

Diseases of Ornamental Fishes and Their Management

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1. Introduction

Because of their beautiful colours, shapes, and behaviours, ornamental fish are often called living jewels and kept in aquaria or garden pools for entertainment and decorative purposes. In aquaculture, ornamental fish culture is an economically important aspect that enhances its worldwide eminence (Hoseinifar et al., 2023). Globally, ornamental fish prices are based on their colour. Fish farmers must enhance/improve the colouration of ornamental fish skin to meet their high demand and profit, as this determines their market value and commercial acceptance (Das, 2023). Carotenoids, as a natural pigment source serving as the main contributors to the pigmentation of fish skin, lead to various colours (red, orange, yellow, and brown) (Kaur & Shah, 2017).

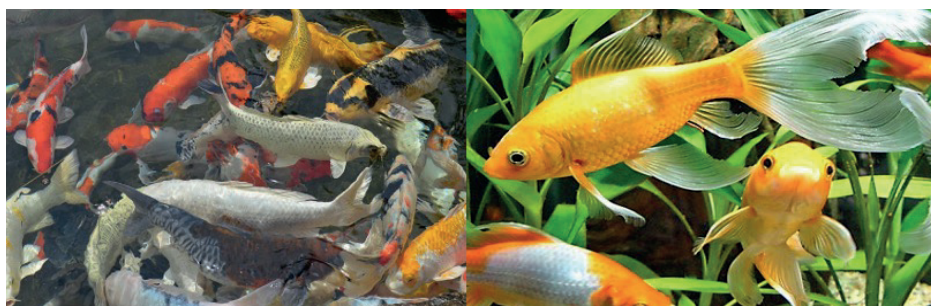


Figure 1. Ornamental fish with brilliant colors

To understand the evolution of ornamental fish, they are systematically classified according to their genetic and morphological characteristics (Pouil et al., 2020).

Table 1: lists some ornamental fish with distinctive features

Sr.#	Common name	Scientific name	Features
1.	Angelfish	<i>Pterophyllum scalare</i>	Anal and dorsal fins elongated, body triangular
2.	Neon Tetra	<i>Paracheirodon innesi</i>	Lustrous blue and red stripes, schooling behavior
3.	Guppy	<i>Poecillia reticulata</i>	Diverse and colorful patterns, live-bearing reproduction
4.	Goldfish	<i>Carassius auratus</i>	Varieties of color, unique body shapes
5.	Zebrafish	<i>Danio rerio</i>	Horizontal stripes, active behavior
6.	Clownfish	<i>Amphiprion ocellaris</i>	Variations in color, symbiotic with anemones
7.	Discus	<i>Symphysodon</i> spp.	Body disc-shaped, vivid colors, complicated social behavior
8.	Siamese Fighting	<i>Betta splendens</i>	Flowing fins, brilliant colors, territorial behavior
9.	Demasoni chichlid	<i>Pseudotropheus demasoni</i>	Coloration is blue and black, nature is territorial and social

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A freshwater fish called the goldfish, domesticated more than 1000 years ago in China, considered the first ornamental fish. Marine ornamental fish refers to coral reefs with brilliant colours and distinctive patterns. As a result of coral reefs for aquariums, Sri Lanka became a major maritime trading centre in the 1930s, with an estimated 1.5 billion ornamental fish traded each year (Biondo & Burki, 2019). Among the world's largest ornamental fish exporters, Singapore stands out as the hub; Betta fish, a popular species symbolic of beauty and resiliency, falls into this category (Ahilan & Kamalii, 2022). Ornamental fish are reared and marketed in more than 7000 species in the present day. They are divided into 5000 freshwater species and 1800 marine species (Chen et al., 2020). The diversity of coastal and marine life, such as ornamental fish, shellfish, and coral reefs, contributes to an especially stunning natural scene. Mangrove forests, seagrass meadows, and coral reefs are other characteristic coastal environments (Kasmi et al., 2022; Sulkifli et al., 2023).

Economic Aspects of Ornamental Fish Trade

The ornamental fish industry was valued at an astounding USD 5.4 billion in 2021, and analyst's project that it will continue to rise at an annual pace of 8.5% until 2030, when it will have a 51.7% revenue share. A lot of freshwater decorative plants may be purchased for as little as \$1–\$6. Over 15% of all traded fish are marine ornamental species, which are prized for their eye-catching coloration and mannerisms (Satam et al., 2018). Over half of the commerce is with Asian nations, with a total export value of USD 130 million. Following North America (3.98%), Africa (2.2%), Oceania (1.4%), South America (7.5%), and the Middle East (0.5%), Europe accounted for 27.6% of the total (Figure 1). With 20% of the total USD 69.32 million in ornamental fish exports, Singapore was the leading exporter (Dey, 2016). Japan ranked second in terms of Koi carp output, with USD 41.34 million (Pinnegar & Murray, 2019).

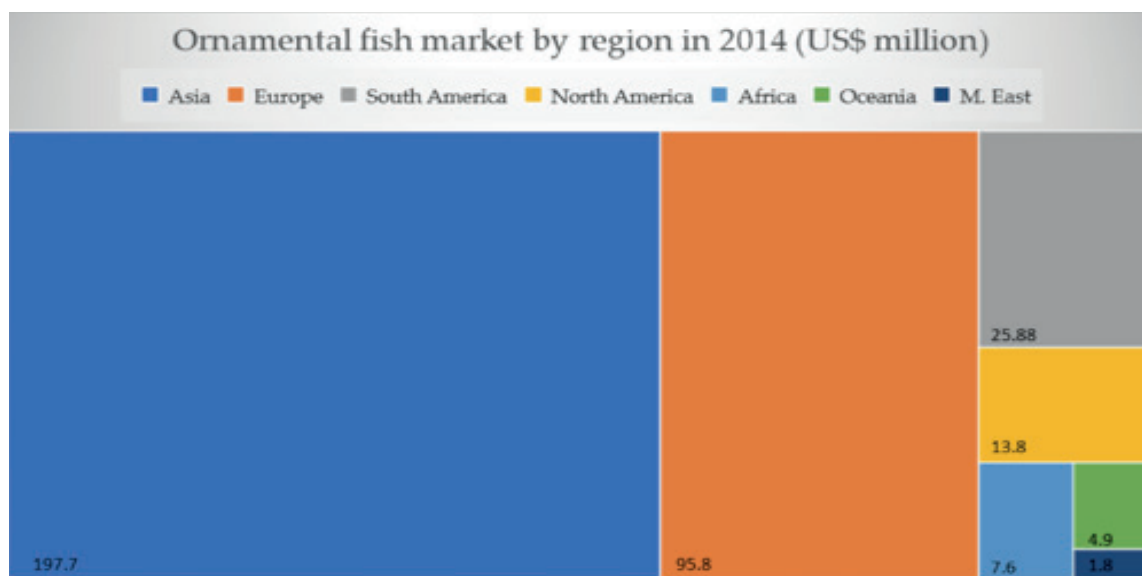


Figure 2. “The distribution of exports across key markets by region in 2014, measured in millions of US dollars.”

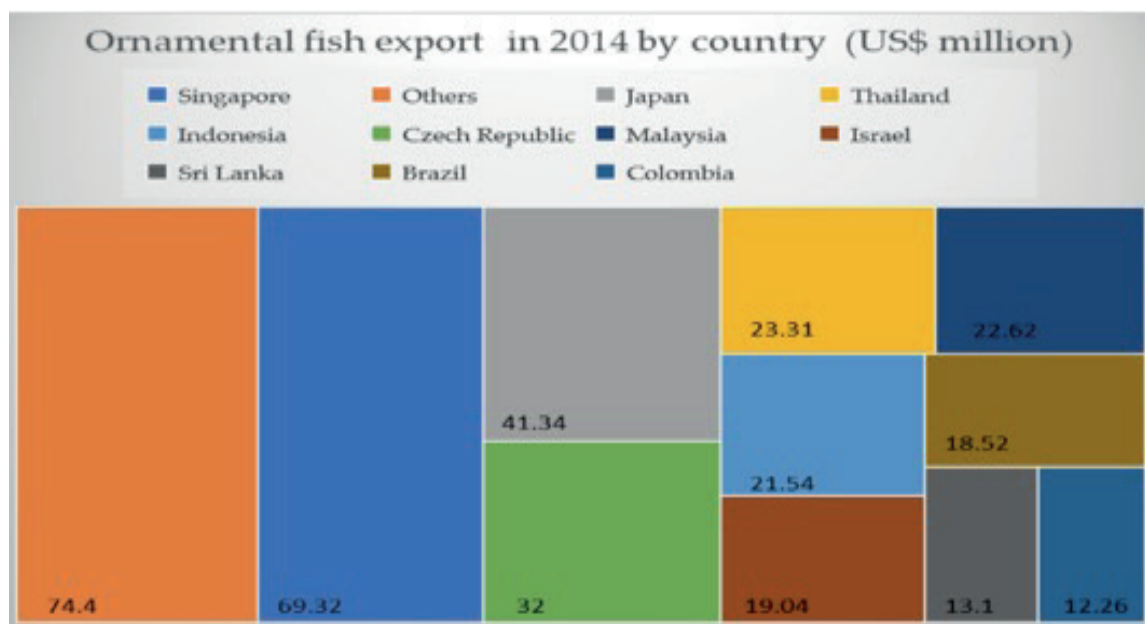


Figure 3. “The distribution of exports across major markets by country in 2014, expressed in millions of US dollars.”

Europe, the US, and Japan are the top three importers of marine ornamental fishes or regions, whereas Indonesia, the Philippines, and Sri Lanka are the top exporters (Biondo & Burki, 2020). Worldwide exports and imports were used to calculate the worldwide market share for each year (Figure 4). The total exports for 1992, 1994, and 1998 were either much less than or equal to the total imports of the three main importing nations (Figure 4). Figure 5 shows the proportion of marine ornamental fishes from the major exporting nations to the worldwide market; a single-digit percentage figure primarily represents marine ornamental fishes.

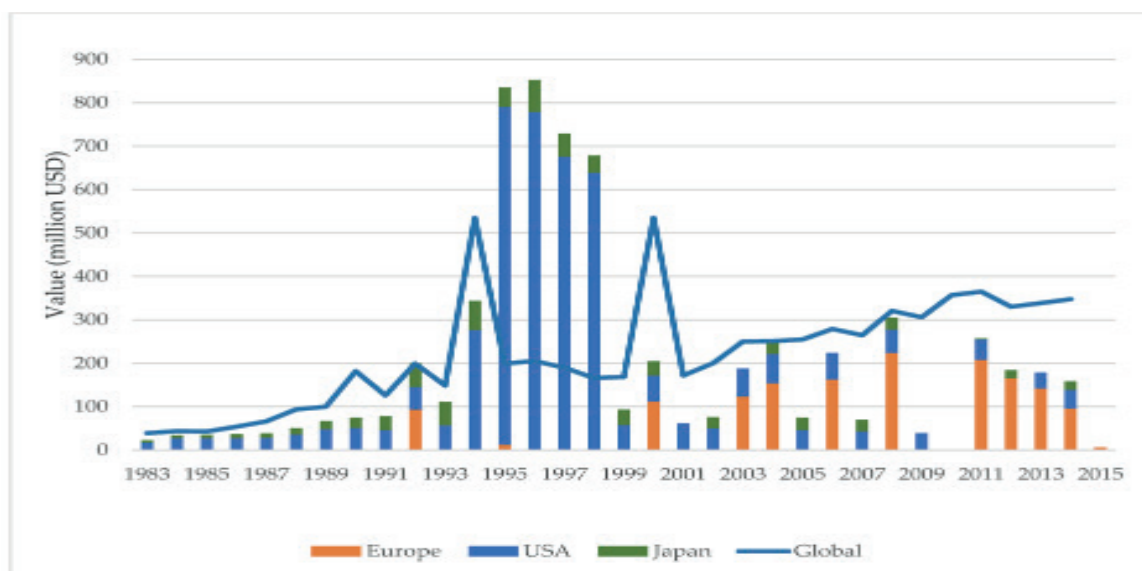


Figure 4. “The average wholesale value, in millions of US dollars, of both freshwater and marine fish for worldwide export, compared to their import values in Europe, the United States, and Japan.”

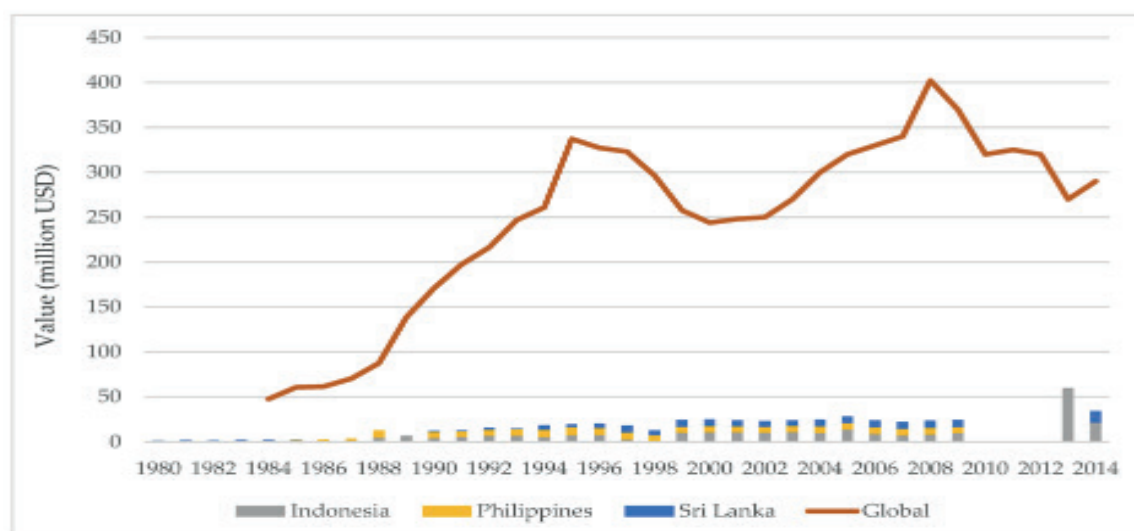


Figure 5. “The wholesale value, in millions of US dollars, of freshwater and marine fish exports by region in 2014, compared to the total exports from individual countries for the same year or the nearest year with available data.”

2. Types of Ornamental Fish

2.1. Freshwater Ornamental Fish:

There are many diverse habitats for ornamental fish. They live in freshwater habitats, including rivers, lakes, ponds, swamps, and saltwater environments. Freshwater ornamental fish are valuable commercially and possess an esthetic quality due to their remarkable colors, shape and health. Ornamental fish, in high demand by the public, are traded as commodities because they can fulfil the market at all price points (Prasetya et al., 2021). According to UN-Comtrade data, the global trade in ornamental fish export in 2021 was worth \$379.1 million. The export of freshwater ornamental fish generated \$279.6 million, while marine ornamental fish generated \$99.5 million (Tarihoran et al., 2023).

2.1.1. Tropical Freshwater Fishes

Tetra fish have brilliantly colourful skin that changes appearance depending on the perspective. These rich hues are produced by special cells known as chromatophores, which include layers that reflect light in a way that produces vivid colours when viewed from different angles (ke et al., 2022). The Neon Tetra fish's stripes change colour from blue-green in light to indigo in darkness by reflecting light off layers of guanine crystals, generating customizable patterns (Setiyowati et al., 2022).

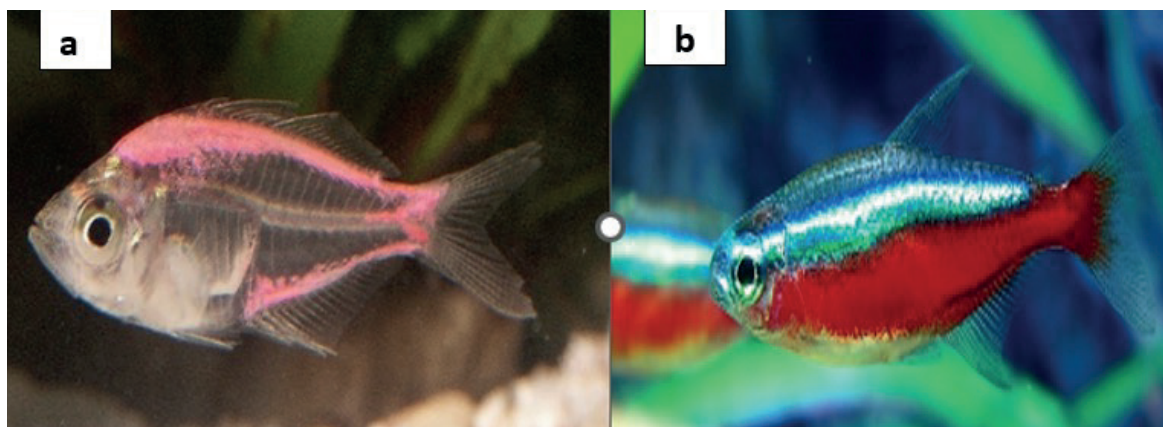


Figure 6. a) Tetra fishes b) Neon Tetra fish

Originating in Central and South America, guppies and mollies are well known for their vivid colours and low maintenance requirements (Tuckett et al., 2021). Guppies have various colours and tail forms and are highly prized in aquariums (Sinha & Pandey, 2023). The beautiful and intelligent angelfish can withstand salinities up to 4 g/L NaCl (Eiras et al., 2019).

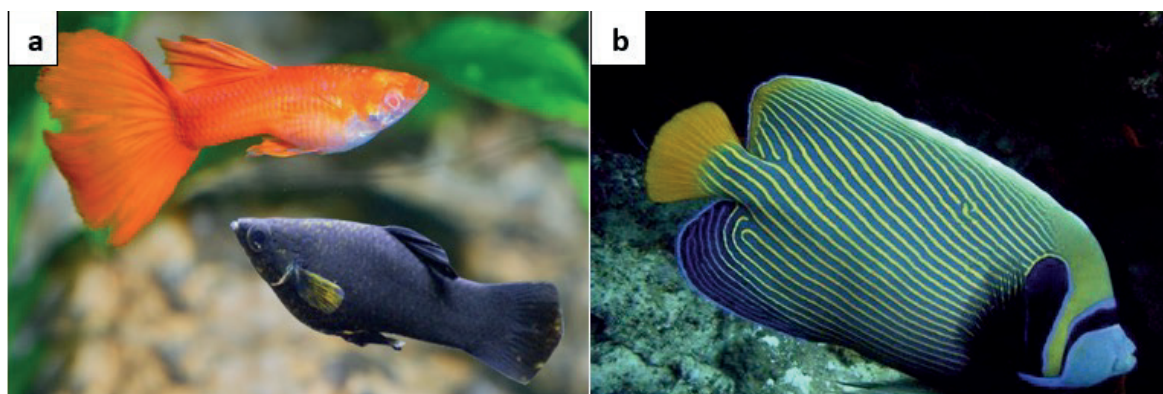


Figure 7. a) Guppy and Molly b) Angle-fish

The diverse shapes, colours, and patterns of discus fish, “the king of Aquarium Fish,” make them highly valuable. Sidi and Sungkowo (2022) stated that discus fish enthral enthusiasts with their unique patterns and elegance. Angelfish thrive in recirculating aquaculture systems. Oros et al. (2022) described betta splendens as a popular ornamental fish with distinctive qualities and high market value.

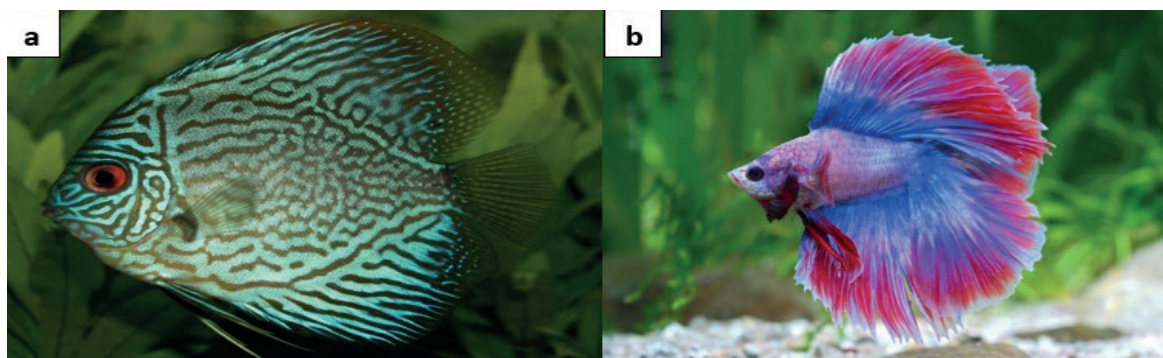


Figure 8. a) Discus fish b) Betta splendens

2.1.2. Cold Freshwater Ornamental Fish

A popular choice in the ornamental fish industry, goldfish come in both common and fancy varieties. Their economic value remains steady due to their consistent demand (Shukla et al., 2022). Koi, Prized for their stunning colours and captivating forms, hold significant economic importance within the ornamental fish trade (Daud et al., 2023). Rosy Red Minnows, Prized for their stunning colours and captivating forms, koi hold significant economic importance within the ornamental fish trade. (Horne et al., 2010).



Figure 9. a) Goldfish b) koi fish c) Rosy Red Minnows

2.2. Types of Saltwater Ornamental Fish

Marine decorative fish, a part of the marine aquarium industry, are mainly obtained from natural habitats because the trade heavily relies on capturing them from the wild (Chen et al., 2023). Clownfish, a beloved species in aquariums, encounter difficulties in breeding. Enhancing their colours, they are widely cherished as pets (Santikawati et al., 2023). Butterflyfish play a role in the Indo-Pacific Ocean ecosystem, acting as health indicators and being sought after in the ornamental fish market (Mahadevan et al., 2023). Damselfishes, crucial for coral reefs, are important as marine ornamental species. Their presence is vital for aquaculture practices aimed at conservation efforts and improving transportation methods (Roberts et al., 2023).

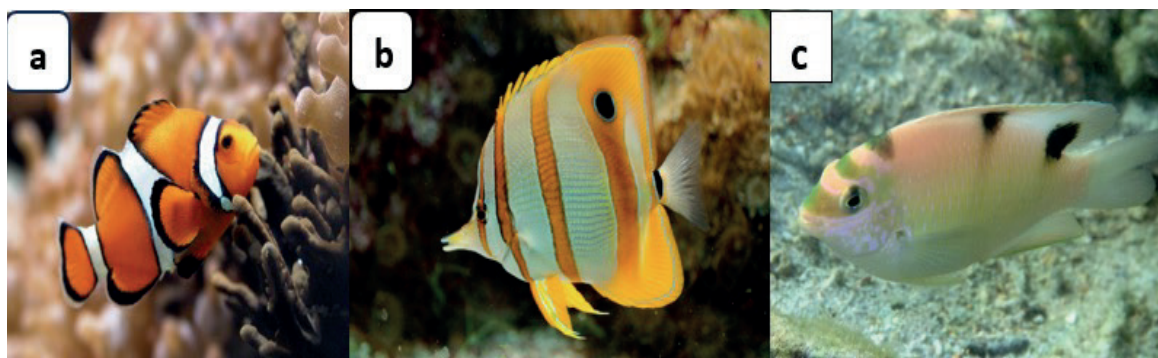


Figure 10. Saltwater ornamental fish a) Clownfish b) Butterflyfish c) Damselfish

2.3. Brackish water ornamental fish:

For sustainable aquaculture, brackishwater ornamental fish production offers a bright future. Freshwater and tropical fish make up the majority of the ornamental fish trade, with brackishwater fish making up a minor portion (Hossain & Heo, 2021). For sustainable aquaculture, brackishwater ornamental fish production offers a bright future. Freshwater and tropical fish make up most of the ornamental fish trade, with brackishwater fish making up a minor portion (Hossain & Heo, 2021).

The silver moony is a native species to the Western Pacific region, and fish is highly prized as a species that can adapt to water environments, including freshwater, brackish water and seawater. The aquaculture of fishes, such as the silver moony, has increased due to their popularity and economic value (Vasantharajan, 2023). The Green Scat, also called Spotted Scat, inhabits the western Pacific oceans, including the Sundarbans in Bangladesh. Its unique ability to tolerate changes in salinity makes it a fascinating subject for studying how animals adapt to salt levels in their surroundings (Washim et al., 2022). The Silver Molly, a true freshwater fish, can surprisingly adapt to slightly salty brackish waters. They play an important role in keeping their environment healthy by what they eat and how they reproduce (Hussein et al., 2023). On the other hand, the Mono Sebae, also known as the Mono angel, thrives in brackish water but can adjust to a range of saltiness, from freshwater to even the ocean. This makes them popular ornamental fish, prized for their beauty and economic value in the aquarium trade (yue et al., 2022).

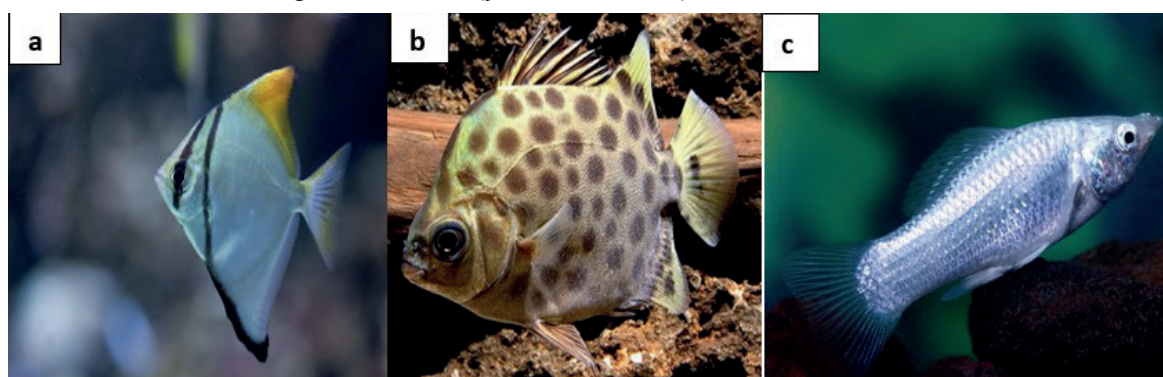


Figure 11. a) Silver moony b) green scat c) silver molly

3. Common Diseases and their Causative Factors

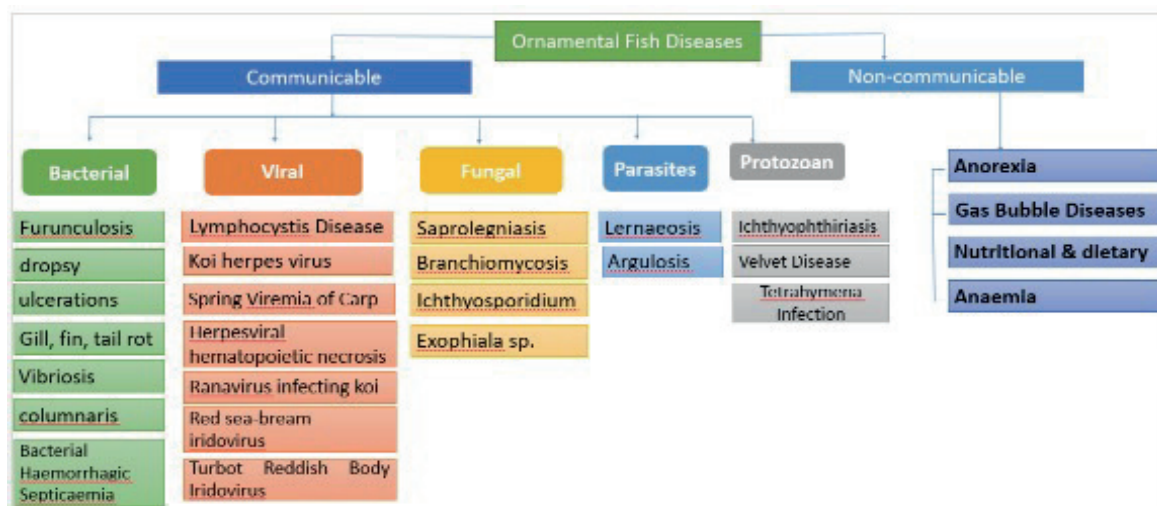


Figure 12: Common diseases in Ornamental fish

3.1 Communicable diseases

Pathogens, /Co-existing organisms (biological entities) are Bacteria, Viruses, Fungi and Parasites

3.1.1 Bacterial diseases

The most prevalent infectious issue affecting ornamental fish is bacterial illness. Numerous bacteria are the cause of bacterial illnesses in ornamental fish. These microorganisms can lead to diseases including dropsy, red pests, ulcerations, fin and tail rot and red sores (Walczak et al., 2017). Environmental factors such as stress and poor water quality can lead to bacterial infections in ornamental fish, both gram-positive and gram-negative. Pet fish mortality and morbidity can be significantly increased by these illnesses, which are impacted by dietary, environmental, and genetic variables. Gram-positive infections spread more slowly and are more difficult to identify in the early stages, whereas gram-negative infections act quickly and can be fatal within 24 hours. Stress plays a major role in developing bacterial illnesses in fish (Irshath et al., 2023). Bacterial pathogens are classified into two major groups: Gram-positive and Gram-negative (Ziarati et al., 2022).

A. Gram negative diseases**Table 2:** Gram negative bacterial diseases

Family	Pathogens	Diseases	Symptoms	Prevention & control	Treatments/ Medication
Aeromonadaceae	"A. hydrophila A. salmonicida A. veronii A. jandaei A. Punctata"	Furunculosis, ulcer disease, dropsy, Bacterial Haemorrhagic Septicaemia, Tail and fin rot	Fin rot, skin ulcers, enlarged eyes, renal dropsy, abdominal distension, and reddening of the body with hemorrhagic patches on the body wall, internal organs, tail, fins, and gills.	Maintain good water quality, reduce stress, avoid overcrowding	"Medicated feed, Terramycin, Antibiotic drug (chloramphenicol), Apply lime"
Vibrionaceae	"V. anguillarum V. salmonicida V. vulnificus, V. parahaemolyticus V. alginolyticus V. Harveyi"	vibriosis, Tail and fin rot	hemorrhagic septicemia, skin ulcers, fin rot and internal organ damage	Proper management practices, including maintaining excellent water quality, hygiene, and nutrition	Suplhamerazine
Pseudomonadaceae	Pseudomonas	Bacterial Haemorrhagic Septicaemia, Tail and fin rot	red sores on the body, ragged fins, lethargy, loss of appetite, and rapid mouth movement	Maintain good water quality, reduce stress, avoid overcrowding	Terramycin, Chloromycetin
Enterobacteriaceae	Salmonellosis		internal organ hemorrhages, skin lesions, lack of appetite, and lethargy	Maintain good water quality, reduce stress, avoid overcrowding	Terramycin
Flavobacteriaceae	Flavobacterium columnare	columnaris disease	skin ulcers, fin rot, and internal organ damage in ornamental fish, resulting in high mortality rates	Proper management practices, including biosecurity measures, monitoring water quality, and implementing vaccination strategies	Bath of copper sulphate or potassium permanganate Terramycin

I. Aeromonadaceae

(Furunculosis, ulcer disease, dropsy, Bacterial Haemorrhagic Septicaemia, Tail and fin rot)

Aeromonas is a Gram-negative bacterium that infects fish and causes illnesses such as ulcer disease, red-sore illness, hemorrhagic septicemia, and motile *Aeromonas* septicemia. Antibiotics are often used to treat infected fish. Aeromoniasis is a bacterial infection caused by *Aeromonas* species, widely seen in ornamental fish (Hossain & Heo, 2021). Aeromoniasis can infect a large number of fish species. *Aeromonas* and *Vibrio* infect fish similarly, although *Aeromonas* is more common in freshwater fish, whereas *Vibrio* species may be found in freshwater, brackish water, estuaries, and the ocean. *Aeromonas* pathogens can cause bacterial infections in ornamental fish, including *A. hydrophila*, *A. salmonicida*, *A. veronii*, and *A. jandaei* (Walczak et al., 2017).

Aeromonas hydrophila is a bacterial infection that have serious consequences for ornamental fish. This bacteria is known to induce septicemia in ornamental fish, which results in high death rates and huge economic losses for the industry (Smith et al., 2009; Anjur et al., 2021). Fish diseased with *A. hydrophila* demonstration a variety of clinical indicators, including abrupt mortality in otherwise healthy fish and symptoms including inappetence, swimming irregularities, pale gills, bloat, and skin ulcerations. *A. hydrophila* illness, also known as Hemorrhagic Septicemia, Motile *A. Septicemia*, Ulcer illness, or Red-Sore Disease, mostly affects freshwater fish and many tropical and ornamental fish species. *A. hydrophila* can induce opportunistic illness in weakfish as a subordinate infection. There have been seen histological changes in the stomach, spleen, gills, liver, and kidney (AlYahya et al., 2018).

Furunculosis caused by *A. salmonicida* usually called koi ulcer disease or ulcer disease, is a common condition in ornamental fish. Most warm-water and freshwater fish, including koi (*Cyprinus carpio*) and goldfish, are susceptible to the sickness identified by the red sores covering the creature. Ecchymosis, enlarged belly, and exophthalmia are other symptoms. The skin bleeds and necroses in the ulcerative type, exposing the muscle and bone (Lewbart et al., 2001). Secondary infections are brought on by bacteria, fungi, and metazoa or protozoa through these sores. Usually, primary or secondary infections and a fluid imbalance cause these fish to perish (Hossain et al., 2021).

The bacterial infection of *Aeromonas veronii* and *Aeromonas jandaei* can seriously harm ornamental fish. *A. veronii* infection in ornamental fish can cause a variety of clinical symptoms such as skin ulcers, enlarged eyes and fluid buildup in the abdomen, renal dropsy, ragged fins and body wall, internal organs, gills, tail, and fins all have hemorrhagic patches and are reddened (Walczak et al., 2017). When fish are infected, these signs may result in serious health problems and perhaps significant mortality rates. One of the most prevalent bacterial illnesses affecting ornamental fish is *A. veronii* and *A. jandaei* which can result in large losses for the ornamental fish culture sector (Soni et al., 2021). Stress factors that can contribute ornamental fish to infections include poor water quality, insufficient nourishment, handling, transportation, and overcrowding of fish (Walczak et al., 2017).

A bacterial pathogen called *Aeromonas punctata* may infect ornamental fish and cause various illnesses. *A. punctata* is known to cause illnesses in fish and other aquatic creatures, especially ornamental fish. These microorganisms are common in many aquatic habitats, including freshwater, brackish, and marine water. Motile *Aeromonas* species are recognized as the causative agents of motile aeromonad infections in ornamental fish. These infections can result in notable fish mortality and financial losses for the ornamental fish trade. When fish are contaminated, these clinical symptoms may cause serious health problems and perhaps significant mortality rates (Hossain & Heo, 2021).

II. Vibrionaceae

(vibriosis, Tail and fin rot)

Vibriosis is a potentially fatal illness that affects fish, and the excessive usage of antibiotics in cultured systems has made the bacterium more resistant to them (Helmi et al., 2020). There are plenty of vibrio species in both fresh and brackish water. Vibrio species are Gram-negative bacteria that cause vibriosis. Pathogens such as *V. anguliforme*, *V. salmonicida*, *V. vulnificus*, *V. parahaemolyticus*, *V. alginolyticus* and *V. harveyi* can infect ornamental fish and cause illnesses. It is well recognized that these Vibrio species are important fish infections, resulting in a range of clinical symptoms and health problems in ornamental fish. They can cause internal organ damage, fin rot, hemorrhagic septicemia and skin ulcers, among other ailments that result in significant mortality rates and financial losses for the ornamental fish business (Saad & Elkamel, 2015).

III. Pseudomonadaceae

(Bacterial Haemorrhagic Septicaemia, Tail and fin rot)

A bacterial disease called pseudomonas can harm ornamental fish, resulting in various symptoms, including ragged fins, red lesions on the body, lethargy, loss of appetite, and fast jaw movement. Most warm-water and freshwater fish, including koi and goldfish, are susceptible to the sickness identified by the red sores covering the creature. Pseudomonas bacterium is the source of the sickness. However, other factors such as seasonal changes, injuries, abrupt changes in water temperature, and inadequate nutrition or cleanliness might make the fish more vulnerable to the bacteria. The opportunistic Gram-negative bacillus Pseudomonas. It is a hazard to fish in stressed conditions since it is a part of their natural microbiota (Algammal et al., 2020).

IV. Enterobacteriaceae

Salmonella species bring on a Gram-negative bacterial illness called salmonellosis. A bacterial illness known as salmonellosis is brought on by Salmonella species (Bibi et al., 2015). Fish can pick up the bacterium and become carriers through polluted water or food sources. The bacterium can be spread by direct contact with sick fish or exposure to polluted water or equipment (Antunes et al., 2018; Gazal et al., 2018). Fish may show symptoms of a systemic illness, such as internal organ haemorrhages, skin lesions, lack of appetite, and lethargy (Mawa et al., 2021). Sick fish can be treated with antibiotics, but prevention is the key.

V. Flavobacteriaceae

(columnaris disease)

Fish kept as ornaments may suffer greatly from the bacterial disease Flavobacterium columnare. This bacteria causes columnaris disease, affecting several fish species and ornamental fish. *F. columnare* is the source of the illness columnaris, which can cause fin rot, skin ulcers, and internal organ damage in ornamental fish. These symptoms can result in significant death rates and financial losses for the ornamental fish business. The prevention and control of the spread of columnaris disease in ornamental fish depend on good management practices, including biosecurity precautions, water quality monitoring, and vaccination programs (Declercq et al., 2013).

B. Gram positive diseases**Table 3:** Gram positive bacterial diseases

Family	Pathogens	Symptoms	Prevention & Control
Streptococcaceae	Streptococcus	exophthalmia, distention of the abdomen, confusion, abnormal swimming, anorexia, opacity in the eyes, skin darkening and bleeding, and finally death	Maintain good water quality, reduce stress, avoid overcrowding
Mycobacteriaceae	Mycobacterium	pigmentation, exophthalmia, stomach distention, lethargy, skin lesions, and mortality	Maintain good water quality, reduce stress, avoid overcrowding
Erysipelotrichaceae	Erysipelothrix	fish may not show any obvious symptoms	Maintain good water quality, reduce stress, avoid overcrowding

VI. Streptococcaceae

Streptococcaceae (gram-positive bacterial family) is responsible for systemic streptococcosis, which harms fish populations globally, causes financial losses and raises health issues for the general public (Iregui et al., 2016). For the ornamental fish sector, the illness is a major threat. In addition, the bacteria have increased the morbidity and death rates in freshwater and marine fish. The disease's clinical indicators vary depending on the type of fish. Nonetheless, exophthalmia, abdominal distention, loss of direction, irregular swimming, and opacity in the eyes, darkening and bleeding of the skin, anorexia and ultimately death are the most common symptoms (Leal et al., 2019). Due to its neurotropic properties, streptococcus is thought to cause imbalanced swimming behaviour in fish. The bacteria are present in the tissues needed by fish for pathogen defence and the liver, gills, kidneys, and spleen. The Streptococcosis species that cause diseases in ornamental fish include *S. agalactiae*, *S. iniae*, *S. dysgalactiae* and *S. parauberis* (Ziarati et al., 2022).

VII. Mycobacteriaceae

Mycobacterium spp. are pleomorphic, aerobic, acid-fast, Gram-positive bacteria that are associated with fish. They are members of the Mycobacteriaceae family of hazardous bacteria (Delghandi et al., 2020). Fish that live in freshwater, brackish water and the ocean frequently contract mycobacteriosis, which is thought to be a primary cause of death for both farmed and wild fish (Hashish et al., 2018). It has also been documented that ornamental fish can harbor *Mycobacterium* spp. (Puk & Guz, 2020). Due to the large variety of host species and the many distinct kinds of bacteria that may infect fish, the clinical symptoms of infection vary. Fish infected with *Mycobacterium* species might exhibit unique symptoms such as pigmentation, exophthalmia, stomach distention, lethargy, skin lesions, and mortality. But through the circulatory and lymphatic systems, the virus has made its way to the eyes, gills, liver, kidneys and spleen, among other fish organs. Furthermore, fish infections may manifest as enlarged liver, kidney, spleen, and internal organ nodules (Delghandi et al., 2020). Fish may show signs including fin rot, emaciation, lethargy, and skin sores. Granulomas and caseous necrosis can be seen in internal organs (El-Amrani et al., 2010). Isolating sick fish and administering the proper antibiotic medication is part of the treatment.

VIII. Erysipelotrichaceae

A Gram-positive bacteria linked to fish is called *Erysipelothrix*. *Erysipelothrix rhusiopathiae* is the bacterium that causes erysipeloid (Rostamian et al., 2022). Before 2014, it was believed that *E. rhusiopathiae* was a common fish bacterium; nevertheless, reports of *Erysipelothrix*-associated mortality have come from several nations. Fish have been shown to harbor *E. piscicarius*, a recently found species of ornamental fish (Pomaranski et al., 2020). Although fish may not show obvious symptoms, they can still carry and release the bacterium into the surrounding water.

3.1.2 Viral diseases

Diseases that spread among ornamental fish due to viruses are a concern, as viral pathogens can harm these fish. Such diseases can lead to illness and death within affected fish populations, threatening the aquaculture industry. While more common in marine and brackish water fish, certain freshwater species like the terror are also susceptible. Some diseases found in fish include Lymphocystis disease, Koi Herpesvirus Disease, Infectious Spleen and Kidney Necrosis Virus (ISKNV) and Red Sea Bream Iridovirus (RSIV). Numerous viral illnesses, such as carp pox, koi herpesvirus, herpesviral hematopoietic necrosis, angelfish herpesvirus, and herpesvirus, iridoviruses, megalocytivirus, and koi sleepy disease, impact ornamental fish populations, leading to significant illness and death. These diseases, caused by different viruses like poxvirus and herpesviruses, pose a serious threat to the aquaculture industry due to their potential to cause high morbidity and mortality among affected fish populations (Su & Su, 2018).

I. Lymphocystis disease

Lymphocystis disease is caused by an iridovirus that infects tissue cells, resulting in hypertrophy and visible lumps in the fish. Outbreaks of this disease often follow events like the capturing and shipping of fish (Borrego et al., 2017). Symptoms include granular lesions on the skin and fins, which sometimes affect the mouth and gills. Infected fish may develop white or grey nodules of varying sizes that alter their appearance. Although lymphocytes usually resolve on their own without causing health problems, they can affect the appearance of the infected fish. Infected fish tend to develop bumps or abnormal growths on their skin, fins, and gills. These growths can come in sizes and quantities potentially leading to infections (Harikrishnan et al., 2010). Prompt veterinary consultation is crucial for an accurate diagnosis and suitable treatment. In the case of Lymphocystis disease in ornamental fish, there is no proven chemotherapeutic treatment, and it often resolves on its own with proper water quality and nutrition (Yanong, 2013). Surgical removal of hyperplastic fibroblasts, followed by topical antibiotics, can be a treatment option. A microscopic examination of the affected areas will reveal circular, clustered, light orange-hued enlarged cells to diagnose the disease. Preventive measures include quarantining new fish arrivals, maintaining excellent water quality, and avoiding overcrowding (Volpatti & Ciulli, 2022).

The Lymphocystis viral disease is more prevalent in marine and brackish water fish. However, it can also impact certain freshwater species like the green terror (*Aequidens rivulatus*), blue gouramis (*Trichogaster trichopterus*), and angelfish (*Pterophyllum scalare*). In Asia, examples of ornamental fish affected by Lymphocystis disease include the *Scatophagus argus*. These fish species have been linked to systemic diseases caused by iridoviruses, including Lymphocystis, resulting in illness and death in freshwater tropical fish populations (Yanong et al., 2003; Hoseinifar et al., 2023). Stress, particularly after fish capture and shipping, plays a role in developing this disease.

II. Ranavirus infecting koi (KIRV)

The ranavirus infecting koi (KIRV) in ornamental fish is a highly contagious viral pathogen first reported in India in 2015. This virus, isolated and characterized by moribund koi (*Cyprinus carpio*), causes severe clinical signs such as skin darkening, loss of scales, uncoordinated swimming, and other abnormalities, leading to significant mortality in infected fish populations. KIRV belongs

to the family Iridoviridae and seriously threatens ornamental fish health and aquaculture practices (George et al., 2015).

III. Megalocytivirus

Megalocytivirus is a group of iridoviruses that impact ornamental fish, including Red Sea Bream Iridovirus (RSIV), Infectious Spleen, and Kidney Necrosis Virus (ISKNV). RSIV primarily affects marine fish, while ISKNV and Turbot Reddish Body Iridovirus (TRBIV) are also significant (Sumithra et al., 2022). RSIV and ISKNV can lead to high mortality in infected fish, showing non-specific clinical signs. RSIV primarily affects marine fish, while ISKNV and TRBIV are more common in freshwater species. These viruses threaten marine and freshwater ornamental fish populations, emphasizing the importance of disease management and prevention in aquaculture. (Yanong & Waltzek, 2010).

IV. Spring Viremia of Carp (SVC)

A highly infectious viral illness that predominantly affects carp species is called spring viremia of carp (SVC), including koi and goldfish. The disease is caused by Rhabdovirus carpio, which can infect fish and potentially pose a risk to humans (Jia et al., 2020). Fish with SVC infection may exhibit a range of clinical symptoms, including lethargy, haemorrhages, swollen abdomen, and gill abnormalities. Mortality rates can vary depending on the severity of the infection (Zhang et al., 2019). In fish, post-mortem examination may reveal haemorrhages, congestion, and abnormalities in the internal organs, particularly the liver and spleen (Liang et al., 2022). The virus that causes SVC is the Spring Viremia of Carp Virus (SVCV), a member of the Vesiculovirus family with a bullet-shaped, encased virion. SVC was once exclusively found in Eastern and Western Europe, but with improved surveillance and the global trade in ornamental fish, it has since spread to North America, Asia, and Europe. Four main genetic clades linked to the virus's expansion in China, where common carp are grown for consumption and koi for export, have been identified by the genotyping of SVCV isolates and pike fry rhabdovirus from Europe (Meng et al., 2021). Currently, there are no vaccines for SVC. Fish hobbyists should keep their fish in separate tanks at events, and anglers must avoid moving fish between water bodies to prevent disease spread. Reporting unusual fish deaths to local fish and game authorities is important.

V. Koi Herpesvirus Disease

The extremely infectious virus known as koi herpesvirus (KHV) infects ornamental carp kinds including koi and ghost koi as well as ordinary carp. The virus, commonly known as cyprinid herpesvirus-3, can cause carps to develop interstitial nephritis and gill necrosis. Infected fish populations can experience up to 100% mortality (Rathore, 2012). The virus is a DNA virus that is closely linked to the goldfish hematopoietic necrosis virus and the carp pox virus. It is a member of the Herpesviridae family. As KHV may live in infected fish for a lifetime, fish that have been exposed to the virus or have recovered from it should be treated as carriers. KHV frequently causes non-specific clinical symptoms, and in infected populations, mortality can start very quickly—deaths can occur 24 to 48 hours following the onset of clinical symptoms. Fish of all ages are affected by the virus, however cohabitation studies indicate that fry are more vulnerable than older fish (Hartman et al., 2013).

VI. Herpesviral hematopoietic necrosis (HVHN)

Herpesviral hematopoietic necrosis (HVHN) is a severe disease affecting ornamental fish like goldfish and crucian carp, caused by Cyprinid herpesvirus 2. This viral infection leads to noticeable symptoms such as gill bleeding, body swelling, abdominal haemorrhages, and pale skin. HVHN results in necrosis in the kidney and spleen's hematopoietic tissue, causing extensive damage and mortality rates of up to 100% in goldfish populations. The virus has been identified in various countries worldwide, affecting goldfish and other cyprinid species like Prussian carp

and crucian carp. Early detection through PCR testing is crucial due to the challenges in isolating and diagnosing this disease, emphasizing the importance of disease surveillance and prevention in ornamental fish (Giovannini et al., 2016; Goodwin et al., 2006).

VII. Viral haemorrhagic septicaemia (VHS) and Infectious haematopoietic necrosis (IHN)

These are not typically associated with ornamental fish. These diseases primarily affect salmonid fish species and are not commonly found in ornamental fish.

3.1.3 Fungal disease

Fungal diseases in ornamental fish can be caused by various types of fungi commonly found in aquariums, such as *Saprolegnia* and *Achyla*. These infections typically affect fish that are stressed, injured, or ill, with poor water quality worsening the situation. Fungal infections in fish, also known as mycoses, are common in freshwater and marine species. These infections are often caused by poor water quality, hygiene, injuries, other diseases, or dead fish or decomposing organic material in the pond. Fungal spores are widespread in aquatic environments and can quickly colonize stressed, injured, or diseased fish, leading to external fungal infections known as 'cotton wool disease' due to their white, fluffy appearance (Verma, 2008).



Figure 13: Fungal Diseases

The visible sign of these fungal infections is often a white fluffy appearance known as 'cotton wool disease'. Freshwater aquarium salt baths or commercially available antifungal medications made especially for aquarium usage are two ways to treat fungal diseases like cotton wool disease in freshwater fish. In cases where individual fish are infected, treating them in a separate hospital tank is preferable. Additionally, applying Gentian Violet, which has antifungal and antibacterial properties, can be an effective treatment method (Ozcan & Arserim, 2021). Fish with dermal lesions from African sharp-tooth catfish (*Clarias gariepinus*), snakeskin gourami (*Trichogaster pectoralis*), gold gourami (*Trichopodus trichopterus*), angelfish (*Pterophyllum scalare*), and red hybrid tilapia (*Oreochromis* spp.) were examined in a study on fungal infections in common ornamental and edible fish species (Routh & Solanki, 2023).

I. Cotton Wool Fungus (*Saprolegniasis*)

Cotton wool fungus, also known as *Saprolegniasis*, is a common fungal infection in freshwater fish, particularly ornamental fish (Vajargah & Majidiyan, 2022). This disease is caused by water moulds, specifically in the genus *Saprolegnia*, which are filamentous protists with specific characteristics like oospores, diploid chromosomes, and cell walls made of beta-glucans and cellulose. *Saprolegnia* species typically infect fish with prior injuries on their external tissues, often caused by mechanical abrasion or other primary pathogens. *Saprolegniasis* manifests as grey or white patches on fish, primarily on the external tissues and gills, and is temperature-dependent, often occurring at low temperatures. The infection manifests as white or brown cotton-like growths on the skin or gills, with early signs showing pale areas that may ulcerate, exposing underlying musculature. In severe cases, systemic infections can lead to mycelial masses in the gut and viscera,

causing peritonitis and extensive tissue damage. The disease is usually transmitted through water or by ingesting contaminated food. Environmental stress, minor injuries, and suboptimal water quality contribute to outbreaks of Saprolegniasis. Treatment involves managing the environment, providing supportive care, and using chemicals like potassium permanganate, formalin, malachite green, and salt to control the infection. Wet mount examinations are crucial for diagnosis, revealing characteristic structures like aseptate hyphae and zoosporangia.

II. Gill Rot Disease (Branchiomycosis)

It is an acute infection of the gills that primarily affects various ornamental and freshwater fish species, including Koi, eels, bass, and perch. This disease is caused by two species of the genus *Branchiomyces*, namely *B. sanguinis* and *B. denigrans*, which produce branched and non-septate hyphae. The infection is transmitted through water, where fungal spores adhere to the gills, germinate, and produce hyphae that penetrate the gill tissue and damage the blood supply to the area (Ozcan & Arserim, 2021). Branchiomycosis, a fungal infection in fish, spreads through water, where fungal spores attach to the gills and grow hyphae that invade the gill tissue. The disease progresses rapidly within 2-4 days under suitable conditions, with clinical signs like weakened movement, fish gathering at water inlets, respiratory distress, and the presence of fungus on or in the gill tissue, leading to obstruction and necrosis. Reddened gills indicate impaired circulation, highlighting the severity of this fungal infection in fish.

Treatment for Branchiomycosis involves using malachite green, formalin baths, copper sulfate, benzalkonium chloride dips, and oral methylene blue. It is crucial to address factors like overcrowding, ammonia levels, algal blooms, organic material levels, water temperature, and hygiene to control the condition. Prompt removal of infected or dead fish and proper quarantine measures are essential to prevent the spread of the disease and maintain a healthy aquatic environment.

III. Ichthyosporidium

Ichthyosporidium is a fungal infection that primarily affects the kidneys and liver of fish, leading to sluggishness, balance loss, and external cysts or sores. This disease is present in ornamental fish and is caused by a fungus that manifests internally, spreading throughout the body after attacking the kidneys and liver. The disease is often associated with poor water quality, poor hygiene, fish injuries, dead fish or large amounts of decomposing organic material in the tank. Treatment options for Ichthyosporidium include a 1% Phenoxethol solution, or Chloromycetin added to the food. Reducing ammonia levels, algal blooms, amounts of organic material, water temperature, and enhancing cleanliness are some of the factors that assist regulate the disease. Fish that are dead or infected should be removed from the tank right away, and new fish should first be given enough time to recover in a proper quarantine.

IV. Exophiala sp.

Exophiala sp. is a group of fungal organisms that can cause darkening, lethargy, and abnormal swimming behavior in fish, along with yellow to white granulomas in visceral organs like the liver, kidney, and spleen. These infections can occur in ornamental fish and are associated with poor water quality, poor hygiene, fish injuries, or dead fish or large amounts of decomposing organic material in the tank. While prevention and therapy are not yet available for some of these infections, maintaining optimal water quality and hygiene can help control their spread. Fish with fungal infections can be treated with formalin baths, copper sulphate or benzalkonium chloride dips, and antifungal medicines like malachite green. Fish should be properly quarantined before being reintroduced to the tank, and any dead or infected fish should be removed right away (Verma, 2008).

3.1.4 Parasitic diseases

Many organisms, including protozoa, trematodes, cestodes, nematodes, acanthocephalans, crustaceans, and arthropods, cause parasitic diseases in ornamental fish. These organisms can infest various host tissues, including the skin, gills, and internal organs, leading to various clinical signs and pathological changes. Various organisms, including metazoan parasites, protozoan parasites, copepod arthropods and digenean trematodes can cause parasitic diseases in ornamental fish. Examples of these parasites include nine species of monogenean trematodes, seven protozoan species, three species of copepod arthropods, one metacercarial stage of a digenean trematode (*Centrocestus* spp.) and one nematode (*Capillaria* spp.).

These parasites can cause various symptoms in ornamental fish, such as irritation, injury, tissue atrophy, occlusions of the alimentary canal, and deprivation of normal feeding. In some cases, parasitic infections can lead to high mortality rates in fish populations. Prevention is the best method of control for many of these parasitic diseases, although some parasites may be susceptible to various parasiticides. Good husbandry practices are essential for reducing further parasite infestations (Thilakaratne et al., 2003; Florindo et al., 2017).

I. Argulosis

Argulosis is a disease in ornamental fish caused by the ectoparasite *Argulus* spp. Because it is common in carp culture, trout farming, and the ornamental fish business and causes large economic losses, this parasite is extensively researched. Using maxillary suckers and hooks, the parasite clings to the host's integument and feeds on its blood and outer tissues. Dermal ulceration, physiological stress, immunological suppression, secondary infections, decreased fish development, and death are among the harms brought on by feeding activities (Steckler & Yanong, 2013). The current strategies for controlling argulosis rely on veterinary medicines, including vaccines. However, the parasite's resistance to anti-parasitic drugs and the significant losses experienced globally necessitate further research and development in vaccination technology.

II. Lernaeosis

Lernaeosis, also known as Lernaeiasis, is a disease in ornamental fish caused by the copepod ectoparasite *Lernaea* spp., commonly called anchor worms. These parasites attach to the exterior parts of the fish, including the gills, fins, and scales, leading to various health issues and potential mortality in infected fish. The disease is prevalent in freshwater ornamental fish and can cause significant economic losses in aquaculture due to high mortality rates in cultured fish populations. Proper identification and treatment of Lernaeosis are essential to prevent the spread of the disease and maintain the health of ornamental fish populations (Steckler & Yanong, 2013).

3.1.5 Protozoans diseases

Protozoan diseases can have varying impacts on the health of ornamental fish (Martins et al., 2015)

I. Ichthyophthiriasis (white spot disease)

Ichthyophthiriasis, commonly known as white spot disease, is caused by *Ichthyophthirius multifiliis* and affects freshwater fish. Ichthyophthiriasis, commonly known as white spot disease, is a significant protozoan disease affecting ornamental fish. It is caused by the ciliated parasite *Ichthyophthirius multifiliis*, which infects the skin and gills of freshwater fish. The disease is characterized by white spots on the skin and gills, which are visible macroscopic manifestations of the trophont stage of the parasite. Ichthyophthiriasis can lead to significant economic losses in the aquaculture sector due to high mortality rates during epidemics. The disease is often associated with low water temperature, affecting health and making fish more susceptible to parasitic infections. During an outbreak, fish are stressed, and their immune reactions are compromised, which enables

aquatic bacterial pathogens to infect the host and increase the severity of the disease (Wei & Yu, 2013) (Dickerson & Dawe, 2006)

II. Piscinoodinium pillulare (Velvet Disease):

Velvet disease in ornamental fish is caused by the dinoflagellate parasites *Piscinoodinium pillulare* in freshwater fish and *Amyloodinium ocellatum* in saltwater fish, leading to yellowish spots on the skin and gills. This parasitic infestation can quickly lead to the death of fish if not diagnosed and treated promptly. The disease is also known as "rust" or "gold dust" disease, characterized by yellow, rust, or gold-dust-colored spots or film on the fish's body, giving it a velvet-like appearance. The treatment for velvet disease in ornamental fish involves specific medications like copper formulations for marine fish and freshwater dips for three to five minutes, along with commercial fish medications containing formalin or malachite green for freshwater fish. Proper quarantine protocols for new fish additions, regular water testing, and excellent water conditions are essential preventive measures to protect ornamental fish from velvet disease (Saha & Bandyopadhyay, 2017).

III. Tetrahymena Infection (Guppy Killer Disease)

Tetrahymena pyriformis is the cause of Tetrahymena Infection, also referred to as Guppy Killer Disease. It mostly affects a variety of tropical aquarium fish species, especially guppies (*Poecilia reticulata*). Infection leads to parasite invasion of internal organs, skin, and muscle in all fish species; the illness is prevalent in crowded environments. The most vulnerable species to Tetrahymena infection are guppies, which in two different tests showed fatality rates of 87% and 100%. Additionally, platyfish have high death rates (77%), whereas molly and angelfish have far lower mortality rates (23% and 33%, respectively). Tetrahymena infection has a lower death rate in goldfish and koi carp (24% and 59%, respectively). Because the parasite is immunogenic, three weeks after infection, koi carp that have been infected have an almost three-fold increased Tetrahymena immobilisation response. Fish that are infected display signs such as internal organ, skin, and muscle parasite invasion; guppies are the most vulnerable species (Sharon et al., 2014) (Thilakaratne et al., 2003).

IV. Pleistophora hyphessobryconis:

The cause of neon tetra disease, infecting a wide variety of aquarium fish, including tetras, barbs, and goldfish.

3.2 Non-communicable diseases

Non-infectious or non-communicable diseases in ornamental fish are caused by environmental problems, nutritional deficiencies, or genetic conditions and are not contagious. These diseases can lead to direct mortalities, productivity losses due to reduced growth, fecundity, product quality, and social factors, and the costs of control measures (Shefat & Karim, 2018; Admasu & Wakjira, 2021).

I. Anorexia

Anoxia in ornamental fish refers to a state of oxygen deprivation in which fish are exposed to low or no oxygen levels, leading to a shift in their metabolic processes towards anaerobic respiration. A concentration of 5mg/l oxygen is considered to be sufficient for most fish. Concentration less than 3mg/l may prove fatal for many species of fish. Goldfish and crucian carp are natural models of anoxia tolerance, with crucian carp being able to survive in oxygen-depleted waters for extended periods due to their ability to produce ethanol as a byproduct of anaerobic metabolism (Fagernes et al., 2017). To prevent anoxia in ornamental fish, proper water conditions, including adequate oxygen levels, temperature, and pH, must be maintained. This can be achieved through regular water changes, aeration, and filtration, as well as the use of air pumps and protein skimmers.

II. Gas Bubble Diseases

Gas bubble disease can affect ornamental fish. It is a condition in which bubbles form within a fish's body due to water supersaturated with dissolved gas. These bubbles can lead to various symptoms like disorientation, visible bubbles in the eyes, skin, or fins, and tissue degeneration. The causes include sudden temperature or pressure changes, faulty filter equipment, and gas influx from an outside source. Prevention involves maintaining proper water conditions and monitoring for excess gas bubbles.

I. Nutritional and dietary diseases

Malnutrition or dietary diseases in ornamental fish can occur due to inadequate nutrition, poor diet, or certain diseases such as heavy tapeworm infestation. Affected fish may refuse to feed, leading to a gradual loss of body mass and muscle wastage. Malnourished fish can become emaciated and develop a pinched-in 'hollow' belly, with their heads appearing disproportionately more significant than their bodies (Admasu & Wakjira, 2021).

Anemia in ornamental fish is characterized by a deficiency of hemoglobin, packed cell volume, or erythrocytes in the blood. It can be caused by various factors, including bacterial, fungal, viral, and parasitic infections, folic acid deficiency, exposure to high levels of nitrates, and infestation of blood-sucking parasites such as leeches. Anemia can lead to severe symptoms such as lethargy, weight loss, and abnormally pale gills in fish.

4. Prevention Measures and Control of Diseases

4.1 Importance of maintaining stable aquarium/environmental conditions

These decorative fish "pets" have seen a sharp rise in commerce worldwide in recent years. There is an urgent need to grow this industry by adding more new ornamental species, as evidenced by recent studies that found that over 20 million marine ornamental fish are thought to be taken from the wild and sold to over 2 million aquarium hobbyists worldwide (Chen et al., 2020). The debate over whether fish can feel pain, discomfort, misery, anxiety, or discomfort has persisted for several decades and is a crucial first step towards comprehending fish welfare. A viewpoint posits that fish lack the requisite anatomical features and cognitive understanding to identify pain (Rose et al., 2014). Because the ornamental fish market is a component of the pet industry, which is sometimes referred to be a multibillion dollar sector with a trade value between \$15 and \$30 billion, aquarium maintenance is crucial (Tarihoran et al., 2023). Because ornamental fish are a popular and simple hobby that relieves tension, they also aid in import and export operations and foreign exchange. There are already 3.2 million aquariums in the EU and 7.2 million in the USA, and the number is rising every day globally. To meet the need, ornamental fish aquaculture is being developed. The biggest markets for ornamental fish worldwide are the USA, Europe, and Japan, while over 65% of shipments are from Asia. This will promote economic growth (Pouil et al., 2020).

4.2 Strategies to maintain a stable aquarium

Maintenance of water quality

The importance of water quality in fish exhibits and habitats cannot be overstated; water composition is essential to the health and well-being of all fish species. However, different species and life stages may require similar or extremely different water quality parameters to provide appropriate environmental conditions for optimal health and welfare. Water quality parameters outside the tolerant range of the species can cause significant changes in several physiological and biochemical properties of a fish, resulting in abnormalities of blood chemistry and hematology, changes in the cellular permeability, and changes in the osmoregulatory needs of the fish. The resulting "stress response", or disturbance in the balance of the physiological homeostasis, initiates various adaptive responses to help return the fish to a stable homeostatic state (Iwama et al., 2005).

Nutrition

The majority of fish species kept in captivity have distinct dietary needs that are currently unknown. Commercially available formulated meals for fish raised in aquaculture, such as carp, salmonids, and catfish, are frequently unsuitable for the variety of fish kept in public aquariums. Therefore, it is often advised to offer a tasty food that satisfies the species' daily needs for nutrition and behavior (Council et al., 2010).

Habitat Design

Any physical environment that fish occupy should be constructed from materials that are safe, non-toxic, and devoid of pathogens, such as crushed coral, gravel, or sterilized sand. Fish behavior and wellbeing are significantly influenced by substrates, and research has revealed that different species—and even individual members of the same species—have distinct preferences. For example, to support their natural foraging habit, corydoras catfish (*Corydoras* spp.) prefer sand over bigger pebbles. Additionally, it has been demonstrated that Nile tilapia exhibit unique preferences for various substrate sizes (Maia & Volpato, 2018).

4.3 Strategies to avoid infected fish or plant in ornamental fish

Introduced plants or fish that are infected might spread the disease to other species in the aquarium, affecting the entire fish population. Different tactics are used to steer clear of these circumstances. The risk of contaminating the primary stock of fish with unknown health statuses must be reduced by enacting stricter quarantine regulations and treatment or mitigation measures for microorganisms that are prohibited from entering the EU.

4.4 Notifiable diseases—Check local and national regulations.

The intergovernmental organization in charge of enhancing animal health globally is the World Organization for Animal Health (OIE). One of the official responsibilities of an OIE Member State is to provide data as soon as possible and transparently on any relevant animal illness situation, including the existence of any zoonosis. The OIE provides a list of fish infections to be taken into account for international commerce as well as further details concerning associated illnesses, diagnostic procedures to detect them, and management strategies (Mocho et al., 2022).

4.5 Assess risk before importation

Before agreeing to accept a shipment of fish, the responsible representative of the receiving facility should review the health reports and facility description of the exporting facility (Mocho et al., 2022).

4.6 Mitigate risk according to fish developmental stage.

The developing stage, which will be approved for shipping, is a crucial control point early in the import process. The lifecycle (length), reproduction mode (oviparous or ovoviviparous), and other reproductive parameters (such as seasonal fertility and the capacity to reproduce in captivity) are among the species' features to take into account. Importing embryos is not possible in many fish research institutions (for example, because of the features of the species or the capacity to undertake egg surface cleaning). In quarantine, adult immigrants may undergo nonlethal screening and postmortem examination following spawning or cryopreserved sperm. To create new colonies, germplasm such as frozen gametes can also be transplanted. Because freezing kills some particular germs, it may lower the risk of contamination. But since many microorganisms are resistant to cryopreservation, frozen biological material can remain a biosecurity hazard (Norris, Watral, & Kent, 2018).

4.7 Biocontain imported fish in quarantine.

All fish should be brought into a quarantine chamber that is physically segregated and controlled once the introduction of additional fish has been permitted. The EU's main building and the quarantine chamber ought to be apart. In addition to being spread by vectors like fish, birds, air, water, or biological materials, infections can also arise via unintentional surface contact. As a result, the primary holding systems and the quarantine area need to share a separate room, washbasin, bench, water system or other piece of furniture. Aside from being separate from other EUs, the quarantine area should include all the equipment required (refrigerators, incubators, feeding devices, microscopes, water testing kits, maintenance tools, etc.).

4.8 Provide ample time for quarantine and acclimatization

Upon arrival, fish should be observed in quarantine for a minimum of two weeks (Aleström et al., 2020). Depending on the estimated risks of the shipment and local regulations (Arthur et al., 2008), this observation period may require an extension for up to or over six weeks. The recommended minimum duration of quarantine in public aquaria is 30 days; in aquaculture, it is 30 to 60 days (Hadfield, 2012; Mocho et al., 2022).

4.9 Screen imported fish for pathogens.

Fish placed in quarantine should be checked for infections and kept an eye out for any overt symptoms of illness or higher mortality. Testing can be done for excluded microorganisms in quarantine system water and some imported fish. The conditions of the existing facility (number of imports present, size of quarantine, phases of development upon arrival, and exclusion of infections) should be taken into account while monitoring the health of imported fish. Screening the system environment, analyzing each import group in-person, and reviewing clinical cases are additional helpful activities (Kent et al., 2011).

5. Treatments

5.1 For bacterial diseases

Bacterial infections are very common in ornamental fish and can be caused by various Gram-negative and Gram-positive bacteria. Treatments often involve antibiotics and disinfecting the water.

5.2 For viral diseases

Lymphocystis is a common viral disease that causes white, cauliflower-like growths on the fish's body and fins. There is no proven treatment, but the infected fish can be separated and the disease is often self-limiting if water quality and nutrition are good

5.3 For fungal diseases

Saprolegniosis is a common fungal disease that causes white, cotton-like growths. It can be treated with antifungal compounds like formaldehyde, malachite green, or salt.

5.4 For parasitic diseases

External parasites like *Lernaea* (anchor worms) can be removed manually or treated with chemical dips.

5.5 For non-infectious diseases

Environmental factors like water quality, temperature, and nutrition play a big role in fish health. Addressing these underlying issues is important for prevention and treatment. Physical injuries from handling or transport can also predispose fish to secondary infections and should be avoided.

A combination of good husbandry, quarantine, and targeted treatments are recommended to control diseases in ornamental fish (Verma, 2008; Lipton, 2006).

Conclusion

Ornamental fish keeping is a significant global industry that relies heavily on ensuring the health and well-being of the fish. These beautiful fish are vulnerable to a variety of diseases, both infectious and non-infectious, which can have a profound impact on their survival and overall health. When it comes to diseases, ornamental fish can suffer from viral infections like lymphocystis, which leads to distinctive white, cauliflower-like growths. Unfortunately, there is no established treatment for this viral disease. Bacterial infections, such as fin and tail rot, dropsy, and ulcerations, are commonly managed with antibiotics. Fungal diseases like saprolegniosis can be addressed with antifungal compounds, while parasitic diseases, including external parasites like anchor worms, may require manual removal or chemical treatments. Apart from infectious diseases, ornamental fish can also be affected by non-infectious conditions triggered by environmental factors like poor water quality, inadequate nutrition, and physical injuries. To safeguard the health of ornamental fish, it is crucial to focus on disease prevention and effective management strategies. This involves maintaining optimal water quality, isolating new fish in quarantine, and administering targeted treatments when needed. By combining good husbandry practices with the appropriate use of medications, the impact of diseases on ornamental fish can be effectively controlled.

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