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Threatened Indian Freshwater fishes in the aquarium trade and its possible consequences
Master´s thesis

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Declaration

I hereby declare that I have authored this master's thesis carrying the name „ Threatened Indian Freshwater fishes in the aquarium trade and its possible consequences "independently under the guidance of my supervisor. Furthermore, I confirm that I have used only professional literature and other information sources that have been indicated in the thesis and listed in the bibliography at the end of the thesis. As the author of the master's thesis, I further state that I have not infringed the copyrights of third parties in connection with its creation.

In Prague on 12th April _____

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Threatened Indian Freshwater fishes in the aquarium trade and its possible consequences

Summary:

Fish trade for pet purposes

Every year, an estimated one billion freshwater fish from more than 5,300 species are traded internationally as pets. The trade of freshwater fish from the countries of origin for domestic pet use is increasing from year to year and its incudes exporting threatened fishes from the origin countries. Such act of humans threatened the sustainability, and we may face to extension of some fishes. Some of the main issues raised about the sustainability of the freshwater aquarium industry include the fact that overfishing and habitat destruction have resulted from the trade in wild fish, as well as the escapes and intentional releases of aquarium fish into habitats outside of their native range.

Millions of enthusiasts engage in the aquarium hobby, also known as ornamental fishkeeping, all over the world. Most freshwater ornamental fish and invertebrates are bred in captivity, in contrast to marine fish. These animals are currently produced both locally and imported from more than many countries. With dozens of very common species, several hundred species and their captive-bred morphs are well-liked and frequently accessible on the market.

Fish trade in India with the legal aspects

The collection of fish species for the aquarium trade in India, which is home to the greatest concentration of endemic freshwater fishes in continental Asia, is completely open access, unregulated, and even encouraged by some governmental and semi-governmental organizations. Indian hotspots known for their exceptional freshwater biodiversity and endemism, the Eastern Himalaya and Western Ghats, are where the majority of wild caught aquarium fish originate. Less than half of the 200 freshwater fish species that have been taken from the Eastern Himalaya for trade are currently exported. Similar to this, only about a dozen of the more than 100 species that have been traded from the Western Ghats are regularly exported.

Thousands of live animals and animal products are sold all over the world as a result of billion-dollar worth wildlife trade. It is remarkable that most of the times the current legal restrictions are ineffective. Although the trade in wildlife can be legal, it is frequently

unregulated and can be harmful to the animals. This illegal trade causes serious issues like the eradication of wild species from their natural habitats, uncontrolled captive breeding, the introduction of invasive species, and the spread of deadly pathogens. It can harm a host country's native biota in addition to endangering the survival of threatened species. Whole communities that depend on wildlife resources for tourism can suffer from the uncontrollable exploitation of wild species which can affect a lot of people.

Research purpose and findings

The purpose of this thesis was to analyse data on freshwater fish export from India and measure the possible consequences of the trade for different freshwater species.

The final results were obtained after gathering all the data and analysing it. The main goal was to determine which fish species were exported most frequently, along with the quantity, cost, and final destination countries. The IUCN Red List statuses of the ten species of freshwater that are exported the most were investigated based on the results that were obtained.

The most exported fish, *Tetraodon travancoricus,* is endangered, and its population is declining yearly, according to the results. *Dawkinsia denisonii* and *Parambassis lala,* the other species from the fish species that are exported the most, are experiencing declining populations. Additionally, *Dawkinsia denisonii* represents an endangered fish species and *Parambassis lala* represents a near-threatened species, which shows a serious threat to the extinction of this species.

According to the research, when it comes to the trade in freshwater fish, Germany is the top importer. While Kolkata is India's primary export hub. The research conducted for this thesis revealed that a total of 130 species were exported from India to 14 different countries.

The analysis of the findings is presented in this thesis' discussion and conclusion. Additionally, it identifies the issues surrounding the current export of freshwater fish from India and any potential negative effects of this act. It also makes suggestions for future improvement measures that could be taken to increase the sustainability of the fish trade.

Keywords: pet trade, fish export destination countries, export from India, ornamental fish trade threads.

Content

1 Introduction

For more than 10,000 years, the exotic animal trade has played a significant role in human culture. The quantity and variety of species traded, and as a general exotic pet ownership have grown significantly over the past few decades (Rhyne et al., 2012; Vall-llosera & Cassey, 2017). Every year, an estimated one billion freshwater fish from more than 5,300 species are traded internationally as pets; since the 1970s, this sector of aquaculture has increased by 14% (Hensen et al., 2010; Maceda-Veiga et al., 2016). The aquarium trade, specifically the trade of freshwater fish from the countries of origin for domestic pet use, is remarkable in the world pet trade (Andrews, 1990; Livengood & Chapman, 2007; Selvarasu & Sankaran, 2012; Allen et al., 2017).

Since 2000, ornamental fish exports have increased consistently, from US $177.7 million to a high of US $364.9 million in 2011, before slightly declining to US $347.5 million in 2014 (Dey, 2016). Asia accounted for approximately 57% of the trade among the 10 regions that supplied the export market in 2014, with exports amounting to US $197.7 million. Europe came next, accounting for 27.6% of all exports (worth $95.8 million in US dollars), followed by South America (7.5%), North America (3.98%), Africa (2.2%), Oceania (1.4%), and the Middle East (0.5%). Singapore was the top exporter of ornamental fish in 2014, with exports worth US $69.32 million, or nearly 20% of the total supply (Dey, 2016; Figure 1). With over 30% of the fish exported coming from foreign sources, Singapore being the primary trading hub in Asia (especially for re-exports). Japan was the second-largest exporter in 2014, with exports worth US $41.34 million. The Czech Republic placed third in 2014. It has a long history of producing aquarium fish and ornamental fish for recreational use. Since the 1960s, when raising tropical fish became a pastime for 40,000 people, there have been hundreds of small breeders in operation. Since the middle of the last decade, countries close to consumers have gradually increased their freshwater ornamental farming. These countries, which benefit from being closer to the major European markets, include the Czech Republic, Israel, Belgium, Germany, and the Netherlands (Dey, 2016).

In the highly biodiverse country of India, the aquarium fish trade is becoming more and more well-known and significant to the fisheries industry (Prakash et al., 2017). Although it benefits the national economy, the exploitation and trade of wild-caught freshwater ornamental fishes has been viewed as a significant threat to conservation in the nation's biodiverse regions (Raghavan et al., 2005; Raghavan et al., 2013; Dahanukar et al., 2011). Despite the fact that India's marine ecosystems are home to nearly 400 species of marine ornamental fishes from 175 genera and 50 families, very little is known about their exploitation and trade (Kumar & Balasubramanian, 2009). For instance, India was not listed among the nations exporting marine aquarium fish to the US. With more than 300 species currently being imported from India for sale in the international pet market, is one of the world's major trading hubs for freshwater ornamental fish (Raghavan et al., 2013). The majority of these are listed as endangered or threatened species, which once again highlights the need for stricter enforcement of laws governing the trade in pets. The Western Ghats and Eastern Himalayas in India are hotspots for

biodiversity (Myers et al., 2000), and there are a lot of freshwater habitats (Abell et al., 2008), which support a wide variety of fish that are desirable to international aquarium traders and hobbyists. In addition, India is very weak in enforcing biodiversity laws and listing threatened species under CITES appendices, making it simple to catch and sell freshwater fish from India (Raghavan et al., 2016; Raghavan, 2010; Raghavan et al., 2013). For the majority of threatened fish species sold as pets, there is little basic knowledge about reproduction (Philip et al., 2016; Solomon et al., 2011).

Opinions on the practice of gathering wild freshwater fish for the aquarium trade are divided (King, 2019; Raghavan et al., 2013; Watson & Moreau, 2006), particularly with regard to the long-term sustainability and effects on the environment. On the one hand, issues resulting from destructive fishing methods and mortality brought on by pretty poor handling and quarantine procedures, as well as issues caused by overexploitation of a species or a specific population at a given location, may exist (Dey, 2016). While some authors (Raghavan et al., 2013; Tlusty et al., 2008; Watson & Moreau, 2006) believe that wild-capture aquarium fisheries are a significant part of local economies and can offer incentives for environmental conservation if well managed, habitat destruction poses a far greater risk to fish faunas than fish collecting.

Most freshwater ornamental fish and invertebrates are produced in captivity, in contrast to marine fish (Tlusty, 2002). These animals are currently produced both locally and imported from more than 100 countries (Whittington & Chong, 2007; Evers et al., 2019). With dozens of very common species, several hundred species and their captive-bred morphs are well-liked and frequently accessible on the market (Kalous et al., 2015).

One of the legal activities connected with the wildlife trade is the supply of animals to pet stores (Auliya et al., 2016; Bush et al., 2014; Maceda-Veiga et al., 2016; Ribeiro et al., 2019). Although the majority of pets are obtained legally, 25% of the world's pet trade is thought to be illegal (Karesh et al., 2007). Fish play a significant role in the large animal population that makes up the global pet market (Maceda-Veiga et al., 2016, Prakash et al., 2017, Raghavan et al., 2013). As of now, more than 6,700 freshwater and 1,802 marine fish species/taxa are exported to the global market on a regular basis (Novák et al., 2020; Prakash et al., 2017; Raghavan et al., 2013), with only 10% bred in captivity (especially marine), with the remaining captured wild (Olivier, 2001). Approximately 90% of ornamental fish are tropical freshwater fish, and Asian countries have been the main suppliers for many years, accounting for 57% of exports with sales of US$197.7 million (Evers et al., 2019; Raghavan et al., 2013).

Non-native species are transported and introduced to new geographical regions via a variety of pathways, with the influence of each changing with global trade flows (Hulme, 2009; Essl et al., 2011). The majority of non-native species introductions follow one of two invasion pathways: Accidental introductions, such as species spread by "hitchhiking" in or on ships and airplanes transporting commodities and people, and pathways in which the species is itself a commodity (Hulme, 2009). The latter group, exemplified by the exotic pet trade has received increased attention in the last decade as global markets for animals have grown, resulting in an

increase in the number of invasive species arriving via this route (Padilla & Williams 2004; Keller & Lodge 2007). Despite the fact that the pet trade has produced a number of high-profile invasive species, most research has focused on how the pet trade affects wild populations (being collected in countries of origin) and brings disease (being spread in destination countries). (Lyons & Natusch, 2013; Tella & Hiraldo, 2014)

Although the unrestricted wild collection of endemic species has been identified as a significant threat to wild populations, there is insufficient quantitative evidence to support this claim (Raghavan et al., 2013). In this study, it is looked at the trade of endemic and endangered freshwater fishes from India for pet markets and talk about the implications for conservation. It is attempted to comprehend the nature of the trade in terms of species composition, volume, exit points, and importing countries using data on aquarium fish exported from India. The research extracts export data for endemic species that are listed as threatened in the IUCN Red List despite the fact that the majority of trade in India is conducted under a generic label of "live aquarium fish." (Raghavan et al., 2013).

2 Scientific hypothesis and aims of the thesis

As the number of freshwater fish exported each year rises, there are potential issues and risks associated with population decrease of some freshwater fish species and, in some cases, even their extension.

The increase of fish trade in general, and especially freshwater fish trade, is one of the main concerns nowadays. Particularly, the focus is on India, which is one of the major hubs for fish export. The majority of fish species are caught illegally, which is the biggest issue, due to a lack of government regulation, lack of control, and some income for local people.

As a scientific hypothesis is used the following:

Unregulated freshwater fish trade from India threads some species, potentially leading to their extinction.

The current freshwater fish trade has a significant negative impact on sustainability.

Maintaining current freshwater fish trade practices may result in biodiversity loss in fish origin countries.

The aim of the thesis is to research threatened Indian Freshwater fishes in the aquarium trade and its possible consequences. The data must be analysed to identify the most frequently exported species with reference to their status on the list of endangered species in order to identify the threads that are connected to this process.

The main question of the work is the following - what are the potential threats related to the freshwater fish export from India and what it can cause in the future.

3 Literature research

3.1 Global pet trade

The wildlife trade is a multibillion-dollar industry (annual profit from illegal sales ranges from $8 to 21 billion USD), with thousands of live animals and animal products sold worldwide (Chapin et al., 2000; Garcia-Daz et al., 2015; Pimm et al., 1995; Scheffers et al., 2019). It is worth noting that existing legislative restrictions are often ineffective (Patoka et al., 2018).

One of the legal activities associated with the wildlife trade is providing animals to pet stores (Auliya et al., 2016; Bush et al., 2014; Maceda-Veiga et al., 2016; Ribeiro et al., 2019). Despite the fact that the majority of pet animals are obtained legally, an estimated 25% of the global pet trade is illegal (Karesh et al., 2007). Among the many animals involved in the global pet market, fish play an important role (Maceda-Veiga et al., 2016; Prakash et al., 2017; Raghavan et al., 2013).

Since the 1970s, the popularity of fish as pets has increased by 14% per year, and over one billion individual fish are exported globally each year (Maceda-Veiga et al., 2016), with an estimated value of US$15-30 billion for aquarium fish (Evers et al., 2019; Novák et al., 2020; Penning et al., 2009). Nowadays, more than 6,700 freshwater and 1,802 marine fish species/taxa are exported frequently to the global market (Novák et al., 2020; Prakash et al., 2017; Raghavan et al., 2013), with only 10% of these (especially marine) being bred in captivity and the remainder being wild caught (Olivier, 2001). Tropical freshwater fish make up about 90% of ornamental fish, and for many years, Asian nations were the primary exporters with sales of US$197.7 million and 57% of the export market (Evers et al., 2019; Raghavan et al., 2013).

3.2 Aquarium trade

Millions of people enjoy the aquarium hobby, also known as ornamental fishkeeping (Andrews, 1990; Livengood & Chapman, 2007; Selvarasu & Sankaran, 2012; Allen et al., 2017). Year after year, an estimated one billion individuals of freshwater fish from more than 5,300 species are traded internationally as pets, and this sector of aquaculture has grown by 14% since the 1970s (Hensen et al., 2010; Maceda-Veiga et al., 2016). In contrast to marine fish, the vast majority of freshwater ornamental fish and invertebrates are the products of captivity (Tlusty, 2002). These animals are currently produced locally and imported from over 100 countries (Whittington & Chong, 2007; Evers et al., 2019). There are several hundred species and their captive-bred morphs that are well-liked and frequently sold (Sales 2003), with dozens of species that are extremely common (Kalous et al., 2015). Aquariology, the study of

organisms kept in aquariums, is a crucial component of laboratory research (Petrescu-Mag & Bud, 2017), but the history of this branch of aquaculture is still largely understudied.

Fish in the very beginning were used as ornaments in ancient China as non-utilitarian resources, and the goldfish species, *Carassius auratus* (Linnaeus, 1758), was developed through artificial selection (Komiyama et al., 2009). Between 1506 and 1521, Japan received the first ornamental goldfish imports, followed by Europe in 1611 and America in 1876 (Balon, 2004; Jassim et al., 2012). Before 1780, in the Netherlands, there may have been the first successful goldfish reproduction in Europe (Billardon de Sauvigny, 1780). The first reports of ornamental goldfish sightings in the wild were made at the end of the 18th century in south-western Europe (Ribeiro et al., 2009; Plumb, 2010a).

Five electric eels, *Electrophorus electricus* (Linnaeus, 1766), were brought to London in 1776 and displayed in George Baker's show to demonstrate the eel's "electric spark" (Plumb, 2010b). This import was not driven by any ornamental purpose and therefore cannot be regarded as ornamental fishkeeping, despite the bombastic spectacle and exhibitionistic context.

Modern ornamental fishkeeping, which involves keeping fish in indoor, typically glass aquariums, has historically been primarily associated with marine biota (Adamowsky, 2015; Gosse, 1854; Hess, 1876; Humphreys, 1857; Rehbock, 1980). Roßmäßler (1856) promoted freshwater fishkeeping and published a manual on how to keep ornamental species in home aquariums. The first books on contemporary ornamental fishkeeping were published in the years that followed (Muller, 1856; Roßmäßler, 1857). Crayfish, insects, mollusks, amphibians, plants, and European cold-water fish species are mentioned among the freshwater aquarium inhabitants in books written by the Society for Promoting Christian Knowledge (1862) and Jäger (1868) and later. Butler (1858) wrote a monograph with the motto "Fish of every size may answer for the Aquaria," which is still accurate today.

From the middle of the 19th century until the end of the First World War, fish were primarily imported into Germany and France during the early history of modern freshwater ornamental fishkeeping. The paradise fish *Macropodus opercularis* (Linnaeus, 1758), which was purchased by a naval officer named Gerault at the request of the French Consul Eugene Simon in south-east China in 1869, was the first species of "exotic" fish to be imported (Myers, 1965). There were 100 fish shipped to France in total, and 22 of them made it there alive. Pierre Carbonnier, a French ichthyologist, successfully bred 17 individuals in the same year (Dagry, 1928): 12 males and 5 females. Carbonnier (1872) published the original reports that summarized the initial experiences with a "Poisson de Paradis." In the following years, demand for this species of labyrinth fish skyrocketed, and it was also made available in Germany, England, and the United States (Holly, et al. 1934–1967; Ward, 1967). Three shipments of the enormous gourami (*Osphronemus goramy* Lacepede, 1801) were acquired by Carbonnier in 1873. Carbonnier (1876) discussed mortality in relation to temperature drop while conducting breeding experiments with this species, which was imported under the name *Osphromenus olfax*, with the aim of familiarizing this large labyrinth fish in France. He also speculated about

the potential survival of fish asphyxiated under the ice. He brought the Siamese fighting fish (*Betta splendens* Regan, 1910) (Reuter, 1911–1915) and the dwarf gourami *Trichogaster lalius* (Hamilton, 1822) to Europe for the first time in 1874. However, Hamburg received a disproportionately large share of shipments of freshwater ornamental fish (Reuter, 1911–1915; Baensch & Riehl, 1985; Riehl & Baensch, 2000, 2002). The Czech Republic has recently been identified as having served as a gateway for ornamental animals entering Europe during the aforementioned period when it was still part of the Austro-Hungarian Empire (Kalous, et al. 2015). Despite its current position on the market, this nation started ornamental fishkeeping after France and Germany did. *M. opercularis*, transported in 1890 from Hamburg by Frantisek Petzold (Peroutka, 1926), was the first "exotic" fish to be brought in for ornamental use. In 1897, the renowned Czech explorer Enrique Stanko Vraz brought in *B. splendens* (mistakenly listed as *B. pugnax*) from Siam directly (Vraz, 1901).

In the 1870s, commercial aquaculture facilities were established in Europe for the production of exotic ornamental freshwater fish. Paul Matte, a specialist in tropical fish importation, established the first facility for this in Lankwitz, Germany, in 1876. Ornamental fish were bred in a number of facilities at the start of the 20th century, and they were featured in hand-coloured catalogue advertisements. Additionally, it was common practice to trade aerated aquariums at this time (Anonymous, 1909–1910; Anonymous, 1923; Brünning, 1921). Other technical equipment from this era was either lacking or limited to external alcohol burners for heating, such as those made by Glaschke in Leipzig starting in 1908 (Anonymous, 1925); fountains and manually filled oxygen bottles were the main sources of aeration (Anonymous, 1925; Knauer, 1907; Nosek, 1910). Electric heaters were typically released on the market no earlier than after World War One, despite the fact that their functionality was unreliable and limited the keeping of exotic fish (Anonymous, 1925). Although ships were typically used to transport fish, other modes of transportation were also employed. For instance, the neon tetra *Paracheirodon innesi* (Myers, 1936), one of the most "iconic" species in ornamental aquaculture, was transported to J. S. Neel in Paris in 1935 by fish collector Auguste Rabaut, who gave the fish the name "neon fish." Following that, these fish were sold in Hamburg to two Germans named Hugo Schnell and Walter Griem for the absurdly expensive sum of $6,500 USD. Although live animal loading was prohibited, five people were transported on the rigid airship Hindenburg to the Shedd Aquarium in Chicago in 1936. The package was labelled as "fish preserves." *P. innesi*'s only survivor was during transportation. This is likely the most expensive fish transportation ever, costing $3,000 (Aqualog, 2014).

The compilation of the first 40 years of contemporary freshwater ornamental aquaculture was published by Taylor in 1910, with a particular emphasis on aquatic plants and invertebrates. Only cold-water species, like the European catfish (*Silurus glanis* Linnaeus, 1758), were mentioned; no tropical fish. Some fish, particularly North American centrarchids (like *Micropterus* sp.), catfish (like *Ameiurus* sp.), and salmonids (like *Oncorhynchus mykiss* (Walbaum, 1792), were imported to Europe initially for human consumption before becoming ornamental species like some native species. However, from the start of the 20th century, there was a rising trend in both the popularity of exotic species and the related interests of German authors. The term "exotic" became increasingly important to authors in the years that followed

in German and Czech specialized literature (Lutz, 1886; Sprenger, 1894; Zernecke, 1907, 1913; Nosek, 1909; Heller & Ulmer, 1913; Janda, 1914; Bade, 1923, 1924; Ullmann, 1927). Despite containing a wide range of significant data, Duffy (2018) and other contemporary authors who specialize in the history of ornamental aquaculture have generally negative opinions of this literature.

However, the early history of exotic fish imports to aquaria is poorly studied and typically simplified. Much has been written about the current effects of ornamental fishkeeping, including among other things as a commercially important industry and also a source of non-native species (e.g., Padilla & Williams, 2004; Patoka et al., 2018).

3.3 Impact of the aquarium trade

Although it may be legal, the wildlife trade is frequently unregulated (Broad et al., 2003) and may be harmful to wildlife. The removal of wild species from their natural ranges, unregulated captive breeding practices, the introduction of invasive species and the spread of deadly pathogens are all serious problems of this illicit trade (Go'mez & Aguirre, 2008; Karesh et al., 2005; Lenzen et al., 2012; Patoka et al., 2014; Putra et al., 2018; Rhyne et al., 2009; Scheffers et al., 2019; Smith et al., 2009). It can harm the native biota of a host country in addition to risking the survival of species that are already endangered (Sala et al., 2000; Scheffers et al., 2019; Smith et al., 2009). The well-being of many people can be impacted by the uncontrollable exploitation of wild species by a small number of individuals because it can harm the livelihoods of entire communities that depend on wildlife resources for tourism (Nijman, 2010; Ribeiro et al., 2019).

A crucial tool for preventing the illegal trade in wildlife and promoting sustainable wildlife trade without endangering the survival of wild species is the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (CITES, 1973; https://www.cites.org/eng/disc /text.php). CITES now has 183 parties, up from just 80 at the time of its founding (referred to as "parties"). Due to (a) the Party's limited resources for effectively implementing CITES provisions, (b) the corruption and abuse of power by authorities who stand to gain financially from the international trade in wild species, the CITES recommendations frequently fail to control the illegal wildlife trade. c) inability of the Party to accurately report trade data about the taxon of conservation concern, which is required for CITES listing of species at risk (Jepson & Ladle, 2005; Regueira & Bernard, 2012; Ribeiro et al., 2019) and (d) lack of accurate scientific information on traded species. As a result, the illegal wildlife trade is booming all over the world, but it is particularly prevalent in developing tropical and subtropical nations (Pimm & Raven, 2000; Pimm et al., 1995; Raghavan et al., 2013; Scheffers et al., 2019).

The most basic international trade chain for animals sourced from the wild includes wild capture and harvest, international shipping, and ultimately private ownership (often in a nation outside the species' native range, and frequently on a different continent). If this process is poorly managed, the exotic pet and aquarium trades run the risk of having an adverse impact on population-level conservation both at the source due to over-collection (e.g., Berkunsky et al., 2017; Auliya et al., 2016) and at the destination due to invasion (e.g., Lockwood et al., 2019) and disease (Travis et al., 2011; Can et al., 2019). Understanding the species, including its status and distribution in the wild, its biological traits (reproduction, longevity, diseases and pathogens carried), and its physiological and behavioural requirements both in the wild and in captivity, are necessary for assessing and possibly mitigating these risks. However, identifying potential target ('high-risk-associated') species can be challenging for biologists and managers eager to identify and manage for conservation risks. This is partly due to consumer demand being cyclical and influenced by passing trends in fashion and popularity (e.g., Harrington et al., 2019). Rare (Tournant et al., 2012), novel taxa (species not typically kept as pets, such as otters or kinkajous, Harrington et al., 2019), and 'newly described' species (Stuart, 2006) are frequently highly sought after, or quickly become popular. Aquarium collectors frequently have an interest in both diversity and rarity (Rhyne et al., 2012), and the trade in aquarium "ornamental fish" serves as an excellent illustration of many of the complexities and multifaceted problems associated with the supply of exotic pets (both aquatic and terrestrial) more generally (see, for example, discussion in Andrews, 1990).

Fish keeping is a very common hobby that supports a global industry that is reportedly worth between USD 15 and USD 20 billion (King, 2019). Although exact figures are unknown, King (2019) speculates that more than a billion ornamental fish may be exported annually around the world. King (2019) hypothesizes that the majority of freshwater species (which make up an estimated 90% of all ornamental fish trade) are captive üed, with 5-10% coming from wild sources. Freshwater fish are among the most endangered vertebrate species (Reid et al., 2013), and ornamental species can experience mortality rates of more than 70% during capture and transport. As a result, the relative benefits and drawbacks of the ornamental fish trade are hotly contested in the literature and among practitioners, particularly in relation to sustainability and local livelihoods (e.g., Maceda-Veiga et al., 2016; Evers et al., 2019).

3.4 Aquarium trade in India

The collection of such species for the aquarium trade is completely open access, unregulated, and even encouraged by some governmental and semi-governmental agencies in India, the nation that is home to the greatest number of endemic freshwater fishes in continental Asia (Froese & Pauly, 2012) (Raghavan, 2010). The Eastern Himalaya and Western Ghats, hotspots renowned for their exceptional freshwater biodiversity and endemism (Allen et al., 2010; Molur et al., 2011), are where the majority of wild caught aquarium fish from India originate. Less than half of the 200 freshwater fish species that have been harvested from the

Eastern Himalaya for the trade are regularly exported (Allen et al., 2010). Similar to this, only about a dozen of the more than 100 species that have come into trade from the Western Ghats are regularly exported (Raghavan, 2010). The remaining species are not viable for trade because they are either extremely difficult to handle and transport, or they are extremely rare and therefore extremely hard to collect.

The charismatic Red Lined Torpedo Barbs (RLTBs), a species complex of colourful cyprinids, are the centre of attraction in India's aquarium trade. Their unmanaged collection over the past 20 years is linked to severe population declines and an "Endangered" listing in the IUCN Red List of Threatened Species (Ali et al., 2011; Raghavan & Ali, 2011). The Department of Fisheries in the southern Indian state of Kerala issued a Government Order in 2008 restricting collection and exports and proposing a number of management measures, including quotas, gear restrictions, minimum catch sizes, and a seasonal trade ban (Mittal, 2009). This was in response to the growing global awareness of the need to conserve RLTBs. However, according to recent studies, these regulations were created with little scientific input and provide little in the way of species protection (Solomon et al., 2011). According to the theory that the RLTBs breed in June, July, and October, for instance, a seasonal closure of the fishery was put into place (Clarke et al., 2009). Research on the biology of the species, however, revealed that the actual breeding season for the species actually lasts from October to March, making the seasonal closure ineffective (Solomon et al., 2011). In general, the lack of empirical data about the trade has hampered efforts to control the collection and export of freshwater aquarium fishes from India.

In India, freshwater fish are classified as "wildlife," and both their status and conservation are somewhat peculiar. The Indian Forest Act (1927), which addresses habitat protection and the use of forest products, the Biological Diversity Act (2002), which implements aspects of the Convention on Biological Diversity (CBD), and the Wildlife Protection Act (1972), which specifies rules for hunting and harvesting wild animals, are the main laws governing wildlife conservation in India. None of these laws specifically address freshwater fish conservation. Several states have also passed "Inland Fisheries" acts, but these haven't put any emphasis on aquarium fish conservation or sustainable use (Dahanukar et al., 2011). The precarious state of freshwater biodiversity is a result of the general perception that freshwater fish is an open access resource and a free good that can be collected from nature (Allen et al., 2010; Molur et al., 2011).

In Continental Asia, India has the greatest variety of endemic freshwater fish (De Silva et al., 2007; Allen et al., 2010). However, unlike marine species (11 of which, together with all syngnathidians [seahorses, pipefish, and seadragons] are listed on Schedule 1 of India's Wildlife (Protection) Act, 1972 [WPA] and thus protected from hunting and trade), none of the freshwater fish occurring in India (with the exception of the pipefish [Teleostei: Syngnathidae] that occur in freshwater) are included under any of the wildlife schedules of the WPA (ENVIS Centre on Wildlife and Protected Areas, Wildlife Institute of India, http://www.wiienvis.nic.in). The WPA in India forbids the "removal of wildlife," which includes fish (see www.indiacode.nic.in), and Section 26 of the Indian Forest Act, 1927 forbids fishing in

"reserved forests," which are the only areas where freshwater fish are formally protected. As a result, there are few federal restrictions on the harvest of freshwater fish in India (whether it is for domestic use or export; (Allen et al., 2010; although regional restrictions might be in place under state law). Exporters of ornamental fish must register with MPEDA (http://mpeda.gov.in), the Marine Products Export Development Authority. For wild caught and captive bred ornamental fish intended for export, a health certificate can also be obtained under the Export (Quality Control and Inspection) Act, 1963, but it is not necessary for export from India. Otherwise, this industry is not heavily regulated by legislation.

According to factfish.com, ornamental fish exports in India currently generate only a small amount of money—roughly one million dollars annually (USD 1.43 million in 2017)—compared to the country's overall exports of fish and fishery products, which were valued at USD 5.9 billion in the same year (www.statista.com). However, recent revenue growth in India's ornamental fish trade (2013-2018, MPEDA, http://mpeda.gov.in) suggests that this industry will continue to grow. Snakeheads (*Channa spp*.) are a diverse group of ornamental freshwater fish species that are found throughout Asia (Conte-Grand et al., 2017; Rüber et al., 2020). In recent years, this group has been the subject of considerable taxonomic interest (Conte-Grand et al., 2017 and references therein), with fifteen or more 'new' species described since the year 2000 (Rüber et al., 2020 and references therein). Currently, c. 21 distinct species are thought to occur in India (Rüber et al., 2020), many of which are thought to be endemic to the Eastern Himalayan (EH) region or to have restricted ranges elsewhere in peninsular India. Snakeheads are unusual because they can travel a short distance over land and may be able to stay out of the water for up to four days (Courtenay & Williams, 2004; Li et al., 2017 and references therein). They are air-breathing predatory fish. The large (>60 cm, cf. Rüber et al., 2020) species in particular may be cultivated for food (in India and elsewhere, Courtenay & Williams, 2004). Both large and small species include brightly coloured forms popular among aquarium hobbyists. Snakeheads are an important local food source (Laxmappa, 2017). Many snakeheads have been introduced outside of their native ranges (Courtenay & Williams, 2004; Herborg et al., 2007), and some places (notably the US, where strict regulations are in place and import and interstate transport are prohibited; US Federal Register 02-25337) consider them to be damaging invasives. The snakeheads are not currently included on the CITES list.

4 Methodology

Methods used for the preparation of this thesis is mainly depended on analysing data which contains the following information – names of the ornamental fishes, family in which they can be associated, quantity of the export, number of the exports and destination where it had been transported.

In the present study, we collected custom-level data for two years, and assessed the trade in threatened freshwater fish in terms of volume, trade routes, ports and global importers.

4.1 Scientific research

For the research described in this thesis, research was conducted as a first step from the very beginning. The most recent, relevant scientific studies, papers, and journal articles served as the main sources for this project. These resources are based on research and offer an alternative perspective on the subjects covered in this work.

The research on endangered freshwater fishes from India is included in the paper "Uncovering an obscure trade: Threatened freshwater fishes and the aquarium pet markets" as well as a general overview of the aquarium pet markets. The paper examines the volume and scale of trade in endemic and endangered freshwater fish from India for pet markets and discusses the implications for conservation. The authors of the paper attempt to understand the nature of the trade in terms of species composition, volume, exit points, and importing nations using data on aquarium fishes exported from India.

“Risks related to the global demand for novel exotic pets: A new and emerging trade in snakehead fish (*Channa spp*.) from India” was also read through and examined. The primary goal of the work is to examine the export trade for the given specie and any potential complications. The authors of the study identify knowledge gaps that are important to national-level management and propose a fundamental shift in thinking, whereby those who trade in "luxury" wildlife products must show that their activities are sustainable and secure, as opposed to conservationists who must show that they are not.

The importance of regulations and laws that are required to preserve biodiversity is highlighted in one of the most significant papers, "Far from home: Tracking the global ornamental fish trade in endangered *Zebra loach, Botia striata*, from freshwater ecoregion and biodiversity hotspot in India." The main export hubs and their contribution to global export are covered in this article.

The authors of "Marine Aquarium Trade in India: Challenges and Opportunities for Conservation and Policy" discuss the major issues that face the export of freshwater fish and recommend that management strategies and conservation plans be provided for the marine

ornamental taxonomic groups that are manipulated in India in order to ensure the long-term sustainability of the coral reef ecosystems and the livelihood opportunities that depend on them.

On the other hand, the freshwater fish trade in Europe is discussed in the papers "Modern Ornamental Aquaculture in Europe: Early History of Freshwater Fish Imports," "Establishment Risk from Pet-Trade Freshwater Turtles in the European Union," and "European Hub for Invaders: Risk Assessment of Freshwater Aquarium Fishes Exported from the Czech Republic." The first paper's additional objectives include identifying the for most widespread aquarium fish species available on the wholesale market, estimating temperature suitability seasonal (winter and summer) survival in the EU, and determining the risk of invasiveness the aquarium fish species with the strongest temperature matching. The final one introduces the history of imported freshwater fish into Europe. It offers the first in-depth analysis of reported imports from the beginning of this aquaculture sector's history through the First World War's conclusion. The total number of species kept has also been updated, along with a projection for the future. The research highlights the significant role of German importers at this time by placing the summarized information in a broad context of historical and contemporary connections and viewpoints.

The most pertinent data related to the study of this thesis's topic was selected from the primary sources mentioned above, analysed, and used to complete the work. With the aid of those papers, it is now possible to examine the current issues with the freshwater fish trade and how they actually impact threatened fish species and possible complications of it.

4.2 Primarily processing of the data

Indian custom served as the source of the research's raw data. The data primarily included the numbers and species of fishes that were not ornamental fishes and were known to be used for food, such as frozen fishes and frozen fish parts. Additionally, information about invertebrates was included.

At the initial stage, the research's pertinent data was identified, and the remaining portions of the primary data were removed. Each choice was based on an analysis of the product description, and Excel tools like filtering were employed. In order to place the dates of fish export from India for the years of 2018–2019 within a frame, they were also checked at the same time. Finally, only the information listed below remained: the export date, the product description, the quantity, the unit, the value, the exporter's information, the export port, the consignee's information, the country and region of destination, and the mode of shipment. Other irrelevant data were also deleted.

The family, genus, and specie of the exported fish were added at the very end. According to the product descriptions, the website of the California Academy of Science's Eschmeyer's Catalog of Fishes was used to determine each product's current taxonomic status.

4.3 Processing of the results

The analysis of the outcomes was done at the end. The following key factors, including fish involved in the ornamental fish trade from India, threatened statuses of the top exported fishes, countries of destination, and lastly Indian ports' inclusion in this process, were taken into consideration in order to see the overall picture of the freshwater fish trade and identify the threads related to exporting different fish species from India.

In general, Excel tools, which will be covered in more detail below, were used for data analysis. Additionally, the general numbers that were produced from the total data using Excel's summary tool are presented in the last section of the results. Information on total quantity, total value, total consignments, total number of destination countries where the export was carried out, and total species involved in the process are all included in the general data. After the primary data processing was completed, the data was summarised.

4.3.1 Processing of the results - fishes involved in the ornamental fish trade from India

After the primary data processing, the data in Excel was categorized and filtered by each species, and the numbers of quantity were summarised in case of each freshwater fish species exported. This was done in order to identify which species were most exported from India in the years 2018–2019. The results' categorisation allowed the species to be sorted from the highest value to the lowest. The top ten fish species exported were separated using this method. The remaining ones were combined and used to create a share percentage chart. A separate table for the top ten species and the "others" was made, the percentage share for each species from the total quantity was calculated, and finally, using the Excel tool, a chart was made that uses different colours to indicate species and displays the share of exported fish species in total export.

4.3.2 Processing of the results - threatened statuses of the top exported fishes

The top ten species were searched in the Red List of Threatened Species maintained by the International Union for Conservation of Nature to determine their most recent statuses after receiving the first part of the results and identification of the most exported freshwater fish species from India. Following the verification of each of the ten species, special marks were

added to the pie table to indicate each species' status on the IUCN Red List and the current population trend.

4.3.3 Processing of the results – countries of destination

The countries to which India exported freshwater fish are listed in the next section of the results. In total, fourteen countries imported various fish species from various regions of India in the years 2018–2019. The sorting and filtering tools in Excel were adjusted to determine which countries exported fish the most. First, the total quantity for each country was summed up after filtering by each country, and the total quantities for each country were obtained. Following this, it was possible to determine the percentage share that each country would have in the total amount and to create a pie that would visualise that information.

Finally, to make things clearer, the export numbers for each country were transferred to a new sheet, and using Excel's charting tools, it was possible to display the results as a world map with each country represented by a different shade of blue, depending on the number of exports from each exporter nation.

4.3.4 Processing of the results – Indian port export

The same Excel tools mentioned above are used in the final section of the result, which displays the share of Indian ports in the total export from India. In this example, the filtering tool was modified for each Indian port that participated in the export of freshwater fish to various countries. A visualised representation of each port's share of the total quantity was created from the summarised data for each port. In addition to this, the quantity of consignments for each port was calculated.

5 Results

For the two years from 2018 to 2019, India reported aquarium fish exports worth 114 314 US dollars. The total amount was made up of 312 335 NOS. For the listed criteria, for this thesis was conducted an analysis of the data and have provided a summary below. For the years 2018–2019, ornamental fish trade from India included up to 130 species in total.

5.1 Fish diversity in ornamental trade India

As with the initial stage, the research's relevant data is identified, and the remaining primary data is removed. Figure 1. presents all of the species involved in the ornamental fish trade from India. This is the primary processed data from the customs data and processed in a way to meet the aim of the research – identification of ornamental fishes within other exported fishes.

The top ten ornamental fish species that were exported from India to various destination countries in terms of value over other species are shown in Figure 2. Additionally, the percentage share of the total data is indicated. As it was discovered during the research, *Tetraodon travancoricus*, with a share of 23.4% in total export, is the fish species that is exported the most. It stands out significantly from *Dario Dario*, which takes second place with a share of 13, followed by *Botia striata* and *Erethistes jerdoni*. The quantity of other top-exported ornamental fish species, which ranges from 4.8% to 2.3% of total export, is roughly equivalent.

Genus	*Species*	*Quantity in NOS*	% share
Tetraodon	*travancoricus*	72945	23,4
Dario	*dario*	42295	13,5
Botia	*striata*	26330	8,4
Erethistes	*jerdoni*	22900	7,3
Botia	*lohachata*	14870	4,8
Dawkinsia	*denisonii*	9059	2,9
Pethia	*canius*	8220	2,6
Oreichthys	-	7780	2,5
Parambassis	*lala*	7750	2,5
Badis	*badis*	7150	2,3
Laubuca	*dadiburjori*	6050	1,9
Botia	*dario*	4615	1,5
Garra	*gotyla*	4450	1,4
Macrognathus	*pancalus*	4085	1,3
Channa	*andrao*	3140	1,0
Danio	*rerio*	2900	0,9

Oreichthys	*cosuatis*	2800	0,9
Stigmatogobius	*sadanundio*	2750	0,9
Channa	*bleheri*	2736	0,9
Pangasianodon	*hypophthalmus*	2720	0,9
Badis	*laspiophilus*	2630	0,8
Dawkinsia	*assimilis*	2438	0,8
Pethia	*conchonius*	2180	0,7
Dario	*kajal*	2050	0,7
Horadandia	*atukorali Deraniyagala*	2000	0,6
Haludaria	*melanampyx*	1810	0,6
Aplocheilus	*blockii*	1775	0,6
Botia	*rostrata*	1775	0,6
Haludaria	*fasciata*	1625	0,5
Oryzias	*dancena*	1600	0,5
Trichogaster	*lalius*	1300	0,4
Gymnothorax	*tile*	1262	0,4
Carinotetraodon	*travancoricus*	1200	0,4
Nemacheilus	-	1200	0,4
Garra	*lissorhynchus*	1130	0,4
Etroplus	*canarensis*	1085	0,3
Macrognathus	*aculeatus*	1039	0,3
Oreichthys	*crenuchoides*	1000	0,3
Chandramara	*chandramara*	990	0,3
Badis	*assamensis*	975	0,3
Microphis	*deocata*	967	0,3
Waikhomia	*sahyadriensis*	835	0,3
Pseudosphromenus	*cupanus*	780	0,2
Channa	*Scopoli*	777	0,2
Channa	*stewartii*	738	0,2
Parambassis	*ranga*	675	0,2
Channa	*marulius*	660	0,2
Haludaria fasciata	*fasciatus*	600	0,2
Etroplus	*suratensis*	600	0,2
Channa	*aurantimaculata*	589	0,2
Rhinomugil	*corsula*	580	0,2
Otocinclus	-	574	0,2
Otocinclus	-	574	0,2
Odontamblyopus	*rubicundus*	570	0,2
Channa	*gachua*	525	0,2
Paracanthocobitis	*botia*	510	0,2
Lepidocephalichthys	*guntea*	510	0,2
Pethia	*phutunio*	510	0,2
Nemacheilus	*corica*	500	0,2
Pseudosphromenus	*dayi*	500	0,2
Dawkinsia	*tambraparniei*	485	0,2
Mesonoemacheilus	*triangularis*	480	0,2
Pethia	*setnai*	420	0,1

Oryzias	*carnaticus*	400	0,1
Desmopuntius	*rhomboocellatus*	400	0,1
Pseudolaguvia	*shawi*	400	0,1
Hemigrammus	-	390	0,1
Puntius	*mahecola*	365	0,1
Danio	*dangila*	350	0,1
Omobranchus	*zebra*	350	0,1
Moringua	*raitaborua*	345	0,1
Astronotus	*ocellatus*	340	0,1
Sperata	*aor*	300	0,1
Mystus	*tengara*	295	0,094
Channa	*punctata*	290	0,093
Nandus	*nandus*	270	0,086
Trichopsis	*vittata*	270	0,086
Acanthocobitis	*botia*	250	0,080
Canthophrys	*gongota*	225	0,072
Danio	*meghalayensis*	225	0,072
Dichotomyctere	*fluviatilis*	211	0,068
Opsarius	*ardens*	205	0,066
Aborichthys	*elongatus*	200	0,064
Schistura	-	200	0,064
Mystus	*vittatus*	195	0,062
Ctenops	*nobilis*	182	0,058
Opsarius	*bakeri*	180	0,058
Aborichthys	*sp.*	175	0,056
Hyphessobrycon	*eques*	160	0,051
Epalzeorhynchos	*frenatum*	160	0,051
Aplocheilus	*lineatus*	150	0,048
Dawkinsia	*rohani*	142	0,045
Devario	*malabaricus*	140	0,045
Glyptothorax	*sufii*	140	0,045
Chaca	*chaca*	136	0,044
Anabas	*testudineus*	135	0,043
Pseudosphromenus	-	124	0,040
Amblyceps	*mangois*	120	0,038
Notopterus	*notopterus*	120	0,038
Brachirus	*pan*	120	0,038
Haludaria	*pradhani*	120	0,038
Channa	*striata*	120	0,038
Leiodon	*cutcutia*	115	0,037
Channa	*pardalis*	110	0,035
Pseudetroplus	*maculatus*	106	0,034
Channa	*diplogramma*	101	0,032
Mastacembelus	*armatus*	100	0,032
Pisodonophis	*boro*	100	0,032
Devario Heckel	*devario*	100	0,032
Xiphophorus	*hellerii*	100	0,032

Badis	-	100	0,032
Rita	*rita*	98	0,031
Erethistes	*hara*	90	0,029
Labeo	*catla*	80	0,026
Ophichthys	*cuchia*	80	0,026
Puntius	*sophore*	80	0,026
Gobioides	-	80	0,026
Pethia	*punctata*	70	0,022
Batasio	batasio	60	0,019
Badis	*burmanicus*	60	0,019
Macrognathus	*siamensis*	60	0,019
Esomus	*danrica*	50	0,016
Pangasius	*pangasius*	50	0,016
Carassius	*auratus*	40	0,013
Bagarius	*bagarius*	40	0,013
Chitala	*chitala*	40	0,013
Polypterus	*delhezi*	40	0,013
Trichopsis	-	40	0,013
Apocryptes	-	40	0,013
Datnioides	-	36	0,012
Pneumabranchus	*albinus*	32	0,010
Opsarius	*barna*	30	0,010
Channa	*royi*	30	0,01
Parachromis	*dovii*	24	0,008
Gagata	*Bleeker*	20	0,006
Allenbatrachus	*grunniens*	20	0,006
Polypterus	*senegalus*	20	0,006
Anabas Cloquet	*testudineus*	20	0,006
Cyprinion	*semiplotum*	15	0,005
Tor	*putitora*	12	0,004
Datnioides	*quadrifasciatus*	12	0,004
Prionobutis	*microps*	10	0,003
Chelonodon	*patoca*	8	0,003
Channa	-	6	0,002
Datnioides	*polota*	2	0,001
Sperata	*seenghala*	2	0,001
Others	-	538	0,2

Figure 1. All ornamental fish species exported from India

Nº	Specie	Quantity in NOS	% Share
1	*Tetraodon travancoricus*	72945	23,4
2	*Dario dario*	42295	13,5
3	*Botia striata*	26330	8,4
4	*Erethistes jerdoni*	22900	7,3
5	*Botia lohachata*	14870	4,8
6	*Dawkinsia denisonii*	9059	2,9
7	*Pethia canius*	8220	2,6
8	*Oreichthys sp.*	7780	2,5
9	*Parambassis lala*	7750	2,5
10	*Badis badis*	7150	2,3
	Others	93036	29,8

Figure 2. The top ten ornamental fish species exported from India

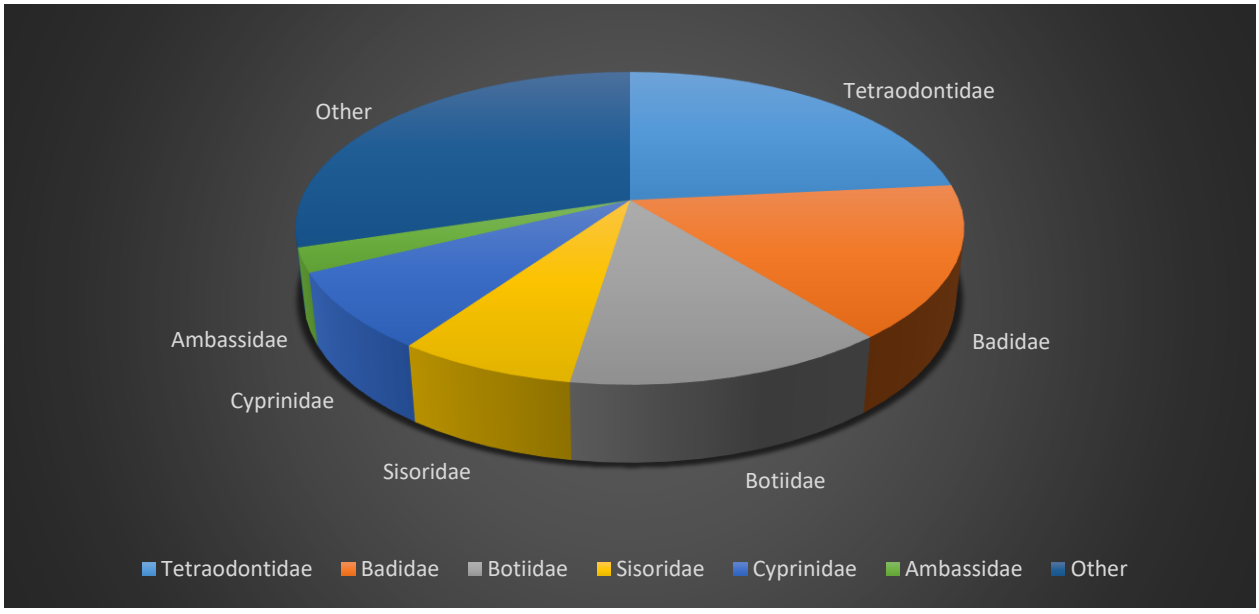

Figure 2.1 The top ten ornamental fish families exported from India

5.2 Threatened statuses of the top exported fishes as per IUCN

Each individual's status was assessed on the Red List of Threatened Species maintained by the International Union for Conservation of Nature based on the data above, which shows the most exported fish species involved in the ornamental fish trade from India. This approach made it possible to identify and discuss the potential risks relating to the specific species of

Indian freshwater fish that are exported in the greatest numbers. The info is displayed in Figure 3. including the relevant statuses.

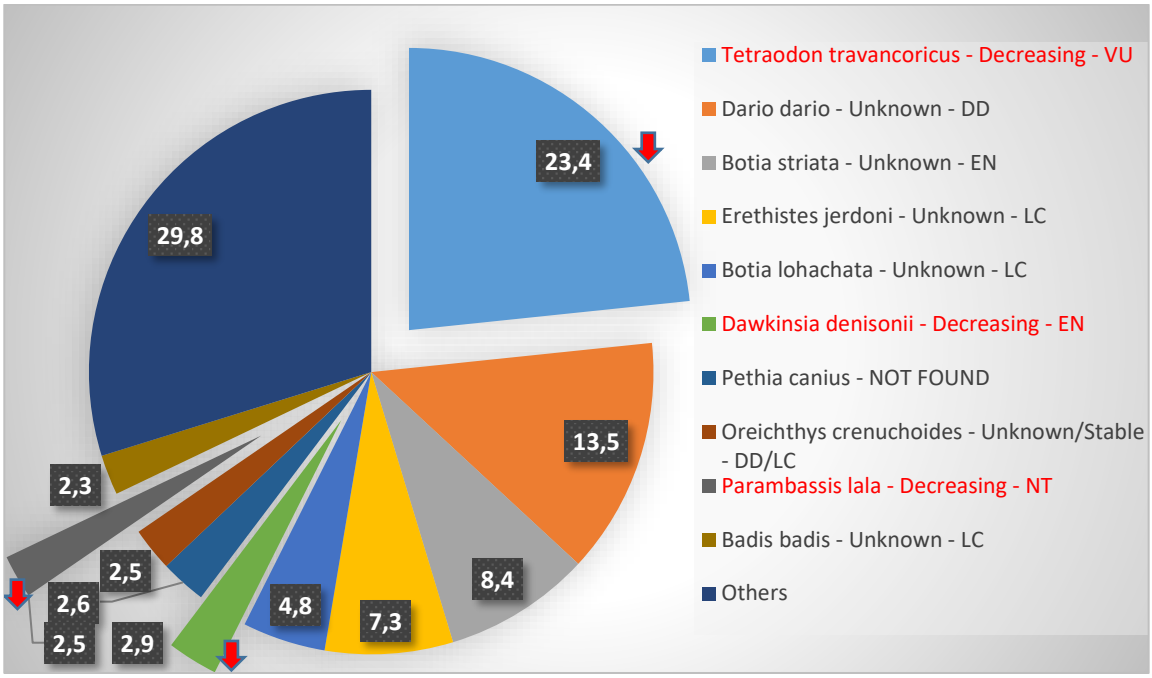

Figure 3. Threatened statuses of the top exported fishes

According to the above- mentioned data, it is clear that *Tetraodon travancoricus*, the most exported fish species with a total export share of 23.4, is endangered and that its population is declining annually. The data also show that there are two additional species, *Dawkinsia denisonii* and *Parambassis lala*, whose populations are also declining. While *Parambassis lala* represents near-threatened species, the *Dawkinsia denisonii* represents an endangered fish species with a 2.9 percent export share and this poses a real threat to this species extinction.

The status of the remaining species from the top ten most exported fish species on the graph is unknown, and it is impossible to measure the treads related to those freshwater fish species and possible consequences of their high quantity export from India.

5.3 Countries of destination

The information on the countries of destination for the exports of freshwater fish species from India was also examined along with other characteristics. Fish export was conducted in 14 different countries in total. Figure 4. displays the share of the destination countries in total export from India for the 2018-2019 years.

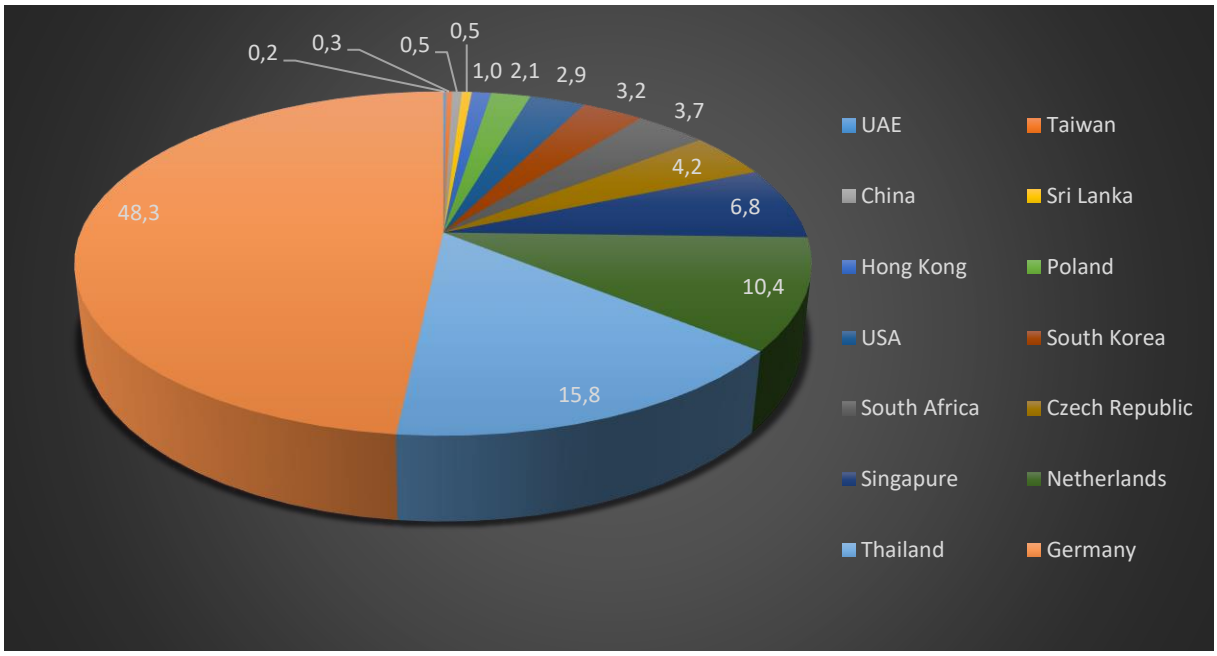

Figure 4. Countries of destination

According to the data, it is clear that Germany holds the top spot with 48.3% of the total exported quantity, far ahead of Thailand in second place with just 15.8%. Netherlands comes the next with 10.4% share. From all destination regions, Europe stands with the highest value with 65% including Germany, Netherlands, Czech Republic and Poland.

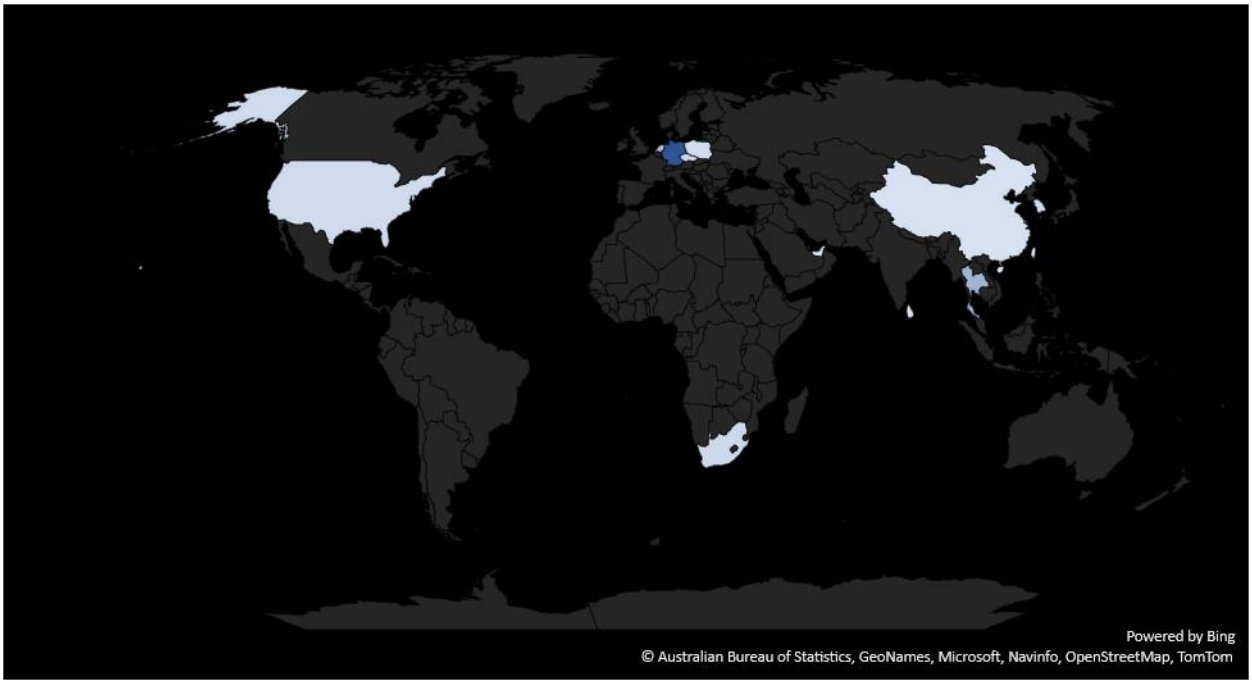

Figure 5. The distribution of the destination countries worldwide

5.4 Indian port export

The information on Indian ports from which the export was conducted is included in the last characteristic of the freshwater fish export from India that was examined. Freshwater fish were exported from a total of four Indian ports. Chennai, Mumbai, Kolkata, and Cochin.
With a share of 78.4% of the total exported volume and 949 consignments, Kolkata takes the top spot with notable differences from other ports. Mumbai comes in second with a share of 14.6% and 164 consignments, followed by Chennai with 6.8%, and Cochin with only 0.2% and one consignment. Figure 6. displays the data for the share of Indian port exports.

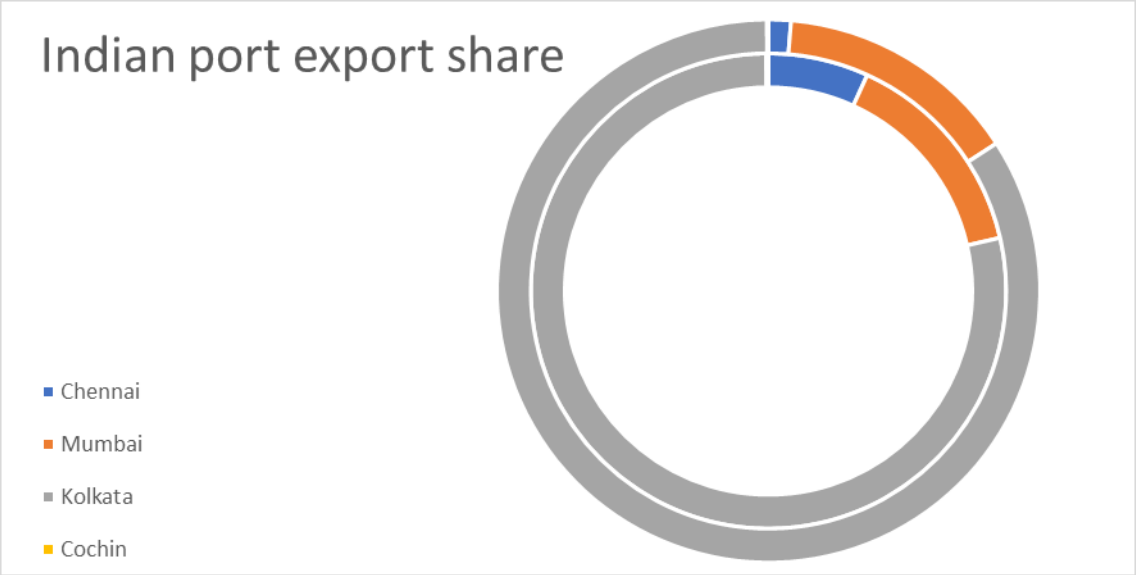

Figure 6. Indian port export share

*Outer level – number of consignments; *Inside level – export quantities in NOS

Quantity (NOS)	**312335**
Value (FOB)	**114314**
No. of Consignments	**1129**
No. of destination country	**14**
No. of species	**130**

Figure 7. Export numbers from India in total 2018-2019.

6 Discussion

It is obvious that the fish trade is very common and widespread, and India is one of the major hubs for this activity, from which large quantities are exported to a variety of countries. First and foremost, it is necessary to discuss the species that are exported and identify their current status in terms of population and potential extension risks. At the same time, the export destination countries and their potential consequences should be examined, as discussed further below.

The trade in freshwater fish is already a problem and could get worse in the future. especially since the vast majority of the fish trade is unregulated and illegal. The main issue with this subject is that there aren't any really effective laws and regulations from the government that would make it possible to control actual threads, especially in the case of some fish species that are endangered and whose populations are decreasing. It requires a lot of attention specifically because the largest hubs are mostly found in Asia and India is one of the biggest and most significant fish exporter countries.

The findings of this study demonstrate actual processed data from which it is evident that some threatened species are still exported in large quantities, potentially putting them at risk with its possible sustainability consequences. The possible consequences for importing country as an explosion of non-native species causing loose of biodiversity is also discussed. Finally, some solutions and ideas for all of the problems mentioned above are presented.

6.1 Threatened species trade

As mentioned above, uncontrolled freshwater fish trade already has and can have even bigger influence on the fauna of India. As the results shows, from India 312 335 freshwater fish were exported in different countries only for two years period. Out of the ten most exported fish species, three species population are decreasing and one of them - *Dawkinsia denisonii* even represents endangered species, while *Parambassis lala* is near threatened species. It needs to be marked that the most exported fish species - *Tetraodon travancoricus* with share from whole quantity of 23.4 is presented as a vulnerable fish species.

Without a doubt, continuing in this manner will have irreversible effects on aquatic life and could have negative repercussions. Despite these threats, India lacks a legal framework that safeguards freshwater fish. There is not a single species of freshwater fish listed in the appendices of the current laws.

6.2 Destination countries and export market – possible consequences

The export markets for Indian aquarium fish are determined by factors like lower freight costs, short travel times, and frequent connectivity. These are the main factors that make Indian exports of freshwater fish so appealing to the global fish trade. From this research it can be identified as the freshwater fish species are exported all over the world and imported into various destination countries at various points from Indian ports. As evidenced by the results, it must be emphasized that Europe, particularly Germany, which has the largest market share in the pet trade and where nearly half of the total quantity was exported, is the primary importer region of freshwater fish from India.

Discussions have mainly cantered on the advantages of wild capture and captive rearing for conservation in the aquarium trade. The long-term effects of unrestricted trade in endemic freshwater fish species have drawn attention. Several important endemic species are frequently found in ornamental fisheries, with more frequently occurring, widely accessible species filling in the gaps. However, these fisheries frequently assist in protecting already-existing ecosystems; as a result, both individual species within a fishery and the entire fishery need to be assessed for their overall contribution to the maintenance of a healthy social-ecological system.

Another consequence in terms of destination countries, exploration to a new species is remarkable. Non - native invasive species are one of the major causes of biodiversity loss, and conservation organizations worldwide pay various levels of attention to this trend. Each year, time, money, and considerable effort are expended in the eradication, control, and mitigation of alien species impacts, primarily because these invaders may displace native species from their ecological niches through different aspects like: resource competition, hybridization, pathogen introduction or predation. As a result, not only illegal fish trade or species extension may be a problem, but the invasion of them into non-native environments and countries must be considered as a possible consequence of the ornamental fish trade.

6.3 Challenges and management suggestions

Monitoring and record keeping are important prerequisites for ethical aquarium fisheries and trade. Increased government oversight of trade and collections has long been advocated as one of the industry's most important needs, but it is still rarely implemented.

In the case of India, fish were chosen for the aquarium industry based on traits that made them desirable for trade, but not, it seems, based on traits that would make them resilient to trade. The first step toward creating a sustainable aquarium industry in India should be deciding which species should be sold and how they should be sourced. Even just from this research, it

is clear how unsustainable and unregulated the entire process of exporting freshwater fish from India is, as well as the threads for some particular species and destination countries.

Any list of potential aquarium fishes for trade, both current and future, should exclude species that are extinction-threatened and also call for a listing of the threatened species that are already being traded under national law. In order to lessen the possibility locations of the country endangered species being categorized and labelled under a general export code, species-level information must also be gathered at the time of export at all places where the export is conducted. A standardized traceability and coding system for freshwater aquarium fish, particularly for wild-caught species, should be developed and adopted at all exit points. This system should include all pertinent data, such as the species name, capture location, size of the fish, and the names of the collector and exporter.

Even the aforementioned suggestion would be a significant improvement, but it is insufficient to guarantee that the harvest of ornamental fish is conducted in a way that does not contribute to further declines of freshwater fish species. It is crucial to verify the accuracy of the trade data and to report on the quantity and variety of species traded each year. It will only be possible to make any assurance that suitable measures are being sufficiently implemented to deliver fish for the hobby of keeping aquariums at home that have full societal and ecological benefits through the collection and appropriate analysis of trade data.

Any conservation effort for exploited species must also have the cooperation and support of the fishing community. Governmental decisions should be made, the appropriate regulations developed, and most importantly, they put into effect. Above all else, though, if those rules are not followed, the current state of affairs won't change either. Additionally, the proper delegation, implementation, and control procedures should be in place. Such a coordinated strategy may have a significant impact on sustainability and the protection of endangered species, at the same time to protect, prevent and control importing countries from invasive species and loose of biodiversity.

7 Conclusion

- Freshwater fish trade is internationally one of the most popular hobbies and it is related to the economy, especially in case of some specific countries, like India. Since most exported freshwater fish are illegally caught, it poses a threat to some particular species whose population are decreasing from year to year and fall under the classification of vulnerable, near-threatened, and endangered species.

- The study's findings highlight how the freshwater fish trade from India is unregulated and how even endangered species are exported in large quantities. Such actions specifically endanger some species and may even result in the extinction of some freshwater species due to the absence of local regulations and controls. The numbers from the data analysis and research presented in this thesis make clear how unsustainable the process is and the detrimental effects it may have on freshwater life in India.

- At the same time, the current trend of the ornamental fish trade and its non-regulated cycle threads to importing country which may face to the exploration of invasive, non-native species on place which may have negative affect to their fauna and even can result in biodiversity loose.

- The lack of proper regulations in the country, proper oversight of freshwater fish exports, proper identification of threatened species, and a proper coding system that would enable tracking and a reduction in exports, particularly of threatened species, is unquestionably one of the most problematic issues. To change the current trend and ensure a sustainable social-economic environment in the fish trade and for those involved in the process, the Indian government must take significant actions.

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9 List of abbreviations and symbols

IUCN Red list - International Union for Conservation of Nature's Red List of Threatened Species.

NOS – Not otherwise specified. The quantity of a product that has been scheduled or nominated for a transaction as accepted by both parties.

FOB - Ex-Factory Price + Other Costs.

VU – vulnerable

DD – data deficient

EN – endangered

LC – least concern

NT – near threatened

 – Decreasing