skin. The hypertrophied cells produce small white nodules up to 1 mm in size.

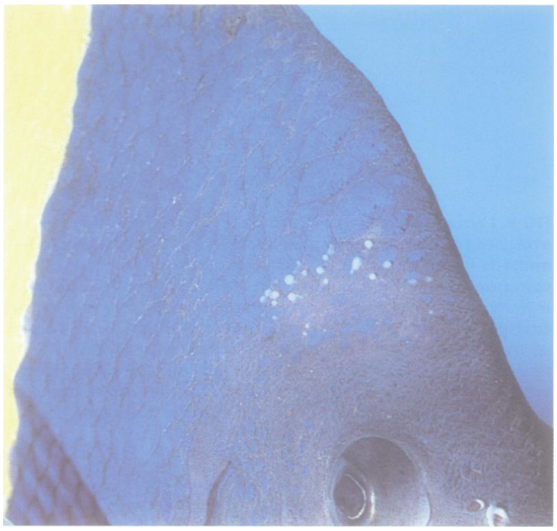


FIG 13. 'Marine white spot' is caused by infection with *Cryptocaryon irritans*, a ciliate protozoan. A small number of maturing parasites (trophonts) can be seen above the head of this marine fish, a purple moon angelfish

FIG 14. Black spot. The two dark spots behind and above the head of this small characin are caused by the intermediate stage of a digenean fluke. The black coloration is due to tissue reaction and stimulation of melanocytes in response to the presence of the parasite. There is no treatment for this disease. The cluster of very small spots near the middle of the body is an area of natural pigmentation

SWELLINGS

It should be possible to differentiate between superficial raised masses on the surface of fish and underlying internal swellings. Disruption of the scales will indicate that a lesion lies in the lower compact dermis whereas epidermal lesions are superficial to the scales. Some swellings can be identified easily on gross inspection but confirmation often requires histological examination.

NODULAR LESIONS

Nodular lesions tend to be small discrete masses which may cluster to form a large, cauliflower-like mass.

Bacteria

Infection with *Mycobacterium* species (fish tuberculosis) and *Nocardia* species produces granulomas in the dermis and other tissues. Lesions vary in size and can affect all species but are more common in aquarium fish.

Parasites

- MYXOZOAN parasites (eg, *Henneguya* and *Myxobolus* species) produce pseudocysts which enlarge slowly in various tissues and are usually found in wild-caught fish.
- MICROSPORIDIANS are intracellular parasites; *Glugea* species can produce large hypertrophied cells or xenomas which are white nodular structures several millimetres in size.
- 'YELLOW GRUB', characterised by cystic lesions up to 5 mm in diameter, is caused by infection with the metacercariae of *Clinostomum* species. This digenean trematode encysts in the musculature of fish and can result in ulceration if near the skin.

Fungus

Ichthyophonus hoferi is a fungus-like organism that causes a chronic systemic granulomatous disease and mainly affects marine fish. Dark raised dermal granulomas, up to 1 mm in size, give the skin a rough sandpaper-like feel due to loss of the overlying epithelium.

Lymphocystis

Lymphocystis is a chronic disease caused by an iridovirus which mainly affects tropical marine fish, producing massive enlargement of dermal fibroblasts. These measure about 1 mm but often cluster to form larger nodules up to 1 cm in size. The disease has a low mortality rate; affected fish may recover if the cause of stress is corrected and environmental conditions improved.

Gas bubble disease

Supersaturation of the water with dissolved gases, particularly nitrogen, results in emphysema of the tissues including the skin and gills – so-called gas bubble disease. A variety of environmental factors which act to draw air into solution under pressure (leaking water pumps, venturis, and so on) predispose fish to this disease.

NEOPLASIA

Several types of skin tumour have been recorded in fish, the most common of which are described below. These are larger masses and are often solitary well-circumscribed lesions which can affect any area of the body. Fish can live for a long time with many neoplasms. Some can be removed successfully under general anaesthesia, although many will recur.

FIG 15. Carp pox, a benign epidermal neoplasm, is technically a papilloma. The characteristic smooth raised lesions resemble drops of candle wax, can affect any area of the body, and range from discrete masses measuring a few millimetres in size to large extensive plaques. Although caused by a viral infection, only a few fish exhibit lesions at any one time. There is no treatment for the disease which will often regress after several months

Carp pox

Carp pox is an infection of epidermal cells with cyprinid herpesvirus 1 and is technically described as a papilloma. It commonly affects carp but is also found in other coldwater and tropical fish. It manifests as drops of 'candle wax' on the body and fins (Fig 15) which are often grey or white although these lesions may contain some pigment. Carp pox (and other papillomas – see below) will often regress spontaneously but may reappear. Some individuals can be affected with extensive lesions for many years.

Papilloma

Papillomas are the most common skin neoplasm of fish and are usually found on individual fish (Figs 16 and 17). Occasionally several fish may be affected, particularly when there is a viral aetiology (see carp pox above).

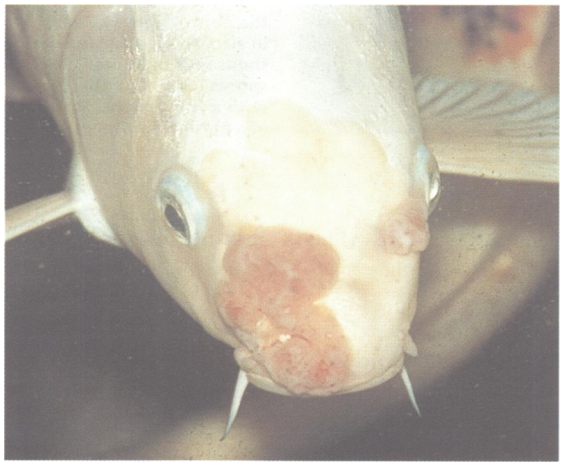


FIG 16. Papillomas vary considerably in size and appearance: they may be smooth or verrucose, sessile or pedunculated, localised or extensive, single or multiple. They can be found on most external sites but rarely cause clinical problems unless they interfere with the mouth or operculae. Papillomas have been found in association with squamous cell carcinoma and epidermal hyperplasia in some species

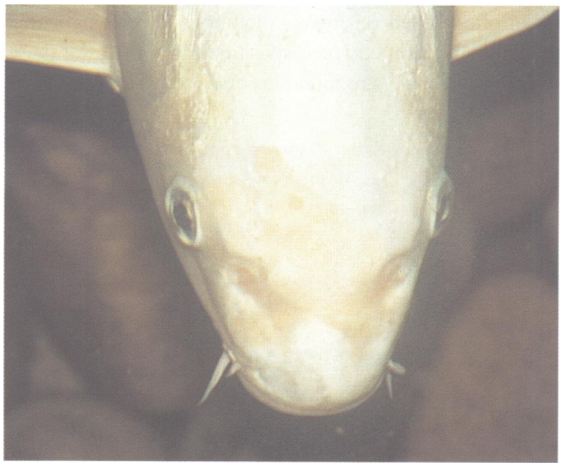


FIG 17. Papillomas may slough periodically. This is the same koi as in Fig 16, pictured four months later. Some epidermal hyperplasia is still present, seen as a darker area on the snout and right-hand side of the head

FIG 18. Fibroma on the dorsum of a lionhead goldfish. This discrete raised mass developed over a period of a few weeks. It was successfully removed by excision under general anaesthesia and the fish lived for a further three years before dying from an unrelated problem. Complete removal of these tumours in scaled fish is rarely possible without disrupting much of the adjacent tissues, hence surgery is often limited to excision of the bulk of the lesion

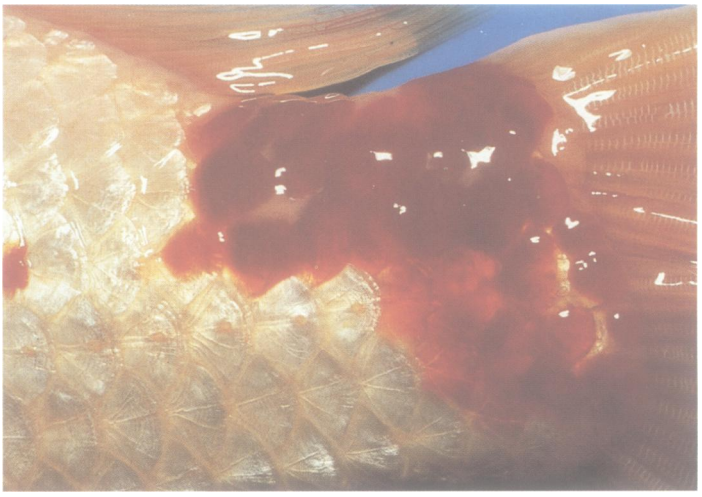


FIG 19. Erythrophoroma (red pigment cell tumour) which developed as an extensive plaque over the peduncle of this goldfish. The lesion had been present for a few years but did not cause any clinical problems

FIG 20. These two goldfish had been isolated for several years before erythrophoromas developed spontaneously on one fish and then 12 months later on the other. Widespread multiple lesions were present on the body, fins and cornea. Biopsies of the raised lesions were taken to identify the tumours but, due to their extensive nature, further treatment was not possible. One fish survived for more than four years although some lesions continued to increase in size

FIG 21. *Dermocystidium koi* lesion on the tail fin of a koi. This fungal-like organism infects the dermis and white hyphae become visible through the epidermis as the lesions increase in size. The lesions rupture as they reach about 1 cm and the exposed hyphae release thousands of spores. This disease has a distinctive gross appearance and the characteristic spores (6 to 15 µm) are easily identified by microscopy. Usually one or two fish are affected with a few lesions. Surgical removal is possible but some lesions may heal spontaneously after eruption. The mode of transmission is unknown

Fibroma

Clinically, fibromas (Fig 18) may resemble papillomas. Histologically, they may be confused with pigment cell tumours.

Pigment cell tumours

Melanomas are the most common type of pigment cell tumour. Erythrophoromas (Figs 19 and 20) also appear to be relatively common but rarely cause clinical problems. Confirmation requires pigment analysis but diagnosis is often based on gross coloration. It is thought that there may be a genetic predisposition among fish for these tumours since they are found in some hybrid species.

FIG 22. Nuptial tubercles (see Figs 11 and 30) occasionally become hyperplastic and develop into large verrucose masses on both pectoral fins. On close inspection there may be other signs of localised epithelial hyperplasia. These lesions rarely affect the health of fish although they may trap strands of filamentous blanket weed in outdoor ponds

OTHERS

Dermocystidium infection

Dermocystidium species are a group of fungal-like organisms which infect many species of fish. *Dermocystidium koi* produces a smooth raised lesion with a uniform colour (Fig 21) in the skin of koi. Small lesions may resemble carp pox, but as these grow they become quite distinctive and eventually rupture when about 1 cm in size.

Subcutaneous fluid-filled cavity

Adverse reactions to long-acting oxytetracycline injections can produce large collections of sterile tissue fluid at the injection site. The serosanguineous fluid should be aspirated to avoid ulceration of the overlying skin. Occasionally, purulent fluid may collect at subcutaneous sites following localised bacterial infection.

Nuptial tubercles

Nuptial tubercles, described earlier under 'spots', occasionally appear hypertrophied as large verrucose masses, up to 1 cm in size, close to the body on both pectoral fins (Fig 22). They should not be mistaken for neoplasms, and rarely cause problems to the fish.

ULCERATIONS

Most ulcerations have a similar gross appearance. They are often caused by bacteria, although fungi may be involved in secondary infections. Lesions may occur on any area of the body surface but some diseases are localised to the lateral line. This is a sensory organ consisting of a canal system with mechanoreceptors which detect sound and pressure changes. The canals are punctuated by a series of small pores which are visible along the flanks and extend on to the head in some species.

Ulcers

Ulcers may be punctate lesions on the head where the skin is in direct contact with the skull, or deep and invasive lesions on the body, which expose underlying muscle (Fig 23) and may penetrate the body cavity.

Superficial ulcers are a common problem in koi and goldfish, and Gram-negative bacteria such as *Aeromonas*, *Pseudomonas*, and *Cytophaga* species are often isolated. Several fish may be affected and the disease can spread to all fish in a pond, causing considerable mortality. Treatment must be vigorous with debridement of the ulcers and application of topical wound antiseptic and waterproof paste. This should be followed with antibiotics given by injection and in the food. Poor water quality and poor husbandry are common underlying problems which must also be improved to assist recovery.

Fish tuberculosis (*Mycobacterium* species) can also produce chronic ulcerative lesions in aquarium fish (see Fig 5) and *Vibrio* species are found in ulcers in marine fish.

'Hole in the head'

In cichlids (eg, discus and oscars), 'hole in the head' presents as shallow ulcerations on the head (Fig 24) and along the flanks. It has been suggested that the disease is due to *Hexamita* species, a flagellate protozoan which causes enteritis, but it may also involve a nutritional component, environmental stress or a superficial bacterial infection.

In catfish, systemic infection with *Edwardsiella ictaluri* may produce ulcers on the head and dorsum. The chronic form of the disease produces an erosion on the top of the skull in some species.

Head and lateral line erosion

Head and lateral line erosion is a syndrome recognised in tropical marine angelfish and tangs which presents as chronic ulceration of the head and lateral line (Fig 25). The lesions vary in size and depth and may develop over many months. Poor nutrition, stress and viral infection are suggested causes of this disease which is associated with a low mortality rate.

'Mouth fungus'

'Mouth fungus' is a term used in the hobby literature to describe an erosion of the mouth in tropical aquarium fish caused by *F columnaris*. The same bacteria produces fin rot and other skin lesions (see Fig 29). Poor water quality, over-stocking, high temperatures and stress predispose fish to this epithelial disease.

Trauma

Skin ulceration can result from poor handling and netting, fighting among fish and attack by herons (Fig 26) and other predators.

FIG 23. Body ulcer on a koi. Ulcers are common in coldwater fish and are often caused by bacterial infection although they may become further infected by fungus. Early lesions start as a localised area of inflammation which later darkens like a bruise and eventually ulcerates, exposing the underlying tissue. Atypical *Aeromonas salmonicida* has been shown to be a primary cause of this disease in goldfish but frequently several species of bacteria may be cultured from these lesions

FIG 24. 'Hole in the head' disease in a discus. This is a common problem in this species and several factors may precipitate clinical disease. Small ulcers develop in the sensory pits on the head which are cranial extensions of the lateral line. The mortality rate is low but the disease is disfiguring. Hobbyists often use metronidazole in the food and in the water but the disease frequently recurs and other systemic antibiotics may be required

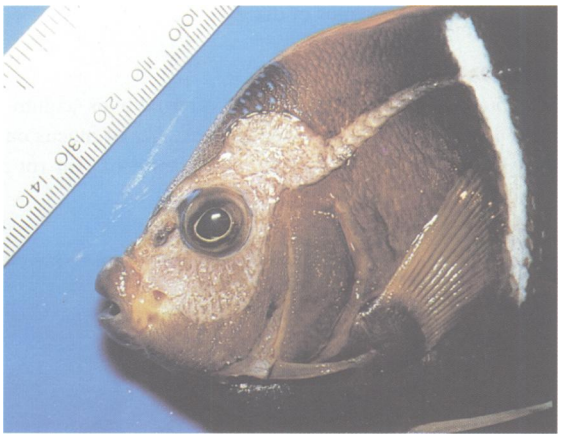


FIG 25. Extensive ulceration in a passer angelfish due to head and lateral line erosion. Also known as 'marine hole in the head', this syndrome often starts a month after captivity and may spread to affect other fish in the same aquatic system. Fish continue to eat but can develop secondary complications. Due to the selective feeding habits and natural diets of some species there may be a nutritional component to the disease. It does not respond to copper-based treatments and there is no known cure

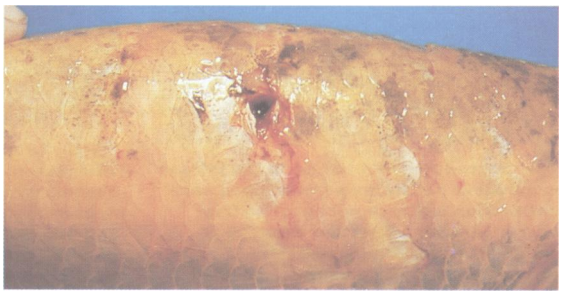


FIG 26. A variety of skin lesions such as lacerations, punctures and erosions can be caused by poor handling and netting, aggressive and carnivorous fish, and predators such as fish-eating birds, cats and foxes. This small puncture wound on the body of an orfe was the result of an attack by a heron and penetrated deep into the dorsal musculature of the fish

TEXTURE CHANGES

Some of these 'textural' conditions are difficult to detect visually (and hence to demonstrate photographically). The use of bare hands when examining fish may allow a better appreciation of the skin lesions.

EXCESS MUCUS

The quantity and consistency of the normal cuticle varies between species; some fish, such as oscars and discus, appear particularly slimy. The non-specific term 'slime disease' is used to describe the condition where abnormal and excessive amounts of mucus are produced by fish in response to the irritant effect of a variety of agents. Excess mucus dulls some colours and gives the skin a greyish sheen.

These cases are best observed using indirect lighting as the fish moves around in the water. Microscopic examination of skin scrapings is usually required to identify ectoparasitic causes of the condition.

Parasites

Many species of parasite irritate the skin and stimulate mucus production (Fig 27). These include protozoans such as *Ichthyophthirius*, *Ichthyobodo* (*Costia*) and *Chilodonella* species and trichodinids such as *Trichodina* and *Trichodinella* species. The metazoan skin fluke, *Gyrodactylus* species, also produces skin disease. In marine fish, similar protozoans (*Cryptocaryon* and *Brooklynella* species) and skin flukes (*Benedenia* and *Neobenedenia* species) can be found.

'Tet disease'

Tetrahymena corlissi, a ciliate protozoan ectoparasite, infests freshwater tank fish including guppies. 'Tet disease' (occasionally called 'guppy killer') produces discrete pale white patches due to excess mucus and focal necrosis, particularly around the eyes. Mortalities occur as a result of invasion of the muscle and deeper tissues.

The marine counterpart of this parasite, *Uronema* species, causes similar pathology, but ulceration is a feature in the later stages of disease.

Bacteria

Infection with *F columnaris*, often referred to as 'columnaris disease', causes localised grey patches of mucus on the skin. The same organism is the cause of 'fin rot', 'mouth fungus' and 'peduncle disease' (see Fig 29) according to its location on the body.

Poor water quality

The irritant effect of some chemicals and extremes of pH (too acidic or too alkaline) can affect the mucus cells or change the quality and consistency of the cuticle.

LACK OF MUCUS

A lack of mucus is normal in some fish, particularly some marine species.

Chronic irritation

Prolonged irritation by pathogens or poor water conditions, as described above, will eventually exhaust the mucus-secreting cells, producing a rough dry texture to the skin surface.

Detergents

Likewise, some medications (eg, benzalkonium chloride) can remove much of the cuticle.

Skin lesions

Damage and erosion of the epithelium by pathogens and the dermal granulomas produced by *Ichthyophonus* cause the skin to feel rough like sandpaper.

RAISED SCALES

'Dropsy' is a non-specific term used to describe oedematous conditions in fish. It can apply to both abdominal distension (ascites) and subcutaneous oedema. The latter causes the scales to protrude and may be either localised around skin lesions or generalised; it is occasionally called 'pine cone disease' due to its gross appearance (Fig 28). Exophthalmos due to retrobulbar effusion occasionally accompanies dropsy and may be unilateral or bilateral.

Any condition which affects osmoregulation, such as gill or kidney disease, can produce tissue oedema. In goldfish, dropsy is often due to kidney disease and some fish may respond to antibiotics. However, many have an asymmetrical abdominal distension due to polycystic kidneys which may be congenital or the result of chronic infection with a myxozoan parasite, *Hoferellus* species. In contrast, large old koi have a high incidence of abdominal neoplasia and consequently many affected carp either deteriorate and die or require euthanasia.

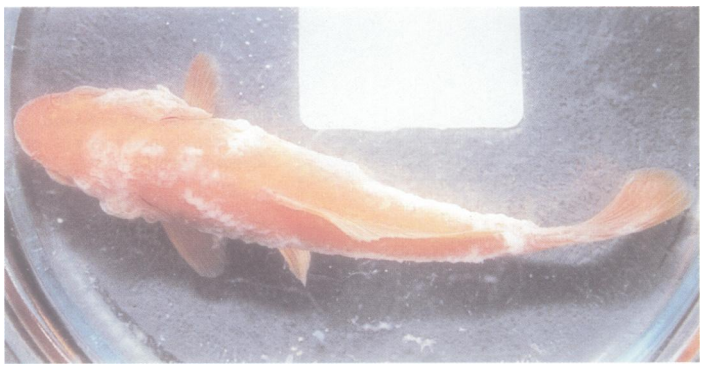


FIG 27. Excess mucus ('slime disease') is produced in response to the irritant effect of several agents and gives the skin a patchy grey-white appearance. Successful treatment requires identification of the causal agent. In this goldfish, a severe 'white spot' and *Ichthyobodo* infestation was readily identified on microscopic examination of a skin scraping. Excessive amounts of mucus were visible when taking the sample using a blunt scalpel blade

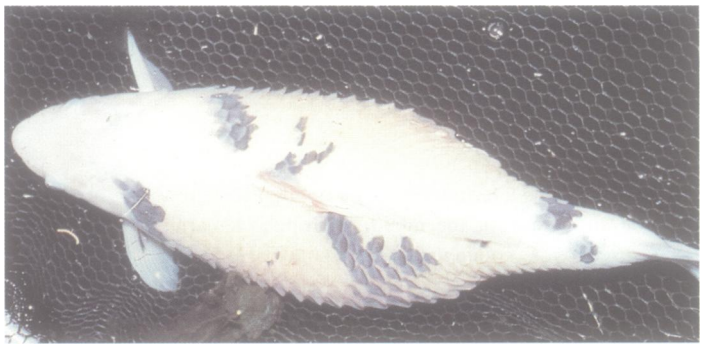


FIG 28. 'Dropsy' is a term describing any disease which produces oedema. Where there is abdominal distension due to ascites and/or subcutaneous oedema with protrusion of the scales, the fish takes on a 'pine cone' appearance. This 10-year-old koi had displayed both abdominal distension and skin oedema for several months but required euthanasia due to its deteriorating health. Postmortem examination revealed severe ascites, a fluid-filled gonad and a large hepatic tumour

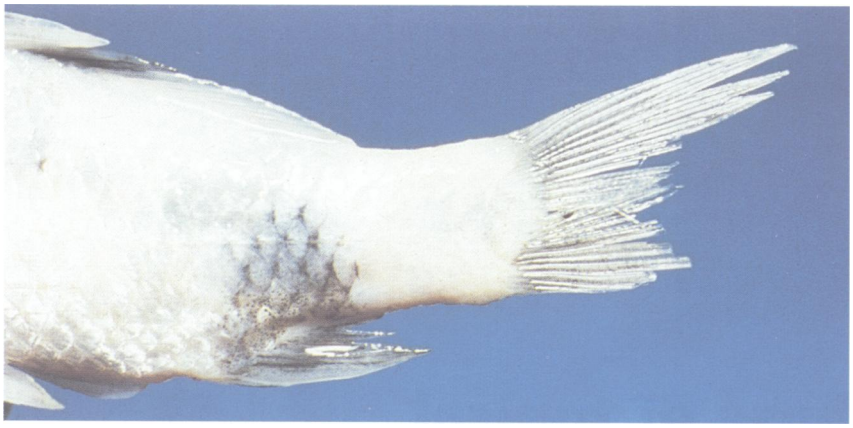


FIG 29. 'Fin rot' is due to a bacterial infection with *Flexibacter (Cytophaga) columnaris* and produces extensive damage to the fins. In this young koi the caudal fin is severely eroded and the disease has progressed on to the peduncle, visible as a grey-white plaque posterior to the anal fin. This disease often affects debilitated fish which have been exposed to poor water quality and stressful conditions (eg, transportation)

FIG 30. Hyperaemia in fish with long delicate fins is often an indication of stress (eg, overcrowding or poor water quality). The prominent blood vessels in the fins are easier to see when the fish is in the water. Normal nuptial tubercles are also visible along the upper leading edge of the pectoral fin of this fancy goldfish

FIN LESIONS

Some diseases of the skin start as lesions on the fins. 'Fin rot', for example, in which the delicate fin tissue literally rots away (Fig 29), is caused by bacterial infection with *F columnaris*. This may progress on to the body from the tail fin to produce 'peduncle disease'. Some diseases, such as carp pox, lymphocystis and epidermal hyperplasia, are more visible on the fins due to their translucent structure. Similarly, some parasites such as white spot (*I multifiliis*) and anchor worm (*Lernaea* species) are more visible when present on the fins in white-coloured fish. Hyperaemia of the fins is readily visible in many species and may be caused by septicaemic infections. In long-finned fish, pronounced blood vessels (Fig 30) are an indication of stress and often resolve when the stressor is removed. Tumours such as papillomas (including carp pox) and fibromas may also be localised on the fins. Nuptial tubercles are found on the leading edge of both pectoral fins of some male goldfish (Fig 30) and may become hyperplastic forming verrucose masses which resemble neoplasms (see Fig 22).

SUMMARY

While it is not possible to show examples of all skin diseases as they appear on different species of fish, hopefully this article will be a useful aid to diagnosis and direct the reader towards an appropriate course of action. Cold water pond fish such as koi and goldfish are commonly seen in practice in the UK but the high financial and emotional value of these fish usually precludes routine sacrifice and limits some investigations. Despite this, it is still possible to achieve reasonable success if a rational approach to the subject is adopted.

Acknowledgements
The author is grateful to Edward Branson and Ewan Ferguson for reading the script and to all his fish health colleagues who have assisted him over the years. Figures 16, 17 and 21 have been reproduced with permission of *The Veterinary Record* and figures 2, 7, 9, 12, 15, 23, 27, 28 and 29 with permission of the *Koi Health Quarterly*. The Fish Veterinary Society provided financial assistance towards the cost of the illustrations.

SCIENTIFIC NAMES OF THE FISH MENTIONED IN THE ARTICLE

Common name	*Species/family name*
Angelfish, passer (king)	*Holacanthus passer*
Angelfish, purple moon	*Arusetta asfur*
Angelfish, tropical marine (family)	Pomacanthidae
Barb	*Barbus* species
Characins (family)	Characidae
Danio	*Danio* species
Discus	*Symphysodon discus*
Goldfish	*Carassius auratus*
Guppy	*Poecilia reticulata*
Koi (carp)	*Cyprinus carpio*
Mollies (family)	Poeciliidae
Orfe	*Leuciscus idus*
Oscar	*Astronotus ocellatus*
Pike	*Esox luscius*
Platys	*Xiphophorus* species
Roach	*Rutilus rutilus*
Rudd	*Scardinus erythrophthalmus*
Tang (family)	Acanthuridae
Tench	*Tinca tinca*
Tetras (subfamily)	Characidae
Wels catfish	*Silurus glanis*

References
BUTCHER, R. L. (Ed) (1992) BSAVA Manual of Ornamental Fish. Cheltenham, BSAVA Publications
NOGA, E. J. (Ed) (1996) Fish Disease: Diagnosis and Treatment. St Louis, Mosby
SOUTHGATE, P. (1994) Laboratory diagnosis of fish disease. *In Practice* **16**, 252-255

Further reading
ANDREWS, C., EXELL, A. & CARRINGTON, N. (Eds) (1988) Interpet Manual of Fish Health. London, Salamander Books
BUTCHER, R. L. (1993) Skin disease in ornamental fish. In BSAVA Manual of Small Animal Dermatology. Ed P. H. Locke. Cheltenham, BSAVA Publications. pp 185-196
MURPHY, K. M. & LEWBART, G. A. (1995) Aquarium fish dermatologic diseases. *Seminars in Avian and Exotic Pet Medicine* **4**, 220-233
PAUL-MURPHY, J. & MORIELLO, K. (1995) Skin diseases of pet fish. In Small Animal Dermatology. Ed K. Moriello and I. Mason. Oxford, Elsevier Science. pp 213-218
STUART, N. (1988) Common skin diseases of farmed and pet fish. *In Practice* **10**, 47-53