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ON ORNAMENTAL FISHES ENTREPRENEURSHIP IN MYSORE, KARNATAKA, INDIA

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Abstract: Systematic investigation was conducted to record the ornamental fish's entrepreneurship and its status in Mysore during May, 2023 to August, 2023 using pre-tested questionnaire by following standard methods. Total 50 aquarium shops were selected randomly at 31 different places in Mysore. Around, 26 different parameters pertaining to the ornamental fishery were considered during the study and the data revealed quite interesting results. Altogether, 115 ornamental fish species which belong to 14 orders and 26 families were used in aquariums. The Cyprinidae and Cichlidae family members were predominantly used by entrepreneurs and which represented respectively 26.9 and 20.8%. Surprisingly, 107 exotic fish species and eight indigenous fish species were used by entrepreneurs who represented 96.4 and 6.6% respectively. In Mysore, Udayagiri area has more number of aquarium shops, accounted 22% and it was followed by Vijayanagara (10%) and Kuvempunagara (8%). Ornamental fish's entrepreneurs were using both Cauvery river water and bore well water respectively 60 and 20% and remaining 20% entrepreneurs didn't reveal clearly the source of water for ornamental fish culture.

The entrepreneurs are graduates (30%) and under-graduates (28%) who are doing ornamental fish trading business on medium scale level (58%). Moreover, 78% men and 22% women folk were involved in this activity. Nearly, 82% ornamental fish's entrepreneurs preferred integrated type of business. Only, 10% entrepreneurs were doing ornamental fishes business exclusively for commercial purpose. Majority of the entrepreneur's preferred artificial pellet feeds to feed ornamental fishes that account 56%. Around 40% of the entrepreneurs prefer to feed both natural and artificial feeds. The most preferred artificial feed was Optimum and Taiyo. The maintenance of aquariums, materials used, waste (both solid and liquid) management, water recycling, plants and decorative items marketing and economics of ornamental fishery are followed as per the standard methods. Further, commonly occurring fish diseases such as white spot, fin rot, tail rot; bacterial, fungal and viral diseases were managed using standard methods. Among the diseases, white spot disease prevalence was 21.3% and it was followed by fungal infection (14.9%) and fin rot and tail rot diseases (12.6% each) and controlled by using Bactonil, Paracidol and Anti-itch medicines. Overall, ornamental fish keeping activity is considered as one of the profitable businesses by many people in Mysore. Mysore is one of the tourist's hubs; ornamental fishery is getting good startup and hence more scope is prevailed in this activity. To get more employment opportunities and good returns, ornamental fishery activities requires encouragement from the government and from the consumers, hobbyists and others who are keeping ornamental fishes in their aquariums for display.

Key words: Ornamental fishes, entrepreneurship, status, Mysore.

I. INTRODUCTION

Aquaculture is one of the remunerative and lucrative activities, being practiced by many people at urban centers across the world. After the invention of glass in 300 B.C., the aquariums were used in Ming dynasty (1368-1643) in China to keep goldfish in earthen and glass vessel for entertainment purposes. In 1805, Robert Warrington insisted the concept of water change to keep the fish healthy for a long time (Pokharkar, 2015). The ancient Romans had fish keeping activities for food and entertainment. However, it wasn't until 1833, when the British Association for the Advancement of Science demonstrated the beneficial relationship between the aquatic plants and fish, then modern style aquaria started to develop. Later, the discovery of aquatic plants absorbs carbon dioxide and release oxygen was a significant breakthrough in understanding the dynamics of healthy aquarium. This knowledge led to the development of modern aquarium.

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Aquariums are designed with various elements to create a favorable environment for fish and aquatic plants (Ramu and Banarjee, 2010). Aquatic plants such as *Vallisneria, Sagittaria,* Fanwort, *Hygrophilia, Limnophila, Lemna, Riccia and Salvinia* are used in aquariums which help in reducing the carbon dioxide (CO_2) content and provide oxygen (O_2) for ornamental fishes (Gupta, 2006; Pandey *et al*., 2013). Ornamental fishes are often referred as 'living jewels' due to their vibrant colors with unique characteristics. They are highly valued for their peaceful nature, which makes them popular choices for fun and fancy and kept as pets in confined spaces such as aquariums or garden pools. In recent years, it has become one of the major sources of income for small scale farmers and unemployed people of the world (Bhatkar *et al*., 2017; Acharya *et al*., 2019; Rahman, 2021). The ornamental fish sector is small but unique and vital part of an international fish trade and become the second most popular hobby next to photography worldwide and indicating a significant demand for ornamental fishes. Around the world, more than 100 million hobbyists involved in aquarium fish keeping activities and it is important economic activities in more than 125 countries with a annual growth rate 14% (Pandey *et al*., 2013). Singapore is the top most exporting country in the world, European Union is the largest market for ornamental fish and United States of America is the largest importing country. It is due to the growing desire for colorful aquarium ornamental fishes among people and considered to be a major drive of industrial development.

In India, ornamental fishes have great demand in international market. India ranks 31st in the ornamental fishes export in the world contribute 0.4% in global ornamental fish trading and earn good foreign exchange with annual growth rate 9%. Hence, there is more scope for aquariculture in India. India has rich water resources like rivers, streams, lagoons and coral reefs which consist of high varieties of attractive fishes (Pandey *et al.,* 2013). The commercially important indigenous fishes such as reticulated loach, zebra fish, glass fish, honey gourami, pencil gold labeo, all black shark, black knife fish, hi fin barb, rosy barb, deninson barb, dwarf gourami are very popular in India. Published reports on aquariculture practices and its entrepreneurship at different parts of the world including India are depicted in Table 1. Several authors (Alan, 1994; Mostafizur *et al.,* 2009; Muhammad *et al*., 2013; Andre *et al.,* 2013; Alam *et al*., 2016; Jharna *et al*., 2019; Frederick *et al*., 2019 Pinnegar *et al*., 2019; Md. Akbal Husan, 2019; Noor *et al.,* 2022) have reported in Brazil, Philippines, Eastern England and Nepal (Table 1). Similarly, in India, Mahapatra *et al*. (2003), Dutta *et al.* (2013), Sajeevan *et al*. (2013), Manab *et al*. (2013), Paul *et al*. (2014), Khomdram *et al*. (2014), Rama Rao (2014), Mahapatra *et al*. (2014) Mohammad *et al*. (2015) Premdass *et al.* (2016) Laksar *et al*. (2016) Gourishankar *et al*. (2016) Bhatkar *et al.* (2017) Kaushik *et al*. (2017), Arif *et al*. (2019) Rupesh *et al.* (2020) Rahman (2021) Shinoj *et al*. (2021), Sonvanee *et al*. (2022) have researched on ornamental fish culture, species employed, ornamental fish's entrepreneurship, status and economics return and other aspects pertaining to aquariculture from different parts of India such as Meghalaya, coastal region of West Bengal, south-west coast of India, West Bengal, a freshwater wetland Kolleru Lake in Andhra Pradesh, Paschim-Medinipur in West Bengal, Manipur, lower Manair dam at Karimnagar district of Andhra Pradesh, east Kolkata wetland, West Bengal, Madhya Pradesh, Tamilnadu, Tripura, Raigarh district of Chhattisgarh state, Ratnagiri district of Maharashtra state, Nagaon of Assam state, Jammu region of Jammu and Kashmir State, Kolhapur in Maharashtra state, Assam state, southern India, Mumbai and Raipur city of Chhattisgarh (Table 1). Further, Government of India (GOI) launched various schemes for the overall development of aquaculture. National Fisheries Development Board (NFDB), Fishery Survey of India (FSI), Coastal Aquaculture Authority (CAA), Central Marine Fisheries Research Institute (CMFRI), Marine Products Export Development (MPEDA) and many other fisheries departments have taken more initiatives towards ornamental fisheries in India (Bhatkar *et al*., 2017). In Karnataka there are around 2500 ornamental fish retailers and 1200 outlets sell ornamental fishes with a monthly turnover Rs.1.5 Crore in Bangalore (Raja *et al*., 2014). Mysore city is located 148 kilometers away from Bangalore, it is one of the fast growing cities in Karnataka and considered as tourists hub. Information on ornamental fish selling centers in Mysore is not available. Published reports from Mysore city are diffuse. Hence the present study was undertaken.

II. MATERIALS AND METHODS

Study area: Mysore city is the second largest city in Karnataka state, considered as one of the cleanest cities of India. It is situated at 12°18′26″N latitude and 76°38′59″E longitude with an altitude 770 meters above mean sea level (Kamath, 2001). The city is located in the south Indian plane 'Deccan plateau' at the foot of the Chamundi hills and spread about 155 sq. km. Moreover, Mysore is in the delta region of river Cauvery and possesses various inland water bodies such as Karanji Lake, Kukkarahalli Lake, Bogadi Lake, Hebbal Lake etc. Mysore records the annual mean maximum temperature 30.2°C and the mean minimum temperature 19.1°C. The city receives nearly 800 mm rainfall (India Meteorological Department, 2023) and experiences pleasant optimal climatic conditions (Kamath, 2001). Mysore has grown in the field of business and economy. The city is famous for tourism due to many tourist attractions like the Mysore Palace, Chamundi hills, Mysore Zoo, Underground aquarium, Shuka Vana, Jaganmohan Palace and more than 200 structures in the city are with heritage tag.

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Methodology: The study was conducted systematically during May, 2023 to August, 2023 by visiting the aquarium shops physically and personally at different parts of the Mysore city using pre-tested questionnaire. Total 31 areas were randomly chosen and 50 aquarium shops were considered during the study (Figure 1). Questionnaire was prepared by including 61 questions pertaining to the aquaculture, ornamental fishes rearing and other aspects. Aquarium shops were visited and personally interacted with the ornamental fish shop keeper/owner to collect the scientific data and aquarium shops were photographed with the help of camera. The study was done by following a random sampling method. In the questionnaire, all the primary data was documented along with photographs using the mobile camera when interviewing each aquarium shop owner. The collected data was systematically classified, compiled and statistically analyzed. The data includes gender, qualification of the shop owners and number of laborers used was recorded. Information regarding, expenditures, profit and ornamental fish varieties were also recorded. The common names of all the ornamental fishes along with price per pair were also collected. Reasons for preference of fish, information regarding the proportion of tank, use of chemicals, medicines and accessories were also documented. Some details on breeding of fish, common diseases occur in the ornamental fishes and feed details along with the price of the different stored feeds used for selling were also collected. The collected data was statistically analyzed and compared as per Saha (2009).

III. RESULTS AND DISCUSSION

Distribution of aquarium shops: In Mysore city, majority of the aquarium shops are located in Udayagiri area, which contributed 22%, and it was followed by Vijayanagara with 10% aquarium shops. Further, Kuvempungara area contributes 8% and remaining other areas has very few aquarium shops (Table 1 and Figure 1).

Aquarium tanks: Type of aquarium tanks used by ornamental fish's entrepreneurs in Mysore city is depicted in Table 2. Total 50% of the ornamental fish's entrepreneurs prefer glass tanks and it was followed by acrylic (Polyacrylonitrile) fiber and molded glass tank (48%) preferred by ornamental fish's entrepreneurs (Table 2). However, 2% of the ornamental fish's entrepreneurs have not given any information about the aquarium tanks used for keeping ornamental fishes. Further, ornamental fish's entrepreneurs preferred glass tanks with different thickness (Table 2). Majority (26%) of the glass tanks has six millimeters thickness and it was followed by 5 and 4 millimeters respectively by 14 and 10% of the ornamental fish's entrepreneurs (Table 2). The glass is considered as best material, popular choice for many shop keepers (Tang, 1999). Glass is transparent and easily made by sealing or attaching the rectangular glass pieces with the help of silicone sealant. This ensures a long term water tight seal. Moreover, thick glass is scratch resistance with better clarity and fiber or acrylic molded aquarium tanks are light in weight and available in different shapes. Currently, acrylic fiber aquarium tanks are widely preferred by many ornamental fish's entrepreneurs. The advantages of fiber tanks are stronger than glass and provide certain amount of temperature insulation. Thus, glass or acrylic fiber molded tanks are easy to maintain for ornamental fish species (Ngueka, 2014). But, these fiber tanks discolored over time with exposure to sun light. Hence, UV stabilization is done to fiber tanks during manufacturing. Therefore, fiber or acrylic tanks are more costly than glass tank. Hence, fiber or acrylic tanks are less preferred than glass tanks. Further, various materials such as aquarium top cover, light source, heaters and thermostats, air pumps, filters, feeding ring, siphon tubes aquarium glass cleaner, thermometer, composts and hand nets are used to maintain different sized aquarium tanks. Further, to conduct biological and chemical filtration, various filters such as bio-filter, corner filter, submersible filter, sand filter bed, underground gravel filter, sponge filter, foam filter, canister filter, wet and dry filter, protein skimmer filter are used as per Datta (2012), Ngueka (2014) and Kammara *et al.* (2021).

Ornamental fish's families and orders: Total 115 ornamental fish species/breeds/varieties which belong to 14 orders and 26 families are currently used for sale in Mysore (Table 3). Commonly sold ornamental fishes families and orders are given in Table 3. Ornamental fishes belongs to the family Cyprinidae (27%) and Cichlidae (20.9%) are more commonly used and it was followed by Osteoglossidae (9.6%), Osphronemidae (7%), Characidae and Poecilidae (6.1% each), Pangasiidae (4.3%) members. However other family members were used less than 2% (Table 3). Among the 14 orders ornamental fishes belong to the order Cyprniformes were used maximum (28%) and it is followed by the order Cichliformes (20.9%), Osteoglossiformes (11.3%), Characiformes (7.8%), Siluriformes and Anabantiformes (7% each), Perciformes and Cyprinodontiformes (6.1% each). However, ornamental fishes belong to other orders use was less than 2% (Table 3).

Type of ornamental fishes used: Ornamental fishes used by entrepreneurs based on habitat and feeding habits are given in Table 4. Majority (98 species) are fresh water ornamental fishes which accounts 85.2% are commonly preferred by the aquarium shop keepers for sale. It was followed by 13 species which belong to brackish water ornamental fishes which accounts 11.3% and remaining four species are marine water ornamental fishes preferred by entrepreneurs for sale (Table 4).

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Maintenance of fresh water ornamental fishes is easy compared to brackish and marine water ornamental fish species as the maintenance cost is little higher. Moreover, marine aquariums require more attention to maintain the salinity and total dissolved solids and water parameters have to be maintained carefully otherwise the marine fishes which are sensitive and will die. It costs more to replace the fish than that of fresh water ornamental fishes. Hence, brackish and marine water ornamental fish species maintenance is more expensive (Satam *et al*., 2018). Thus, freshwater ornamental fishes are more used in Mysore.

Socio-economic conditions: Majority of the ornamental fish's entrepreneurs are not well educated, but they are with normal graduation, under graduation and high school level education respectively 30, 28 and 14% (Table 5). Only 12% shops keepers have done post-graduation in Marine Biology (Table 5). The education status of ornamental fish's entrepreneurs is given in Table 5. Majority of the entrepreneurs (84%) were undertaking this ornamental fishes entrepreneurship as the primary business and the remaining 16% are doing it as a part time business. In Mysore, most of the people have undertaken this business activity as hobby and don't have proper information regarding the exotic and indigenous varieties and details of this information will be published elsewhere.

Size of the aquarium shops: In Mysore, ornamental fish business is conducted on various levels. Majority (58%) ornamental fish's entrepreneurs are doing this business on medium scale and it was followed by 38% of the ornamental fish's entrepreneurs do this business on large scale level and have large infrastructure and conduct wholesale business of ornamental fish selling activity. Only, 4% people are doing ornamental fish business on small scale level (Table 5).

Type of business: Highest (82%) entrepreneurs sell ornamental fishes along with other pet animals and aquarium accessories and hence they involved in integrated type of fish selling activity. Remaining 14% of the ornamental fish's entrepreneurs are selling only ornamental fishes along with fish feed and other accessories. However, 4% of the ornamental fish's entrepreneurs are selling only ornamental fish feed and aquarium items. Hence, ornamental fish for aquariums business is not even, but varied considerably among the shops keepers in Mysore (Table 5).

Educational status of employee: Majority of the employees involved with ornamental fishes and aquarium business are below graduation level education. The employees were educated with below high school, high school and pre-university level respectively 12.2, 41.5, 43.9% (Table 6). However, only 2.4% employees have completed graduation (Table 6). Education is one of the important tools, educated or knowledgeable employee would help understand, maintain and handle fishes and aquariums with utmost care safely.

Laborers used: Majority (54%) of the ornamental fish's entrepreneurs are not employing any laborers, but attending the ornamental fishes and aquarium business on their own. However, 46% of the ornamental fish's entrepreneurs are depend on laborers to maintain their shops (Table 6). Further, majority (78%) of the employed laborers was male workers and it was followed by (22%) employees were female workers (Table 6).

Feeding ornamental fishes: Total 42% of the entrepreneurs feed their aquarium fishes twice a day. It was followed by 8% shop keepers feed once/twice per day, 2% shops keepers feed once/thrice per day. Various ornamental fish species/breeds requirement of food is not alike and varies considerably (Table 7). Generally, surface feeders would prefer floating feeds and bottom feeders would prefer sinking feeds. And, different fish species/breeds have specific feeding efficiency. For example, small sized fishes feed less and larger fishes feed more food. Accordingly, number of feeds per day has been given to fishes. Moreover, few fishes are voracious feeders and some are weak feeders. Since, fishes have small stomach and cannot hold lots of food and overfeeding leads to the stress, indigestion which affects the health and leads to infections. Moreover, more feeding would add accumulate at the bottom which leads to the contamination of the aquarium water that becomes cloudy and in turn affects the health of the fish. Therefore, proper feeding of fishes with adequate food is very much essential for maintaining healthy aquarium (Ramu and Benarjee, 2010). Further, improper feeding or overfeeding or inadequate feeding to ornamental fishes would produce more uneaten food in the aquarium tank. It elevates ammonia concentration in water due to decomposition of uneaten fish feed and this stimulate the growth of fungi in the aquarium tank water and also affects the health of fishes in the aquarium.

Commonly used feeds: Table 8 shows the commonly used feeds with their brand names to ornamental fishes. Of all the different fish feeds with different brand names, feed with a brand name 'Optimum' is more preferred (11.4%) and it was followed by 'Taiyo' (10.1%). The 'Humpy head (Taiyo)', Aini (Taiyo)', 'True-colour' and 'Shrimp-E (XING)' were preferred respectively by 6.9, 6.6, 5.9 and 4.5% of ornamental fish's entrepreneurs (Table 8). However, other feeds were preferred less than 3% by ornamental fish's entrepreneurs in Mysore (Table 8).

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Storage of fish feed: Ornamental fish's entrepreneurs generally preferred (68%) normal air tight storage method and it was followed by 16% preferred frozen storage methods and remaining 16% ornamental fish's entrepreneurs preferred both (Table 9). Mainly, the air tight storage method for preserving artificial dry pellet feeds and freeze storage method is used to store natural fish feeds (blood worms, shrimps etc,) (Table 9).

Cleaning of aquarium tanks: Cleaning and recycling of solid and liquid wastes are commonly disposed at all the aquarium shops. It vary considerably among the ornamental fish's entrepreneurs and it is being done on daily, weekly, monthly and yearly basis respectively by 12, 62, 12 and 6% ornamental fish's entrepreneurs (Table 10). However, 8% of the ornamental fish's entrepreneurs didn't inform about cleaning of aquarium tanks (Table 10). Moreover, 20% of the entrepreneurs are completely recycling the inorganic solid waste and only 4% of the entrepreneurs are partially do recycling. However, majority (76%) of the ornamental fish's entrepreneurs didn't do recycling of inorganic solid waste (Table 10). Further, 16% of the entrepreneurs are recycling the waste water and 84% of the shops keepers didn't practice recycling of waste waters from their aquariums. During the ornamental fish keeping and their sale, various inorganic wastes such as broken glass pieces, plastic hood, plastic covers and other wastes are produced. These wastes are properly removed or recycled to maintain the aquarium shops clean, neat and tidy. Ornamental fish's entrepreneurs are recycling the broken glass pieces by sending to glass manufacturing industries for recycling activities. The plastic covers are reused for packing the sold fishes. Further, waste water generated by the release of metabolic waste of fishes. The metabolic waste of fishes occur in two forms namely: dissolved and suspended form. This waste water contains high concentration of ammonia, nitrate, phosphates and other minerals that is recycled properly. The waste water contains many dissolved organic mineral (Phosphorous and Nitrogen) is nutrition for plants it is used to water the plants. And few entrepreneurs use bio-filters to recycle the toxic waste water. Aquarium tank cleaning is mandatory and it avoids pollution (Powell *et al.*, 2021). Most of the ornamental fish's entrepreneurs are doing it by siphoning the substantial volume of tank water, vacuuming out of the substrates in order to remove waste substances and pumping fresh water back in to the tank. Moreover, majority of the entrepreneurs use filters to clean water and remove waste from the water again and again. Further, periodically, water is changed every month after cleaning and sterilization. It is depended on the density of ornamental fishes to avoid the deposition of waste that in turn results the increase of ammonia, nitrate and nitrite, which promote rapid growth of algae. Hence, frequent cleaning is accompanied by changing of water to reduce the algal growth. Furthermore, the physico-chemical parameters such as temperature (17-38°C), pH (7.0-8.5), Carbon dioxide (<5ppm), dissolved oxygen (6.0-8.0ppm), alkalinity (75-120ppm as $CaCO_3$), hardness of water (60-100ppm), free ammonia (<0.05ppm) and ionized ammonia (<0.1-0.4ppm) maintained as per the standard methods as described by Datta (2012).

Disposal of dead fishes: The dead ornamental fishes and their waste are generally organic in nature and it becomes unwanted waste should be disposed in a proper manner. Ornamental fish's entrepreneurs prefer different kinds of disposal methods. Majority (38%) of the entrepreneurs dispose the dead fish and their waste directly in to dustbin. Around 16% of the entrepreneurs used dead fishes and their wastes as pet food and give to dogs and cats. Remaining entrepreneurs dispose directly into drainage (10%), bury in the soil (12%) and others (10%) use dustbin to dispose the dead fishes. Hence, dead ornamental fish's disposal is varied considerably (Table 11).

Disease incidence and management: Diseases are commonly occurring to ornamental fishes. Majority of the ornamental fish's entrepreneurs have witnessed the incidence of different diseases during their business. Infectious and non-infectious diseases incidences recorded during the present investigations at ornamental fish's aquarium shops in Mysore (Table 12). Protozoan, bacterial, viral and fungal diseases along with parasitic and mixed infections and their per cent occurrence at aquarium shops are depicted in Table 12. Further, non-infectious diseases such as rashes and wounds, infection due to contaminated water, stress, scale discoloration and inflammation are reported at aquarium shops (Table 12). Further, causative agent of different diseases, commonly occurring symptoms and the treatment followed by the aquarium shops keepers are given in Table 13. Most of the ornamental fish's entrepreneurs are using standard methods to treat the diseases using several of types of medicines and antibiotics (Table 13). It is a routine practice, to minimize the death of ornamental fishes, antibiotics and medicines which are to be regularly used. Maintaining the quality of water is very crucial in aquariculture. If water is contaminated, it influences the incidence of bacterial and parasitic diseases in ornamental fishes. Moreover, the disease prevalence varies with season and it is high during summer. Therefore, maintaining good water temperature, pH, oxygen and minimizing the ammonia and total organic carbon in the aquarium tanks is very essential to reduce the fish's death (Chidambaram *et al*, 2013; Vishwas *et al.*, 2013; Pedro *et al*., 2019). Ornamental fish's entrepreneurs are using standard methods to treat diseased fishes as per Pedro *et al.* (2019) and Vishwas *et al*. (2013).

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Precautionary measures taken by ornamental fish's entrepreneurs: Majority (80%) of the ornamental fish's entrepreneurs take precautionary measures by adding monosodium phosphate to the tank water to reduce the stress in ornamental fishes (Table 14). Other medicines such as Paracidol, Paraclear, Bactonil Anti chlorine, Water clear, General care, Antibiotics, Blue care, Antibiotics like tetracycline are added to minimize the rate of occurrence of diseases in the fishes thereby control the diseases (Table13). The use of heaters for proper temperature maintenance and filters to keep the clean water is also done by shop keepers (Tables 14). Around 58% of the shops keepers are doing this practice and 22% of the shop keepers are not doing it regularly. However, remaining 20% of the ornamental fish's entrepreneurs are not knowing about the disease outbreak and not practicing disease control methods (Table 14). Further, quarantine measures adopted by the ornamental fish's entrepreneurs to maintain healthy ornamental fishes in their shops are given in Table 14. The quarantine measures are taken every week, between first and second weeks and every two weeks and above by 60, 20 and 8% of the entrepreneurs in their aquarium shops (Table 14). However, 12% of the aquarium entrepreneurs not knowing the quarantine measures not practiced it (Table 14). Quarantine becomes important procedures that help avoid serious problems related to infectious diseases. Most of the ornamental fish's entrepreneurs use separate quarantine tanks during the treatment. It takes one to two weeks for the curing of the most of the diseases in the ornamental fishes in the aquarium shops. It depends on the medications, maintenance and treatment conditions until the fish show no sign of the diseases (Barrio *et al*., 2022). Moreover, dosage of the medicines depends upon the severity of the diseases, amount of water and the type of the ornamental fish affected. Antibiotics like oxytetracycline are used against the bacterial infections which help to control the population growth of bacteria (Bhatkar *et al.,* 2017). Further, sale and transportation of ornamental fishes are followed as per the standard methods as described by Shinoj *et al*. (2021), Lian *et al.* (2003) and Ramachandran (2002) by the shops keepers in Mysore. Details of such observations are published elsewhere.

IV. CONCLUSION

Ornamental fish's enterpreneuring activity is gaining good momentum in fast growing cities like Mysore. It is emerging one of the vital sector in aquaculture especially in urban areas. Many people are depending on this business and become part time to full time entrepreneurs and become self employed and provide employment opportunities to literate and illiterate youth. Many entrepreneurs are making good profits by selling ornamental fishes and encouraging ornamental fishery in Mysore. Now-a-days, it becomes the most popular hobby, practiced by thousands of people in Mysore. Currently, ornamental fish culture is growing at a larger scale and taking on its own shape by indicating a significant demand for ornamental fishes and their culture.

V. RECOMMENDATIONS

Ornamental fish's entrepreneurship has more scope in Mysore. More educated youths and science graduates can undertake aquariculture practices to become self employed and to have their own startups to avoid unemployment problems.

- Ornamental fish's entrepreneurs, science graduates and youths who are practicing Ornamental fish business on small scale levels should be given financial assistance and subsidiaries from concerned government departments.
- Every oornamental fish's entrepreneurs should be given training on modern aquaculture techniques in general and ornamental fish's culture in particular compulsorily.
- Periodic check up should be made by fishery personnel to update about the healthy status of ornamental fishes.
- Every ornamental fish entrepreneur should get quality feed easily and for that concerned government departments take measures to establish market to buy and sell quality feed to fishes.
- In depth investigations are required on different aspects of ornamental fishery farming to formulate the new methods and techniques to overcome the diseases incidences faced by the entrepreneurs.

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Figure 1. Map showing the study sites in Mysore City

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Table 1. Published reports on aquaricultre in India and other parts of the world

Sl. No.	Work done	Country	Authors & Year
1.	Marine ornamental fish and aquarium fish trade	Sri Lanka	Alan Friedlander (1994)
2.	Native ornamental fishes and their cultural prospects	Meghalaya, India	Mahapatra *et al*. (2003)
3.	Status of ornamental fish keeping	Khulna district, Bangladesh.	Mostafizur *et al.* (2009)
4.	Developed a method to assess risk of invasion of ornamental fresh water fish trade in six rivers of Minas Gerais State	Brazil	Andre *et al.* (2013)
5.	Aquarium fish business status	Jossore district, Bangladesh.	Muhammad *et al.* (2013)
6.	Surveyed in the Coastal region and identified 20 species of ornamental fishes	Digha to Talpati, West Bengal, India	Dutta *et al.* (2013)
7.	Involvement of customer preference for aquarium keeping	West Bengal, India	Manab *et al*. (2013)
8.	Field survey conducted in different ponds and collected 41 ornamental fishes	East Kolkata, West Bengal, India	Mahapatra *et al*. (2014)
9.	Recorded the diversity of natural indigenous ornamental fishes	Paschim Medinipur, West Bengal, India	Paul *et al*. (2014)
10.	Studied the ornamental fishes	Manipur, India	Khomdram *et al*. (2014)
11.	Freshwater ornamental fishes in Lower Manair Dam	Karimnagar district, Andhra Pradesh, India	Rama Rao (2014)
12.	Reported 168 ornamental fish commerce units (aquarium businesses)	Madhya Pradesh	Mohammad *et al.* (2015)
13.	Recorded 14 species of ornamental fishes	Tamilnadu, India.	Premdass *et al.* (2016)
14.	Studied the ornamental fish keeping and aquarium management	Tripura, India	Laksar *et al*. (2016)
15.	Recorded the status of ornamental fish's diversity	Raigarh district, Chhattisgarh, India	Gourishankar *et al*. (2016)
16.	Assessed the ornamental fish resources and their trading situation	Bangladesh	Alam *et al*. (2016)
17.	Described the traits and evaluate the current situation of the ornamental fish business.	Ratnagiri District, Maharashtra, India	Bhatkar *et al.* (2017)
18.	Studied the ornamental fish diversity in Dhing area	Assam	Kaushik *et al*. (2017)
19.	Ornamental fish industries	Philippines.	Frederick *et al*. (2019)
20.	Survey in 50 marine aquarium shops	Eastern England	Pinnegar *et al*. (2019)
21.	Cultural practices and commercial aspects of ornamental fish keeping	Khulna city, Bangladesh	Jharna *et al*. (2019)
22.	Status of ornamental fish import, research and scope	Nepal	Md. Akbal Husan (2019)
23.	Recorded the distribution and abundance of indigenous ornamental fishes in local water bodies	Jammu and Kashmir, India	Arif *et al*. (2019)
24.	Surveyed by visiting 13 aquarium shops	Kolhapur, Maharashtra	Rupesh *et al.* (2020)
25.	Identified the status of ornamental fish diversity and anthropogenic impact on ornamental fishes	Assam, India	Rahman (2021)
26.	Studied the status and prospects of ornamental fish and fish feed industry	Southern India	Shinoj *et al*. (2021)
27.	Ornamental aquarium organisms and their trade	Bangladesh	Noor *et al.* (2022)
28.	Status of ornamental fish marketing in Raipur city	Chhattisgarh, India	Sonvanee *et al.* (2022)

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Table 2. Aquarium tank and their thickness used by ornamental fish entrepreneurs

Sl. No.	Type of tank	% Occurrence	Sl. No.	Thickness of aquarium glass (mm)	% Occurrence
1.	Glass tank	50.0	1.	3.5	2.0
2.	Both fiber and molded glass tank	48.0	2.	4	10.0
3.	Not given information	2.0	3.	5	14.0
			4.	6	26.0
			5.	8	8.0
			6.	10	6.0
			7.	12	8.0
			8.	18	4.0
			9.	19	4.0
			10.	No information	18.0
Total		100.0	Total		100.0

Table 3. Commonly used ornamental fishes order and family

Sl. No.	Order	Fish species	% Occurrence	Sl. No.	Family	Fish species	% Occurrence
1.	Cyprniformes	32	27.8	1.	Cyprinidae	31	27.0
2.	Cichliformes	24	20.9.	2.	Cichlidae	24	20.8
3.	Osteoglossiformes	13	11.3	3.	Osteoglossidae	11	9.5
4.	Characiformes	9	7.8	4.	Osphronemidae	8	7.0
5.	Siluriformes and Anabantiformes	8 each	7.0 each	5.	Characidae and Poecilidae	7 each	6.0 each
				6.	Pangasiidae	5	4.2
6.	Perciformes and Cyprinodontiformes	7 each	6.2 each	7.	Serrasalmidae, Loricariidae And Muraenidae	2 each	1.7 each
7.	Angulliformes	2	1.8	8.	Lepisosteidae, Dasyatidae, Scatophagidae, Notopteridae Apteronotidae, Ambassidae Scophthalmidae, Clariidae Channidae, Cobitidae Pomacentridae, Toxotidae Polycentridae, Pomacanthidae Tetraodontidae, Lepidosirenidae	1 each	0.9 each
8.	Lepisosteiformes, Myliobatiformes, Pleuronectiformes, Dipnoi and Tetraodontiformes	1 each	0.8 each				
Total			100.0	Total			100.0

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Table 4. Habitat, feeding habit and type of feeds used during the culture of ornamental fishes by entrepreneurs

Sl. No.	Habitat	No. of species	% Occurrence	Sl. No.	Feeding habit	No. of species	% Occurrence	Sl. No.	Type of feed used	% Occurrence
1.	Freshwater	98	85.2	1.	Herbivorous	2	1.7	1.	Natural feeds	4.0
2.	Brackish water	13	11.3	2.	Carnivorous	41	35.7	2.	Pellet feeds	56.0
3.	Marine	4	3.5	3.	Omnivorous	72	62.6	3.	Both	40.0
Total		115	100.0	Total		115	100.0	Total		100.0

Table 5. Socio-economic conditions of ornamental fish's entrepreneurs

Sl. No.	Education of entrepreneurs	% Occurrence	Sl. No.	Size group	% Occurrence	Sl. No.	Type of business	% Occurrence
1.	Illiterate	2.0	1.	Small scale	4.0	1.	Sell only ornamental fish feed and aquarium items.	4.00
2.	Primary School	6.0	2.	Medium scale	58.0	2.	Sell ornamental fishes along with fish feed and other aquarium accessories	14.0
3.	High School	14.0	3.	Large scale	38.0	3.	Sell ornamental fishes along with other pet animals and all other aquarium accessories	82.00
4.	Under Graduation	28.0						
5.	Graduation	30.0						
6.	Post-Graduation	12.0						
7.	No information	8.0						
Total		100.0	Total		100.0	Total		100.0

Table 6. Education of employee, gender of laborers used in the aquarium shops

Sl. No.	Education of employees	% Occurrence	Sl. No.	Laborers use	% Occurrence	Sl. No.	Gender	% Occurrence
1.	Below SSLC	12.2	1.	Yes	46.0	1.	Male employees	78.0
2.	SSLC	41.5	2.	No	54.0	2.	Female employees	22.0
3.	PUC/Diploma/ITI	43.9						
4.	Graduation	2.4						
Total		100.0	Total		100.0	Total		100.0

Table 7. Feeding practices followed by ornamental fish's entrepreneurs

Sl. No.	No. of feedings	% Occurrence
1.	Once/ day	40.0
2.	Twice/day	42.0
3.	Both once/twice per day	8.0
4.	Both once/thrice per day	2.0
5.	Both twice/thrice per day	2.0
6.	All of the above	2.0
7.	Once in two days	4.0
Total		100.0

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Table 8. Commonly used feeds (with brand names) to ornamental fishes

Sl. No.	Name of the fish feeds (Brand name)	% Use
1.	Optimum	11.4
2.	Taiyo	10.1
3.	Humpy head (Taiyo)	6.9
4.	Aini (Taiyo)	6.6
5.	True colour	5.9
6.	Shrimp-E (XING)	4.5
7.	Tetra bits complete, Taiyo bits (Taiyo) Hi-red (Taiyo) and Discovery gold (Taiyo)	2.6 each
8.	Micro pellets (Hikari, Optimum, Taiyo), Blood worms, Royal feeds and Champion (Vacation food)	2.3 each
9.	Red-fin micro bits	2.1
10.	Guppy bits (Taiyo), Osaka green and Tusker	1.6 each
11.	Osaki-tuifex, Royal red, Amber, Inch gold and Super red	1.3 each
12.	Arowana sticks and Optimum quick red	1.1 each
13.	Flakes (Taiyo, Hallo feeds), Shrimp (Hallo feed), Hikari, Algae wafers (Hikari) and Ever red (Taiyo)	0.8 each
14.	Rich gold, Wild elite bits, Blood red parrot (Hikari), Gene eleven micro pellets, Instincts with Spirulina, Okiko, Sera arowana, Colour plus, Dry worms, Brine shrimp, Artemia, Shrimpy, Starry head, Raifest, Food sticks (Hikari), Speedy red (Taiyo), Fizza and Koi gold (Optimum)	0.5 each
15.	Cichlid fish food, Star bite economy, Stars forms, Red worms, Cichlid gold XO, Neel worms, Hi-color tropical fish feeds, Taiyo staple food, Wild micro bits, Brine shrimp flakes, Bio gold (Hikari), Aquatic remedies (Gene eleven), Aqudine fish feed, Super gold (Taiyo), Frozen worms, Rapid plus Red coin and Platinum (Okiko), Ocean free, Head up (Okiko) and Guppy super special (Premium food)	0.3 each
Total		100.0

Table 9. Ornamental fish feed storage practiced by entrepreneurs

Sl. No.	Storage method	% Occurrence
1.	Normal air tight packets/bottles	68.0
2.	Frozen	16.0
3.	Both	16.0
Total		100.0

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Table 10. Cleaning and solid waste recycling practices followed by entrepreneurs

Sl. No.	Tank cleaning	% Occurrence	Sl. No.	Recycling of inorganic solid waste	% Occurrence	Sl. No.	Recycling of waste water	% Occurrence
1.	Daily	12.0	1.	Completely recycled	20.0	1.	Recycled	16.0
2.	Weekly	62.0	2.	Not recycled	76.0	2.	Not recycled	84.0
3.	Monthly	12.0	3.	Partially recycled	4.0			
4.	Yearly	6.0						
5.	No response	8.0						
Total		100.0	Total		100.0	Total		100.0

Table 11. Dead ornamental fish's disposal

Sl. No.	Dead ornamental fish disposal practices	% Occurrence
1.	Disposed directly into drainage	10.0
2.	Disposed into dustbin	38.0
3.	Dead fishes buried in soil	12.0
4.	Dead fishes are used as pet feed (food to dogs and cats etc)	16.0
5.	Either in dustbin or to drainage	10.0
6.	Either to drainage or buried in soil	2.0
7.	Either to drainage or to feed the other pet animals.	2.0
8.	All of the above	2.0
9.	No information regarding this	8.0
Total		100.0

Table 12. Disease incidences recorded with ornamental fishes in aquarium shops

Sl. No.	Infectious diseases				Non-infectious diseases		
	Name of disease	Sl. No.	Type of disease	% Occurrence	Sl. No.	Name of infection	% Occurrence
1.	Protozoan	1.	White spot	21.3	1.	Rashes and wounds	5.7
2.	Bacterial	1.	Fin rot and tail rot	12.6	2.	Water infection	5.7
		2.	Common bacterial infection	3.4	3.	Water stress/ transportation stress	1.7
		3.	Swim bladder disease	0.6	4.	Scale discoloration	1.7
		4.	Cloudy eye	4.6	5.	Inflammation	0.6
3.	Viral	1.	Sleeping disease	4.0			
4.	Fungal	1.	Common fungus disease	14.9			
		2.	Red spot disease	4.0			
5.	Parasitic	1.	Leeches	2.3			
		2.	Head in hole disease	2.3			
		3.	Ticks and lice	6.9			
		4.	Anchor worms	1.2			
		5.	Gill flukes	2.3			
6.	Mixed infections	1.	Stomach bloat	4.0			
Total					Total		

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Table 13. Commonly occurring diseases, causative agent, symptoms and treatment of ornamental fishes

Sl. No.	Disease name	Type	Causative agent	Commonly occurring symptoms	Treated with
1.	Dropsy	Bacterial disease	*Aeromonas* sp. and *Pseudomonas fluoerescens*	Fluid retention or renal failure, bloats and develops protruding scales, pale gills, increased respiratory rate, redness of the skin or anus	Use of salt, cleaning the aquarium water and treating with antibiotics
		Viral disease	*Rhabdoyirus caprio*		
2.	Cloudy eye	Bacterial disease	*Streptococcus* sp.	White film on infected fishes eyes, hazy, inflamed, or sunken eyes	Use of salt, Pracidol, Paraclear and Bactonil and other antibiotics
3.	Tail rot and fin rot		*Aeromonas* sp. and *Pseudomonas* sp.	Skin ulcers with grey or red margins, blood on the edges of the fins, disintegrating fins and hazy eyes	Tetracycline
4.	Swim bladder disease		*Aeromonas* sp. *Hydrophila* sp. and *Shewanella xiamenesis*	Swim bladder deformation, excess of fluid accumulation in the body, over inflation and herniation	Potassium permanganate, salt bath, Melafix and other antibiotics
5.	Carp Edema Virus Disease	Viral disease	Carp Edema Virus	Hemorrhagic skin lesions with swelling of the underlying tissues, sunken eyes and gill lesions	0.3 to 0.5% salt, Paracidol
6.	Saprolegniosis	Fungal disease	*Saprolegnia* sp.	Tufts of filthy, cotton-like growth on the skin of the fish	Methylene blue, Pimafix and cleaning aquarium water with antibiotics
7.	Red spot		*Aphanomyces invadans*	Red spots or small to large ulcerative lesions on the body, jerky movement	Removing infected fishes, cleaning of water frequently
8.	White spot	Protozoan disease	*Ichthyophthirius multifiliis*	Shimmering dots or salt-like flecks on fins and body along with respiratory problems	Anti-white spot, Paracidol, Blue medicine cleaning of water
9.	Hexamitiasis Hole in the head		*Hexamita* sp.	Lesion appears on the head and flanks of the fish	Metronidazole administration in medicated food or in a bath treatment
10.	Fish louse	Parasite	*Argulus* sp.	Infected fishes scraping against hard inner surface of aquarium, clamped fins, inflammation and irritation at attachment sites	Aquadene, Paracidol, Para clear, weak formaldehyde solution, removal of lice with the help of forceps
11.	Anchor worm		*Lernaea cyprinacea*	Infected fishes scraping against hard inner surface of aquarium, hanging whitish-green threads in an irritated area	Aquadene, Paracidol, Para clear, Potassium permanganate dip, removing physically parasites
12.	Flukes		*Dactylogyrus* sp. and *Gyrodactylus* sp.	Production of excess mucus, tiny red spots or yellow dusting, shedding of slime coat, clipped fins, infected fishes scraping against hard inner surface of aquarium scraping against objects, fast gill movement	Common salt, Potassium permanganate bath, Aquadene, Paracidol, Para clear
13.	Leeches		*Piscicola geometra*	Reduced growth, skin irritation, changes in behavior such as reduced feeding activity, hiding, or swimming erratically	Aquadene, Paracidol, Para clear, physically removing parasites with the help of forceps

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Table 14. Precautionary measures, disease control and quarantine practices followed by entrepreneurs

Sl. No.	Precautionary measures	% Shop keepers practiced	Sl. No.	Disease control	% Shop keepers practiced	Sl. No.	Quarantine measures	% Shop keepers practiced
1.	Yes	80.0	1.	Yes	58.0	1.	1 week	60.0
2.	No	20.0	2.	No	22.0	2.	Between 1 and 2 weeks	20.0
			3.	No knowledge on the disease outbreak	20.0	3.	2 weeks and above	8.0
						4.	No proper information regarding this	12.0
Total		100.0	Total		100.0	Total		100.0