1.0. INTRODUCTION

1.1. Ornamental fish sector - An overview

The ornamental fish sector is a widespread and global component of international fisheries trade and development. However, the scope of this sector and its impact on human and aquatic communities is often inaccurately recorded and unappreciated. Statistics reported to FAO from member countries indicate that, the world export of ornamental fish in 1998 was US$ 174 million with imports valued at US$ 257 million. Since 1985, the value of international trade in exports of ornamentals has increased at an average growth rate of approximately 14% per year. Developing countries account for about two third of the total export value. The entire industry has been estimated to be worth around US$ 15 billion. Such a vast and important industry has a potential to contribute to the economic growth of countries concerned and the sustainable development of aquatic resources, but faces future challenges regarding environmental and social issues.
During the last five decades, there has been considerable growth and diversification in the international trade on ornamental fishes. Globally, the aquarium industry is valued at $4 to $15 billion, and in USA 89 million freshwater fishes are maintained in 12.1 million tanks, while 5.6 million marine tropical fishes in 1.1 million tanks (Hoff, 1996). Schiotz (1989) reported that, the ornamental fish trade is insignificant in comparison to the productivity of the habitats and the amount of fish removed for table consumption.

Currently 80% of fresh water fishes in the ornamental trade are captive bred, whereas virtually 100% of the marine fishes, invertebrates and algae are collected from the wild. About 800 species of ornamental fishes are actively marketed (Chapman et al., 1997) of which, only 30 species (less than 5%) are bred in captivity (Tellock, 1996). Marine aquarium keeping is almost exclusively tropical in nature and is broadly divided into a fish sector and invertebrate sector (Lolita Ty, 1987). The supply of fishes for this trade comes from the wild catch which rates to about 90% of the total demand. The rest of the 10% comes from captive breeding. Presently about 100 species of marine
fishes are bred under captivity, which includes certain species of clown fishes and sea horses. Certain species of tropical marine fishes are being over-exploited for this trade in some areas and there is a need to develop long-term management strategies for sustainable utilization.

1.2. International status

Aquarium fish keeping in China is an old hobby which dates back to 2,000 AD. Conservative estimates suggest that, at least 150 million ornamental fish are now sold on a worldwide basis each year (Andrews, 1990).

In Taiwan, there were 205 ornamental fish farms, 69% of them were in Southern Taiwan (Yeh, 1999), with a total area of 69.39 ha (Anon, 1999), which could artificially produce more than 120 species of fresh water ornamentals (Yeh, 1999). There were 1,299 aquariums around the island, 47.4% of them were in Northern Taiwan. The total value of ornamental and its related industries were estimated at 4.5 billion. Their major importing and exporting species are cichlids, live bearers, koi, goldfish etc.
Lolita Ty (1987) has listed out 25 groups of fish comprising 243 species that are available for aquarium trade in Philippines. The group and their corresponding number of species are : Angle fish (28), Butterfly fish (35), Cardinal fish (4), Clown fish (6), Goat fish (3), Goby (20), Grouper (16), Grunt fish (6), Hawk fish (4), Lion fish (7), Parrot fish (5), Pseudochromis (3), Puffer fish (7), Shark (4), Snapper (5), Tang fish (9), Trigger fish (10), Wrasse (19). These groups of fishes were also recorded and upgrade the farming and breeding of a few high-value species such as the varieties of Discuss and Dragon fish.

The ornamental fish and marine food fish sectors make up the aquaculture industry in Singapore. Together, they produce over US$30 million worth of farmed fish a year. The production from the ornamental fish sector accounts for about 75% of this total value. Freshwater food fish production is insignificant. It was also estimated that, a total of US$ 57 million worth of ornamental fish was exported in 1994. By market demand, a diversity of species is cultured. More than 300 varieties, comprising of livebearers (viz., guppy, platys, mollies, sword tail) and egg layers (angel fish, tetras etc.).
Malaysia is now one of the leading producers of ornamental fish in the world, producing more than 500 varieties, comprising over 250 species. In 2002, Malaysia produced 407.80 million ornamental fishes of which 95% were exported, with the European Union being one of the main markets (Bernama, 2005).

The ornamental fish trade in Sri Lanka consists of fresh water as well as marine and brackish water species. While the marine and brackish water aquarium fish are generally caught from the wild (Indian Ocean), the fresh water fish are either caught from rivers and streams of Sri Lanka are bred and reared in captivity, through the export or local trade. A considerable quantity is imported from the Maldives and India for re export purposes. Sri Lanka’s share in world market is 1%.

Ornamental fish production for aquarium industry is a multimillion dollar industry in the United States. Annual sales from Florida alone are estimated at over 175 million dollars in retail value. Because, the vast majority of fish varieties sold, originate from tropical
regions of the world, in the United States, the majority of production is limited to South Florida. Farms in Florida now produce over 700 varieties of ornamental fish and ship them to wholesalers and retail pet shops around the world. Besides the production of Florida farms, there are minor operations in warm water spring in the Western US and numerous 'backyard' operations throughout the country (Waston and Shireman, 2002).

Aquarium as a hobby is extremely popular in North America, with over 10% of households possessing ornamental fishes (Ramsey, 1985; Chapman et al., 1997). Freshwater species constitute 96% of the volume of fish imported (Chapman et al., 1997), thus lakes and rivers appear particularly vulnerable to invasion from this vector. Approximately, 100 species of ornamental fish have been recorded as introduced into North American natural waters via the aquarium trade, of which 40 have established populations (Courtenay and Stauffer, 1990; Fuller et al., 1999 and Crossman and Cudmore, 1999a).
The capture of ornamental fishes provides the principle economic activity in South America. The trade contributes at least 60% of the income. At least 300 families are reported to be involved in the trade (Anon, 1994), and many others, possible 80% (Eisenstadt, 1992), have some economic relation to the trade.

In Australia, aquaculture production of aquarium species occurs mainly in New South Wales, Victoria, Queensland and Western Australia. The Victorian ornamental sector involves a high level of exposure and produces more than 100 temperate and tropical species for the aquarium trade. The majority of temperate fish produced are varieties of gold fishes (NRE, 2002).

Aquarium fish in Queensland produced both in recirculating systems and ponds. In 2001 - 2002, 1.7 million exotics, valued at $7,41,000 and 3,42,000 natives valued at $1,21,000 were produced along with 1500 Saratoga valued at $43,000. New South Wales produced 5,44,000 aquarium and ornamental fishes valued at $3,38,000 in 2001 - 2002. Western Australia produced 2,88,000 aquarium fish in
2000-2001 (Department of Fisheries, 2002). Only a small percentage of ornamental fish produced in Australia is exported. The majority of exports in ornamental fish are Australian native species. Although most of Australian production is sold domestically, it is believed that this market is close to being saturated (AAQ, 1999).

1.3. National status

Despite being a gold mine of ornamental fish resources with more than 125 indigenous varieties and an equal number of exotic species, India's share in ornamental fish trade is negligible. Most of these resources are expected to have high demand in national and international markets, if properly marketed. Inspite of the fact that, the aquatic habitat in India is blessed with a variety of untapped resources suitable for marketing, and no concerted effort has so far been taken in this regard. There are 150 full time and 1500 part time ornamental fish breeders in our country. There is a wide gap between demand and supply of ornamental fishes in India. More than 200 species of fresh water ornamental fishes are bred in India for the domestic market. Most of them are exotic, with high demand. Rivers of North-Eastern
States have an abundant number of fresh-water ornamental fishes. Recent studies in the state of Kerala also show great potential for exploring the possibilities of marketing indigenous species to overseas markets. There are only 10 active exporters of ornamental fishes from India. During 1999 - 2000 India’s share in international trade was only 0.06% of the world ornamental fish trade of US$ 650 million.

The tropical climate of India is ideal for culture and breeding of ornamental fishes found in fresh, brackish and seawater. Calcutta, Bombay and Chennai have already emerged as major centers for breeding fresh water ornamental fishes. These accounts for all the exports of ornamental fishes from India. The large-scale commercial farms, which are also limited in number are confined to the metropolitan cities and certain sub-urban regions. More farms must be established throughout the country and also there must be expansion and intensification of several of the medium and small size farms in the resourceful areas so that the production of fresh water ornamental fishes in the country can be considerably increased. Instead a few, many more species of attraction should be tried and mass-produced
for sustainable improvement in export. Since rearing, breeding and mass production of freshwater fishes are easier, these areas must be strengthened more.

So far, India has not made the presence felt in the international markets as far as the ornamental fish trade is concerned. Compared to other sectors in fisheries, the ornamental fish industry does not pick up in India and due to various reasons. The main reasons are lack of breeding and rearing technologies for the native species, inadequate live transportation facilities, both on land and by air, poor market information system, and primitive catching and handling methods and improper quality assurance (Ramachandran, 2001). India currently exports only around 30 million (US$650 million) of ornamental fish. However, the North East of India has many species of fish that have great potential in the ornamental fish trade and many of which are attractive to foreign markets. There is a great potential to expand the local industry (Das and Kalita, 2003).
1.4. Need of the study

Disease outbreaks in aquaculture facilities are recognized as an important limiting factor to production and trade. Fish mortalities represent a direct loss of investment in feed, labour, juveniles and other components of the overall production cost. Disease, particularly chronic infections also have an even larger, though often unnoticed, effect on production through reduced growth and feed efficiency. In the United States, some of the tools available to the aquaculture industry for dealing with disease include quarantine, disease prevention through good husbandry, biosecurity and vaccination and depending on the fish species. Vaccines and other preventive medicine practices are considered as the preferred method of health management. However, even an effective vaccine cannot protect every fish in a population. Additionally, very few commercially available vaccines are available for diseases of aquatic organisms and the ones which are manufactured target economically important species. Also in many situations, no vaccines exist for less traditional commercial fish. In the event of a vaccine failure or a disease outbreak, when a vaccine was not used, antibiotics are frequently the next alternative. Although
the treatments available are effective against a wide spectrum of bacteria, the approved antibiotics are not always effective against all bacterial diseases of farmed fish.

Koi carp (Cyprinus carpio) and fancy goldfish (Carassius auratus) have been symbolic figures in the paintings, pottery and oral history of Asian and far Eastern countries for centuries. They also are popular and intensively reared ornamental fishes for pets, display and show. Intensive rearing of these fishes usually results in high population densities, which subsequently may result in a high incidence of disease.

Ulcerative skin disease of koi and gold fish is of special concern because such disease may result in death or permanent disfigurement. Loss of market value of diseased fish is obvious and may be a cause for considerable economic concern. The cause of skin disease in fish are diverse and include trauma (including netting injuries), poor water quality, stress, parasitism, and viral, fungal and bacterial infections (Siegal et al., 1999).
Ultraviolet and ozone sterilizing units can help to reduce overall pathogen numbers in a system, but they will not prevent spread of pathogens within a system unit (e.g. tank or vat). Sterilizing units must be sized properly, according to manufacturers recommendations and they also must be strictly maintained. Only the water that contacts the sterilizers will be affected. Poor husbandry (for example, not dipping nets when using them between tanks) will negate the benefits of these sterilizing systems, also ozone can be dangerous to fish and humans (Yanong, 2003).

Chemicals used in a system may have undesirable effects on the water, biological filter, the fish or employees. Therefore the pros and cons of each chemical used in the system must be understood. All chemical should only be used in an appropriate manner (Yanong, 2003). Research has shown that there are some differences in the inhibitory effects of formalin, malachite green (illegal for use in food fish), methyl blue (methylene blue is not recommended by fish health specialists and is illegal for use with food fish), copper sulphate and
potassium permanganate on the biofilter bacteria (Collins et al., 1975; Levine and Meade, 1976).

Different studies show different effects. Formalin used in one study at 25 mg.l⁻¹ had no effect, whereas another study showed reduction of biofilter bacterial activity by 27% when used at 15 mg.l⁻¹. As a rule of thumb, most aquaculturists do not consider use of formalin at 15 – 25 mg.l⁻¹ to have a major impact on the biofilter. However, when testing for ammonia levels, formalin will react with Nessler’s reagent (a component of most ammonia test kits) and can give a falsely elevated ammonia reading. In systems treated with formalin, the salicylate reagent test for ammonia is recommended (Hach Company, 2002) because it does not react with aldehydes (E.g. formaldehyde found in formalin). It is important to reiterate that antibiotics are never recommended for use in system-wide bath treatment because of the potential for development of antibiotic resistant strains of pathogens and serve detrimental effects on the bacterial within the biofilter (Yanong, 2003).
The prevalence of antimicrobial resistance is increasing worldwide and this growing problem is often attributed to the widespread use of antibiotics for clinical purposes in human medicine and by the agriculture industry. The development of resistant bacteria is not only an important concern from a public health perspective as it can reduce treatment alternatives, but it can also decrease the treatment efficacy on fish farms. Bacteria have the ability to produce mutants that are resistant to many drugs.

Use of indigenous drugs from plant origin forms a major part of complementary and alternative medicine / traditional medicine (CAM/TM). Herbal drug technology includes all the steps that are involved in converting botanical materials into medicines, where standardization and quality control with proper integration of modern scientific techniques and traditional knowledge will remain important. Herbal medicinal products may vary in composition and properties, unlike conventional pharmaceutical products, which are usually prepared from synthetic chemically pure materials by means of reproducible manufacturing techniques and procedures. Correct identification and quality assurance of the starting material is
therefore, an essential prerequisite to ensure reproducible quality of herbal medicine which contributes to its safety and efficacy (Straus, 2002; De Smet PAGM, 2002).

1.5. Aim and Objectives

The present investigation has been undertaken to study the disease causing pathogens in ornamental fishes and further attempts on the possible herbal therapy for ornamental fish disease management through the following aspects:

- Isolation and identification of bacterial pathogens from chosen ornamental fishes.
- Isolation and identification of fungal pathogens from chosen ornamental fishes.
- Antibacterial sensitivity of coastal medicinal plants against isolated bacterial pathogens.
- Antifungal sensitivity of coastal medicinal plants against isolated fungal pathogens.
- Effect of *Cinnamomum verum* extract on the percentage survival of chosen ornamental fishes.