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DISEASES IN THE AQUARIUM FISHES: CHALLENGES AND AREAS OF CONCERN: AN OVERVIEW

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Abstract

Progress over the past years has revealed much strength of the ornamental fish as an alternative model for the environmental sideline in the aquaculture both in fresh water and marine waters. These include low rearing costs, an earlier life stage. Aquarium fish are one of the largest groups of pets in the world. There is an increasing demand for the veterinary services that are related to the ornamental fish. Early clinical signs in many infectious and noninfectious diseases of fish are manifested by the skin. More diseases in fish have been described and have been associated with the research for the future has been discussed. This article also describes the more common environmental and pathogen related dermatologic diseases of the aquarium fishes. Disease prevention, control and various treatment methods also have been discussed.

Key words: Ornamental fishes, diseases, clinical signs, treatment, ornamental aquaculture.

Introduction

The ornamental fish industry is an aquaculture based business which is the popular hobby around the world which gives hundreds of millions of dollars and supports the rural people in developing countries. And the veterinarians are increasingly becoming involved in disease management of the related species whether for private home clients, retail and wholesale operations, which are in larger display settings. Diseases of fish arise through many of the same pathways of influencing the primary, and perpetuating factors as of their other animals. Often results in the practical approach of euthanizing one or more of the severely affected fish, and using various tools (Chapman et. al., 1997). Early clinical signs in many infectious and noninfectious diseases of fish are manifested by the skin (Schmale, 1995).

In general, as in all vertebrates, the skin of fish consists of epidermis which is very thin and composed, from the inside outward, of a basal layer of germinal cells, a variable number of layers of cuboidal to squamous cells and an outer cuticle layer and dermis was supported by a hypodermis (Stoskopf MK, 1993; Gratzek et.al., 1992). The color of fish is affected by many normal physiologic and environmental factors including age, diet, temperature, stress and in some cases sunlight and colors may fade to some extent during sleep, the clinician must consider these facts when evaluating a fish because there are also many color changes associated with different disease conditions. The first sign, the fish shows when it is ill is a change in its body color, usually the fish becomes darker (Stoskopf MK, 1993; Gratzek et.al., 1992).

Although, in recent years, there has been a worldwide increase in both basic and applied research concerning viral diseases and viral infections of fish species important to the aquaculture industry (Agius C, 1982). The major reason for this inequity is the higher socioeconomic importance placed on fish destined for human consumption. In addition, there is a little incentive for private aquarium fish owners to authorize detailed and expensive virological examinations, where a positive diagnosis, in most cases results in destruction of the fish rather than implementation of a treatment with the possibility of a cure (Hill BJ, 1990).

Dermatologic disease associated with aquarium fish

Aquarium fish often live in suboptimal conditions involving limited volumes of water in aquarium systems with a restricted capacity to maintain adequate water quantity, unlike natural fish; they cannot escape a potentially harmful environment. Even the preeminent outfitted aquarium, combined with meticulous concern of water quality parameters, can never truly ape natural conditions in the wild. Thus, the keeping of fish in aquaria is a finding the middle ground that usually has a pessimistic influence on the fish wellbeing (Magnadottir, 2006). In wild fish live in an environment that is full of disease causing organisms and parasites (Nunez et.al., 1990) which usually have a low burden of a wise varieties of parasites when they are captured, frequently without showing any signs of disease (King et.al., 2004). Protozoa, trematodes and crustaceans are among the many parasites which usually infect the fishes. Some of the figures of the disease associated with aquarium fish in the Hatchery are shown in figure 1.

Protozoan Diseases

Velvet or Rust

Symptoms: Clamped fins, respiratory distress (breathing hard), and yellow to light brown "dust" on body.

This disease has the appearance of a golden or brownish dust over the fins and body. The fish may show signs of irritation, like glancing off aquarium decor, shortage of breath (fish-wise), and clamping of the fins. The gills are usually the first thing affected. Velvet affects different species in different ways (Lederberg et.al, 1992). This disease is highly contagious and fatal. The best treatment is with copper at 0.2 mg per liter (0.2 ppm) to be repeated once in a few days if necessary. Acriflavine (trypaflavine) may be used instead at 0.2% solution (1 ml per liter). As acriflavine can possibly sterilize fish and copper can lead to poisoning, the water should be gradually changed after a cure has been affected.

Marine velvet disease

Symptoms: Respiratory distress (fast breathing - gills opening more than 80 times per minute); White, yellow to light brown, or grey "dusty" appearance on body, Loss of appetite, Rubbing or scratching against decor or substrate.

Marine velvet is one of the most common maladies experienced in the marine aquarium, with the other being Marine Ich. It is found in all the oceans of the world and often infects wild and newly caught marine fish. It is a fast moving disease that can cause mass

Fig. 1. Different types of diseases associated with the aquarium fish in the Hatchery

(A) Yellow wrasse (*Halichoereschrysus*) effected with the tail rot which is caused by the Bacterial diseases (*Pseudomonas fluorescens*);

(B) Long finned Bat fish (*Plataxpinnatus*) which was effected with the signs of bacterial diseases on the mouth region (reddish in color);

(C) Orange skunk clownfish (*Amphiprionsandaracinos*) which was affected with the fin rot diseases caused by the bacteria.

(D & E) Butterfly fish (Chaetodontidae) with the reddish colored spots on the body which was effected with the *Vibrio sp*.

(F) Clown fish (*Amphiprionocellaris*) effected with the fungal infections.

casualties. Primarily it infects the gills of fish but can attach itself to the body as well, burrowing deep into the skin's subcutaneous layer. Deaths are generally a result of interference to the respiratory system. This disease is highly contagious and fatal. Chemical treatments for this disease include using copper. Follow the instructions provided by the manufacturer. Natural methods include hypo salinity, a quarantine tank with a low salinity. A danger with using low salinity is in re-acclimating the fish to a higher salinity (Kolandasamy et.al., 1999).

Costia

Symptoms: Milky cloudiness on skin.

This is a rare protozoan disease that causes a cloudiness of the skin. The best treatment is with copper at 0.2 mg per liter (0.2 ppm) to be repeated once in a few days if necessary. Acriflavine (trypaflavine) may be used instead at 0.2% solution (1 ml per liter). As acriflavine can possibly sterilize fish and copper can lead to poisoning, the water should be gradually changed after a cure has been affected. Raising the water temperature to 80º - 83º F for a few days has also been affective (Kolandasamy et.al., 1999).

Hexamita

Symptoms: The first symptom is slimy, white mucous feces, even while still eating and acting normal. Further signs are the fish hiding in the corner it's head down, head above the eyes gets thin, they blacken in color, and swim backwards.

Hexamita are intestinal flagellated protozoa that attack the lower intestine. Discus and other large cichlids, especially Oscars, are especially prone to Hexamita. As it is a disease of the digestive tract, a wasting away or loss of appetite may be experienced.An effective treatment is the drug metronidazole. A combined treatment in the food (1% in any food the fish will eat) and in the water (12 mg per liter) is recommended. Repeat the water treatment every other day for three treatments.

This disease is often confused with another disease called Head and Lateral Line Erosion (HLLE), which use to be called "hole-in-the-head" disease, because both these diseases are often seen simultaneously in the same fish. Head and Lateral Line Erosion disease looks like cavities or pits on the head and face. It is not a protozoan disease, but is actually caused by environmental conditions.

Ich or White spot disease (Ichthyophthiriusmultifiliis)

Symptoms: Salt-like specks on the body/fins. Problems breathing (ich invades the gills), clamped fins, loss of appetite.

Ich is the most common malady experienced in the home aquarium. Luckily, this disease is also easily cured if caught in time.Ich is actually a protozoa called Ichthyophthiriusmultifiliis. There are three phases to the life cycle of these protozoa. Normally, to the amateur aquarist, the life cycle is of no importance. However, since Ich is susceptible to treatment at only one stage of the life cycle, an awareness of the life cycle is important. These three phases take about 4 weeks at 70º F but only 5 days at 80º F. For this reason it is recommended that the aquarium water be raised to about 80º F for the duration of the treatment. If the fish can stand it, raise the temperature even higher up to 85º F.

The free swimming phase is the best time to treat with chemicals. Raising the aquarium temperature to 80º F will greatly shorten the time for the free swimming phase to occur. The drug of choice is quinine hydrochloride at 30 mg per liter (1 in 30,000). Quinine sulphate can be used if the hydrochloride is not available. The water may cloud but this will disappear. By reducing the time (with raised temperature) of the phases, you should be able to attack the free swimming phase effectively.

Some aquarists like to use malachite green, but it tends to stain the plastic and silicone in the aquarium. Most commercial remedies contain malachite green and/or copper, which are both effective.

***Marine Ich* (*Cryptocaryonirritans*)**

Symptoms: Salt-like specks on the body/fins. Rubbing or scratching against decor or substrate, Excessive slime. Problems breathing (ich invades the gills), Frayed fins, Loss of appetite, Cloudy eyes, Abnormal swimming.

Marine ich or white spot disease is one of the most common maladies experienced in the marine aquarium, with the other being Marine Velvet. This protozoa has four phases to its life, lasting up to 38 days depending on the temperature of the environment. This parasite affects marine and brackish water fish. Aquarists are most familiar with the stage where the protozoa is infesting the host, the small white spots similar to a sprinkling of salt on the fish's body and fins. Unfortunately this visual clue is also the reason for difficulty in eradicating marine ich. Once the parasite has left the host's body many aquarists believe their fish is cured and the problem is solved and so they cease treatment, only to have another larger reoccurrence.

For eradication treatment must be carried through to completion, so understanding the parasite's life cycle will greatly increase your chances of success. The life cycle of this parasite can vary dramatically and is dependent on temperature; they cycle faster in a warmer environment (Leong et.al., 1988). Ideally the parasite would be eliminated while on the host or shortly after leaving the host. However, those that are buried in the gills are immune to treatment until they leave the fish. This along with the variability of the cycle makes it difficult to treat in a timely manner. So to rid the aquarium of this protozoon, it is recommended that you use a combination of water changes and chemical treatment, a multiple number of times.

Chemical: Chemical treatments for this disease include using copper, formalin, or a combination of copper and formalin. Follow the instructions provided by the manufacturer.

Natural: Natural methods include either a quarantine tank with a low salinity (hypo salinity) or large frequent water changes. For low salinity keep the specific gravity of the water at approximately 1.009-1.010 with temperatures of 78 - 80° F (25 - 27° C) for 14 days. A danger with using low salinity is in re-acclimating the fish to a higher salinity. You must be able to accurately measure the salinity and must increase it very slowly. For the water change method, replace 50% of the aquarium water daily for 14 days. This is perfectly safe method as long as temperature and salinity are the same, and this will remove the parasites while in a free swimming stage.

Reportably some healthy fish can develop a limited immunity. This immunity is short-lived lasting only about six months and may not be a total immunity, being a small amount of infestation rather than extensive infestation.

Neon tetra disease

Symptoms: Whitened areas deep into the fishes' flesh. Muscle degeneration leading to abnormal swimming movements.

It is caused by the sporozoa *Plistophora hyphessobryconis*. Even though it is named after Neon Tetras, it can appear on other fish. Whitish patches appear as if just below the skin. In Neon Tetras it destroys the bright blue-green neon stripe. The organisms form cysts which burst and release spores. The spores penetrate further and form more cysts. Eventually, the spores migrate to the water and are eaten by other fish in the food. These spores migrate into the digestive tract, then the muscles, and a new infection starts. There is no known cure. It is best to destroy the infected fish and clean the aquarium (Leong et.al., 1988).

Gluea and Henneguya

Symptoms: Similar to Lymphocystis, the fish will have nodular white swellings on fins or body. Glugea and Henneguya are sporozoans that form large cysts on the fish's body and release spores. Luckily, these diseases are very rare. The fish bloat up, with tumor like protrusions, and eventually die. No cure, as of yet. It is best to destroy the infected fish before the spores can spread (Leong et.al., 1988).

Chilodonella

Symptoms: Dulling of the colors due to excessive slime, fraying of the fins, weakness, gill damage.

This disease causes a blue white cloudiness on the skin and attacks the gills. Later the skin may be broken down and the gills destroyed. The fish may behave like they have irritations, by glancing off aquarium decor, they may have clamped fins and difficulty breathing. Acriflavine (trypaflavine) may be used at 1% solution (5 ml per liter). As acriflavine can sterilize fish, the water should be gradually changed after a cure has been affected. It also helps to raise the temperature to about 80º F (Leong et.al., 1988).

Bacterial Diseases

Red pest

Symptoms: Bloody streaks on fins or body.

Red Pest is called such because of bloody streaks that appear on the body, fins and/or tail. These streaks could proceed to ulcerations and possibly lead to fin and tail rot with, in severe cases, the tail and/or fins falling off. As the disease is internal, external treatments are usually not effective, except in very slight cases. In slight cases, treat the aquarium with a disinfectant and clean the aquarium as best as possible. Do not feed a lot while the aquarium is being treated. To disinfect, use acriflavine (trypaflavine) or monacrin (monoaminoacridine) using a 0.2% solution at the rate of 1 ml per liter. Both disinfectants will color the water, but the color disappears as the disinfectants dissipate. Then add an antibiotic to the food. With flake food, use about 1% of antibiotic and carefully mix it in (Leong et.al., 1993).

Mouth fungus

Symptoms: White cottony patches around the mouth.

Mouth Fungus is so called because it looks like a fungus attack of the mouth. It is actually caused from the bacterium *Chondrococcuscolumnaris*. It shows up first as a gray or white line around the lips and later as short tufts sprouting from the mouth like fungus. The toxins produced and the inability to eat will be fatal unless treated at an early stage. This bacteria is often accompanied by a second infection of an *aeromonas* bacteria. Penicillin at 10,000 units per liter is a very effective treatment. Treat with a second dose in two days. Or use chloromycetin, 10 to 20 mg per liter, with a second dose in two days. Other antibiotics can also be effective. Kanacyn (kanamycin) will treat both bacteria at once. Maracyn (erythromycin) is effective against C. columnaris, and using Maracyn 2 (minocycline) in conjuntion with it will treat the Aeromonas bacteria as well.

Tuberculosis (Mycobacteriosis)

Symptoms: Emaciation, hollow belly, possibly sores.

Tuberculosis is caused by the bacterium Mycobacterium piscium. Fish infected with tuberculosis may become lethargic, hollow bellied, pale, show skin ulcers and frayed fins, have fin and scale loss, and loss of appetite. Yellowish or darker nodules may appear on the eyes or body and may deform the fish. The main causes for this disease appears to be overcrowding in unkempt conditions; ie. Poor water quality. All fish species could be susceptible though some are more susceptible than others. Those most susceptible are the labyrinth air breathers like the Gouramis, Bettas, and Paradise Fish. Others include Neon Tetras, Discus, and the Ram Cichlid. If either unkempt conditions or overcrowding are the suspected cause, correct the condition (Leong et.al., 1993).

Dropsy

Symptoms: Bloating of the body, protruding scales.

Dropsy is caused from a bacterial infection of the kidneys, causing fluid accumulation or renal failure. The fluids in the body build up and cause the fish to bloat up and the scales to protrude. It appears to only cause trouble in weakened fish and possibly from unkempt aquarium conditions. An effective treatment is to add an antibiotic to the food. With flake food, use about 1% of antibiotic and carefully mix it in. If you keep the fish hungry they should eagerly eat the mixture before the antibiotic dissipates. Antibiotics usually come in 250 mg capsules. If added to 25 grams of flake food, one capsule should be enough to treat dozens of fish. A good antibiotic is chloromycetin (chloramphenicol). Or use tetracycline (Leong et.al., 1993).

Scale protrusion

Symptoms: Protruding scales without body bloat. Scale protrusion is essentially a bacterial infection of the scales and/or body.

An effective treatment is to add an antibiotic to the food. With flake food, use about 1% of antibiotic and carefully mix it in. If you keep the fish hungry they should eagerly eat the mixture before the antibiotic dissipates. Antibiotics usually come in 250 mg capsules. If added to 25 grams of flake food, one capsule should be enough to treat dozens of fish. A good antibiotic is chloromycetin (chloramphenicol). Or use tetracycline.

Tail Rot and Fin Rot

Symptoms: Disintegrating fins that may be reduced to stumps, exposed fin rays, blood on edges of fins, reddened areas at base of fins, skin ulcers with gray or red margins, cloudy eyes.

Tail and fin rot appears to be a bacterial infection of the tail and/or fins and may be caused by generally poor conditions, bully, or fin nipping tank mates. If aquarium conditions are not good an infection can be caused from a simple injury to the fins/tail. Tuberculosis can lead to tail and fin rot. Basically, the tail and/or fins become frayed or lose color.

First, attempt to ascertain the cause. Then treat accordingly. Also, treat the water or fish with antibiotics. If added to the water, use 20 - 30 mg per liter. If the fish is to be treated add an antibiotic to the food. With flake food, use about 1% of antibiotic and carefully mix it in. If you keep the fish hungry they should eagerly eat the mixture before the antibiotic dissipates. Antibiotics usually come in 250 mg capsules. If added to 25 grams of flake food, one capsule should be enough to treat dozens of fish. A good antibiotic is chloromycetin (chloramphenicol) or tetracycline.

Fish Vibriosis

Symptoms: Lethargy, increased respiration, loss of appetite, skin hemorrhages, and death.

Vibrio is a genus of Gram-negative bacteria found primarily in saltwater or brackish water, and consisting of 70 or more strains. Fish Vibriosis involves a variety of infectious strains of Vibrio bacteria, most notably *Vibrio anguillarum*,*V. ordalii*, *V. damsela*, and *V. salmonicida*(Leong et.al., 1993).

Fish Vibriosis occurs most often in marine animals or brackish water fish, though it can occasionally be found in tropical species. Fish contract the bacteria through open sores or feeding on dead fish that died from the disease. Hemorrhaging starts with reddening or blood streaks under the skin surface, becoming red spots on the ventral and lateral areas of the fish. Swollen dark lesions develop, turning into ulcers and release bloody pus. There may also be eye problems with cloudy eye, which can lead to pop-eye and eye loss.

The course of a vibriosis infection in fish is usually very rapid. Most infected fish die without showing more visual signs than the ulcers, and sometimes death may occur suddenly before any signs are noticed at all. The best treatment includes oral antibiotics. Kanamycin is one of the best, also chloramphenicol or furazolidone are good. When treating with antibiotics, it must be done in a quarantine tank rather than the main aquarium. This is because antibiotics will damage the biological filter in the main tank, throwing the nitrification cycle into reverse and cause a spike in nitrites and ammonia after just a few days (Lee et.al., 2002).

Viral infections and tumors in ornamental fish

Ornamental fish may harbor viruses without any clinical signs yet become diseased with the slightest decrease in water that have significant influence include dissolved oxygen, suspended solids, organic content and nitrogen concentration in the form of ammonia and nitrate, unless these parameters remain within their optimum range, they will contribute to the overall stress experienced by the inhabitant fish (Lapierre et.al., 1998a).

Thus, development of a viral infection to the onset of disease is a multifactorial process, and there are no treatments available for specific viral infections. Early diagnosis is critical so that we can attempt to reduce mortality associated with disease by concerning any contributory factors (Lapierre et.al., 1998b).

Viral infections in ornamental fish not only render the fish susceptible to that particular virus, but the constant presence of an infectious organism can also exhaust the fish immune system, making it more vulnerable to other infectious agents or noninfectious problems (Lapierre et.al., 1998). Infected fish may have an effective immune system and not show the clinical signs of disease but may become carriers of the virus. Consequently, other more susceptible fish of the same or different species cohabiting in the tank system may become infected (Southgate PJ et. al., 1992).

Members of several virus families have been drawn in the etiology of tumors in fish. The literature contains numerous publications in which members of virus families Herpesviridae, Papillomaviridae, and Retroviridae are associated with the development of tumors in fish (Bowser et a., 1993). In some instances, the evidence supporting a retroviral association is compelling and includes viral sequencing and successful transmission trials using a well-characterized inoculums (Quackenbush et.al., 2010). In other instances, a retroviral association is based on detection of retrovirus-like particles or reverse transcriptase activity in tissues from proliferative lesions. Proving a retroviral etiology in the pathogenesis of tumors is notoriously challenging. Due to the paucity of fish cell culture lines, most fish retroviruses are amplified by polymerase chain reaction (PCR) and sequenced using degenerate PCR approaches, rather than cell culture. Only 6 tumorigenic piscine retroviruses have been fully or partially sequenced. These include walleye dermal sarcoma virus, walleye epidermal hyperplasia viruses 1 and 2, perch epidermal hyperplasia viruses 1 and 2, and salmon swim bladder sarcoma virus (Quackenbush et.al., 2001).

Before evaluating a lesion, any case of a fish tumor must be considered in light of the fish as an ectotherm. Much of the biology of fish is affected by water temperature and seasonality of various physiological processes. It is well known that the immune response in fish is modified by changes in water temperature and other physiological stressors, such as spawning activity (Magnadottir B., 2006). A review of the case records of most fish disease diagnostic laboratories will show the largest number of neoplastic cases to occur in the spring, a time of changing water. Studies of tumor induction by retroviruses and DNA viruses have led to key advances in understanding cell proliferation and oncogenesis, and form the foundation for modern cancer studies. The discovery that retroviral oncogenes are derived from cellular proto-oncogenes provided important clues about the roles of proto-oncogenes in normal cell proliferation and in tumor induction (Markussen et al., 2008; Rovnak et.al., 2010; Poulet et.al., 1993).

The formation of tumors involving the peripheral nervous system and pigment cells is a function of effects of the virus infection on specific cell types rather than simply a limitation on the range of cell types susceptible to infection by the virus. This might be homologous to the life cycle of infection of many of the small DNA tumor viruses that produce tumors in cells which are non-permissive for complete viral replication (Schmale et.al., 2002). In these cases, Isshiki 2004 described that an aborted cycle of replication in non-permissive cell types results in the survival of the cell containing the viral genome. This state of continued, suspended infection then predisposes the cell to neoplastic transformation by a continued expression of a combination of viral genes that stimulate cell replication.

Another factor relevant to understanding the relationship between virus and non-tumorous but apparently infected tissues in fish with spontaneous or induced tumors is the type and level of viral RNA transcripts present which was described by Poulet et.al., 1995. Conversely, no data are yet available on the levels of RNA expression in tumors relative to grossly normal infected tissues. Although transcriptional silencing has been proposed to explain lack of tumor development in healthy fish, unaffected tissue types in diseased fish did exhibit normal transcription levels, suggesting a different mechanism must avert tumorigenesis in these cells (Schmale et.al., 1996).

Diseases associated with deficiency in Nutrition

Generally, the optimal dietary protein level for the growth is also the optimal level for the reproduction. This has been demonstrated in *oreonchromisniloticus* (DeSilva & Radampola, 1990). Nutrition requirements of the brood stock fish are also generally similar to that for optimal growth. Since dietary protein quality has a significant influence on the success of reproduction and also the health requirements of the broodstock, which preferable gives the good quality of eggs and better young ones.

Vitamin E deficiency

The requirement for vitamin E in the diet of terrestrial animals is well documented, although a demand for this nutrient in fish has only been demonstrated in a few cultured species (Huerkamp et.al., 1988 and Blazer, 1992). The accidental feeding of a vitamin E deficient diet to a group of ornamental fish resulted in progressive fraying and declension of the tail and then the fins. At the terminal stages of the disease, an external fungal infection will be developed and which can lead the high mortality in the tank. The clinical itinerary of onset to death will be around 6 – 7 days. And the effected fish also shows the signs of the epidermal necrosis and bacterial infections. Enrichment of vitamin E diet which can results in immediate and permanent improvement of the fish and also reduction in mortality.

Vitamin C deficiency

Vitamin C in the diet for the vertebrates and invertebrates is predictable for the better management. And a stipulate for this nutrient in fish has only been explained in few ornamental cultured fishes (Bowser et.al., 1991 and Noga, 1993). The deficiency of this vitamin in the diet of the fish results in the various allergic conditions of the fish which shows scrimmaging and deterioration of the fins and loss of scales on the body. At the end stages of the disease, bacterial infection will be developed and results high mortality. Enrichment of vitamin C in diet is essential for the enhancement of the fish and reduction.

***Head and lateral line erosion syndrome* (HLLE)**

It is a common syndrome of marine species that are reared in captivity (Varner et.al., 1991). The symptoms which show on the fish include superficial erosions of the head and face which progress down the lateral line. It is nonfatal but can result in permanent scarring of the skin surface (Varner et.al., 1991and Stoskopf, 1991).

Deterrence and control of diseases

Defensive medicine is always the best medicine. This is especially true when dealing with the aquarium fishes. Treating captive fish is often difficult and may be costly in term of the value of the fish, necessary requirements and time. The same accepted principles for disease prevention and control can be applied to the aquarium fish which are raised in the captive condition. Most of these management practices become more critical in captive fish rearing because the fish are held at much higher densities, the system has added components, such as biofilter which may harbor disease organisms and carrier fish can reside in the system even after its recovery from the disease. The authors would recommend that any clinicians involved in treating aquarium fish which consult references on species compatibility (Stoskopf, 1991, Lewbart 1991 and Lewbart et.al., 1993), lighting (Lewbart et.al., 1993), biological filters (Scholtfeldt et.al., 1991), treatment tanks, disinfection and sterilization (Lewbart 1991), water quality (Newman, 1993) and environmental control (Noga, 1993; Huerkamp et.al., 1988).

The main preventive measure is to keep known pathogens from inward bound the system by avoiding the introduction of infected fish. If a disease enters in a system and a outbreak occurs, the organism can spread rapidly throughout the population due to the high loading density which were explained by Scholtfeldt et.al., 1991.

Insulation

The quarantine aquarium temperature should be actually maintained at the upper end of the species optimum range to speed parasite life cycles.

Acclimatization involves floating the transport bag in the quarantine water system and slowly siphoning the system water into the bag to effect a complete transition to the new water conditions in 1 – 2 hours (Lewbart et.al., 1993).

Vaccination

This is an outward appearance of preventive medicine has little application as yet in the ornamental fish system. Only few commercially available vaccines for fish which are used exclusively in the food fish industry. Vibriosis, furunculosis and enteric red mouth disease are the diseases for which fish may be vaccinated (Lewbart et.al., 1993; Ingebrigtsen, 1991). Several vaccines against bacterial and viral pathogens are under development and should be available in the forthcoming future and should not be used in the home aquarium (Newman, 1993; Leong et.al., 1993).

Concern on research

With the increasing use of risk analysis for disease prevention and the development of precautionary management measures, generating information to support biosecurity assessments should be given high priority. Research to support aquaculture biosecurity should focus, for example, on the pathways of pathogen spread, methods for inactivation of infectivity, and ‘‘barrier’’ vaccination strategies. Epidemiological research should include investigation of biological factors which includes identification of risk populations, hazards, pathways, and pattern of spread, incubation period, and nature of the pathogen, risk factors, interventions, and methodologies. Risk analysis information or knowledge requirements should be given high priority. Essential research areas, for example, include pathogen studies, information on trade and most importantly, biological pathways for the introduction, establishment and spread of a pathogen. Other important areas of research include studies on host susceptibility; modes of transmission; infectivity, virulence and stability; intermediate hosts and vectors; effects of processing, storage and transport. For newly emerging diseases as well as some diseases in poorly studied aquatic animal species, basic studies on their pathology and methods for rapid and accurate diagnosis are essential to facilitate accurate risk assessment and biosecurity management. Increased surveillance of wild fish to detect significant disease problems at an early stage will also be required (Arthur et al., 2002).

Institutional strengthening and manpower development

Subasinghe et al. (2001)indicated that although there has been an increase in the number of diagnostic laboratories, universities and other institutions offering short and long-term training courses in fish and shellfish health, the increase in number has not matched the needs of the rapidly developing aquaculture sector, especially in the developing regions of the world, where most aquaculture activities take place. Because of the wide range of resource expertise and infrastructure required for disease diagnostics, FAO (2000)recommends the promotion of three levels of diagnostics (Levels I, II and III) according to existing resources. Reference laboratories and collaborating centers of expertise are essential to the successful implementation of any aquatic animal health programme because they:

- Provide a range of services and assistance such as generalized support services and confirmatory diagnosis of both current and newly emerging diseases;

- Facilitate research and act as contact centers for advice and training;
- Crucial partners in standardizing, validating and assisting in the quality control of development and research programmes.

Opportunities for fisheries biologists and veterinarians

Aquatic animal health management has only recently assumed high priority in many aquaculture producing regions of the world. This was stimulated by the serious socio-economic losses, environmental impacts and investment costs involved, as previously discussed in this paper. Many countries have improved their laboratory facilities, diagnostic expertise, and control and therapeutic strategies in order to handle disease outbreaks more effectively. There has also been some progress in dealing with aquatic animal disease problems in terms of increasing awareness, creating effective policy and legislation, and enhanced research and manpower development.

However, this progress has not matched that of the rapidly developing aquaculture sector. There is more room for inter-disciplinary studies to expand this window of opportunity for fisheries biologists and veterinarians to work together in research, diagnostics, extension and training. Taxonomy, although a significant branch of science is currently less well funded by various research agencies worldwide. However, it remains of critical importance for the first and all important accurate identification of pathogens in aquatic animal health, and will continue to be an important field and its value will be highlighted in risk analysis studies. Epidemiology will continue to be sought after as one effective approach to disease investigation and control. In the foreseeable future, we can expect to see more involvement of veterinarians in dealing with diseases affecting aquatic animals.

Conclusion

The culture of ornamental fish and the aquarium system is governed by many factors, including the availability of water, water temperature, the energy required to utilize the water and the product price that can be obtained. Recent regulations on disease and quarantine, use of drugs and effluent discharge have made it clear that the economics of traditional ornamental fish will change. The key to success once an outbreak occurs is prompt diagnosis and treatment. Routine observation of mortalities and abnormal swimming or feeding behavior is useful in early detection of a disease problem. Tackling health questions with both pro-active and reactive programmes has become a primary requirement for sustaining aquaculture production and product trade. The current strategy in the ornamental fish system emphasizes responsible health management to minimize the risks of disease incursions. The ornamental fish sector will continue to intensify; trade in live organisms will also persist because it is a necessity for ornamental fish development at both the subsistence and commercial levels. The risk of major disease incursions and newly emerging diseases will keep on threatening the sector, and unless appropriate health management measures are maintained and effectively implemented, the government and private sectors will be faced with more costs in terms of production losses and the efforts needed to contain and eradicate diseases, funds that would have been better spent in preventing their entry into the system. Focusing efforts on prevention, on better management practices and on maintaining healthy fish maybe more important than focusing on why fish get sick. Health management is a shared responsibility, and each stakeholder's contribution is essential to the health management process. An important component of the future success of the ornamental culture and aquarium systems will be the implementation of fish health management programs that aim at preventing diseases from being introduced. The availability of better disease prevention and control methods, such as vaccines and a wider variety of approved drugs, will contribute to successful fish culture in commercial aquarium systems.

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Table. 1. Different types of diseases and medication of aquarium and finfish culture

Symptom	***Possible Cause***	***Medication***
Small white spots on fins / skin, clamped fins	Ich	For fresh water species (Sea water Bath) and for Sea water species (Fresh water Bath), Formalin and Malachite green is preferably used for this type of cause.
Peppery coating, yellowish, clamped fins	Velvet	Copper sulphate bath for 1-2 minutes
Gray or white fluffy patches	Fungus	Methyl Blue, Antibiotics for secondary infections.
Gray or white fluffy patches around mouth	Mouth Fungus	Erythromycin, Kanacyn, Fish Pen (penicillin), Maracyn Antibiotics for secondary infections. (Use Maracyn simultaneously with Maracyn II)
Pale appearance	Neon Tetra disease	No Known Cure
Unusual racing around tank. Black to red nodules beneath skin.	Flukes	Paragon, Clout, Proxipro, Fluke-Tabs
Milky cloudiness on skin	Costia, Chilodone lla	Copper sulphate, Acriflavine
Destruction of fins or tail	Tail or fin rot	Maracyn, Methylblue, Antibiotics, Tetracycline, Chloromycetin
Red streaks on body	Red pest, Fin rot	Tetracycline, Penicillin. Acriflavine, Chloromycetin, Fish Pen (penicillin)
Yellow to black nodules on skin	Ichthyosporidium	
Ulcerated patches on skin	Red pest,Ichthyospori dium	

Emaciation, hollow belly, possibly sores	Tuberculosis	No Known Cure
Protrusion of scales with bloated body	Dropsy	Feed Anti-Bacteria medicated food
Protrusion of scales, body normal	Scale protrusion	
Eyes protrude	Pop eye	Penicillin or amoxicillin
Cloudiness of eyes	Eye problems, Ich, velvet	Maracyn, Maracyn Plus, Antibiotics for bacterial infection, Increase vitamin A.
Hole in head, ulceration of lateral line, loss of appetite	Head and Lateral Line Disease (Hole-in-the-Head)	Copper sulphate
White slimy feces, loss of appetite, swim backwards	Hexamita	Metronidazole
Crustaceans on skin	Argulus, Ergasilus	Trifon, Anti-Fluke treatment
Flukes on skin or gills	Flukes	
Worms hanging from anus	Nematoda	Trifon, Worm Parasitic treatment
Heart shaped worms	Leeches	
Nodular white swellings on fins or body	Lymphocystis,Glugea, Henneguya	Since lymphocystis is not harmful and will drop off after some time, no cure is necessary.
Glancing off rocks or plants	Velvet, Ich, flukes,anchorworm,Chilodonella, Costia	Ich Medication (Ich) fresh water bath
Severe loss of balance	Swim bladder disease	Check aquarium parameters; look for signs of other disease.
Gasping at surface	Oxygen/ O_2deficiency, CO_2excess, tank too hot, toxins, shock	Oxygenex, Oxygen stones - (short-term). Provide better water circulation, lower temperature
Jumping out of water	pH wrong, toxins	Check for phextremes, do water changes with dechlorinated water.
Appetite dwindles,	Constipation or Internal Parasites	Medicinal parrafin oil, change in diet, Anti-Parasitic Medicated Food

belly swells, feces trails		
Fins frayed or split, scales missing	Injuries	Wound Treat, Bio Bandage, Stress relievers. Look for and remove bully fish.

Table. 2 The Socio economic and other impacts of diseases in finfish and ornamental fish aquaculture in selected Asian countries (Source updated from BondadReantaso, 2004)

Country	Disease/Pathogen	Its Impacts due to diseases	Reference	Year
Indonesia	White spot disease (*Ichthyophthirius*)	10,000 Dutch guilders, an amount that exceeded losses of salmonids in European countries caused by similar outbreaks between 1919–1928	Buschkiel (1935), Sachlan (1952)	1932
Indonesia	*Lernaeacyprinacea*	30% Of hatchery production in main hatchery centers of Java, northern Sumatra and northern Sulawesi affected. In Java, an estimated 1.48 billion fry were lost, worth some 7.4 billion rupiahs (approximately US$ 11.4 M)	Djajadiredja et al. (1983)	1983
Malaysia	Diseases of cage-cultured grouper, snapper and seabass	US$ 1.3 M in potential income—combined loss estimates of private sector and government farms	Wong and Leong (1987)	(1989 - 1993)
Thailand	Seabass diseases	US$ 0.8 M in 1989	ADB/NACA (1991)	1990
Thailand	Grouper diseases	US$ 1.07 M in 1989	ADB/NACA (1991)	1990
China	Bacterial diseases of fish (*Aeromonashydrophila*, *Yersinia ruckeri* and *Vibrio fluvialis*)	>US$ 120 M annual losses	Wei (2002)	1990 – 1992

Thailand	Jaundice disease	US$ 4.3–21.3 M	Chinabut (2002a)	1992
Malaysia	Vibriosis	US$ 7.4 M—outbreak	Shariff (1995)	1990
Singapore	Grouper diseases	$360,500	Chua et al. (1993)	1993
Japan	Marine fish disease	US$ 114.4 M	Arthur and Ogawa (1996)	1994 – 1998
Thailand	*Alitropustypus*	US$ 234–468/cage culture of tilapia	Chinabut (2002b)	1998 – 1999
Philippines	Grouper diseases	75% Reduction in household income; 19.4% increased debt	Somga et al. (2002)	2001
Singapore	Grouper iridovirus	>50% Mortality among Malabar grouper	Chang (2001)	2000
China	Viral nervous necrosis (VNN)	100% Mortality among 3 species of grouper	Zhang (2001)	2000
Singapore	Viral nervous necrosis (VNN)	80–100% Mortality among fry and fingerlings	Chang (2001)	2000
Indonesia	Viral nervous necrosis (VNN)	100% Mortality of larvae in national hatcheries	Yuasa and Koersharyani (2001)	1999 – 2000
Indonesia	Suspected Koi herpes virus (KHV)	50 Billion Rs. in one area alone during first 3 months of outbreak	NACA (2002), Bondad-Reantaso (2001)	2001
Japan	Suspected Koi herpes virus (KHV)	US$ 15 M	Sunarto et al. (2004)	2003