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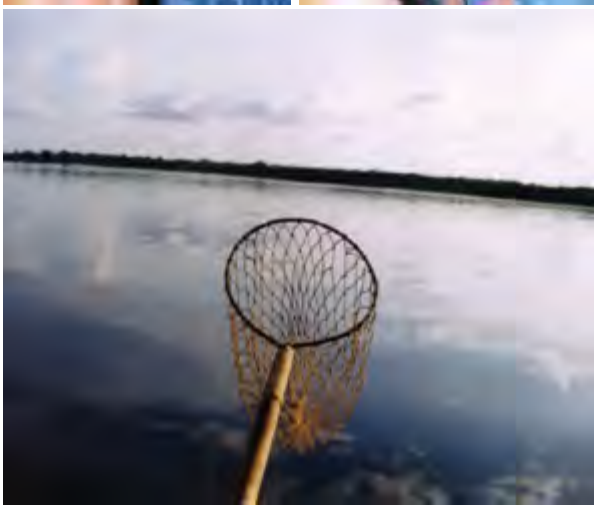

The Ornamental Fish Trade

Volume 102

The Ornamental Fish Trade

Production and Commerce of Ornamental Fish: technical-managerial and legislative aspects

by

Pierluigi Monticini

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The ornamental fish sector is a small but vital part of international fish trade. It contributes positively to rural development in many developing producing countries, and in the major markets for ornamental fish, the retail value is many times that of its trade value with a positive impact throughout the value-chain. The sector presents numerous challenges to operators, ranging from issues related to animal welfare and health to the protection of endangered species. Demand is linked to the health of the overall economy, adding to the cyclical nature of the industry. The report presents an overview of production, trade and markets for ornamental fish species. It provides extensive information on import regulations and requirements in major world markets.

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Layout: Gloria Loriente
Cover photographs courtesy of author.

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LIST OF ACRONYMS

AC	Animal Care
ACN	Aquatic Conservation Network
AMDUCA	Animal Medicinal Drug Use Clarification Act
APHIS	Animal and Plant Health Inspection Service (USDA)
AQS	Animal Quarantine Service, Japan
ASMI	Alaska Seafood Marketing Institute
AWA	Animal Welfare Act
AWB	Air way bill
BIP	Border inspection post
CBD	Convention on Biological Diversity
CDC	Centers for Disease Control and Prevention
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CNGV	Carp nephritis and gill necrosis virus
CoP	Conference of the Parties (CITES)
CVED	Common veterinary entry document
DEFRA	Department for Environment Food and Rural Affairs, UK
DFO	Department of Fisheries and Oceans, Canada
DG SANCO	Directorate General for Health and Consumers
DOA	Death on Arrival
EC	European Community
EPA	Environmental Protection Agency, USA
ESA	Endangered Species Act
EU	European Union
EUS	Epizootic ulcerative syndrome
FAO	Food and Agriculture Organization of the United Nations
FDA	Food and Drug Administration, USA
FIES	Fisheries and Aquaculture Information and Statistics Service (FAO)
FOB	Free on board
FROM	Fondo de Regulación y Organización del Mercado de los Productos de la Pesca y Cultivos Marinos, Spain
GFP	Green fluorescent protein
GMO	Genetically modified organism
IATA	International Air Transport Association
IBAMA	Brazilian Institute of Environment and Renewable Natural Resources
IES	International endangered species

IUCN	International Union for Conservation of Nature (formerly World Conservation Union)
KHV	Koi herpes virus
LCES Fauna,	Law for the Conservation of Endangered Species of Wild Flora and Japan
MAC	Marine Aquarium Council
MAFF	Ministry of Agriculture, Forestry and Fisheries, Japan
MOE	Ministry of the Environment, Japan
Mott	Mycobacteria other than tuberculosis
MS222	Tricaine methanesulphanate
MUMS Act	Minor Use and Minor Species Animal Health Act, 2004
NES	National endangered species
NGO	Non-governmental Organization
NMFS	National Marine Fisheries Service, USA
NOC	Nuclei Operativi Cites
NTM	Non-tuberculosis mycobacteria
NVAL	National Veterinary Assay Laboratory, Japan
OATA	Ornamental Aquatic Trade Association
OFI	Ornamental Fish International
OIE	World Organisation for Animal Health
SIPI	Società Italiana di Patologia Ittica
SSA	Seafood Services Australia
SVC	Spring viraemia of carp
UNEP	United Nations Environment Programme
USD	United States Dollars
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
UVAC	Veterinary Offices for Community Affairs
WCMC	World Conservation Monitoring Centre
WTO	World Trade Organization

EXECUTIVE SUMMARY

The purpose of this work is to provide an updated and comprehensive overview of the ornamental fish trade, covering numerous aspects, from the nineteenth century naturalists who first discovered ornamental fish species of interest to breeding and reproduction in the various exporting countries, from socio-economic, regulatory and technical factors to techniques concerning the procedures and documentation required for importing ornamental fish from Asia and South America.

In exporting countries, the sector of ornamental fish produced and bred in captivity is undergoing rapid growth – a fact supported by both FAO statistics (2007) and data provided by the University of Amazonas in Manaus. In a socio-economic context, this growth is important for the development of rural and poor populations, who can use this sustainable and renewable source of income with a minimal impact on natural ecosystems.

More than 90% of freshwater ornamental fish are bred in captivity, in contrast with marine species. Indeed, most marine species, both fish and invertebrates, are caught directly in their habitats of origin using often unsuitable methods, resulting in the depletion of marine ecosystems and destruction of coral reefs, particularly in Southeast Asia.

Therefore, ornamental fish species caught in the wild by fish-producing countries do not always meet the environmental protection and biosecurity requirements of importing countries, which over the years have become increasingly stringent in terms of animal health and well-being. The situation in importing countries is in continuous evolution (most recently, also as a consequence of international economic and political tension). The current economic crisis could lead to a significant drop in the ornamental fish trade – a trade which to date has been subject to rapid growth and development, providing a basis for socio-economic opportunity in various developing countries.

The problems of greatest relevance to operators in the sector relate to health and the interpretation of the many regulations in the field of animal welfare and the protection of endangered species.

FOREWORD

This paper aims to provide a full-ranging overview of the ornamental fish trade. Nineteenth-century discoveries made during expeditions to various continents – by British naturalists Alfred Russel Wallace, Charles Darwin and Henry Walter Bates (Hernandez, 2004) – remain to this day the basis of the modern aquarium.

Photograph 1. Heckel and Scalare in aquarium

Courtesy of P. Monticini

In 1836, the Austrian naturalist Johann Natterer brought more than 50 000 animal specimens to Vienna, collected on expeditions to South America over a period of 18 years. The collection included 1 700 fish; these were catalogued and classified by Johann Jacob Heckel, ichthyologist at the Museum of Natural History in Vienna (Mayland, 1994). In 1840, he carried out his study on the fish of the Rio Negro, including *Symphysodon discus discus* (to which he also gave his name).

In the early 1900s, numerous expeditions were conducted by German researchers, and of these, Wilhelm Praetorius – a famous collector of fish – had an incredible stroke of luck: he became the first person to catch the discus (Bleher, 2006). He also caught other fish and specimens of various aquatic species. Animals of potential interest from a commercial point of view, such as large turtles (*Podocnemis expansa*), were also captured. However, Praetorius's attempts to import live specimens were unsuccessful, and he later disappeared without trace while exploring the Rio Negro.

After the Second World War, trade in tropical ornamental fish increased significantly, and it was common practice to collect fish directly at the source to be sold for ornamental purposes. Since the late 1950s, the ornamental fish trade has undergone major changes. Some countries in Southeast Asia (Singapore, Thailand, Hong Kong and Indonesia) have a highly developed ornamental fish breeding industry, and more than 90% of freshwater ornamental fish are now bred in captivity. However, the situation is quite different for marine species, which are often caught using unsuitable methods,

directly at the place of origin, contributing to significant depletion of marine ecosystems and coral reefs, in particular in some countries in Southeast Asia.

The major exporters of ornamental fish are Asian countries, the United States of America (Hawaii), the Netherlands, Germany and some Central and Eastern European countries (Czech Republic and Russia).

Intensive breeding in Asian countries has without doubt produced socio-economic benefits for the local population, as well as creating new varieties of fish with different colour variations or long fins. While such activities have helped stem the depletion of numerous species, reducing the probability of extinction, they have also produced notable biological and medical problems.

As a result of intensive breeding and the abuse of genetic selection which tends to standardize size and colour variations, the resistance of some of the most popular species (poeciliids, cichlids, *Barbus* spp.) has decreased, with a subsequent increase in induced pathologies.

1. STATISTICAL DATA

1.1 VOLUME OF TRADE

Every year the ornamental fish industry is responsible for the movement worldwide of a large number of specimens. While it is not possible to calculate the exact number, the weight of each box is known and the value can be estimated. The weight depends on the water content, as well as the substrate where marine organisms are anchored (e.g. live rocks, hard corals).

The percentage of space actually occupied by the fish is difficult to determine, as it depends largely on the species and their size, but 5–8% is a reasonable estimate.[1] It is estimated that more than 2 billion live ornamental fish are moved annually worldwide. However, an accurate figure cannot be obtained as statistics are based on information from a range of countries, and data vary in terms of reliability and completeness. FAO provides statistics on export, re-export and import (figures in US dollars [USD]). Often, the only figures available concern value – not numbers or species. Only in 2007–08 did researchers attempt to provide detailed and accurate data.

An assessment of the situation of importing countries following the economic and financial crisis at the end of 2008 is likely to reveal a sharp contrast with the previous trend (1975–2008), which reveals a steady increase in the trade of ornamental fish.[2]

1.1.1 Export countries

FAO began to provide data in 1976 when just 28 countries were known to be exporting. Later their numbers increased significantly (taking into account re-exporting), reaching 105 in 2004; in 2007 the figure dropped to around 100. For many nations, particularly those in developing countries, the reproduction of ornamental fish represents a great opportunity for income growth in rural communities. However, low-cost production does not always mean good quality, and problems can arise in the field of biosafety or animal welfare. Five major exporting countries supply about 70% of the global market, and the first 25 account for 93% of total exports.

According to FAO data, the volume of exports increased in value from USD 21.5 million in 1976 to USD 315 million in 2007. The share of re-exports increased from USD 22 000 in 1975 to USD 4.5 million in 2007, peaking in 2003 at USD 8.5 million.

However, FAO export data are in terms of value; figures for quantity (volume, number of specimens or species marketed) are not available. Furthermore, trade statistics are only relative to fish which are actually registered. Incomplete data are provided on quantity and estimated value, and only for 2007; it is, therefore, impossible to put these data to significant use.

[1] Figures are derived from FAO databases (2004–07) and from Project Piaba of the Federal University of Amazonas, Brazil (2003–05) – as well as those figures relative to certain species (e.g. cardinal tetra, *Cheirodon axelrodi*).

[2] Unfortunately the data in this publication do not go beyond 2008. Please refer to later editions of this publication for an update with a careful assessment of the economic and social situation of the exporting countries and possible impact on their ornamental fishing industries as a result of the financial crisis and probable decreased demand from importing countries.

Asia accounts for 51% of exports, Europe 29%, North America 4% and South America 6%. The largest exporters of ornamental fish are Singapore (21% market share), Malaysia (8%), the United States of America (3.5%), Spain, the Czech Republic, Japan, Thailand and Israel.

In terms of import value in 2007, Singapore reached a total of USD 66 million, Malaysia USD 25 million and the Czech Republic USD 23 million. The 2007 import value of ornamental fish originating in South America is relatively low: Brazil USD 5 million, Colombia USD 8.5 million and Peru USD 3.8 million, because all major ornamental species are now bred in Asia (where the mortality rate is low and prices affordable). Furthermore, South American countries have increasingly restrictive national laws, severely limiting the possibility of taking stocks of wild fish directly from the source (e.g. the national legislation of Brazil and Peru).

Spain had a total export value of USD 31 million in 2007, thanks not to their domestic industry (fish farming activities), but to commercial networks with countries in South America (Brazil and Peru), the Caribbean and Southeast Asia, which increased the value of their exports. The network flourished due to Spain's geographic position and the excellent network of air links with the various world regions. Nevertheless, Spain saw a significant decrease in imports in 2008, with a value of just USD 18 million – the result of the financial crisis.

Japan is an export leader with a total share of 6.5% to a value of USD 21 million (Table 1). Most koi and other goldfish strains come from Japan – a net exporter of these cold-water fish.

Table 1. Japan exports

Country or Area	Year	Comm. Code	Commodity	Trade ('000 USD)	Weight (kg)
Japan export	2008	30110	Ornamental fish, live	21 557	229 481

Source: UNdata, United Nations Statistic Division, Commodity Trade Statistics Database

The United States of America is an important export country, but total exports do not cover imports (USD 11 million against USD 43 million in 2007).[3]

There was a moderate increase in the value of US exports in 2008 and 2009: USD 8.9 million in 2009, compared with USD 5.7, 5.8 and 7.3 million for 2005, 2006 and 2007, respectively. Partial monthly figures for January 2010 indicate a volume equal to USD 712 000, which is in line with the figure for 2009: USD 710 000.

The United States of America exports ornamental fish to numerous countries, including Japan, Canada, Mexico and Taiwan Province of China. Exports of live ornamental fish pass through Miami, and Florida is an important international source of wild caught and

[3] United States ornamental fish export data for 2008, 2009 and January 2010 are provided by the United States Department of Agriculture (USDA), collected by Customs and Border Protection (Department of Homeland Security) and are drawn up and distributed by the Foreign Trade Division of the Census Bureau (Department of Commerce). Data are updated on a monthly basis.

raised live ornamental aquatic organisms. Thousands of marine ornamental fish and invertebrates are collected in Hawaii, mostly for the domestic market, but also for international trade, in particular Europe and Japan. In 1994, more that 200 permits were issued, but fishing accounted for fewer than 100 full-time jobs.

Species of reef fish caught and sold for export:

- Hawaii: *Zebrasoma flavescens*, *Acanthurus achilles*, *Zaclus cornutus* and *Centropyge loricula*, the flame angelfish.
- Puerto Rico: *Gramma loreto*, *Holocanthus tricolour*, *Pomacanthus paru*, *Balisted vetula* and *Opistagnathus aurifrons*.

Figure 1. Number of export countries

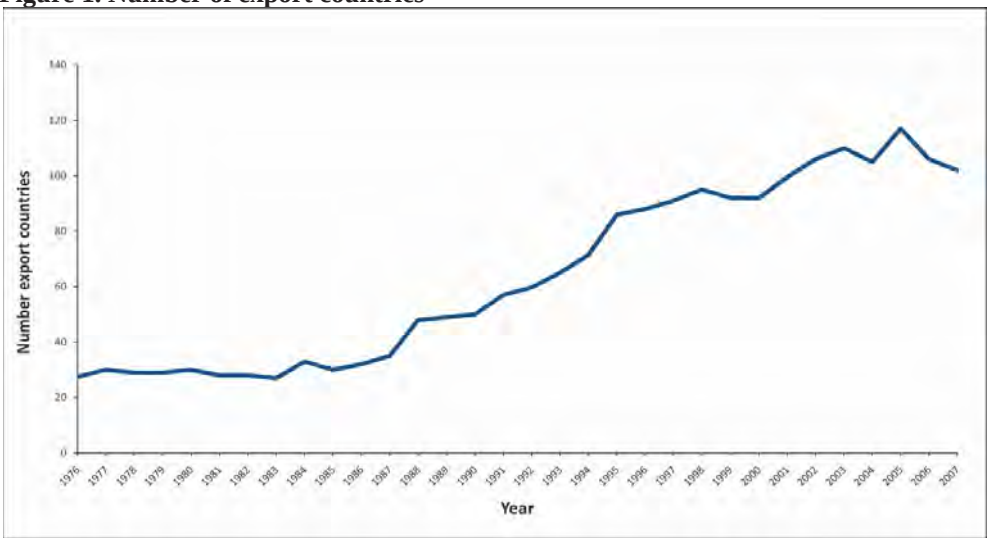


Figure 2. Export value

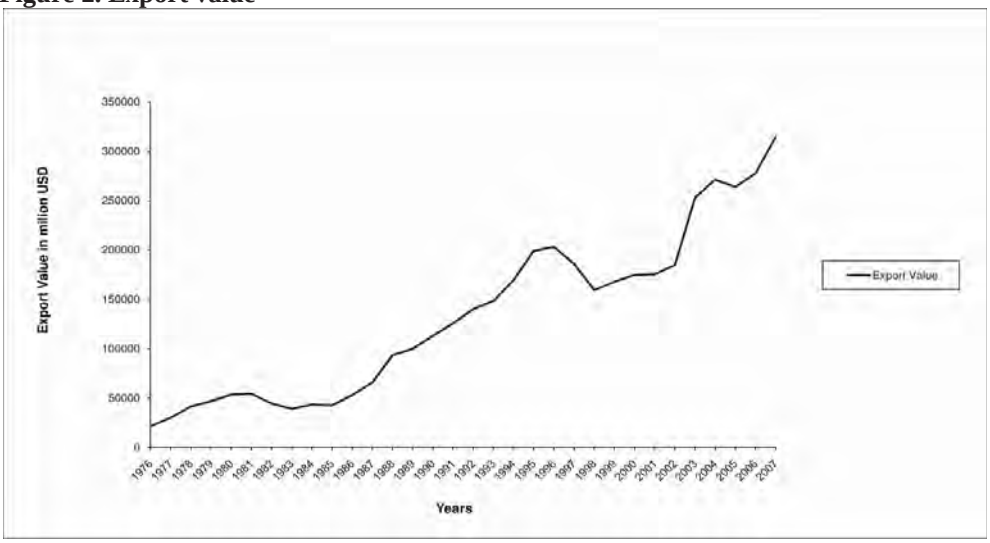


Figure 3. Main export countries

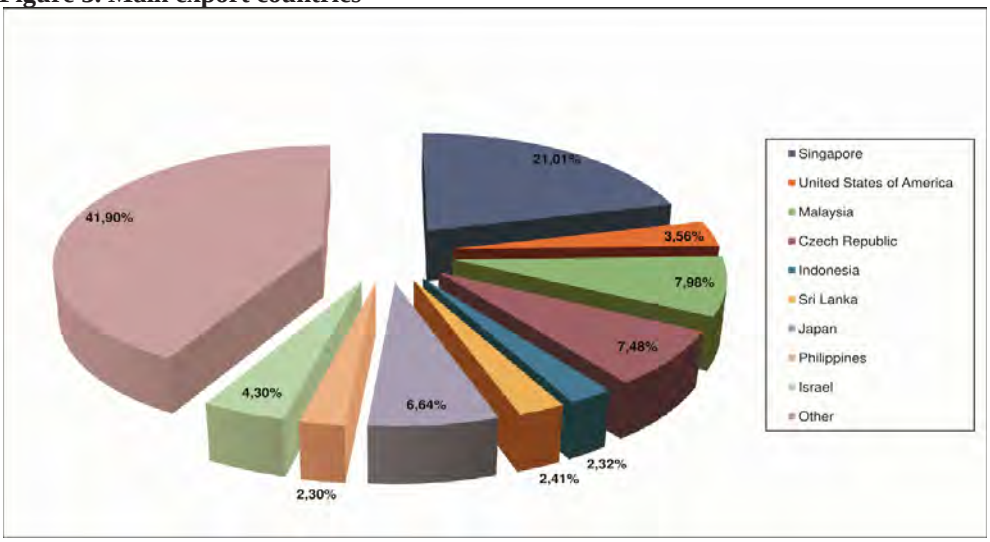


Table 2. Main export countries

Export countries	Value ('000 USD)	Share of total export (%)
Singapore	66 079	21.01
United States of America	11 224	3.56
Malaysia	25 127	7.98
Czech Republic	23 527	7.48
Indonesia	7 305	2.32
Sri Lanka	7 592	2.41
Japan	20 886	6.64
Philippines	7 382	2.30
Israel	13 593	4.30
Other	131 789	41.90
Total	314 504	100

Source: Fisheries and Aquaculture Information and Statistics Service, FAO (FIES) (2007)

Table 3. United States exports ('000 USD)

Product	2005	2006	2007	2008	2009	Jan 2009	Jan 2010
Ornamental fish	5 774	5 882	7 309	9 058	8 995	710	712

Source: US Department of Commerce, Bureau of the Census

Figure 4. Development in top five export countries

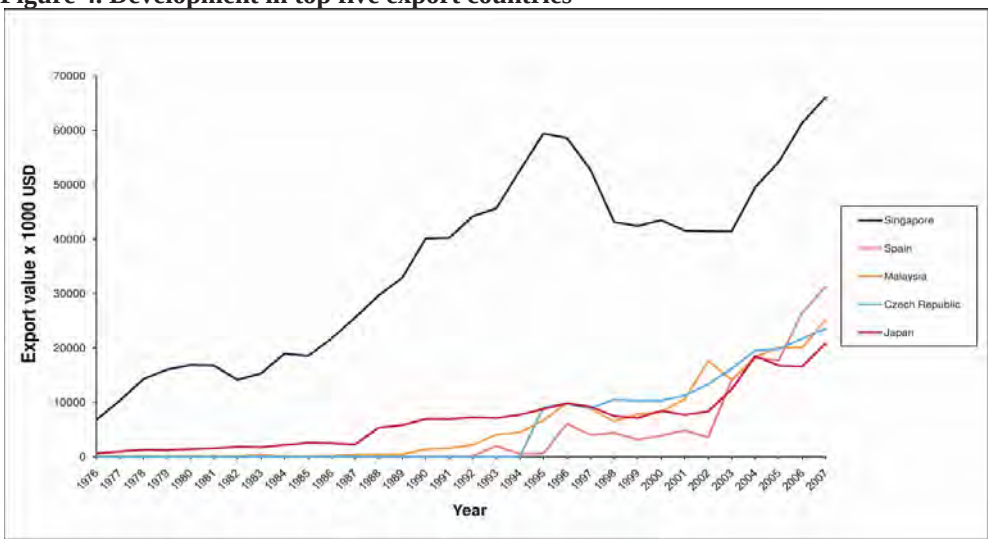


Figure 5. Exports by continent

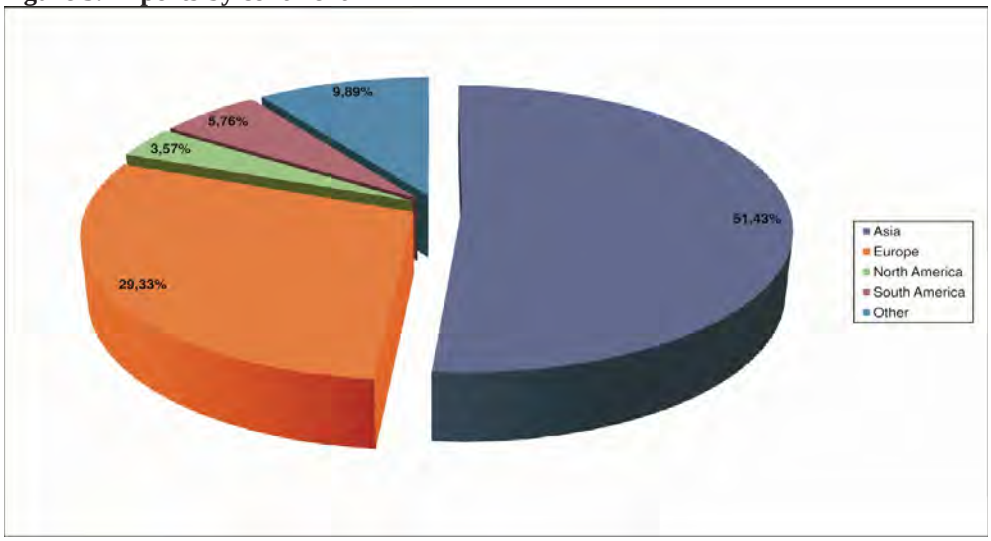


Table 4. Exports by continent

Export countries by continent	Value ('000 USD)	Share of total export (%)
Asia	161 763	51.43
Europe	92 245	29.33
North America	11 255	3.57
South America	18 139	5.76
Other	31 102	9.89
Total	314 504	100

Source: FIES (2007)

1.1.2 Origin of ornamental fish

While numerous countries are involved in the trade of ornamental fish, only a few geographical areas are affected.

Southeast Asia boasts a large number of exporting countries. There are many farms in this region, most of them professional, and almost all species are bred and reproduced on a large scale. The rivers and forests are also important sources for the supply of ornamental native species.

In southern China there is a huge market, even if production is currently for the domestic market only and therefore not destined for export; complete data are not available (Subasinghe, 2006).

The European Union plays an important role, in particular Central and Eastern European countries (the Czech Republic has a 30% share of European exports) and Spain (29%). Only a small proportion of the fish are reproduced, while 99% are from re-export, triangulation stocks from Africa and South America.
Other sources of ornamental fish are the Amazon region (5–6%) and the regions of the African Great Lakes (4–5%). Marine organisms are also included in these market shares, even if they account for just one-tenth.

South America's low market share is related both to the increasingly stringent regulations on animal protection imposed by Brazil and Peru, and to the fact that in Southeast Asia, almost all the species originating from the Amazonian rivers are now reproduced on a large scale. The products are of excellent quality with highly competitive prices and benefit from an efficient supply chain.

Florida dominates freshwater ornamental fish culture with about 200 farms raising over 800 freshwater fish strains. The most important ornamental fish families for breeding in Florida are listed below.

- Cyprinidae (*Barbus* spp., *Capoeta* spp., *Brachydanio* spp., *Boraras* spp., *Labeo* and *Epalzeorhynchus* spp.), reared in Florida; temperate species are goldfish and koi.
- Characidae and relatives (*Hyphessobrycon* spp., *Megalamphodus* spp., *Paracheirodon innesi* [neon tetra], *Gymnocorymbus ternetzi* and *Colossoma macropomum* [South American pacu]), reared in Florida.
- Piranhas (*Serrasalmus* spp. and *Pygocentrus* spp.), not reared in Florida as possession is illegal.
- Melanotaeniidae: all rainbow fish species from Australia and New Guinea.
- Loricariidae: *Ancistrus* spp., *Plecostomus* spp. and *Pterygoplichthys gibbiceps*.
- Cichlidae: all Central and South American cichlids (e.g. *Geophagus* spp., *Cichlasoma* spp., *Heros* spp., *Astronotus ocellatus*, *Pterophyllum scalare*); most dwarf cichlids (e.g. *Apistogramma* spp.) and cichlids from the Malawi, Tanganyika and Victoria Lakes in Africa (e.g. *Pseudotropheus* spp., *Julidochromis* spp., *Lamprologus* spp., *Melanochromis* spp.).
- Poecilidae: all livebearer species, *Poecilia* spp. (guppy, latipinna and mollienesia) and *Xiphophorus* spp. (swordtail, maculatus and variatus).

- Osphronemidae: all labyrinth fish (e.g. *Colisa* spp., *Trichogaster* spp., *Helostoma temmincki* and *Betta splendens*).

Table 5. Most imported marine ornamental fish species

Species name	Wholesale price in importing country (EUR)
Amphiprion spp.	10–18
Chromis virdis	3–4
Dascyllus sp.	3–4
Zebrasoma spp.	5–70
Synchiropus splendidus	10–14
Centropyge sp.	14–50
Chelmon rostratus	18–20
Chaetodon sp.	18–20
Pomachanthus spp.	15–20
Hippocampus reidi	40–50

Table 6. Most imported freshwater ornamental fish species

Species name	Wholesale price in importing country (EUR)
Poecilia reticulata	0.96–2.20
Paracheirodon innesi	0.46–1.40
Xiphophorus maculatus	0.80–1.40
Xiphophorus helleri	1.25–1.60
Poecilia velifera	0.99–2.80
Pterophyllum scalare	1.20–15
Carassius auratus	0.41–2.05
Brachydanio rerio	0.69–0.96
Symphysodon spp.	7.50–250

Table 7. Species of marine fish and invertebrates reproduced in captivity and marketed

Hippocampus reidi yellowisch (CITES)	*Amphiprion clakii* (yellow fin)
Hippocampus reidi yellow (CITES)	*Amphiprion frenatus*
Pseudochromis fridmani	*Amphiprion melanopus*
Pseudochromis spingeri	*Amphiprion ocellaris*
Pomacanthus asfur	*Amphiprion ocellaris* (black) Darwin
Pomacanthus maculosus	*Amphiprion ocellaris* (black) Darwin
Pomacanthus maculosus	*Premnas epigramma*
Amphiprion clakii (yellow fin)	*Lysmata wurdermanni*

1.1.3 Imports

The number of importing countries gradually increased from 32 in 1976 to about 130 in 2001, to then settle at around 120; following a slight decrease in 2004, importing countries numbered around 135 in 2007. The 10 largest importing countries account for around 78% of the market share and the top 25 for 95%.

The largest importers of ornamental fish are the United States of America, the United Kingdom, Germany, France, the Netherlands and Italy. In Asia, Japan and Singapore are

the major importers; China has a tradition of keeping ornamental cold-water fish. Europe accounts for 44% of imports, Asia 23% and North America around 18%.

In Europe, the United Kingdom accounts for 10% and Germany 8%, while France, the Netherlands, Spain and Italy each account for less than 10%, and imports to Eastern and Central Europe are negligible. The United States of America covers around 13% of the total market.

High unit price fish species (e.g. *Symphysodon* spp.) are mainly imported by Hong Kong and Singapore, and in Europe by Germany.

The trend of transactions of the four largest European importers of ornamental fish was stable in 2006 and 2007, while data for 2008 (only available for France, Germany and Spain) indicate a substantial fall in imports due to the financial crisis of that year, although Germany remained in line with previous years.

Japan's imports remained stable during 2006 and 2007: USD 27.2 and 26.9 million, respectively, followed by a slight drop in 2008.

Table 8. Japan imports

Country or area	Year	Comm. Code	Commodity	Trade ('000 USD)	Weight (kg)
Japan import	2008	30110	Ornamental fish, live	26 632	184 926

Source: UNdata, United Nations Statistic Division, Commodity Trade Statistics Database

Japan imports only small quantities of koi carps and goldfish, as Japanese breeders monopolize the market. In contrast, around 95% of all other tropical fish in Japan are imported: two-thirds freshwater, one-third marine fish and invertebrate species.

Most arowana "bonytongues" are bred in Singapore and Indonesia (the third generation are crossbred) and shipped under permit from the various national agencies. Recently, there has been an increase in imports to Japan from South America (Peru, Brazil and Colombia) and Africa (Kenya and Ghana) by direct air flight. Viet Nam also ships some tropical fish to Japan.

Imports of freshwater aquatic plants must be placed under quarantine procedures at the port of entry by the Japanese Animal Quarantine Service (AQS).

Note that species included in Appendix I of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), e.g. *Scleropages formosus*, are protected by the 1992 Law No. 75. However, sea anemones and live coral (not under CITES) are not subject to any import restrictions.

Almost 80% of all United States ornamental fish arrive from Asia: Singapore, Thailand and Indonesia are the major exporting countries. South America is the second largest exporting region, where Brazil and Peru are the major exporters. Europe has only a minor trade role.

In 2008, imports remained stable at USD 44 million (the USDA figure for 2007 is USD 43 million, in line with the FAO figure). In 2009, there was a notable drop in imports to USD 39 million – a decrease of USD 5 million compared with the previous year and a result of the economic crisis. A similar drop had only been seen previously in 2002.

Freshwater fish represented 95% of total volume and 80% of total import value. The other 5% and 20%, respectively, were accounted for by marine fish and invertebrates. Most ornamental fish imports arrive in Miami, Florida, the most important hub for this sector.

Figure 6. Number of import countries

Figure 7. Import value

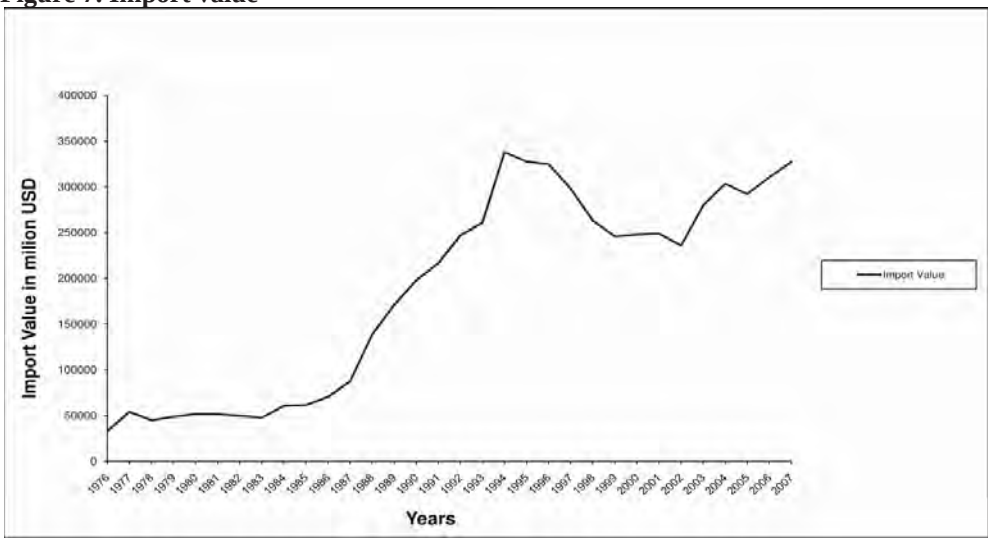


Table 9. United States imports ('000 USD)

Product	2005	2006	2007	2008	2009	Jan. 2009	Jan. 2010
Ornamental fish	46 014	48 354	43 147	44 233	39 113	3 694	3 156

Source: US Department of Commerce, Bureau of the Census

Figure 8. Imports by country

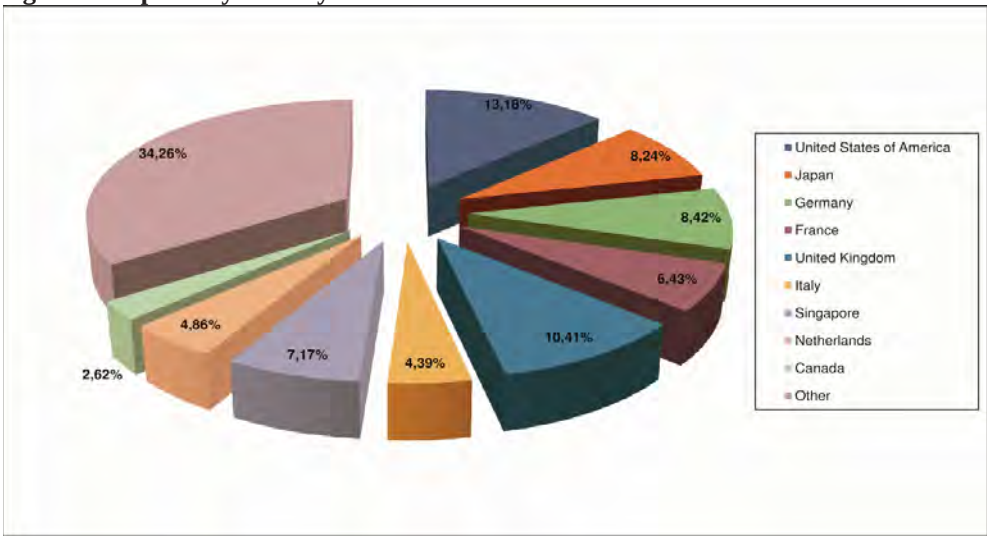


Table 10. Main import countries

Import countries	Value ('000 USD)	Share of total import (%)
United States of America	43 136	13.18
Japan	26 971	8.24
Germany	27 567	8.42
France	21 033	6.43
United Kingdom	34 078	10.41
Italy	14 386	4.39
Singapore	23 465	7.17
Netherlands	15 897	4.86
Canada	8 573	2.62
Other	112 177	34.26
Total	327 283	100

Source: FIES (2007)

Figure 9. Imports by continent

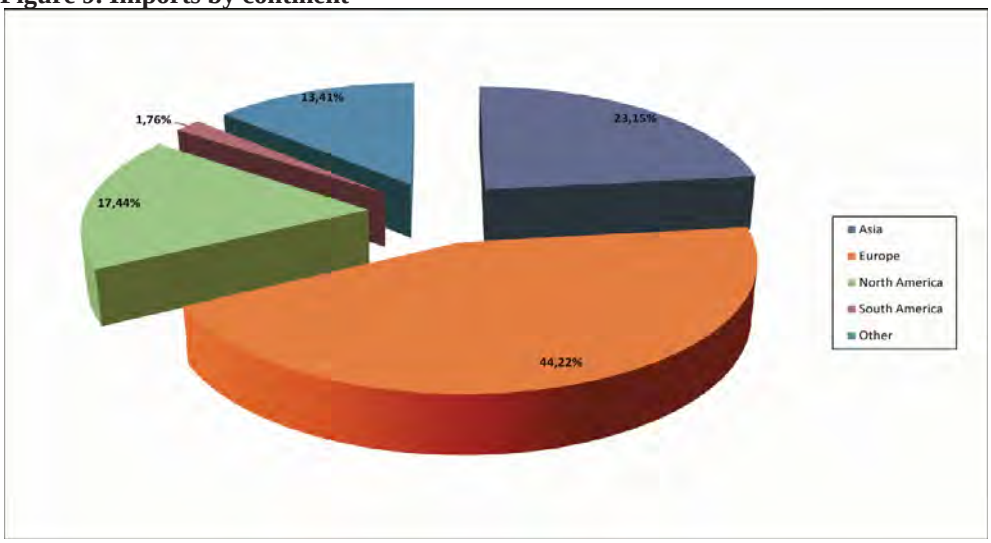


Table 11. Imports by continent

Import countries by continent	Value ('000 USD)	Share of total import (%)
Asia	75 773	23.15
Europe	144 736	44.22
North America	57 110	17.44
South America	5 769	1.76
Other	43 895	13.41
Total	327 283	100

Source: FIES (2007)

Figure 10. Re-exports

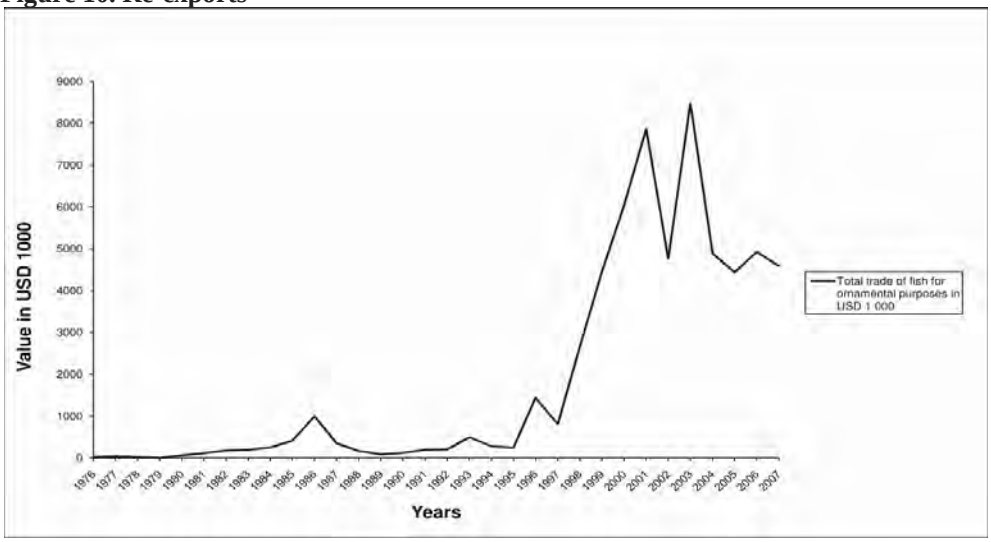


Figure 11. Trade trend

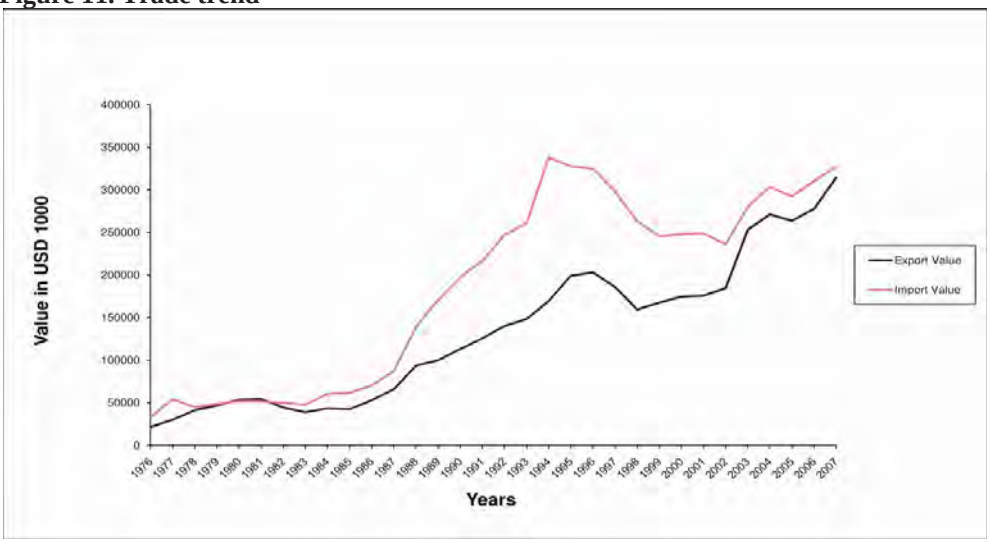


Table 12. Total trade ('000 USD)

Year	Re-export value
1990	122
1991	195
1992	206
1993	494
1994	278
1995	246
1996	1 438
1997	812
1998	2 666
1999	4 458
2000	6 039
2001	7 865
2002	4 758
2003	8 480
2004	4 885
2005	4 438
2006	4 923
2007	4 589

Table 13. Re-exports ('000 USD)

By country 2007	Value
China, Hong Kong SAR	4 519
United Arab Emirates	34
Taiwan Province of China	16
Malaysia	11
Oman	5
Jordan	3
New Zealand	1
Total	4 589

Source: FIES

Table 14. United States import and export trend ('000 USD)

Year	Import value	Export value	Balance
1998	67 309	10 609	56 700
1999	57 359	11 007	46 352
2000	60 008	8 289	51 719
2001	61 766	7 045	54 721
2002	39 686	8 381	31 305
2003	64 215	8 561	55 654
2004	68 146	8 664	59 482
2005	46 051	9 793	36 258
2006	48 365	5 860	42 505
2007	43 136	11 224	31 912

Source: FIES

1.1.4 Summary

- The trend has been one of constant growth since FAO started keeping statistical records, i.e. since 1975.
- There are new trade situations in both exporting and importing countries.
- There are new ornamental species on the market as a result of extreme selection of phenotypic characters; some of these species are genetically modified.
- The biggest exporters are in Southeast Asia, in particular Singapore with a 20% share of the market.
- The biggest importers are the United States of America, Japan and some European countries (Germany, the Netherlands and Italy).
- A total of 95% of ornamental and freshwater fish are bred in captivity.
- The economic crisis in late 2008 has hit the sector hard:
  - significant fall in the volume of trade (major importers most affected);
  - notable drop in the offer of ornamental species of high absolute value (especially species captured in the wild and hard to breed);
  - reduction in annual imports by operators in Europe, due to fall in internal demand;
  - no significant innovations of a technical nature or with regard to keeping ornamental species; and
  - international fairs attended by fewer companies.

- At present, the socio-economic repercussions for importing countries are unclear. Most of the rural populations in exporting countries make a living out of breeding, catching and selling ornamental species, so studies should be carried out to ascertain the impact of the crisis in these countries and on these rural populations.
- The continuing rise and fluctuation in fuel prices has had serious repercussions for trade.
- The trend will remain negative until the biggest importing countries (e.g. the United States of America) recover from the crisis and potential buyers have enough money to spend on their hobby.
- The current global outlook is bleak; there are, however, ample margins for improvement on the two previous years.

Table 15. Trade in selected European countries

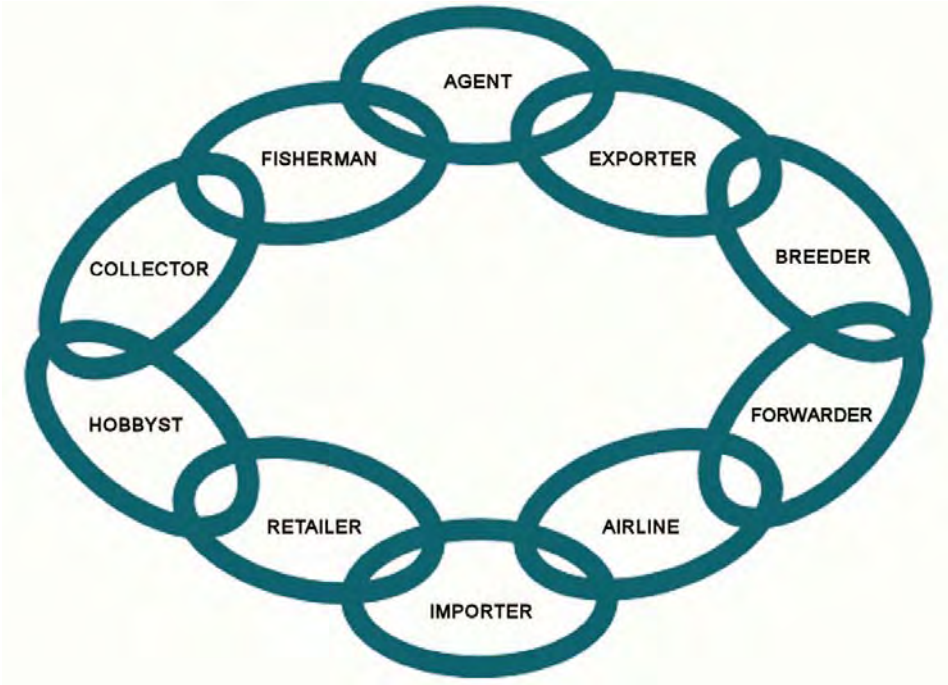
Country or Area	Year	Comm. Code	Commodity	Flow	Trade ('000 USD)	Weight (kg)	Quantity Name
France	2009	30110	Ornamental fish, live	Import	21 814	700 868	Weight in kg
France	2009	30110	Ornamental fish, live	Export	3 419	109 311	Weight in kg
France	2009	30110	Ornamental fish, live	Re-import	124	2 900	Weight in kg
France	2008	30110	Ornamental fish, live	Import	23 413	683 701	Weight in kg
France	2008	30110	Ornamental fish, live	Export	9 464	158 818	Weight in kg
France	2008	30110	Ornamental fish, live	Re-import	58	40 800	Weight in kg
United Kingdom	2009	30110	Ornamental fish, live	Import	29 841	1 975 361	Weight in kg
United Kingdom	2009	30110	Ornamental fish, live	Export	4 651	530 524	Weight in kg
United Kingdom	2008	30110	Ornamental fish, live	Import	33 684	2 069 308	Weight in kg
United Kingdom	2008	30110	Ornamental fish, live	Export	3 956	546 174	Weight in kg
Germany	2008	30110	Ornamental fish, live	Import	27 772	380 187	Weight in kg
Germany	2008	30110	Ornamental fish, live	Export	5 152	21 543	Weight in kg

Country or Area	Year	Comm. Code	Commodity	Flow	Trade ('000 USD)	Weight (kg)	Quantity Name
Italy	2008	30110	Ornamental fish, live	Import	53 807	7 337 134	Weight in kg
Italy	2008	30110	Ornamental fish, live	Export	3 140	240 682	Weight in kg
Netherlands	2008	30110	Ornamental fish, live	Import	16 069	667 396	Weight in kg
Netherlands	2008	30110	Ornamental fish, live	Export	8 487	461 991	Weight in kg

Source: UNdata, United Nations Statistic Division, Commodity Trade Statistics Database

2. THE VALUE CHAIN

2.1 SUPPLY CHAIN



The value chain – or supply chain – in the ornamental fish trade is highly specialized and varied; a multiplicity of actors come into play, from the fisherman of the Amazon River, through the veterinary services of the territorial jurisdiction to the aquarium hobbyist (the end user). In order to guarantee the quality of the ornamental fish on the market, the numerous components of the industry must be rationalized.

In the field of fish and marine invertebrates, supply depends almost exclusively on the natural environment. There are several contributing factors, however: the discovery of new species, the high cost of research into the captive breeding of reef fish, low labour costs.

What is more, fishing in a natural environment contributes to the livelihoods of the predominantly rural fishing communities, be they fishermen or Amazonian *piaberos*, Filipinos or Indonesians. The sustainable exploitation of natural resources has important socio-economic repercussions: the local population can obtain a renewable source of income, without a destructive impact (or with limited impact) on the rain forests and coral reefs.

The structure of fishing varies from area to area and from country to country, and according to local practices; for example, the traditional Ornamental Fish Festival in Barcelos, Brazil, on the Rio Negro is central to the local fishing trade.

Fishing is based on a large number of fishermen (collectors), usually working independently at household level. Some work part-time, others full-time, such as the Brazilian fishermen in their fishing stations in the middle of the forest, who remain for several days (at least until they have captured a sufficient number of specimens).

Such activities do not require large financial or technical investments. The fishermen usually supply the exporters, but not always. Given the distances involved (often several days of navigation) and issues regarding the transport of livestock, intermediaries are used (sometimes affecting the price trend on the market), who in turn supply the wholesalers (in Manaus, for example).

Commercial operations regarding the collection of ornamental fish directly in the field are carried out in several countries, mainly in South America (Amazonian countries), Africa (the region of the Great Lakes: Malawi, Victoria and Tanganyika) and the Asian subcontinent.

With regard to the breeding of ornamental fish in captivity, the supply chain is less complicated, more straightforward and shorter. The reproduction of different species contributes to the selection of new profitable commercial strains. Over the years demand has created numerous strains of fish: goldfish (heteromorphy variety), poeciliids (countless varieties of *Poecilia reticulata*), *Betta splendens* (fighting fish), the beautiful and expensive discus strains and angelfish. Often, species bred in captivity prove easier to keep in aquariums and more adaptable.

Fish farms vary, both in size and specialization, each one breeding a different species or family of fish (e.g. *Barbus* or cichlids).

They range from small farms managed at household level, to large facilities financed by foreign investors and employing dozens of collaborators. In some Asian countries (e.g. Sri Lanka) there are government programmes for the construction of ornamental fish farms; such projects are financed through microcredit and constitute a basis for rural development and for supplying to wholesaler countries.

2.1.1 Fish farms and breeders

The vast majority of breeding businesses are based in Asia, especially in Singapore, but there are also many in North America (especially Florida) and South America. Other countries, such as the Czech Republic and Israel, have also started to develop breeding businesses.

There are various kinds of breeder. In Asia, especially Singapore, fish-rearing businesses are family firms. Increasingly, they are grouped in agrotechnology parks developed by government agencies. More rudimentary rearing businesses also exist. In the Philippines, for example, people rear fish in urban slums where sanitary conditions are poor. In Guyana, rearing basins can be holes in the soil, lined with waterproof canvas and with floating plants on the surface.

In the United States of America, investment has been made in high-capacity industrial breeding. Europe on the other hand, has very few commercial rearing businesses, and

groups of amateurs may supply local retailers and individuals, while some professional breeders sell to wholesalers, retailers or directly to the public. In most countries, rearing facilities must obtain a licence or permit from the environment ministry (or other responsible ministry), which then sends biologists or veterinary officers to check the sanitary conditions.

2.1.2 Exports

Ornamental fish (bred or wild) are shipped and exported from different tropical and subtropical areas around the world; exchanges depend on the flight routes and timetables (strikes or delays can lead to a high mortality rate). In several countries, it is possible to re-export "imported" fish through commercial networks (common practice in some European and Asian countries to bypass restrictive regulations relating to animal welfare).

2.1.3 Airlines

Air transport is central to trade in ornamental fish. Indeed, without the rapid development of intercontinental flights, the aquarium would not be possible (Fossa, 2007). The transport of tropical animals requires specific expertise in the field of handling, even if it accounts for only a marginal part of foreign trade.

Photograph 2. Customs in Manaus

Courtesy of P. Monticini

A quality carrier service is crucial to the success of the export of ornamental fish.

2.1.4 Imports

A variety of economic factors condition ornamental fish imports. Training and specialization are required in numerous areas: professional skills, existing regulations, problem awareness and acclimatization. In general, as a result of the economic crisis, the volume of trade and purchase direct from the wholesaler has declined.

The phenomenon of "transshipping" is unique to the ornamental fish trade: third party companies offer services to small importers to combine multiple orders (each for small amounts) and form large shipments; customs papers for the various parties are thus reduced, as are the costs for shipping and handling for animal health certification. Small wholesalers can therefore obtain goods from different suppliers without having to order large quantities. This arrangement, however, does not exempt the wholesaler from the practical logistics of conditioning and acclimatization of the fish.

Following quarantine, the fish are sold to retailers: small outlets with just a few tanks selling a limited number of species; highly specialized shops dedicated exclusively to ornamental fish; or pet shops and garden centres, where fish are sold alongside other pets or combined with the management of ornamental garden ponds.

2.1.5 Transshipping

Transshipping is a relatively new activity involving the grouping of orders from several retailers, collection of the fish at the airport and redistribution. The boxes are not opened and the transshipper does not check the quality of the fish. The retailer takes responsibility for the whole consignment, including any fish that died during the flight. The transshipper is a logistic agent, grouping orders so as to maximize profit, but this method is profitable only when there are a large number of minor clients making small orders to various suppliers. The idea is to reduce freight charge and decrease the documentation requirements, but the livestock is inevitably endangered.

When additional services are provided, the activity is called "consolidating"; it is a growing business, in spite of concern about the quality of non-acclimatized fish and high mortality rates. For transport by plane, the transshipper and the importer must negotiate freight tariffs with one of the transport associations regulating the shipment of live animals, such as IATA (International Air Transport Association – Live Animal Regulations) and OFI (Ornamental Fish International). They can also become members of such associations and obtain better tariffs.

Transshipping may represent a danger for the sector, because fish that have not been acclimatized, and which have come directly from the point of capture (or from the rearing site), can transmit diseases or parasites to healthy fish if the retailer sells them on without a proper quarantine period.

2.2 SOUTH AMERICA

2.2.1 Amazonian flooded forest

The basin of the Amazon River covers a wide area – about 7.5 million km^2 – and passes through numerous countries: Bolivia (Plurinational State of), Brazil, Colombia, Ecuador, French Guyana, Suriname, Peru and Venezuela (many of which are net exporters of ornamental fish). It is the biggest river in the world and supplies about 20% of all the freshwater in the Atlantic Ocean. Its tributaries come from the Andes in Guyana and Brazil. The colour of the water varies depending on the substrate flow and the substances dissolved inside: white water (*agua branca*), clear water (*agua clara*) and black water (*agua preta*).

2.2.2 Areas of origin

In the Amazon, it is possible to distinguish three different types of environment (biotopes), identified by the colour of the water (white, black or clear).

Photograph 3. *Liosomadoras oncinus*, the jaguar catfish

Courtesy of P. Monticini

***Agua branca* (white water)**
Density of milk, yellow ochre colour, the result of the enormous amount of clay, laterite and debris in suspension, together with mud that the strong current of the river washes continually from the riverbed.
Visibility: < 50 cm.
Chemical values: pH 6.2–7.2; KH (carbonate hardness) 0.2°–0.4°dH (German degrees of hardness); GH (general hardness) ≤ 1°dH.

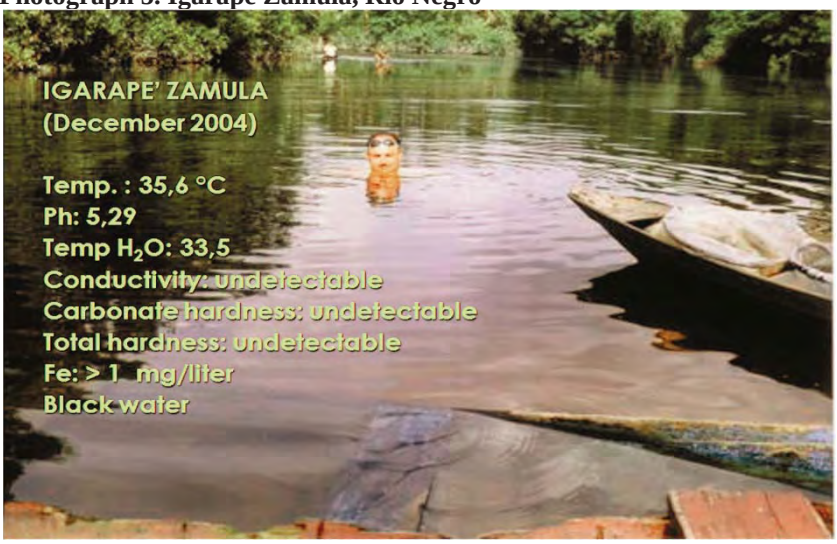
***Agua clara* (clear water)**
Clearness remains all year round, even during periods of plankton bloom, and water flows at a low speed. Bed formed of gravely or sandy soils, sand and gneiss (a type of sedimentary rock, similar to sandstone, light and dark in colour) or granite.
Found in small streams which come together to form larger rivers, such as the Rio Maues.
Visibility: 1–4.5 m.
Chemical values: pH 4.5–7.8; KH < 0.3°dH; GH 0.3°–0.8°dH.

***Agua preta* (black water)**
Characteristic brown "coca-cola" colour, due to high content of humic acids resulting from large amount of decomposing organic material (leaves and tree trunks submerged during the rainy season). Studies (Mayland, 1994) show that in 1 ha of the Amazon basin, an average of 15 tonnes of leaves fall every year.
Found in the Rio Negro and its tributaries, biotope of the Heckel discus. It is known by the natives as "waters of hunger", because of the shortage of dissolved solids inside and the scarcity of life forms. Fish often found in stretches of river in which different types of water (including *agua preta*) are mixed together (Bleher, 2006).
Visibility: 1.30–2.50 m.
Chemical values: pH 3.8–4.7; KH cannot be measured because of the low level of carbonates; GH ~0.1°dH.

Photograph 4. Manaus beach during dry season

Courtesy of P. Monticini

Photograph 5. Igarapé Zamula, Rio Negro



Courtesy of P. Monticini / Source: Hydra (2006)

The major tributaries of the Amazon river include: Rio Negro, Rio Branco, the Japurá, Rio Madeira, Rio Purus, Rio Tapajos, Rio Tocantis, Rio Trombetas and Xingu. They all represent important sources of ornamental fish and are home to an estimated 3 000 specimens from different genera, families and species, including local varieties. The Amazon accounts for approximately 7–10% of the trade of freshwater ornamental fish. Brazil, Colombia and Peru are the major exporters.

Fishermen live in remote villages and, since the early 1950s, ornamental fish have increasingly represented the livelihood of tens of thousands of rural people (*cablocos*). The capture of ornamental fish produces socio-economic benefits and safeguards natural ecosystems by reducing deforestation and slowing the abandonment of rural communities by fishermen heading to the suburbs of cities (e.g. Manaus), thus limiting the phenomena of social exclusion and deprivation. The government and various conservation projects encourage investment in small trade in ornamental fish and the protection of the forest.

2.2.3 Barcelos, Rio Negro: a case study

The environment and socio-economics of the middle stretch of the Rio Negro, Amazonia, Brazil (Piabas), depend largely on the international demand for ornamental fish (Chao *et al.*, 2001). While ornamental fish (*peixes ornamentais*) account for a marginal share of exports in the whole Amazonas State, for the Municipality of Barcelos (population of 20 000) they represent over 60% of the economy. An estimated 1 000 families are actively involved in the capture and transport of ornamental fish, and about 80% of the population are active at some level in the market.

Photograph 6. View of Barcelos, Rio Negro

Courtesy of P. Monticini

In recent years, the growing demand for aquarium fish has resulted in an increase in the number of fishermen (*piaberos*). However, the value chain is controlled by commercial companies and intermediaries: there is little scope for those at the base of the chain to make large profits. A feudal system operates which stems from the system originally created for fishing catfish. The local fishermen are paid very little for ornamental fish, as they compete with farmers from the United States of America, Eastern Europe and Southeast Asia. Moreover, rather than being paid in the local currency (real), their basic needs are met by payment in goods. This is detrimental to the development and self-determination of the rural population of fishermen.

Photograph 7. Acará bandeira after catching

Courtesy of P. Monticini

In 1955, Barcelos became the capital of ornamental fish; it has been calculated that around 20 million fish are traded every year (Chao *et al*., 2001). There are several technical stages: capture in the forest, transport to Manaus, rearing and shipment. The equipment used for capture varies, depending on the species concerned (Chao *et al*., 2001).

Catches are high during the dry season (from September to March of the following year); the water level is lower and the fish are concentrated in small shallow "stream" channels. In contrast, during the rainy season (April to August), catches are very low, because the fish hide in the flooded forest (resulting from the high water level). Some specimens, such as *Symphysodon* discus, are caught during the night (in the dry season) with the use of lamps; they are generally captured individually with long mesh screens to avoid damaging the fish.

Photograph 8. Fishing tools used on the Rio Negro

Courtesy of P. Monticini

Courtesy of P. Monticini

During fishing trips, fish are placed in plastic boxes where the water is changed often to avoid overheating. The length of a fishing trip depends on the size of the catch, but can last 8–9 hours. The fish are then delivered to the "field" (fishing camp), divided according to species and placed in different types of container. Cardinals are placed in "pens" of nylon nets, submerged and anchored in the water, discus in large wooden boxes (*Viveiros*, 1.5 × 2 × 1 m) immersed in the water with small holes for water exchange.

Photograph 9. Export facilities in Barcelos

Courtesy of P. Monticini

Other specimens are placed in stacks of simple plastic boxes. Unfortunately, the fishing methods and storage techniques adopted result in a high mortality rate, despite frequent water changes (approximately 5 times in a 3-hour period).

The fish remain at the "fishing camp" for between 24 hours and 3 weeks, depending on demand, distance from Barcelos and transport; during this stage, the fish are poorly fed. They are separated, counted and sorted by size and quality, before being loaded and transported to Barcelos, where they remain for between 6 hours and 2 weeks. The number of fish placed in each container varies, depending on species and size. For example, cardinal 600–1 000, discus 3–6, *Carnigella strigata* 200–300.

Transport by boat from Barcelos to Manaus takes between 6 hours and 4 days (usually about 30 hours). The fish remain in their containers throughout the journey, and the water is only changed prior to departure from Barcelos.[4]

A change of water has a strong impact and can be stressful for the fish and cause skin lesions.[5] Upon arrival in Manaus, the fish are transported to wholesalers where they remain for between 1 week and 1 month. The fish are then quarantined and stored in glass or cement tanks. Prior to export, they are treated for ectoparasites (e.g. *Saprolegnia* spp. and *Ichtyobodo necator*) and bacterial infections.

The various stakeholders in the supply chain lack sensitivity – partly the result of the low prices at which the fish are offered to the United States of America and the European Union. South Florida is a hub of sales, distribution, breeding and shipping of ornamental fish (Harvey, 2004).

[4] From personal experience, recorded in the field, the water is also replaced during transport.
[5] Although literature cites the use of salt and antibiotics, I have no personal experience of such.

Photograph 10. Symphysodon discus after quarantine

Courtesy of P. Monticini

2.2.4 Assessment of water quality

In order to limit losses during the various stages of a fishing expedition, it is important to assess the water quality in the storage containers.

- Temperature: For cardinal tetra, the temperature of the water in the fishing camp is higher than at capture and during transport, while for discus, the highest temperature is recorded at capture and in the fishing camp.
- Oxygen: Concentration of O_2 decreases significantly at each stage, a factor affecting all species. The lowest concentration is detected at the export facilities in Barcelos and during transportation to Manaus. Hypoxia is stressful for the fish, resulting in susceptibility to attack by pathogens, bleeding, hyperplasia and hypertrophy of gills epithelia.
- pH: The pH value is very variable: between 2.8 and 6.4, depending on the fishing season.
- Ammonia: Concentration of NH increases as the fish go from the fishing camp to Manaus; it can reach very high levels, due to stress and osmoregulation problems, and causes damage to gills epithelia.

The critical points in the chain are storage in Barcelos and transportation to Manaus. The problems are poor water quality (observed during transportation) and the absence of standardized procedures for the packing and handling of different specimens. The mortality rate peaks at the two critical points (storage and transportation), reaching 30%. Data from the Piaba Project, on the other hand, show the mortality rate to be lower (< 3-5%).

Table 16. Mortality rate

	Mortality rate		Cumulative mortality average rate		Mortality rate
	Globefish GRP No. 67 (2001)	**Project Piaba (2003)[6]**	**Globefish GRP No. 67 (2001)**	**Project Piaba (2003)[7]**	**Monticini (2009)[8]**
Before transportation (Barcelos)	30–40%	< 1%	35%	< 1%	35%
During transportation	25–30%	0.2%	48%	< 1.15%	40%
At the wholesaler (Manaus)	25–30%	~ 1%	62%	< 1.96%	40%
At the retailer (United Kingdom)	25–30%	3.5%	73%	< 5.46%	30%

2.2.5 Exporters in Manaus

Over 25 companies in the State of Amazonas have export permission from IBAMA (Brazilian Institute of Environment and Renewable Natural Resources), but not all are operative. A total of 90% of the ornamental fish market in Manaus is controlled by just four exporters:

- Aquarium Corydoras Tetra LTDA
- Prestige Aquarium LTDA
- Turkys Aquario LTDA
- Aquamazon Import & Export LTDA

Photograph 11. Different specimens of *Symphysodon aequifasciata* spp. in Manaus

Courtesy of P. Monticini

[6] Author's own observation from places of capture and from wholesalers and retailers.
[7] Author's own observation from places of capture and from wholesalers and retailers.
[8] Author's own observation from places of capture and from wholesalers and retailers.

Each exporter uses intermediaries (Chao *et al*., 2001). The number of buyers and intermediaries varies, depending on the fishing location, the type of boat used for shipment and the type of corporate structure.

Smaller exporters have no direct control over the territory and buyers are therefore more independent: prices are agreed each week and vary from season to season. Payment is made to the agent upon arrival of the fish, alive at destination (e.g. Manaus).

2.2.6 Brazilian Institute of Environment and Renewable Natural Resources (IBAMA)

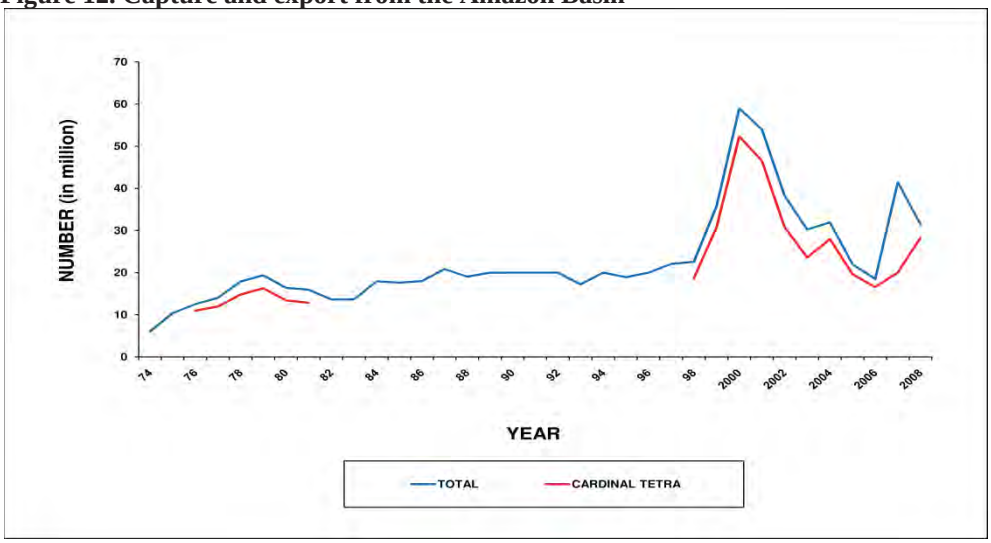
IBAMA was established in 1990. It carries out missions in the institutional sector, applies controls and encourages intervention with appropriate techniques in the environment to safeguard the Amazon forest through:

- regulation of the number of species and the number of ornamental fish caught for export;
- prevention of fishing during the spawning season (May–June);
- prevention of biopiracy;
- clarification of regulations to avoid irregularities in the industry; and
- monitoring to guarantee environmental quality.

Although IBAMA is under the Ministry of Environment, it exercises independent administrative and financial powers throughout the federal territory of Brazil. It can propose administrative and criminal sanctions, and tasks often overlap with those of the public veterinary service, leading to problems of coordination and expertise (especially at international airports with each livestock shipment).

2.2.7 Statistical data

Figure 12. Capture and export from the Amazon Basin



Source: Chao et al. (2001)

The graph shows the number of ornamental fish and the proportion of cardinal tetra (*Cheirodon axelrodi*) caught and exported between 1974 and 2008 from the Amazon Basin.

Many South American countries export ornamental fish, but the major exporting countries are Brazil, Peru and Colombia, where there is a long tradition and the rural people have acquired the necessary skills.

The total export value from these three countries in 2007 was approximately USD 17 million. This was much lower than in Asian countries where a large number of fish species originating from the Amazon Basin are bred in captivity (in Singapore, exports in 2007 were around USD 66 million).

The increasingly restrictive national laws also limit export: there are strict limits on taking wild fish directly from the source (e.g. Brazil Portaria No. N-062-N, 1992 – IBAMA, applied to more than 150 freshwater fish species and 100 marine ornamental fish, and the numerous species prohibited for export in Peru).

Table 17. Trade in Brazil

Country or Area	Year	Comm. Code	Commodity	Flow	Trade ('000 USD)	Weight (kg)	Quantity Name
Brazil	2009	30110	Ornamental fish, live	Import	179	8 537	Weight in kg.
Brazil	2009	30110	Ornamental fish, live	Export	7 106	96 594	Weight in kg.
Brazil	2008	30110	Ornamental fish, live	Import	156	6 589	Weight in kg.
Brazil	2008	30110	Ornamental fish, live	Export	5 628	130 555	Weight in kg.

Source: UNdata, United Nations Statistic Division, Commodity Trade Statistics Database

Figure 13. Export countries from South America

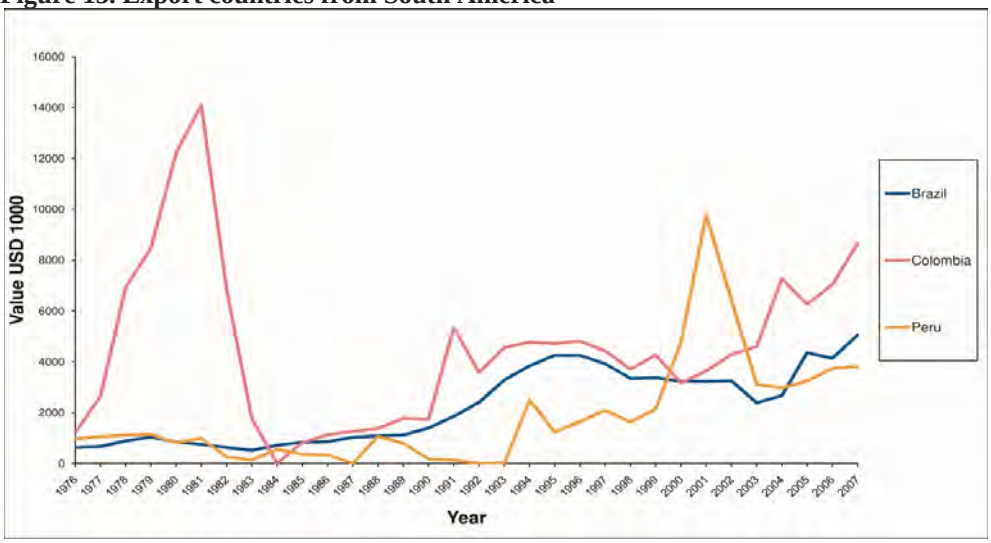


Table 18. Development in top three export countries in South America ('000 USD)

Year	Peru	Colombia	Brazil
1976	973	1 209	625
1977	1 051	2 627	665
1978	1 105	6 934	884
1979	1 142	8 451	1035
1980	811	12 221	843
1981	992	14 083	743
1982	255	6 851	622
1983	133	1 759	515
1984	552	1 500 F	711
1985	359	823	833
1986	335	1 122	859
1987	-	1 258	1 023
1988	1 061	1 373	1 078
1989	795	1 768	1 110
1990	172	1 723	1 393
1991	131	5 339	1 848
1992	-	3 583	2 396
1993	-	4 558	3 277
1994	2 494	4 770	3 833
1995	1 236	4 713	4 252
1996	1 643	4 819	4 249
1997	2 089	4 423	3 921
1998	1 628	3 705	3 345
1999	2 140	4 265	3 371
2000	4 753	3 162	3 235
2001	9 776	3 636	3 226
2002	6 439	4 284	3 250

Year	Peru	Colombia	Brazil
2003	3 102	4 599	2 379
2004	2 967	7 272	2 664
2005	3 247	6 258	4 350
2006	3 731	7031	4 136
2007	3 813	8 652	5 052

Source: FIES (1976-2007)

2.2.8 Sustainable management of ornamental fish species in Mamiraua: a case study

This section is an abstract of the documents relating to the project by the Darwin Initiative of DEFRA (Department for Environment Food and Rural Affairs, UK). The Darwin Initiative was launched by the United Kingdom Government at the Rio Earth Summit in 1992. It assists countries that are rich in biodiversity but poor in financial resources to meet their objectives under one or more of the three major biodiversity conventions.

Darwin projects typically address issues related to:

- institutional capacity-building;
- training;
- research;
- implementation of the Convention on Biological Diversity (CBD); and
- environmental education and awareness.

The key objectives of the Darwin Initiative are to:

- draw on expertise relevant to biodiversity from within the United Kingdom;
- work with local partners in countries rich in biodiversity but poor in resources;
- achieve the conservation of biological diversity and the sustainable use of its components; and
- achieve the fair and equitable sharing of benefits arising from the utilization of genetic resources.

Purpose: To protect the different species of ornamental fish in Mamiraua in a sustainable environment, by strengthening the capacity of fishers, the local community, researchers and reserve management.

Activities: Research and monitoring of the natural ecosystem; meetings with stakeholders; training workshops; and production of material for academic purposes and for wholesalers.

In order to have a baseline for the evaluation and monitoring of eventual impacts of exploitation, it is necessary to:

- identify the fish fauna of four lakes during the seasonal cycle phases;
- determine the natural abundance of species selected to be sustainably exploited; and
- describe the structure of the fish community.

Outputs:

- Biodiversity of ornamental fish species assessed and standardized, repeatable monitoring programme established.
- Social and economic parameters of community determined and monitored, local knowledge and needs identified, and feedback loop established.
- Market and economic potential identified, business plan and standardized guidelines established for trading procedure from source to end-user.
- Standards for sustainable harvesting upheld within the reserve.
- Understanding of, support for, and participation in sustainable ornamental fishery achieved within the community.

2.2.9 Biopiracy

Biopiracy is the illegal appropriation of wildlife – micro-organisms, plants and animals – and the traditional cultural knowledge that accompanies it.

Biopiracy is in violation of international conventions and corresponding domestic laws (where they exist); it does not recognize, respect or adequately compensate the rightful owners of the life forms appropriated or the traditional knowledge related to their propagation, use and commercial benefit. The term "legalized biopiracy" refers to international scientific expeditions. However, no legislation exists to decide the quality of the scientific expedition; furthermore, in Brazil, local researchers often lack the necessary authorization to collaborate.

In April 2003, following 10 years of negotiations, 182 countries of the CBD signed an agreement prohibiting the use of medicinal plants in developing countries for the manufacture of medicines and biotechnology to generate large profits. This agreement reflects the worldwide effort to establish laws against biopiracy and the trade of wildlife and native plants.

Rigorous legislation is being developed and enforced in Brazil. IBAMA has adopted a list specifying which fish may be captured, commercialized and exported for ornamental purposes. At present, a total of 215 freshwater species can be exported legally from Brazil – a major reduction on the 400 fish that have been traded for years (*OFI Journal*, No. 23, May 1998) and, therefore, a significant improvement.

2.3 SOUTHEAST ASIA

The Southeast Asian ornamental fish trade differs from the trade in Central and South America. A large number of countries are involved, each with different conditions of capture and breeding. In some countries, freshwater fish dominate and are reproduced on a large industrial scale. In others, marine fish and invertebrates play a major role, given the very extensive area. There are many countries involved, including Sri Lanka, Thailand, Malaysia, Singapore, Indonesia and Viet Nam.

2.3.1 Singapore

Singapore is one of the world's largest exporters of ornamental fish and the trading hub of Asia. In addition to its own exports, Singapore re-exports fish collected and bred in other countries in Asia (Indonesia, Thailand and Malaysia) and South America (Brazil, Peru and Colombia). Singapore is a duty-free zone and there are no heavy import duties to pay. It therefore imports a significant proportion of the Asian products and livestock and bulks them together for re-export worldwide. More than 60 countries receive ornamental fish from this small territory.

Singapore owes its success to its subtropical climate, good market conditions, chemically valid water and the availability of live food. It is strategically positioned with an excellent air transport service linked to all the major countries in Europe as well as to North America, Australia and the rest of Asia.

Ornamental fish breeding is the most important industry in Singapore's primary sector. It began at the end of the 1930s, and today Singapore produces more than 30 fish species with hundreds of varieties (new colours, long fin etc.). They are mostly reared in small family farms, which usually specialize in one particular species or family (e.g. Cichlidae). Over 70 farms currently operate in Singapore.

Ornamental fish production is:

Oviparous (70%):
- Cyprinidae (goldfish and koi, fighting fish and gourami);
- Characidae (tetra); and
- Cichlidae (African and South American fish, discus and angelfish and relatives).

Viviparous (30%):
- *Poecilia reticulata* (guppy, with tens of strains selected for colour and fin shape), accounting for around 80% of production; and
- Platy, black molly, and mollienesia.[9]

While it remains one of the largest producers of ornamental fish, Singapore's share in world exports has decreased because most farms are suffering from serious problems relating to quality, diseases (e.g. ADS angelfish sickness and discus plague) and biosecurity. Sanitary problems are associated with:

- overcrowding – diseases are transferred to healthy fish and native stock can be contaminated, both at the supplier and later at the retailer;
- the intensification of fish breeding and farming (especially -breeding) – the brood stock degenerates, resulting in the disappearance of the desired species in its original form; and
- the use of antibiotics – resistance increases as a result of overdosing.

[9] Data from Fishbase.org.

Statistical data

Singapore is one of the most important exporters in Southeast Asia and accounts for around 20% of world exports. Export volume has increased ten-fold since 1976; a drop in 2001 has been followed by a slow recovery.

It is still the leading exporting country, although many of the species exported from Singapore are commonly bred in Malaysia. Other Asian countries specialized in breeding freshwater fish, such as Sri Lanka and Viet Nam, export their production to Singapore.
Exports by Singapore in 2008 were USD 68.96 million (most recent data available).

Importing from Singapore: simulation of an order

A preliminary contact is usually made between the companies (wholesalers and exporters) via research databases or international associations of professionals (OFI or MAC [Marine Aquarium Council]), or directly in the country of origin with subsequent communications by telephone, fax or e-mail.

The terms of trade are agreed on: price and discounts (based on quantity), fish type. Payment is usually by bank transfer and takes place in advance – at least for the first delivery. Prices may be FOB (free on board), i.e. without a freight charge. Other costs to be incurred (in addition to the cost of the fish at source) can be briefly summed up as follows:

- Documentation for each shipment (regardless of the number of boxes purchased): USD 20–150 (depending on the exporter).
- Packing fee: USD 6–15 per box.
- Heating appliances in winter: USD 10–15 per box (approx.).
- Freight charge (based on the number of boxes shipped, total weight and volume): USD 5–7 per box, but shipping cost is usually halved for shipments over 100 kg; this figure may vary depending on fuel prices and the trade policies of the different airlines.
- Health certificate (if not already included by the exporter in the "documents for shipment"): USD 50–100 (approx.).

Once all conditions are established, an order and then a pro-forma invoice are sent, and final payment is made. About a week after sending the money (usually by bank transfer), the exporter communicates (via fax or e-mail):

- the AWB (air way bill) number;
- the shipment information (flight details, gross weight of shipment, content – usually "live tropical fish"); and
- the shipping costs of the forwarding agent (due agent) and carrier (due carrier).

In some transactions (e.g. shipments from Peru), the carrier (usually Lufthansa) sends all details of the shipment to the customer. Customs charges and shipping costs are paid directly at the port of arrival on clearance, once the importing company accepts the shipment in writing.

The biggest problem for exporters and traders is the complicated health legislation and paperwork concerning endangered animals. Moreover, these regulations are subject to constant change and variations in a very short period of time. The following rules are in force in the European Community:[10]

- Commission Decision 2006/656/EC
- Commission Decision of 21 November 2003 (2003/858/EC)
- Commission Decision of 6 October 2006 amending Dec. 2003/858/EC (2006/680/EC)

All documents must be issued in compliance with law Dec. 2006/656/EC (Annex IV), indicating the model of animal health certificate for imports of tropical ornamental fish into the European Community. Annex I of this law lists those countries from which imports of ornamental cold-water fish are authorized, and states the requirements for the transportation of fish in accordance with Article 3 of EC Regulation 1/2005 in accordance with the rules on animal welfare during transportation.

The box used for transportation must specify "tropical ornamental fish introduced only for decorative purposes in the European Community". Once the fish arrive at destination, authorized agents usually see to customs clearance, dealing with:

- the veterinary authorities (health records);
- the State Forestry Department (documentation for compliance with EC Regulation 338/1997 on the protection of endangered species of flora and fauna); and
- the customs authorities (taxes and duties).

Costs include customs duties, taxes, handling transactions and shipping fees. Upon completion of all bureaucratic formalities (time required: 4–5 hours), the fish are released and shipped to a holding structure for quarantine.

Table 19. Trade in Singapore

Country or Area	Year	Comm. Code	Commodity	Flow	Trade ('000 USD)	Quantity Name
Singapore	2008	30110	Ornamental fish, live	Import	24 702	No Quantity
Singapore	2008	30110	Ornamental fish, live	Export	68 963	No Quantity

Source: UNdata, United Nations Statistic Division, Commodity Trade Statistics Database

[10] Note that 2006/88/EC does not apply to imported ornamental fish intended only for the aquarium (closed systems).

Figure 14 and Table 20. Singapore/World exports ('000 USD)

Year	Singapore	World
1990	40 104	113 002
1991	40 234	125 611
1992	44 194	140 063
1993	45 666	148 279
1994	52 631	169 251
1995	59 411	199 004
1996	58 574	203 025
1997	52 757	185 913
1998	43 156	159 308
1999	42 417	167 561
2000	43 502	174 556
2001	41 581	175 466
2002	41 460	184 524
2003	41 427	252 931
2004	49 528	271 250
2005	54 162	263 717
2006	61 403	277 705
2007	66 079	314 504

Source: FIES

Figure 15. Singapore export value

2.3.2 Thailand: a case study

Ornamental fish is a growing business in Thailand. The high quality of the fish, abundant natural resources (water and live food) and the climate, combined with experience and low labour costs, have contributed to the expansion of this sector.

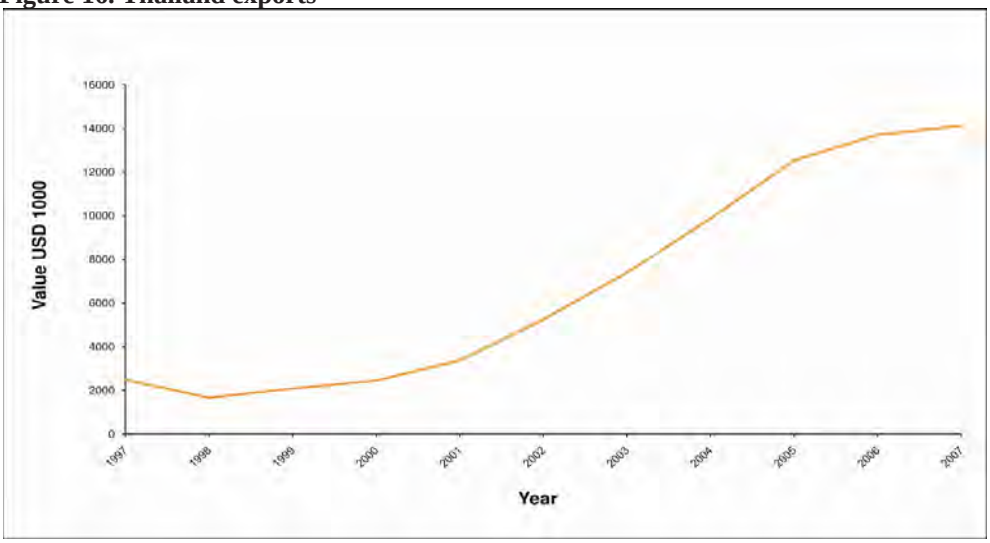
The Government supports the trade of ornamental fish through research programmes in the province of Pathumthsui; it aims to increase efficiency and profitability throughout the chain and to contribute to the biosustainable development of rural and coastal areas. Indeed, much progress has been made in the laboratory cultivation of ornamental aquatic plants, thus minimizing their removal from natural ecosystems. Government projects also fund the marketing of artificially bred marine fish.

The ornamental fish trade is promoted by the Department of Fisheries, which seeks to increase quality exports.

Table 21. Thailand exports ('000 USD)

Country	Year							
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Thailand	2 446	3 370	5 245	7 392	9 864	12 534	13 697	14 113

Figure 16. Thailand exports



Source: FIES

Table 22. Trade in Thailand

Country or Area	Year	Comm. Code	Commodity	Flow	Trade ('000 USD)	Weight (kg)	Quantity Name
Thailand	2008	30110	Ornamental fish, live	Import	502	116 315	Weight in kg.
Thailand	2008	30110	Ornamental fish, live	Export	21 558	3 679 570	Weight in kg.

Source: UNdata, United Nations Statistic Division, Commodity Trade Statistics Database

Ornamental fish business

There are more than 60 exporters in Thailand involved in the export of fish and plants for ornamental purposes (Appendix 1). The business involves several thousand families, about half of which are located in Bangkok. The biggest sellers are located in the vicinity of the ornamental fish market in the Chatuchak weekend market area (Bangkok). The "wild collectors" are small businesses that work in different areas through small cooperatives at local level. The catch usually takes place during the dry season, but it depends on the type of fish. Wholesalers or exporters often organize education programmes for the fishermen and provide for them financially. Once caught, the fish are quarantined and prepared for shipment.

The distribution of ornamental fish in Thailand is relatively well organized and structured, and the supply chain is certainly shorter than in South America (e.g. Brazil):

- Breeders usually specialize in a limited number of specimens. Discus and other fine varieties are bred in large-scale facilities located in central Bangkok where they can have water with good chemical and physical characteristics and all the necessary logistic facilities. Other fish are bred by farmers using the countless irrigation

channels (clong) in the immediate suburbs of the city. A licence is required to start a farming business; it is granted by the Department of Fisheries, which subsequently certifies the health of the fish.

- Suppliers obtain fish from breeders or fishermen.
- Exporters usually buy live stocks from suppliers or intermediaries; the fish are then acclimatized and placed in quarantine, which can last from a few days to several weeks, depending on the health of the fish and the personal experience of the various exporters and farmers.

The most frequently observed pathological manifestations during quarantine are those caused by stress (Richardson, 2008) and they occur when immunity is low. Therefore, much attention is paid to hygiene, water quantity and quality, overcrowding and nutrition prior to shipment. A health certificate is issued by the Department of Fisheries and each shipment must certify the species' marketing destination. Random controls are carried out by government biologists to confirm the health status of fish prior to shipment.

The exact number of fish exported from Thailand is difficult to ascertain. The two most reliable sources are the Thai Customs Department and the Department of Fisheries, and the figure can be estimated on the basis of documents and the weight and density of fish in each box.

Major ornamental fish species reared

Freshwater ornamental fish breeding stock are originally obtained from the wild. More than 300 different species, including *Bettas*, *Barbus*, *Corydoras* spp., goldfish, rasbora, *Symphysodon* spp. and guppy, are reared on small family-run farms. Tens of new species have been discovered and imported into Thailand; once bred on a large scale, they are re-exported to the major world markets. (Japan, the United States of America and Europe).

More than 100 native marine species are caught and commercially available. Most are caught close to Phuket in the province of Rayong; others are imported from the Philippines and Indonesia. The Department of Fisheries in Krabi recently announced that it had conducted successful artificial breeding programmes for a range of marine fish: *Monodactylus argenteus* (silver angle), *Platax orbicularis* (batfish) and six species of *Amphiprion* spp. (clownfish). For a complete list, see Appendix 2.

Approximately 400 marine species are prohibited for export. Numerous freshwater species, including *Pangasiadon gigas* (giant Mekong catfish – not for ornamental purposes) and *Scleropages formosus* (Asian arowana), are under the protection of CITES.

2.3.3 Sri Lanka: an overview

The capture, breeding and export of ornamental fish is an important industry in Sri Lanka, generating jobs and income. However, it also triggers concern: the collection of ornamental fish for export can have a negative impact on the fragile ecosystems of the island, such as coral reefs, which teem with marine life.

The ornamental fish trade in Sri Lanka has come a long way in the last 75 years and is now a valuable foreign exchange earner. Ornamental fish are exported to over 30 countries, including the United States of America, Japan, the United Kingdom and other European Community countries. Consignments to Singapore, Hong Kong and the Netherlands are mostly re-exported to other western countries. Exports have increased in the last few years, particularly since prices have become more competitive.

Sri Lanka boasts a rich tropical biological diversity. Freshwater exports come from both wild-caught and captive-bred/hatchery-reared stocks, while marine varieties are all caught wild. The freshwater ecosystems boast some 80 species of native fish (of which 27 are endemic) and 53 of them are regularly exported (e.g. *Rasbora vaterifloris, Puntius nigrofasciatus, Puntius titteya*). The only non-endemic specimen is *Monodactylus argenteus*.

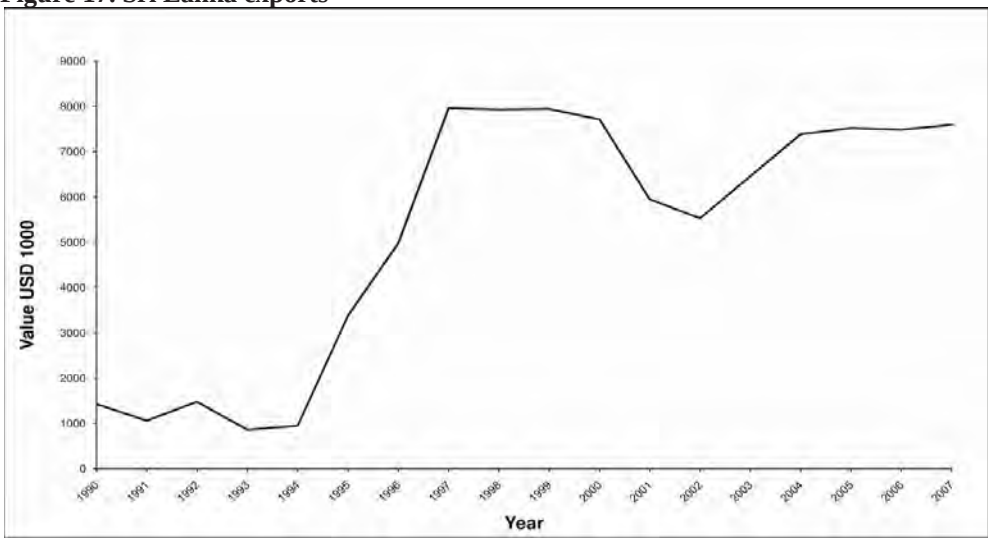
Collection, especially in marine waters, involves both habitat destruction and stress to the collected organism. Stress is the result of poor storage practices, especially during the holding and transport phases.

In recent years, exports have expanded to include over 200 species and the numbers of fish exported have also increased. There is also a growing trend in the export of fish to other countries for transshipment.

Table 23. Sri Lanka exports ('000 USD)

Country	Year									
	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Sri Lanka	1 425	3 378	7 714	5 944	5 527	6 459	7 385	7 522	7 486	7 592

Figure 17. Sri Lanka exports



Data for 2006 and 2007 are estimated. Data before 1990 are not available.
Source: FIES

2.3.4 Ornamental Fish International (OFI)

Founded in 1980, OFI is the worldwide association representing the ornamental fish trade. It is present in about 45 countries and members come from the supply chain and related fields: editors, reporters, fishermen, breeders, producers of aquatic plants, importers, exporters and airlines.

Members range from individuals to some of the largest ornamental fish farms in the world and leading wholesalers. What they all have in common, irrespective of their size or specialization, is that they are directly or indirectly involved in the international ornamental aquatic industry.

OFI has more than 190 members and they all subscribe to a Code of Ethics. OFI's mission is to develop the sector, both directly and indirectly, through the quality of commercial transactions. It produces specialist publications and organizes meetings at different international events (Interzoo, Acquarama), bringing together experts and scholars of animal welfare laws and regulations, health certification and biosecurity management.

2.4 ORNAMENTAL FISH FROM THE CZECH REPUBLIC

The Czech Republic is a leading European producer of ornamental fish and the sector continues to expand. A tradition of technology development combined with access to new scientific developments has brought excellent progress since the 1970s.

Small family farms have gradually been replaced by large technically advanced fish farms, and the Internet has played a major part in the expansion of the Czech market. Farmers have improved their level of excellence and their stands are present at major events, such as Aquarama and Interzoo. There is also an import/export business with Asia and South America (though it should be noted that not all species are always sold or offered in good health).

The strengths of the Czech Republic market are:

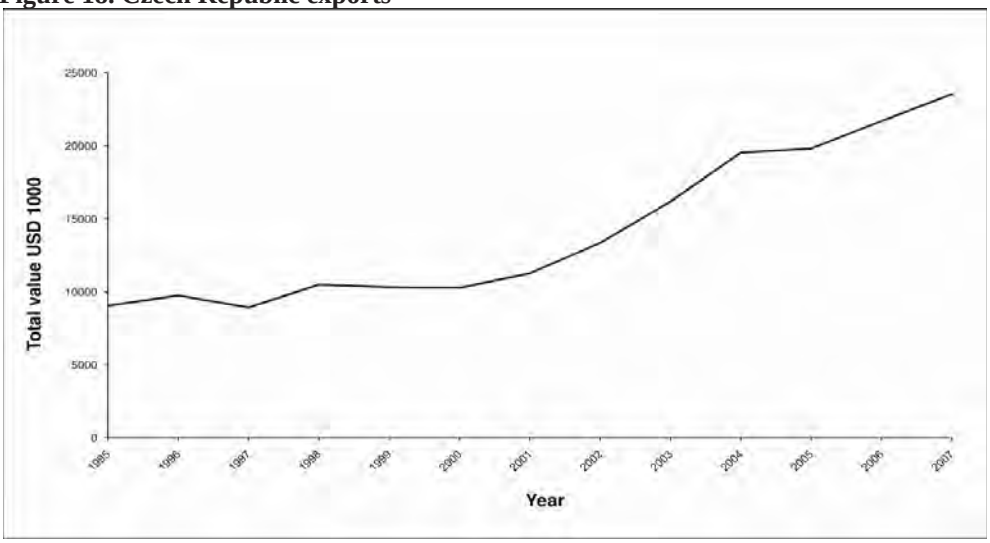
- proximity to other European countries;
- good logistics (including road network);
- intrinsic quality of the fish market; and
- competitive prices.

It is for these reasons that the Czech Republic has become a country of transit, responsible for transshipping in Europe.

Table 24. Czech Republic exports ('000 USD)

Country	Year							
	2000	2001	2002	2003	2004	2005	2006	2007
Czech Republic	10 273	11 272	13 353	16 183	19 540	19 827	21 700	23 527

Figure 18. Czech Republic exports



Data before 1995 not available.
Source: FIES

Table 25. Trade in the Czech Republic

Country or Area	Year	Comm. Code	Commodity	Flow	Trade ('000 USD)	Weight (kg)	Quantity Name
Czech Rep.	2008	30110	Ornamental fish, live	Import	3 384	29 514	Weight in kg
Czech Rep.	2008	30110	Ornamental fish, live	Export	21 168	376 353	Weight in kg

Source: UNdata, United Nations Statistic Division, Commodity Trade Statistics Database

2.5 GLOBAL TRADE OF MARINE ORNAMENTAL SPECIES

About 2 million people worldwide are involved in the ornamental fisheries trade. Corals, invertebrates and reef fish are fished and shipped from various parts of Southeast Asia, mainly to the United States of America, Europe and Japan (Wabnitz *et al*., 2003).

The sustainable exploitation of these natural resources creates a reliable income for coastal areas. In general, samples reveal the damage to coral reefs to be minor; however,, high mortality among the catch is recorded – the result of poor fishing methods and lack of competence in packaging and shipping.

Since the 2000s, various organizations, such as UNEP (United Nations Environment Programme) and MAC have worked to achieve the integration and standardization of procedures. Databases provide valuable information about performance in terms of quality of the marine ornamental fish trade.

2.5.1 Marine Aquarium Council (MAC)

MAC is an international, multistakeholder, non-profit, non-governmental organization that brings together conservation organizations, fishermen, exporters, importers, public aquariums, hobbyist groups and government agencies, all of which are involved in the trade of ornamental fish and invertebrates.

MAC's mission is to protect coral reefs and other marine ecosystems through the creation of standard labour and certification procedures capable of binding the various stakeholders in the sector. MAC promotes sustainable development; it creates incentives for certification and increases the awareness of rural people in the environment. Activities include:

- production of independent best practice certificates;
- public awareness raising with regard to marine ecosystem conservation;
- promotion of sustainable exploitation of reef ecosystems through responsible fishing practices;
- promotion of health and quality of marine ornamental organisms through responsible collection and quarantine;
- promotion of best practices in packing, handling and shipping;
- promotion of training and education for fishermen;
- application of a ban on fishing of marine ornamental organisms which are either endangered or unsuitable for aquariums;
- application of a ban on capture of non-targeted species; and
- support of sustainable aquaculture.

The mortality of tropical fish prior to reaching the aquarium market is estimated at around 80%. This high figure is due to a range of factors, including poor capture and husbandry practices, stress and poor shipping practices. The ornamental fish trade is a potentially sustainable activity capable of supporting rural coastal communities. However, it is essential that destructive practices cease and fishermen be educated in the sustainable harvesting of tropical fish.

2.5.2 Fish

The ornamental marine fish trade concerns about 1 500 varieties from over 50 families, and the number of fish caught is approximately 20–25 million.

Around 400 species from 75 families are exported from the Philippines, a major supplier of marine aquarium fish.

Preferences for particular sizes, colours or rarity can produce extremes in selective harvesting. Fish of a length of about 2–10 cm are preferred and the colour and shape are very important.

Many dealers prefer fish from areas where animals are known to be caught and handled well, because they survive longer. For this reason, fish from the Red Sea or Central Pacific islands often command higher prices than those from the Philippines and

Indonesia, where fishing methods may even include the use of cyanide and where poor shipping and handling practices are not uncommon (Sale, 2006).

The Pomacentridae family accounts for about half of the catch: angelfish, surgeonfish and butterfly fish are the main species caught; *Chromis vividis* (green damselfish) and *Amphiprion ocellaris* (clown anemone fish) are the most marketable.

2.5.3 Corals

A total of 140 species of hard coral (*Scleratinia* spp.) are on the market with about 12 million pieces traded. They belong to various genera, including *Trachyphyllia*, *Euphyllia*, *Goniopora*, *Acropora* and *Plerogyra*, and account for about 56% of the coral trade.

About 60 kinds of soft coral (approximately 400 000 pieces) are also caught and sold. *Sarcophyton* and *Dendronephytya* are the most common and widespread species; the latter has the added advantage of being adaptable and easily bred in captivity. Most of the soft corals traded originate from the Indo-Pacific Ocean.

Studies of the coral trade originating in the Philippines and Indonesia describe how the Philippines has been a major source of coral in international trade for a long time.

2.5.4 Invertebrates

More than 500 species – an estimated 10 million specimens – of invertebrate (other than corals) are sold for ornamental purposes. They include shellfish, shrimps and anemones, with the latter accounting for about 15% of the invertebrate market.

Marine ornamental shrimps are mainly collected in the Indo-Pacific Region, but also in the Caribbean (Calado, 2008). The number of marine ornamental shrimps collected each year from coral reefs worldwide may be 10 times higher than the currently reported figure. Destructive techniques (e.g. the use of cyanide), commonly employed to capture marine ornamental fish in Southeast Asia, are not suitable for the collection of marine ornamental shrimps, which are collected by divers equipped with small tubular hand nets and slim rods.

Breeding in captivity has grown, thanks to scientific research; but the high costs have limited development and the sector currently accounts for 1% of fish, 1% of corals and 20% of giant clams (*Tridacna* spp.).

2.5.5 Conservation of ecosystems and prevention of destructive practices

Bad fishing practices have been used for years to increase the catch and they are very difficult to eradicate. The use of cyanide (*sodium cyanide*) or other chemicals to stun reef fish results in:

- high mortality rate post-capture;
- coral habitat destruction; and
- killing of non-target specimens, including species of sessile invertebrates.

Extraction of live rock, on the other hand, results in:

- erosion; and
- loss of important marine habitats and coastal zones.

While dynamite is not actually used for the capture of ornamental fish, it is still used in food fishing in many countries and causes serious indiscriminate damage to all species of fish and to the reef; it is even more dangerous than cyanide.

2.5.6 Human impact

Fishing for marine ornamental fish species has a negative effect on coral reefs – indeed, studies reveal decreases in catches. However, there is also evidence that in some cases the catch has remained constant over time.

In order to achieve sustainability, it is necessary to limit the catch, depending on the resilience of the species and on the size of the ecosystem in question. Some Asian countries and South America have imposed restrictions on the capture of certain fish species following their decrease in number. If fishermen continue to fish certain species as before, the ecosystem will be affected.

2.5.7 Post-capture mortality rates

Numerous factors contribute to post-capture mortality: physiological damage, use of chemicals, poor preparation procedures for stocking, and disease. The highest losses occur as a result of poor shipping practices, which cause stress and related illnesses. Approximately 15% of fish die immediately after being caught, another 10% during the various stages of transport, and about 5% in stocking stations.

Experiments have shown that by following the correct fishing practices, improving stock and transportation, and increasing skills and education, the overall mortality rate can fall below 5%. Sessile organisms have a lower post-capture mortality rate compared with coral fish, as the short-term stress is lower. The use of UV light and skimmers can drastically reduce losses by maintaining high water quality in the stocking facilities.

2.5.8 Technical aspects: collection

Fishermen work individually or in small family groups, often operating also as wholesalers and exporters. They work with basic equipment, catching fish with different types of nets (e.g. hand nets, cast nets); fishermen in Sri Lanka use simple nets, while in Australia and Pacific networks they use wide barrier nets. Fishing without damaging either the prey or the coral reef requires experience and skill. The techniques adopted vary, depending on the country, the type of fish or, in the case of sessile invertebrates, the coral reef.

Once caught, coral and fish are placed in plastic containers or bags. Corals are wrapped in layers of plastic. In order to avoid damage to the bladder, fish are placed at a depth of 3 m for 30–40 minutes until they reach a stage of decompression. Catches may be

transported to the stocking facilities on the day of capture – depending on the distance from the fishing stations. Once stocked, fish and invertebrates are separated and sometimes immediately prepared for transport and export.

Fishermen are usually paid for the number of specimens caught. Once on the international market, on the other hand, prices depend on the species and their popularity. Therefore, there is a huge discrepancy between the amount paid to fishermen and that paid by the end user. In Indonesia, for example, the price of a clown fish is about USD 0.10, the price to the wholesaler (in Italy) is about USD 1 (not counting expenses), and the final price in the store EUR 15. Studies show that of the price paid for a fish for export, only 15% goes to the fisherman.

The quarantine period lasts from several hours to several months, but there is evidence that not all fish are actually placed in quarantine.[11] The specimens are packed in double plastic bags (filled with one-third water and two-thirds oxygen), which are sealed and placed in thermal polystyrene boxes. Aggressive species or those with spikes are sealed in dark coloured bags and placed in the bottom of the box to avoid breakage of the other bags. To limit mortality, shipment should not last more than 40 hours (from packaging to arrival); a standard shipment is 24 hours.

Fish and invertebrates must be accompanied by the necessary documentation: tax papers, health certificates and CITES permits (if required). Customs practices vary from country to country and different administrative procedures are followed.

2.5.9 The Philippines

The Philippines is currently one of the major exporters of marine ornamental fish in the world, and 98% of specimens are caught in the wild. Trade dates back to 1952, when fish were caught with nets and traps set on the coral reef.

However, in 1962, fishermen started using cyanide to stun the fish and make them easier to catch. This became common practice and it is estimated that at one time around 150 000 kg of cyanide were being used every year. Experts started studying the phenomenon in the 1980s, after importers, wholesalers and fish lovers suffered numerous losses. It was found that the single most common cause of death in the fish was cyanide (other problems included lack of air conditioning, no quarantine and selection of the most popular sizes).

When cyanide is not used, the impact on the barrier reef is minimal and fishing is a sustainable and renewable activity. Therefore, NGOs (non-governmental organizations) and MAC organize education and awareness programmes to promote the use of nets to catch reef fish, but the large number of fishermen (approximately 4 000) means that it is difficult from a logistical point of view to implement conversion programmes.

Development programmes alone are not enough to solve the problem, as – in addition to environmental and sociocultural factors – economic problems exist. It should be noted

[11] In Italy, wholesalers tend to be small companies who sometimes prefer to maximize profits by skipping the quarantine stage and selling immediately to the retailer; they are indifferent to the high mortality rate in the tanks of shops or hobbyists.

that the same price is paid for fish caught using cyanide and fish caught with a net. What is more, exporters demand fish at increasingly low prices in order to be competitive on the international market.

Table 26. Trade in the Philippines

Country or Area	Year	Comm. Code	Commodity	Flow	Trade ('000 USD)	Weight (kg)	Quantity Name
Philippines	2008	30110	Ornamental fish, live	Import	123	72 378	Weight in kg
Philippines	2008	30110	Ornamental fish, live	Export	7 348	6 441 410	Weight in kg

Source: UNdata, United Nations Statistic Division, Commodity Trade Statistics Database

Figure 19. Asian tiger exports

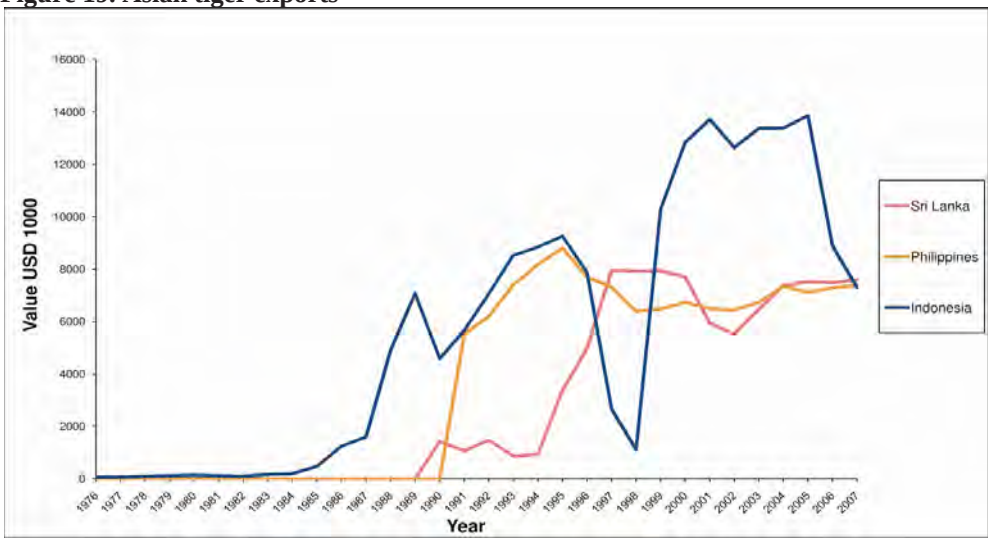


Table 27. Exports from Sri Lanka, the Philippines and Indonesia ('000 USD)

Year	Sri Lanka	Philippines	Indonesia
1990	1 425	...	4 590
1991	1 059	5 530	5 668
1992	1 477	6 198	7 058
1993	861	7 404	8 527
1994	945	8 178	8 847
1995	3378	8 808	9 264
1996	4 973	7 705	7 880
1997	7 955	7 315	2 655
1998	7 925	6 403	1 122
1999	7 940	6 475	10 286
2000	7 714	6 737	12 841
2001	5 944	6 497	13 722
2002	5 527	6 439	12 648
2003	6 459	6 729	13 372
2004	7 385	7 346	13 389
2005	7 522	7 126	13 863
2006	7 486	7 287	8 892
2007	7 592	7 382	7 305

Source: FIES

Note: Data from Sri Lanka in 2006 and 2007 are estimated; only data from Indonesia are complete from 1990; collection data from Sri Lanka and the Philippines start from 1990–91.

2.6 GMOS – A NEW FLUORESCENT FISH

GloFish® was not originally developed for the ornamental fish trade, but it is now the first genetically modified animal available to the public as a pet.

In 1999, Dr Zhiyuan Gong experimented with a gene called green fluorescent protein (GFP), originally extracted from a jellyfish that naturally produced bright green bioluminescence. The gene was inserted into a zebra fish embryo, allowing it to integrate into the zebra fish's genome; the fish became brightly fluorescent in both natural white light and ultraviolet light. The objective was to develop a fish capable of detecting pollution by selectively fluorescing in the presence of environmental toxins. The development of the always-fluorescing fish was the first step in this direction.

Shortly thereafter, the team developed a line of red fluorescent zebra fish by adding a gene from a sea coral, and a line of yellow fluorescent zebra fish by adding a variant of the jellyfish gene. GloFish® was introduced to the United States market in late 2003 after more than 2 years of extensive environmental research and consultation with various federal and state agencies, as well as with leading experts in the field of risk assessment. GloFish® has been successfully marketed in the United States of America

since 2003 and no ecological concerns associated with its sale have been reported to date.

However, the sale or possession of GloFish® is illegal in California, where there are restrictions concerning all genetically modified fish (introduced before the arrival of GloFish® in response to concern about a fast-growing biotech salmon). Canada also prohibits import or sale in the absence of sufficient information to guarantee safety. The import, sale and possession of GloFish® was banned in the European Union on 9 November 2006. Furthermore, in Italy, universities have been entrusted with developing a medical protocol aimed at the complete eradication of transgenic specimens (including zebra fish TK-1) from the aquariums of wholesalers and dealers.

Opponents of GMOs (genetically mofified organisms) apply the “precautionary principle”: until it is absolutely certain there are no risks involved, genetic engineering should be avoided. There are serious environmental concerns, as there is no guarantee that modified organisms will not spread and cross-fertilize with wild populations. Genetic engineering often involves increasing a species' ability to live in harsh and unfavourable conditions, outside the normal acceptance range of the species, by inducing alien temperature or moisture tolerance, or resistance to otherwise natural enemies.

Alien invasive species are a modern-day concern and it is clear that artificially engineered laboratory life forms carry a higher risk of becoming invasive. Even the induction of sterility in specimens by triploidisation (triploid = having three copies of chromosomes, in contrast to the usual two necessary for producing functional germ cells) is no guarantee against spreading, since the genetic changes cannot be accurately assessed, monitored or controlled (OFI website).

3. TECHNICAL ASPECTS

3.1 TRANSPORT

Transport and packing are critical stages in the ornamental fish trade. The vast majority of fish are exported; therefore, in addition to beauty and colour, the fish must have the strength to endure long intercontinental trips by air (Ploeg *et al.*, 2007). The advent of polyethylene bags in 1950 led to a considerable reduction in weight and, therefore, shipping costs – which nevertheless still account for a considerable proportion of total costs. Handling costs, combined with freight charges and shipment certificates, often exceed the cost of the fish.

3.1.1 Packaging system

The most common system used for packaging live ornamental fish is the "closed" system using polyethylene bags. The bags are filled with the appropriate proportions of water and oxygen, and the base of the bag is folded to prevent the fish being crushed by the weight of the water inside the box. Most freshwater fish and many marine species are packed at a low density. Aggressive species (e.g. cichlids and betta) and particularly valuable or sensitive varieties are packaged individually, to avoid injury and stress.

For individually packed fish, a single bag is used. When more fish are present in the same bag, the wholesaler uses two or more bags inside each other; up to six bags may be used, depending on the value of the fish. Sheets of newspaper separate the bags to prevent holes and leakages of water and oxygen. Drinking water (or seawater) pre-treated with chemicals is used, and pure oxygen is added (overfilling with oxygen can cause stress to the fish or breakage of the bags).

Once water, fish and oxygen are in the bag, it is closed tightly using one of two methods:

- Elastic and metal clips, suitable for large numbers of fish in the same bag; a mechanized system, if bags are damaged they are not re-usable.
- Heat-sealing, suitable for individual fish in single bags (often used for the shipment of small reef fish from Southeast Asia).

The bags are then placed in protective polystyrene boxes in varying numbers, depending on their size. The box is usually covered with a carton of similar size bearing the exporter's name. The polystyrene box is essential for maintaining the correct temperature during all stages of transport. To facilitate loading and unloading, there are two standard sizes of box: 48.5 × 36.5 × 36.5 cm and 60.5 × 45.5 × 30.5 cm. A warming device is often applied on the inside of the lid of the box during the winter season.

3.1.2 Biomass

The number of fish within each bag is limited by the amount of water, which in turn depends on the species and size of the fish, as well as the transit time (i.e. the period from packing through to stocking). Short transit times (12–14 hours) allow a density increase of up to 50%; long transit times (36–48 hours) mean a density decrease of around 20–40%.

Photograph 12. Wild Heckel discus in a polystyrene box just arrived at destination

Courtesy of P. Monticini

The density is related to the size and behaviour of each species: metabolism slows as weight increases, larger fish are less active, consume less oxygen and produce less nitrogen in the form of ammoniac compared with small fish with a high metabolism – therefore, the larger the fish, the higher the density.

3.1.3 Principles of transport

In air freight, the net weight of the fish (biomass) accounts for just 5–8% of the total shipment; the rest is water, oxygen and packaging material. Shipping costs can therefore be reduced significantly, simply by packing a larger number of fish into the same volume of water. The objective is to maximize density without increasing mortality by:

- increasing stress resistance by optimizing procedures during the various stages of transport;
- minimizing the transit period and reducing the amount of oxygen required for respiration and metabolic processes; and
- reducing the metabolism of the fish.

3.1.4 Packaging technology

The density of the fish is directly related to the transit time: the shorter the time, the greater the number of fish placed in a small volume of water. Waiting times must therefore be kept to a minimum, and shipments are arranged on the basis of the opening hours of customs offices and veterinary units in the various airports of arrival. Furthermore, exporters avoid delivery at the airport on certain days or at certain times (holidays, Sundays, strikes etc.).

The oxygen supply must be adequate during transit, as lack of oxygen can be fatal. The amount of oxygen required depends on the number, size and species of fish, as well as the type of packaging. The ratio is calculated by dividing the volume of oxygen (ml) by the total fish biomass (g). In practice, exporters adopt a ratio of between 4:1 (4 parts O_2, 1 part H_2O) and 6:1 to guarantee a good supply of oxygen even when there are dead fish at the bottom of the bag during shipment. The large amount of oxygen used for packaging also affects shipping costs, which are calculated according to weight and not volume.

3.1.5 Quality control of fish

The shipment of ornamental fish is a long process comprising capture, packaging, transport, acclimatization and conditioning. At any stage, there may be instances of stress leading to mortality; it is therefore important to carefully assess the quality and health status of the ornamental fish prior to shipment. Only fish of good quality, in perfect health and with resistance to stress factors should be packaged for delivery.

To optimize the chances of survival, it is necessary to follow the steps below:

- Careful examination of the fish when selected for packaging and placing in polyethylene bags.
- Constant review and monitoring to prevent disease and stress (e.g. hyper pigmentation, exophthalmos, lethargy, bacterial diseases).
- Pre-packaging: fish are usually pre-packed in bags and placed in a controlled atmosphere at 22°–23°C for approximately 4–6 hours; they can acclimatize to captivity conditions (e.g. limited space, overcrowding, low temperatures).
- Immediate removal of specimens unable to support the pre-packaging stage: mortality inside a bag leads to high consumption of oxygen (due to bacterial growth and formation of toxic catabolites) and affects the other fish.

3.1.6 Fasting

Fasting traditionally takes place before shipment to increase chances of survival. In the hours before packaging, the fish empty their stomachs and intestines: this prevents regurgitation of food and limits faecal excretion during transport. Fasting also reduces the stress response to the packaging system, reducing losses during this phase.

Fasting lasts approximately 24 hours from the start of the transit period and can continue for several days (up to 10) on arrival at destination, depending on the species. The technique is widely used by discus breeders, since this species tolerates well prolonged periods of fasting. A few species, such as guppy (*Poecilia reticulata*) and neon (*Paracheirodon innesi*), do not tolerate fasting well and only one day of fasting before departure is possible.

3.1.7 Temperature

Table 28. Temperature/oxygen saturation

Temperature °C	Oxygen saturation in mg/l
0	14.16
2	13.40
4	12.70
6	12.06
8	11.47
10	10.92
12	10.43
14	9.98
16	9.56
18	9.18
20	8.84
22	8.53
24	8.25
26	7.99
28	7.75
30	7.53
32	7.32
34	7.13
36	6.94
18	9.18
20	8.84
22	8.53
24	8.25
26	7.99
28	7.75
30	7.53
32	7.32
34	7.13
36	6.94
38	6.76
40	6.59

CELSIUS	FAHRENHEIT
20°	68°
21°	69.8°
22°	71.6°
23°	73.4°
24°	75.2°
25°	77°
26°	78.8°
27°	80.6°
28°	82.4°
29°	84.2°
30°	86°
31°	87.8°
32°	89.6°

Temperature is of primary importance during the transport of delicate ornamental fish. High temperature:

- increases metabolism (hence oxygen consumption);
- increases the production of ammonia and bacterial growth; and
- reduces solubility (hence the bioavailability of oxygen for the packaged fish).

For these reasons, a low temperature is used in order to maximize the density. Optimum temperatures are as follows:

- Tropical ornamental fish: 22°C (fish are less active, lower their metabolism, but swim and breathe normally).
- Temperate water fish (e.g. koi carp and goldfish): 15°–18°C.
- Amazonian fish (e.g. tetra – *H. bleheri*, *H. erythrozonus*): 24°–25°C or slightly higher.

It is essential, in all cases, that the correct procedures are followed at every stage: pre-packaging, acclimatization and shipment.

NITROGEN COMPOUNDS, NH_3

NH_3 (NH_4)
Ammoniac (ammonium)
↓
NO_2
Nitrite
↓
NO_3
Nitrate

During shipment, nitrogen compounds (e.g. ammonia) accumulate catabolites in the water – the result of the fish's physiological removal process and bacterial activity. Ammonia is extremely toxic and harmful, especially for gill epithelia. High concentrations of free ammonia in the gills predispose the fish to secondary infections and the growth of fungi, such as *Saprolegnia*.

To remove these harmful substances from the water in the bags, absorbents (e.g. ion exchange resins, zeolites and charcoal) are often used. Zeolites are added directly into the bag: 15–20 g per litre of water. Zeolite is also used when packing certain varieties of wild fish from South America (e.g. *Corydoras* spp.) that emit toxins.

3.1.8 Changes in pH during transport

During transport, the accumulation of CO_2 as a result of the fish's respiratory processes (especially in marine specimens) can substantially lower the pH in the water. A "buffer" is used to stabilize the pH by converting the CO_2 into bicarbonate ion – a procedure useful during the acclimatization of reef fish. The pH value measured in shipping bags is around 6, while in the quarantine tank, it is 7.8–8.2. Italian wholesalers use large tanks for all fish, and lower the pH with CO_2 a few hours before the arrival of the fish in order to prevent shock.

For fish requiring a low pH (around 6.5), some exporters use – for freshwater fish only – *Terminalia catappa* leaves: they have valuable acidifying properties and release unique tannins for the fish. This technique is used in the packaging of delicate specimens, such as chocolate gourami (*Sphaerichthys osphromenoides*), rasbora, pangio and other fish requiring a pH of 6.0–6.5.

3.1.9 Use of salt (NaCl)

Oslo-regulatory dysfunction is a common phenomenon in ornamental fish during shipment; however the use of sodium chloride (NaCl) in the bags can prevent physiological problems and reduce mortality in many species. Common practice is to use salt containing 92–97% NaCl solution (1%) in order to create isotonic conditions; however, this leads to an increase in pH and in the concentration of free ammonia ($\leq$ 3–9% NH_3).

3.1.10 Use of anaesthetics

Anaesthetic substances can be used to reduce metabolism, oxygen consumption and, as a consequence, the production of nitrogenous catabolites. There are two methods of administration: inhalation and bath immersion. The anaesthetics are added to the water bags directly or indirectly (after the use of solvents) and the fish are exposed throughout the period of transit.

The dosage is critical and overdose can cause death. The concentration (as specified by the manufacturer) aims to achieve sedation: the fish become lethargic but maintain regular gill movement. The most widely used product is MS222 (tricaine methanesulphanate). Anaesthetics are not universally used for various reasons:

- They have a high cost.
- The strength of the fish species varies and depends on numerous factors (species, size, and chemistry, temperature and pH of the water).
- Usage can lead to mortality in the days following arrival.

3.1.11 Light management

Stress is caused as light strikes the fish when the boxes are opened. It is, therefore, common practice to keep light emissions to a minimum (especially during unpacking operations).

Exporters from northern Europe unpack ornamental fish in rooms with particular lighting management, using hot and red light emission. Another method is to colour the water inside the bags: blue, using methylene blue; or amber, using humic acid in liquid form or *Terminalia catappa* leaves.

3.1.12 Acclimatization and packaging of fish after arrival

Acclimatization following arrival at destination is another critical point in the supply chain, as fish must overcome the stress accumulated during transport, before being re-packaged and sold to retailers. Indeed, optimum physical and chemical conditions are essential and the water should be prepared and stabilized before the fish arrive at the quarantine station.

The closed plastic bags (with the fish still inside) are placed in the storage tanks, in order to reduce the temperature difference to less than 2°C. This operation usually takes about half an hour when the temperature difference is 4°–5°C.

To reduce the risk of infection or contamination, the operator must avoid introducing the water used during transportation into the new aquarium when the fish are transferred. The fish are, therefore, caught with nets and washed with new water before being immersed in the tank. Immersion is done with fine mesh nets, but discus wholesalers place the fish by hand to avoid water contamination.

The chemical and physical characteristics of the water used must be optimal, suited to the basic needs of the different species of fish. Use of salt can increase resistance to stress factors and, hence, decrease post-shipment mortality. The necessary operations may be summarized as follows:

Before shipment

- Tanks must be cleaned and the efficiency of the biological filter (if present) or other filtering system assessed.
- pH must be stabilized at around 7 for freshwater ornamental fish and around 8 for saltwater ornamental fish and invertebrates.
- The general hardness (GH) and carbonate hardness (KH) must be adjusted depending on whether the fish originate from soft or hard water.
- Salinity must be adjusted to 1 015–1 018 for marine organisms.
- The water supply (minimum 50% of the total tank capacity) must be prepared with the appropriate chemical and physical characteristics.

After shipment

- Each box must be opened with the utmost care.
- For some specimens (e.g. *Barbus tetrazona*), semi-darkness or a red light atmosphere is required.
- The fish must be removed from the bag as soon as possible (due to poor water conditions during the long transport phase).
- All waste water and transport bags must be removed to prevent contamination.

3.1.13 Quarantine

Once acclimatization is complete, the fish must be submitted to quarantine for a variable period of time in order to prevent the proliferation of pathogen organisms via new arrivals. The minimum period of quarantine varies, depending on the type of organism; for fish, it is 30–90 days (Richard, 2008). Invertebrates, sea anemones, corals, live rock and plants are also potential carriers of pests and must be quarantined separately for 30–60 days to interrupt the lifecycle of parasites and prevent the spread of pathogens (Wildgoose, 2001).

In order for quarantine to be effective:

- it must take place in separate rooms on the farm, equipped with a self-filtering system;
- all water parameters must be optimal (for each genus and species);
- all operations must be performed under the strictest hygiene conditions; and
- staff must be appropriately trained and well prepared and must make personal use of topical disinfectants.

New arrivals must be constantly monitored. Any symptoms of illness or discomfort usually occur within the first 24–36 hours. The most common symptoms are: change in colour (darker or paler), swimming lethargy, anorexia and closed fins. Manifestations of rejection of food (e.g. in wild *Symphysodon*) may occur, in which case they may be fed with frozen food or live food (Ploeg *et al*., 2009).

The characteristics of a standard quarantine tank are as follows:

- Size and capacity well defined (e.g. 100 × 50 × 50 cm).
- Capacity appropriate to the number and size of fish hosts.
- Water having the original characteristics of the fish bag.
- Capacity to isolate new arrivals for 1–5 weeks (depending on the source).
- Treatment available for skin ectoparasites (*Ichthyobodo* spp., *Chilodonella* spp., gill flukes) and bacterial diseases (not preventive treatment).
- Free from "extras" – only new fish and water, no sand, no wood, no rock.
- Minimal technical equipment.
- Set of accessories available (pipes, scrapers, water analysis tests, nets etc.).

3.1.14 Prophylactic treatment

The use of chemotherapy as a preventive measure during the quarantine period must be carefully evaluated, taking into account the potential effects (usually deleterious) on the fish, biological filter and water quality. Any treatment must be proportionate to the different species and their potential pathogenic micro-organisms. Bacterial infections usually occur 14–20 days after arrival, and the quarantine protocol should then be modified according to the diagnosis made and the type of treatment. Note that wrong dosages can be ineffective or even toxic.

During treatment, the drugs destroy bacteria in the biological filter; it is therefore recommended to maintain high levels of dissolved oxygen through an appropriate airflow. Approximately 48 hours after treatment, it is recommended to: change the water (90%); reactivate the biological filter; and use absorbent materials such as hyperactive coal.

Table 29. Prophylactic treatment

Day	Marine fish	Freshwater fish
1–10	Furazone green® (proprietary product containing nitrofurazone, furazolidone and methylene blue) added once on day 1, removed on day 10	As for marine fish
11–12	Fenbendazole in gel food	As for marine fish
14–18	Copper therapy started and increased gradually to therapeutic levels	Fromalin and malachite green: 3 doses, 72-hour intervals with 50% water changes between doses
19–39	Therapeutic levels maintained at 0.18-0.20 mg/l	
17–21	Metronidazole in gel food	As for marine fish
26–27	Fenbendazole in gel food	As for marine fish
31–33	Praziquantel in gel food	As for marine fish

- Wild ornamental fish: oxytetracycline or nufurpirinol (neo furadantin 100) + malachite green oxalate + formalin 30% after 24 hours.
- Farm and garden pond fish (with the exception of *Potamotrygon* spp.): neomicine sulphate + green oxalate + formalin 30% after 24 hours – or seawater bath at 3% for 30 seconds to 30 minutes.
- Cichlids (e.g. Lake Malawi or *Symphysodon* spp.): in addition to the above, metronidazole (flagyl 250 mg) to prevent internal parasites like *Cryptobia iubilans* or *Spironucleus* (internal flagellates).
- Marine ornamental fish (with the exception of rays and sharks): low level of salinity or freshwater bath + copper sulphate.
- Koi carps: 0.6% NaCl and formalin after 24 hours.

3.2 DISEASES

Disease can occur in ornamental fish for numerous reasons:

- Bad management – it is imperative that the breeder make an accurate diagnosis of the pathogens responsible (Untergasser, 1989).
- Environmental factors – temperature, salinity and content of nitrogenous substances must all be monitored carefully.
- Biological agents – resulting in parasitic or bacterial (infectious) diseases.

Parasitic diseases are more likely to occur under the following conditions:

- Overcrowding and high density of biomass – especially with regard to direct cycle ectoparasites, such as Costia and Monogenea parasites (*Gyrodactylus* spp. or *Dactylogyrus* spp.).
- Inadequate water chemical values (especially nitrogen compund levels) for the needs of different species – the gill epithelium may be predisposed to infection by *Saprolegnia* spp.
- Poor water exchange.

- Continuous manipulation and changing of tanks – can lead to skin abrasions resulting in infection accompanied by opportunistic fungi.

3.2.1 Fungal infection in ornamental fish

Water moulds are the most common fungal infection in ornamental freshwater fish (Noga, 2000). They are present in both saltwater and freshwater, at cool and warm temperatures; distribution is worldwide and every freshwater fish is probably susceptible to at least one species of mould.

Fish fungi are classical opportunists that usually feed saprophytically; they also thrive on dead substrate and are incapable of manufacturing their nutriments by photosynthesis. Water moulds are ubiquitous and can become a problem if fish are under stress from other factors:

- immunosupression;
- disease;
- poor water or environmental conditions (e.g. high ammonia levels);
- poor nutrition or over-feeding;
- wounds – following mechanical trauma or when other pathogens provide a portal of entry (Noga, 2000);
- presence of dead organic matter; and
- overcrowding.

Fungi infection appears as a superficial, cottony growth on the skin and/or gills. It spreads rapidly over the skin, but rarely penetrates beyond the surface. However, superficial damage can be fatal: mortality and morbidity rise as the amount of affected skin and gill tissue increases. Animals become lethargic and lose their equilibrium. With severe infections, fish usually die within a few days. The cause of death is associated with impaired osmoregulation due to loss of epithelial integrity (Eiras, 2008).

Saprolegnia is an important pathogen in fish eggs. Infection begins in unfertilized or non-viable eggs and can rapidly spread to healthy eggs, eventually resulting in complete loss of the spawning.

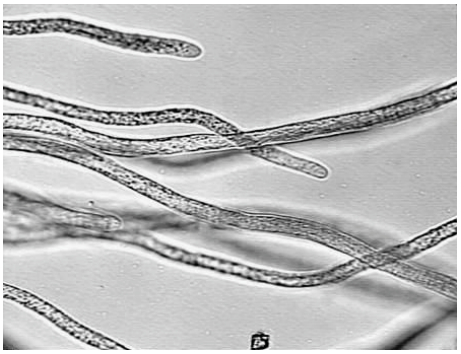
Once a diagnosis is obtained, the chance of successfully treating saprolegniosis in the fish is directly related to the number of organs infected. Severe infections are difficult to treat and may result in death. Furthermore, water moulds cannot be eradicated from centralized systems. Malachite green is the most effective agent for curing *Saprolegnia* infection in fish, but its use is not approved in many countries, given its teratogenic and mutagenic properties. An alternative treatment is a low prolonged bath with salt (an effective prophylactic treatment during transport or acclimatization to a new environment). Prophylactic antibiotics may be needed to treat secondary infections.

***Saprolegnia* spp.**

Family
Saprolegniaceae

Disease
Saprolegniosis

Signs
Fluffy tufts of cotton-like material, white-coloured skin, gills and eyes.



Source: Laboratory of Ittiopatologia, DSPVPA, University of Bologna

Morphology and reproduction
Saprolegnia reproduce asexually by production of zoospores. The fungal spores are a type of seed, resistant to all environmental conditions (e.g. heat, drying) and disinfectants. Sexual reproduction occurs under special circumstances.
Life cycle: direct.

Hosts
Common in fresh and brackish ornamental fish.

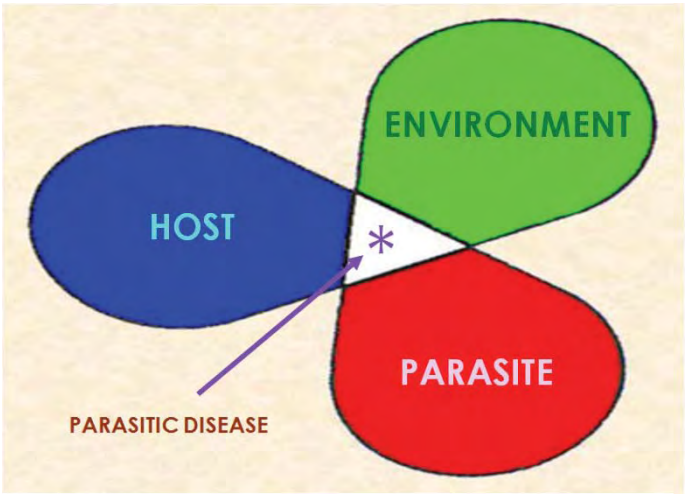
Site
Skin, gills (fish succumb when their skin is damaged due to bad farming practices or to wounds caused by ectoparasites such as *Argulus* spp. and *Learnea* spp. – the broken skin facilitates the initial invasion of the fungus eggs).

Optimum water temperature
Higher temperature than usual for ornamental fish: 26°–30°C (59°–86°F).

Predisposing factors
Overcrowding, poor water conditions, presence of other diseases, high temperature, low dissolved oxygen, wounds on the skin. Eggs are damaged by *Saprolegnia* spp. when infected during artificial incubation; invasion is promoted by existing necrotic substances such as unfertilized and damaged eggs.

Control and prophylaxis
Control and quarantine, high level of dissolved oxygen, low ammonia level, keep injury to a minimum (especially during spawning), good nutrition. Malachite green oxalate, potassium permanganate, formalin and povidone iodine solution. Methylene blue (to prevent invasion after spawning).

3.2.2 Parasitic disorders



Parasitic diseases are major limiting factors when raising and breeding ornamental fish, although it is not always the host-parasite association which generates the disease. Other biotic factors prone to encourage the development of a parasitic disease in a fish farm are the state of health of:

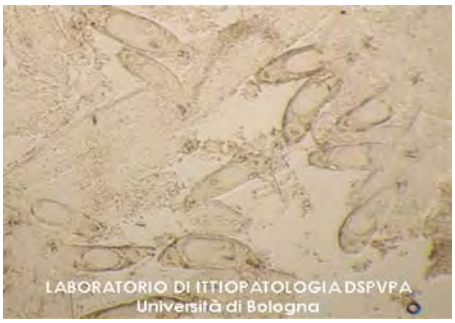
- the host (nutrition, immune competence); and
- the parasite (intrinsic pathogenicity, biological cycle, terms of replication).

- Parasites that tend to affect ornamental fish include protozoa, helminths and crustaceans; they are low-host-specific and direct cycle (no intermediate host). Some parasites may also find indirect cycle intermediate hosts to complete their life cycle. They develop in their larval stage, for example, *Capillaria* nematodes or *Camallanus* within copepods or crustaceans which are sometimes used on South Asian farms as live feed, or *Mixosporidium* (e.g. *Splaerospora a*nd *Mixobolus celebralis*), when benthic oligocete (*Tubifex*) is used at the bottom of the tanks.

The tank is an ideal habitat for reproductive amplification and colonization of aquatic organisms, such as protozoa (ubiquitous commensals of the genus *Trichodina*), and many parasites become opportunists – even in conditions of poor water quality –taking advantage of the low immune system of fish. Parasites most frequently found in ornamental fish:

- *Ichthyophthirius multifiliis*
- *Ichtyobodo necator*
- *Gyrodactylus* spp.
- *Dactylogyrus* spp.
- *Cryptobia iubilans*
- *Capillaria* spp.

***Gyrodactylus* spp.**



Kingdom: Animalia
Phylum: Platyhelminthes
Class: Monogenea
Order: Monopisthocotylea
Family: Gyrodactylidae
Genus: *Gyrodactylus*

Disease
Gills and skiln flukes.

Morphology and reproduction
Elongated and flat worm. Size 300 μm – 1 mm (depending on species). With hooks (*haptor*). Viviparous, very high rate of reproduction, correlated with temperature and species affected (three generations may be represented in one).
Life cycle: direct (Eiras, 2008).

Host
Marine ornamental species and freshwater ornamental fish species.

Site
Skin and gills (ectoparasites).

Optimum water temperature
Depends on the species.

Predisposing factors
Stress, overcrowding, other diseases (high sensitivity in juveniles).

Symptoms and diagnosis
Over-production of mucus, skin lesions, rubbing of the fish infected, altered operculum movement if gills are involved.

Prevention and control
Control and quarantine period. Avoid high density in aquarium.

Treatment and cure
Organophosphate insecticide trichlorphon (also known as dipterex, dylox, neguvon). Studies have found monogeneans to be restistant to trichlorphon (Eiras, 2008). One prolonged exposure to this substance causes more problems for the host than the monogenean infection and, in some cases, the medicine may be responsible for the host death. Formalin bath, potassium permanganate prolonged bath, praziquantel prolonged immersion, commercial products.

***Dactylogyru* spp.**

Kingdom: Animalia
Phylum: Platyhelminthes
Class: Monogenea
Order: Monopisthocotylea
Family: Dactylogyridae
Genus: *Dactylogyrus*

Disease
Gill flukes.

Morphology and reproduction
Elongated and flat worms. Size 300 µm – 1.2 mm (depending on species). With hooks (*haptor*). Small oviparous parasites with high reproductive rates. Not obligate parasites (adult can live without hosts ≤ 6 days).
Life cycle: direct.

Host
Freshwater and marine fish species.

Site
Mainly gills (ectoparasites).

Optimum water temperature
Depends on the species.

Predisposing factors
Stress, population density, poor hygiene of the tank bottom. Juveniles of *Symphysodon* spp. highly susceptible.

Symptoms
Hyperventilation with impaired operculum movement, loss of appetite, dark colour.

Prevention and control
Inspection and quarantine period; avoid high density; ensure tank hygiene.

Treatment
Organophosphate insecticide trichlorphon (also known as dipterex, dylox and neguvon). Studies have found monogeneans to be resistant to trichlorphon (Eiras, 2008). One prolonged exposure to this substance causes more problems for the host than the monogenean infection and, in some cases, the medicine may be responsible for the host death. Formalin bath, potassium permanganate prolonged bath, praziquantel prolonged immersion, commercial products.

Capillaria pterophylli (Heinze, 1933)

Kingdom: Animalia
Phylum: Nematoda
Class: Adenophorea
Subclass: Enoplia
Order: Trichurida
Family: Trichinellidae
Genus: *Capillaria*

Morphology and reproduction
Worms with elongated and cylindrical body. Fish serve as definite host.
Life cycle (for some species, e.g. *Capillaria pterophyllii*): direct.

Host
Freshwater fish.

Site
Intestine (endoparasites).

Optimum water temperature
Undefined.

Predisposing factors
Live fish food (indirect life cycle). Poor hygiene conditions (direct life cycle).

Symptoms and diagnosis
Fasting, low growth, slimming.

Prevention and control
Good quarantine period, stool sample, no live food such as *Tubifex* or blood worms, continuous monitoring/enforcement.

Treatment
Levamisole, mebendazole, fembendazole, piperazine. Other anthelminthic (mixed with the food) or as a bath.

Ichthyobodo necator (Pinto, 1928), (Costia necatrix, Leclerq, 1890)
Flagellate (Mastigophora, Kinetoplastida)

Morphology and reproduction
Small fast flagellate, skin parasite (ectoparasite), reproduction by binary fission.
Life cycle: direct.

Host
Ornamental fish.

Site
Skin and gills of ornamental fish (ectoparasites); *I. necator* attaches itself to the epithelia cells of the host.

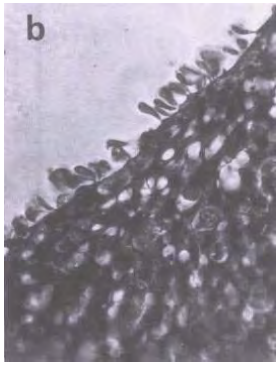
Optimum water temperature
Undefined, water temperature does not seem to be an important parameter, as massive infections may occur at both low (12°–17°C) and high (25°–30°C) temperatures.

Predisposing factors
Poor water conditions, high density of population, and other infected fish present without adequate quarantine period.

Symptoms and diagnosis
Lethargy, clamped fins, rubbing and flashing; skin can take on a grey white opaqueness. Mucus production, respiratory distress and general debilitation; eyes may also appear sunken.

Prevention and control
Good quarantine period, good management of the water parameters, no overcrowding in the aquarium.

Treatment
Formalin bath or prolonged immersion, potassium permanganate prolonged immersion, high temperature (> 30°C [86° F]), salt bath (only for freshwater fish).



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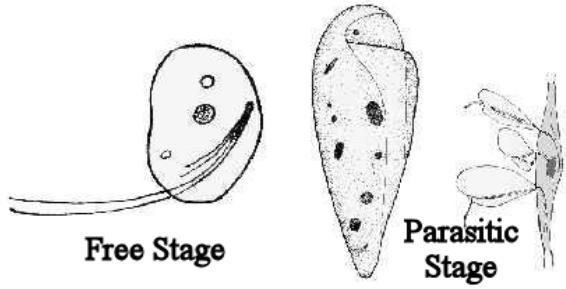


Laboratory of Ittiopatologia, DSPVPA, University of Bologna

Cryptobia iubilans (Nohynkova, 1984)

Kingdom:	Animalia
Phylum:	Euglenozoa
Class:	Kinetoplastea
Order:	Bodonida
Family:	Bodonidae
Genus:	*Cryptobia*

Host
Pterophyllum spp., *Symphysodon* spp. and other cichlid species.

Site
Intestinal tract of the fish (endoparasites).

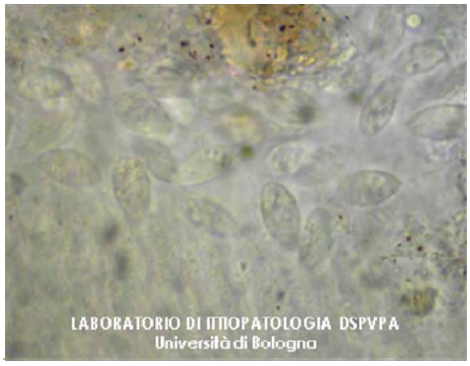
Optimum water temperature
Low temperature (< 28°–30°C) promotes propagation (in *Symphysodon* spp.).

Predisposing factors
Poor nutrition, stressors.

Symptoms and diagnosis
Slimming (hole in head disease), food refusal, white stringy faeces, dark colour.

Prevention and control
Control and quarantine period, elimination of predisposing factors.

Treatment
Flagyl (metronidazole, dimetridazole) in the food or as a bath. Thermal therapy, commercial products.



Ichthyophthirius multifiliis (Fouquet, 1876)

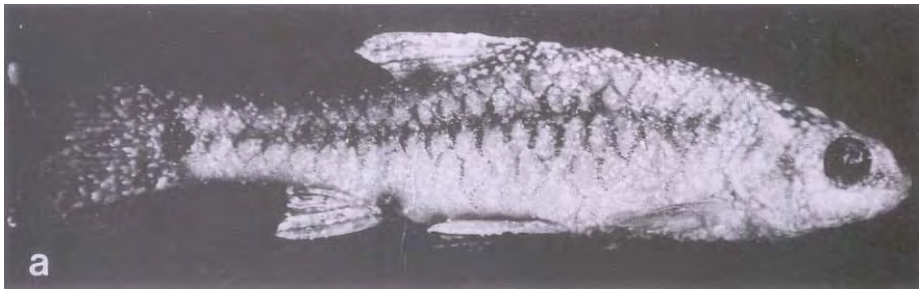
Domain: Eukaryota (unranked) Alveolata
Phylum: Ciliophora
Class: Oligohymenophorea
Order: Hymenostomatida
Family: Ichthyophthiriidae
Genus: *Ichthyophthirius*

Disease
Freshwater white spot disease or ich. Ich is a protozoan parasite usually transmitted by a carrier fish.

Morphology and reproduction
Parasitic stage (trophonts): rounded by cilia on the entire surface of the body with characteristic macronucleo horseshoe, diameter 50–1 000 µm.
Infective stage (theronts): fusiform, internal structure called *perforatium* covered with cilia (free swimming 24–48 hours, average size 25 × 60 µm).
Reproductive stage (tomont): roundish with gelatine capsule, binary fission, produce tomites 3–28 days.
Life cycle: direct (an obligate parasite, it must have a fish host to survive).

Symptoms and diagnosis
White speck on the skin of the infected fish, closed fins in early stage.

Treatment
Formalin, copper sulphate ($CuSO_4$), potassium permanganate ($KMnO_4$) and salt (NaCl). Control and treatment of ich outbreaks can be difficult because only the free-swimming tomites are susceptible to chemical treatment; this means that application of a single treatment will kill tomites which have emerged from cysts and have not yet burrowed into the skin of the host fish.



Source: Paperna (1996)

3.2.3 Bacterial infection

Bacterial diseases, such as internal infections (septicaemia) and external conditions (corrosion of skin and fins), are the major cause of mortality in ornamental fish. The role of these micro-organisms varies from primary pathogen to opportunist invader of a host rendered moribund by another disease.

Germs are often a normal component of the bacterial flora in aquatic habitats (in most cases they live inside the media of biological filter). Stress – often inevitable in a farm system or during transport – predisposes fish to bacterial-borne diseases.

Diagnosis is not always easy because the fish often lack specific symptoms. Laboratory tests should be carried out as soon as possible to determine the pathogen agent and their susceptibility. Diseases can be divided into gram-negative and gram-positive bacterial infections.

Gram-negative

Many diseases affecting aquarium fish are caused by gram-negative bacteria, in particular *Flavobacterium*, which causes a high mortality rate. Most affected are fish of the Cichlidae genus and of the family of poeciliids. *Flavobacterium* disease causes:

- erosions and ulcers of the skin and fins;
- change in pigmentation;
- petechial haemorrhages; and
- sluggish swimming.

It leads to death in a very short period of time – acute clinical conditions associated with systemic infections produced mortalities within 34–48 hours.

Vibrionaceae, such as *Aeromonas* and *Pseudomonas*, and other unidentified gram-negative bacteria were also reported to cause high mortality in reared ornamental fish. They are facultative and ubiquitous bacteria – so not primary pathogens – and they can cause bacterial diseases, such as *Aeromonas hydrophila*, under particular environmental conditions.

Fish are generally predisposed to systemic gram-negative facultative bacteria infection as a result of handling or poor environmental conditions, such as bad water, inadequate feed, high density and low temperature. Possible treatments are antibiotic therapy, medicated feeds (if the infected fish are still willing to eat) and long baths.

Gram-positive

Gram-positive infections are less common in ornamental fish, but they are nevertheless very important in terms of biosecurity and risk management.

Streptococcus infections have been reported, particularly in cichlids and marine ornamental fish. In cases of acute infection, symptoms develop after a few days: gross

ascites and dermal lesions. Exophthalmia (known as "Popeye" in tropical fish) is characteristic of the chronic stage and can result from poor water quality.

Gram-positive bacteria belonging to the genera *Mycobacterium* and *Nocardia* produce infections that cause chronic nodular features (Chinabut, 1999). All species can be affected, including *Puntiu tetrazona*, *Poecilia reticulata* and *Paracheirodon innesi.*

It is possible to combat and eradicate all the major diseases caused by bacteria if the following conditions are achieved:

- control of stress factors;
- elimination of poor farming practices;
- valid quarantine protocol; and
- correct diagnosis.

Photograph 13. Atypical mycobacterium

Source: Laboratory of Ittiopatologia, DSPVPA, University of Bologna

Atypical mycobacterium – or "fish tuberculosis" – refers to various localized or systemic disorders, characterized by chronic evolution, supported by gram-positive bacteria alcohol-acid-resistant saprophytes belonging to the genus *Mycobacterium* (but not belonging to the species *M. tuberculosis*, *M. bovis* and *M. leprae*).

Mycobacterium genus characteristics:

- Alcohol-acid resistance.
- Aerobic asporige.
- High-lipid content in cell wall (60% dry weight) – therefore does not stain with gram.
- Saprophytic.
- Ubiquitous in water, soil and sediment.

- Good resistance to physical agents (survive for long periods in the environment).
- Cosmopolitan (no countries are germ-free).

Public health

- NTM (non-tuberculosis mycobacteria) are opportunist pathogens.
- The pathologies induced by these germs are not contagious; their appearance indicates the existence of a source of organic contagion and a host with compromised immune system.
- The most frequent cause of zoonoses of atypical mycobacterium is *Mycobacterium marinum*, while *M. chelonae* and *M. fortuitum* are opportunist species more rarely found in humans.
- In aquariums, the most common cases are cutaneous infections of the soft tissues in pre-existent injuries.
- Operators in the sector are at risk.
- Infection is through inhalation, ingestion and contact (contamination of continuous skin solutions).
- All cutaneous manifestations caused by these germs are persistent and difficult to cure.

Atypical mycobacterium

Order: Actinomycetales
Family: Mycobacteriacea
Genus: *Mycobacterium*

Criteria for identification include: growth rate, pigment produced, morphology of the colonies, and resistance to antibiotics that can be used as a taxonomic proposal.

Morphology: pleomorphs, immobile, non-obligatory gram+, diameter 0.2–0.6 μm.

Atypical mycobacteria (in fish) are classified as NTM (non-tuberculosis mycobacteria) or Mott (mycobacteria other than tuberculosis).

Group I: Photochromogens
Slow growth saprophyte species (incubation > 7 days). Called Photochromogens because they only produce pigments when exposed to light.
Examples: *Mycobacterium marinum, M. kansasii.*

Group II: Scotochromogens
Slow growth saprophyte species, also called real chromogens, they produce pigment both when exposed to light and in the dark.
Examples: *Mycobacterium gordonaee, M. xenopi.*

Group III: Non-chromogens
Slow growth mycobacteria (incubation > 7 days), non-chromogens (do not produce pigments).
Examples: *Mycobacterium avium, M. terrae.*

Group IV: Rapid growth
Incubation < 7 days, variable pigmentation. They are present as saprophytes in soil, water and plants.
Examples: *Mycobacterium chelonae, M. fortiutum.*

Hosts
More than 160 species are subject to this disease.
Found also in fish feed (such as trash fish food) and Penaeidae.
Extremely variable prevalence in ornamental fish (10–100%), depending on whether they are wild or bred.
Statistical data on ornamental fish from Southeast Asia give cause for concern.

Clinical signs
Injuries are normally localized in the cutaneous layers and internal organs of the fish. In the early stage of infection the following organs are affected: liver, kidneys and spleen (mycobacteria have also been found in the swim bladder).

Symptoms
External: Anorexia, emaciation, lethargy, haemorrhagic nodules or ulcers on the skin, darkening of the skin, desquamation and skeletal deformation, multiple deaths in the tank.
Internal: Increase in volume and loss of consistency in spleen, liver and kidneys, presence of characteristic white-grey nodules in internal organs, peritonitis and ascites, fluid accumulating in peritoneal cavity.

Clinical manifestations (in humans)

In humans, granulomas and hypercheratonic injuries form on the extremities, spreading upwards and causing lymphadenitis of the corresponding joint. Treatment is with long-term antibiotics (also after symptoms have passed).

Photograph 14. Zoonosis of atypical mycobacterium

Source: Laboratory of Ittiopatologia DSPVPA University of Bologna

3.2.4 Zoonoses

A zoonosis is an animal disease that can be transmitted to humans either directly (contact with skin, blood, secretions etc.) or indirectly (via biological carriers or ingestion of contaminated food). The natural reservoir for infectious agents is an animal.

Zoonoses typically affect humans who have close contact with animals, primarily professionals, but also immune-compromised individuals. In the present context (ornamental fish), people who come into contact with contaminated water are the most affected (pathogens are often found in bio-filter media).

3.2.5 Viral diseases

The spread of pathogens is caused mainly by the movement of animals when health controls are not adequate (Bovo, 2002). With ornamental fish, the risk is particularly high because of the unsanitary conditions of farmed fish in most countries of origin. What is more, certain viral agents are extremely resistant and can remain in the aquatic environment (including waste water) for a long time and maintain their pathogenicity.

Since the late 1970s, researchers have identified more than 20 viral agents in ornamental fish. They can represent a major biological risk to the same (or other) species, affecting yield and imports in the international market. Since 1998, there have been numerous incidents of mortality affecting the koi carp, a very popular variety in the ornamental fish market. Another disease that affects this species is spring viraemia of carp (SVC); it can cause serious damage to goldfish breeding.

Koi herpes virus (KHV)

Koi herpes virus (KHV) or carp nephritis and gill necrosis virus (CNGV) is a severe systemic disease with a seasonal pattern. KHV is caused by a DNA virus with envelope; it was described for the first time in Israel in 1998 and its hosts include *Cyprinus carpio* and koi (other fish species appear to be unaffected). The disease has spread rapidly in all countries where koi and other carps are bred (Ploeg, 2008) and it produces a high mortality rate (90–95%). It is included in the new European Regulations 2006/88 and in the OIE (World Organisation for Animal Health) list (Aquatic Code 2006).

Symptoms:

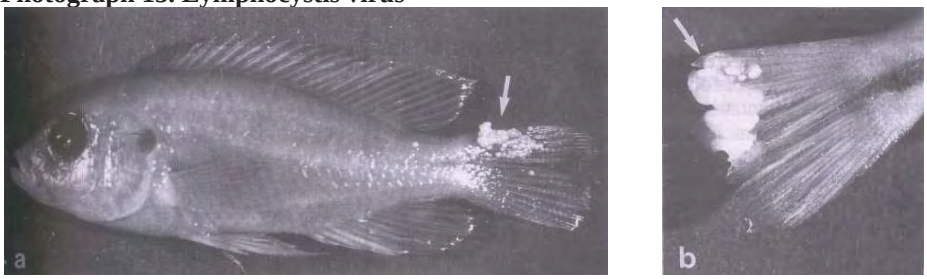
- Whitish skin lesions (followed by lifting of scales).
- Lesions in the gills (with hyper secretion of mucus, swelling and severe necrosis).
- Sunken eyes.
- Lethargic swimming.
- Bleeding, splenomegaly and hyperplasia of internal organs.
- Hypertrophy of gills epithelium.

Fish can be affected at any age, but mortality is higher in the juvenile stages. Temperature is important: the optimal range is between 17° and 26°C (i.e. the temperature in many European and North American countries for long periods of the

year). Transmission is horizontal. No effective treatments or vaccines exist at present; the disease can only be limited by risk management, quarantine (for about 3 weeks at 17°–28°C) and by purchasing specimens from wholesalers considered germ-free (Haenen, 2005).

Lymphocystis virus

Photograph 15. Lymphocystis virus



Source: Paperna (1996)

In captivity, the disease occurs in marine fish, such as angelfish, butterfly fish and clownfish. While less common in freshwater fish, cichlids (such as *Pterophyllum* spp.) are the most affected.

Lymphocystis disease is the result of the iridovirus invading the dermis cellular hypertrophy, which significantly increases in volume. It is a large DNA virus and histological sections reveal aggregates of grossly hypertrophic cells.

Symptoms:

- One or two clusters of rounded pustules (in most cases on the fins).
- Neo-formations, usually white or pink, affecting skin and fins (rarely the apical parts of the body).

The disease is rarely fatal, and within 20 days to a few months it regresses; infection does not recur, which suggests acquired resistance. However, the malformations make the fish unsuitable for sale.

There is no known effective treatment; surgery is possible on the fins affected, but only if the problem is severe. In order to eradicate the disease, total disinfection of the installation and destruction of affected stock fish is recommended.

3.2.6 Treatment and prophylaxis

Prevention is always better than cure. However, treatment is frequently necessary and a small number of very specific rules should always be followed:

- Treat affected specimens only after diagnosis.
- Always remember that the lethal dose for the pathogen is very close to that for the host.
- Use separate tanks with a known volume of water in order to precisely determine the active substances.
- Verify the physical-chemical properties of the water (temperature and pH) – crucial to the success of treatment.
- Turn off or remove any equipment, including bactericidal lamps (UV lamp, skimmers, absorbents and/or resins from the filters such as active-coal and resins of the tanks to be treated).
- Administer treatment early in the morning (when possible) to allow continuous monitoring of the sick fish.
- Make available sufficient water for water changes after treatment.
- Never mix fish from different backgrounds and with different needs in terms of breeding conditions.
- Keep a proper index of the biomass in each tank, with a proper and efficient filter system (preferably non-centralized).

It should be noted that fish from the same suppliers usually have the same health problems; it is therefore sufficient to identify the problem once and apply the solution. The active ingredients may be administered (Wildgoose, 2001):

- directly in the water;
- in the feed;
- by injection (intramuscular or intraperitoneal); or
- by topical application.

Directly in the water

Recommended for ectoparasites, bacteria or fungi, the active ingredient is absorbed directly through the skin and gills.

The filtering system can be seriously compromised by active substances, and treatment is therefore recommended in separate tanks where it is easy to monitor the water quality. Treatment may be:

- short bath – high concentrations of medicine in the quarantine aquarium; or
- long bath – less stressful for the fish, but the long-term toxic effects of certain active substances are unknown and it is difficult to dose for large volumes of water (treatment in lakes, ponds or large centralized systems).

In both cases, strong aeration is required to maintain a high concentration of dissolved oxygen in the water.

In the feed

Drugs are administered directly with the feed. This method is very effective, not excessively stressful, pathogen-targeted, and the impact on the biological filter system is limited.

However, there are disadvantages:

- If fish are too unwell to feed, treatment fails.
- Ineffective against ectoparasites of the skin and gills.
- Not always easy to determine the dose actually taken of the medicated feed administered.

Injection

Only used in particularly serious cases or in individual subjects of particular value (breeding stock or specimens for competition). There are two types of administration:

- Intramuscular, between the lateral line and dorsal fin – the active ingredient is injected into the muscles of the anterior dorsal-lateral of the trunk above the lateral line with a slope of 45°.
- Intraperitoneal, in the area near the ventral pelvic fins.

Usually special fish needles are used for both types of administration. Injections are performed at 24-hour intervals to reduce the risk of damaging vital organs. Typically this application is made under anaesthetic (MS222).

Topical application

Topical application is recommended for specimens of considerable size when treating wounds or abrasions; it is always individual – not collective – treatment. Application is directly on the skin.

Typical products are skin disinfectants and antibacterial products. The choice of the active ingredient is based on a careful assessment of symptoms and disease severity; it must be effective against the micro-organisms in question and the presence of antibiotic-resistant germs must also be taken into account in order to reduce the risk of failure.

If the fish is in poor health, a lower dosage must be applied to prevent an increase in stress (Wildgoose, 2001).

3.2.7 Death On Arrival (DOA)

Photograph 16. DOA in Paracheirodon innesi from Peru

Courtesy of P. Monticini

Business operators are very reluctant to release data on mortality rates during the various steps of the supply chain and there is only limited information from scientific researchers. The term DOA (Death On Arrival) refers to the loss of fish within 24 hours of their arrival at destination. The mortality figure must be communicated to the exporter as soon as possible so that a refund can be calculated into the subsequent order – only fish costs are refunded; shipping costs (freight charge) and all other costs borne by the importer remain. While this system brings benefits to both parties, mortality remains an important obstacle. High mortality is the result of several factors:

- Repeated structural problems in the preparation of the shipment: fasting period, characteristics of the water (factors requiring skill and expertise).
- High density of fish in each bag to lower the fixed costs of shipping: the more fish present in each litre of water, the lower the weight, and therefore the lower the costs for the importers (on the other hand, a higher density increases the level of mortality and consequently the refund payable by exporters for DOA).
- Unsuitable temperature in the aircraft hold.
- Mismanagement of the boxes on arrival by airport staff.
- Strikes or closure of airport offices, missed connections or bureaucratic delays leading to an increase in transit time.

Finally, data reveal no difference between the mortality rate of caught and farmed fish.[12]

[12] In my personal experience, however, there is higher mortality for caught fish. Furthermore, the statistics available do not reflect reality; more accurate data collection and global regulations are required to obtain an accurate estimate of the DOA, for which the true figure is far higher than the reported figure.

4. REGULATIONS

4.1 INTERNATIONAL LEGISLATION

4.1.1 Introduction

Legislation of the ornamental fish trade exists at various levels and covers a range of aspects of the business. Regulations may be international, national, EU (European Union) or adopted by exporting countries. There are regulations concerning:

- taxation, invoices, payments and customs duties;
- animal welfare, in particular during the various phases of transportation and in relation to animals in captivity;
- biosecurity and health; and
- protection of endangered species.

Many loopholes in the regulatory framework have been closed in recent years, and many issues have been successfully dealt with, but problems continue to arise regarding interpretation and there can still be tedious bureaucratic delays, slowing the effectiveness of the entire system and of the value chain in general.

This paper deliberately excludes the fiscal aspects of the trade, as more often than not companies ship goods through acknowledged shipping agents who take care of all the paperwork in the airport.

4.1.2 World Organisation for Animal Health (OIE)

The OIE is an international organization established in 1924 in Paris and ratified by 167 countries. Its principal objectives are to:

- protect global trade (it publishes health standards for live animals and animal products);
- provide practical experience in epizootic controls;
- guarantee the health of products of animal origin (it has created a list of diseases for which health measures are required at global level); and
- promote animal well-being through a scientific approach.

OIE guidelines include the possibility of a country declaring itself “disease-free” for certain diseases with a relevant biological and sanitary impact.

The OIE provides member states with the instruments for preventing and controlling pathologies in aquatic animals, indicating measures of a general nature (preventive medicine, risks associated with imports) and specific measures (certification, acknowledgement of immunity). Regulations are based on the following:

- Aquatic Animal Health Code 2009, 12th edition (aquatic code) – aims to guarantee the healthy trade of aquatic animals (fish, molluscs and crustaceans), without limiting trade between the various countries.

- Manual of Diagnostic Tests for Aquatic Animals 2009 (aquatic manual) – provides scientific and laboratory knowledge useful in diagnosis of the diseases in the code.

The OIE epizootic list of diseases requiring notification includes several pathologies affecting fish, but only three of these concern ornamental species:

- Spring viraemia of carp (SVC)
- Epizootic ulcerative syndrome (EUS)
- Koi herpes virus (KHV)

Some zones have already been declared disease-free of SVC. On the other hand, KHV has only recently been included in the list of diseases requiring notification, and it is not clear whether or not eradication programmes have been implemented (a very difficult process, due to the major costs involved in realization and control).

4.2 EUROPEAN LEGISLATION

4.2.1 European Fish Health Regulation

European integration has made it possible to establish a system of monitoring and control – rather than regulation in the strictest sense – with the following objectives:

- Simplify the trade of goods (live animals) and exchange of information.
- Promote the correct management of biological risk to guarantee safety in the food industry.
- Protect the life and health of animals and vegetables.
- Protect the environment and contribute to its sustainable development.

In order to be effective, these programmes must be based on an integrated approach between production and government bodies (local, national and international). For this reason, the Directorate General for Health and Consumers (DG SANCO) created a modern computer network architecture, called TRACES (Dec. 623/2003), connecting all the competent veterinary health and control authorities.

TRACES helps manage health problems, tracking the movements of animals to and from a certain place, envisaging control at destination in conformity with the various regulations in force. Member states have used TRACES since 1 April 2004, when it replaced the SHIFT and ANIMO systems (resolution 2004/294/EC-30/03/2004 pursuant to the application of the TRACES system with modification of resolution 92/486/EC).

BIP and UVAC (see below) are the decentralized bodies of the Ministry of Health (Italy) responsible for health controls.

4.2.2 Border Inspection Post (BIP)

BIPs are peripheral veterinary offices, acknowledged and authorized on the basis of EU procedures to perform veterinary checks on live animals and products of animal origin coming from other countries to be sold on the EU market or in transit to other countries. Procedures are established in Directive 97/78/EC and Directive 91/496/EC, implemented respectively with Legislative Decree No. 80-25/02/2000 and Legislative Decree No. 93-03/03/1993.

BIP operates at major airports and ports, with authorization to control a certain product range. As well as health controls on animals coming from other countries, some BIPs carry out checks in accordance with European regulations on the well-being of live animals.

4.2.3 Veterinary Offices for Community Affairs (UVAC)

UVACs are peripheral offices of the Ministry of Health established with Legislative Decree No. 27-30/12/1993 and created in implementation of Directive 89/608/EC. UVAC exists to guarantee the correct application of veterinary and zootechnic legislation following the abolition of controls at the frontiers between the member states of the EU. UVAC is responsible for controls at destination at national level on goods coming from the EU.

The functions and duties of UVAC were established by decree of the Ministry of Health on 18 February 1993:

- Each UVAC has territorial competence, generally covering a specific region, operating in coordination with the regional veterinary services, local health authorities and Ministry of Health.
- The arrival of stock must be reported to UVAC and the veterinary service of the competent local health authority with at least 1 day's notice.
- Operators must be registered with UVAC and be fully integrated with the TRACES system: data concerning the lot shipped must be transmitted on the day the health certificate is issued by the local veterinary unit in the country the goods are shipped from, to the health authority of the country they are shipped to (in the case of Italy, local health authority veterinary service and Ministry of Health).
- UVAC has the power to apply administrative sanctions for the non-observance of the regulations on registration/conversion and pre-notification.

From a regulatory point of view, Commission Regulation (EC) No. 136/2004 establishes the method to adopt for veterinary checks at EU BIPs on products imported from other countries:

- Notification of arrival using the common veterinary entry document (CVED) (Article 2); this document is issued in several copies by the person importing the goods and must accompany the shipment during all stages.
- Part 1 is filled in by the person responsible for the shipment.

- Part 2 is filled in by the veterinary official (Article 3) at the frontier inspection post after the veterinary checks have been carried out.
- Once through customs, the original copy of the CVED is sent with the goods to the fish farm.

The resolution passed by the Commission on 20 September 2006 (2006/656/EC) is a rule of law establishing the conditions concerning veterinary policy and certification for importing fish for ornamental purposes.

- It includes a list of countries from which member states are authorized to import live fish into the community, together with health conditions and veterinary certification requirements.
- The field of application includes ornamental fish caught wild and bred, imported and sold in shops, garden centres, public aquariums and in any case without coming into contact with EU waters (Article 1).
- Article 2 defines ornamental fish as "fish species, bred or sold for ornamental purposes only". Reference is made to cold-water ornamental fish susceptible to pathologies such as SVC and KHV (again in observance of Directive 91/67/EC).
- The conditions for importing cold-water ornamental fish (Article 3) and tropical ornamental fish (Article 4) are established.
- The control procedures for fish imported from other countries are subject to veterinary controls at the BIP of the member state they are entering, in accordance with Article 8 of Council Directive 91/496/EC; the CVED must be in compliance with Regulation (EC) No. 282/2004.
- The prevention of natural water contamination is fundamental (Article 6) and fish imported for ornamental purposes must not be freed in fish farms to prevent the risk of them reaching community waters.

This resolution was modified by a Commission Resolution on 24 August 2007 (2007/592/EC) in part II of Annex I, indicating that as the country concerned was the Maldives, due to pending OIE adhesion (denied on 31 December 2007), the importation of tropical ornamental fish was suspended from that date.

4.2.4 Council Directive 2006/88/EC, 24 October 2006

This is a definitive regulation on the health conditions applicable to animal species for aquaculture and relevant products, for the prevention of certain diseases in aquatic organisms.

The animals in question are normally kept in aquariums or private ponds, fish farms or display aquariums: they do not come into contact with EU waters and do not expose other EU aquaculture sectors or wild stock to the same risk. Therefore, special regulations are required for the sale, transit and importation of ornamental aquatic animals kept in these conditions.

However, when ornamental aquatic animals are not kept in closed systems or aquariums, but come into direct contact with EU waters, there is a potential major risk for EU aquaculture and species living in the wild. This is the case in particular with carp

(Cyprinidae) populations, such as the popular ornamental koi carp (subject to widespread distribution), as it is a carrier of diseases that can be transmitted to other species of carp bred in the EU or found in the wild. In this case, the provisions of the directive should be applied.

Again in accordance with the directive, animals kept, bred or sold for purely ornamental purposes are defined as "ornamental aquatic animals". The "ornamental" theme is dealt with in depth in section 5 of Article 21.

4.2.5 Commission Regulation (EC) 1251/2008 and Commission Regulation (EC) 719/2009

This regulation lays down some amendments to Regulation (EC) 1251/2008 with specific regard to the importation into the European Community of ornamental aquatic organisms. The text in the annex to this regulation replaces Annex III, which lays down the list of third countries and territories from which ornamental aquatic animals may be imported into the European Community.

Detailed rules can be found in the following implementing measures:

- Commission Regulation (EC) No. 1251/2008 implementing Council Directive 2006/88/EC as regards conditions and certification requirements for the placing on the market and the importation into the Community of aquaculture animals and products thereof and laying down a list of vector species.
- Commission Regulation (EC) No. 719/2009 amending Regulation (EC) No. 1251/2008 as regards the list of third countries and territories from which certain crustaceans and ornamental aquatic animals may be imported into the Community.
- Commission Regulation (EC) No. 1252/2008 derogating from Regulation (EC) No. 1251/2008 and suspending imports into the Community from Malaysia of consignments of certain aquaculture animals.
- Commission Decision 2008/946/EC implementing Council Directive 2006/88/EC as regards requirements for quarantine of aquaculture animals.

4.2.6 Regulations on the well-being of animals

The European Union acknowledges that animals are living beings which have a right to protection. EU regulations establish minimum requirements aimed at protecting animals from unnecessary sufferance during three main phases: breeding, transportation and killing.

Protection of farm animals

Council Directive 98/58/EC of 20 July 1998 establishes the minimum regulations concerning the protection of farm animals. All EU member states have ratified this agreement, the principles of which concern suitable refuge, feeding and care to meet the animals' requirements.

This directive applies to animals (including fish, reptiles and amphibians) bred for various purposes. It does not apply to wild animals, animals for cultural activities, laboratory animals and invertebrates.

Animal well-being during transportation

Council Regulation (EC) No. 1/2005 of 22 December 2004 is a reworking of regulations on animal well-being during the various phases of transportation and associated operations. While this regulation mainly concerns animals sold for profit, it is generally applied to all animals including ornamental fish (Ploeg *et al.*, 2007).

The regulation establishes the operators and their responsibilities, consolidating the steps to be taken to monitor the activities and envisaging restrictive regulations on transportation over long distances, as well as the vehicles used. The previous directives, Directive 64/432/EC and Directive 93/119/EC, and Regulation (EC) No. 1255/97 are modified.

It is a "vertical" regulation which extends responsibility to all subjects involved in the process, including operations before and after transportation. It concerns the carriers, organizers and owners of the animals transported. All subjects must be suitably trained; in particular, the drivers must hold a certificate of conformity issued following a training period on animal well-being after passing an exam held by an independent body acknowledged by the competent authorities.

Regulation (EC) 1/2005 makes a distinction between different regimes of transportation on the basis of distance and time taken:

- For shipments < 65 km, no authorization is required by the carriers, and only documents certifying the species transported, destination and estimated consignment time are necessary.
- On all distances > 65 km, carriers must obtain authorization from the competent authority of the EU member state. Authorization is valid for 5 years, has an official European format, and is registered in an electronic database accessible by the authorities of the member states.
- In the case of long journeys through several countries, carriers must also keep a logbook (as established by the transportation organization in accordance with the standardized model), containing information on the journey (identification of the animals and persons travelling with the same, departure and destination, and checks carried out at various times during transportation).
- For journeys > 8 hours, more restrictive rules are applicable.

During checks, the competent authority must verify the validity of the authorizations, the certificates of homologation and conformity, and the information in the logbook (where applicable). Veterinary officials must also verify that the animals are in a suitable condition to proceed with the journey.

This regulation ratifies and replaces the previous directive 91/628/EC as of 5 January 2007.

4.3 UNITED STATES LEGISLATION

4.3.1 Regulation of aquaculture

Aquaculture in the United States of America is regulated at both federal and member state level. At federal level, the most important agencies are the Food and Drug Administration (FDA), the Department of Agriculture (USDA) and the Environmental Protection Agency (EPA); each regulates a specific part of the aquaculture sector. The FDA covers all matters concerning food and safety regulations and drug approval. However, there are other federal agencies involved in aquaculture activities: Centre for Veterinary Medicine in the FDA, the Animal and Plant Health Inspection Service in the USDA (APHIS), and the United States Fish and Wildlife Service (USFWS) of the Department of the Interior.

At federal level, aquaculture is defined by the National Aquaculture Act, 1980. With the exception of this act, federal laws rarely address aquaculture directly. There are a number of laws which specifically address the ornamental fish trade, a small number of which are analysed herein: the Minor Use and Minor Species Animal Health Act, 2004; the Animal Welfare Act, 2007; the Lacey Act; and the Endangered Species Act.

Centers for Disease Control and Prevention (CDC)

CDC regulations govern the importation of animals and animal products capable of causing disease in humans (zoonoses). The CDC does not require general certificates of health for pets for entry into the United States of America. However, health certificates may be necessary for entry into some states, or may be required by airlines for ornamental organisms.

There are no CDC regulations regarding the importation of live ornamental fish. The USFWS may have requirements, especially if an endangered (e.g. arowana dragon fish) or dangerous (e.g. *Channa* spp. or piranhas) species is involved. The National Marine Fisheries Service (NMFS) may also have regulations regarding the trade of tropical fish.

4.3.2 Import and export of live fish

USDA has no import requirements for live finfish imported into the United States of America, except for the following eight species of fish that are susceptible to SVC:

- common carp (*Cyprinus carpio*), including koi (for ornamental purposes);
- goldfish (Carassius auratus);
- grass carp (Ctenopharyngodon idellus);
- silver carp (Hypophthalmichthys molitrix);
- bighead carp (Aristichthys nobilis);
- crucian carp (Carassius carassius);
- tench (*Tinca tinca*); and
- catfish (Silurus glanis).

Regulations regard live fish and their gametes (eggs and milt) in order to protect local stock; they are applicable to commercial shipments and fish brought into the United States of America with personal baggage. Live fish of these species may continue to be imported, if they are accompanied by a USDA import permit and a veterinary health certificate issued by a full-time veterinary officer or competent authority of the government of the exporting country.

Legislation concerning movement of aquatic stocks between states may vary from state to state. For international shipments, each state may have specific health regulations (i.e. similar to EU health regulations) for the entry of aquatic animals. USDA and APHIS have specific international aquatic animal health regulations and guidelines. Some countries may have further restrictions on certain species (see USFWS related legislation and CITES appendix animals). APHIS is the leading agency for health certification of farmed fish.

USDA health certificate forms for the import and export of aquatic animals:

- APHIS Certificate mod. 7001 (certificate of health for small size animals)
- VS Certificate mod. 17-141 (certificate for the export of live fish and invertebrates)
- VS Certificate mod. 17-129 (certificate for import or transit of animals, embryos or hatching eggs)
- VS Certificate mod. 17-140 (origin health certificate)

Officially recognized veterinarians must fill in the certificates accurately, without crossings out or correction, and then sign in a different colour. The certificate is universally valid for 30 days. APHIS has no specific animal health requirements for the importation of fish, reptiles and other animals or endangered species which have not been inoculated with pathogens for scientific purposes (when they have been inoculated, they require VS Form 17-129, released by an approved laboratory).

4.3.3 Minor Use and Minor Species Animal Health Act, 2004

The Minor Use and Minor Species Animal Health Act, 2004, often referred to as the "MUMS Act", became law in August, 2004. This legislative proposal was developed by the FDA, veterinarians (wildlife, zoo and public aquarium) and animal drug companies. The law provides innovative ways to market products for small animal populations and is designed to help pharmaceutical companies overcome the financial roadblocks they face in providing limited-demand animal drugs.

"Minor use" refers to a drug used for a major species for a condition that occurs infrequently or in limited geographical areas. "Minor species" refers to all small animals other than humans that are not one of the major species. They include zoo animals**,** parrots, ferrets and guinea pigs. Some animals of agricultural importance are also considered minor species (e.g. catfish). All aquatic animals, including finfish (also for ornamental purposes), aquatic turtles, crustaceans and other invertebrates, are considered minor animal species. Animals kept as household pets, for display or educational purposes in zoos and public aquariums, and those raised commercially as food or for recreational fishing are all considered minor species.

In total, there are many minor species requiring pharmaceutical aid to improve their health and welfare (see also the Animal Welfare Act, 2007). Each minor species has a significant impact nationally, regionally or locally. Maintaining the health of rare, threatened and endangered animals is the responsibility of the zoo veterinarian; however, the availability of drugs for this class of animal is still limited. The currently approved drugs are outlined below.

Immersion (long or short bath)

- Formalin (for all finfish, all finfish eggs and Penaeidae shrimps)
- Hydrogen peroxide (for different freshwater species)
- Oxytetracycline dihydrate (basic broad-spectrum antibiotic for gram-negative bacteria)
- Tricaine methanesulphonate (e.g. Finquel MS222 anaesthetic for cold-blooded animals)
- Metomidate hydrochloride (for the sedation and anaesthesia of all ornamental finfish)

Injectable

- Chorionic gonadotropin HCG (to induce breeding in fish)
- Ovaprim, sGnRHa + domperidone (only for use as a spawning aid in ornamental finfish brood stocks)

Medicated food

- Florfenicol (antibiotic for catfish and salmonids)
- Oxytetracycline dihydrate (all farmed freshwater fish)
- Sulphadimethoxine

Furthermore, under the 1994 Animal Medicinal Drug Use Clarification Act (AMDUCA), veterinarians may prescribe human drugs under certain conditions, giving greater flexibility in the use of approved drugs for animal use. Indeed, with the exception of formalin, no drugs are approved by FDA for use in ornamental finfish species (e.g. anti-bacteria or anti-parasites).

4.3.4 Animal Welfare Act, 2007

The Animal Welfare Act (AWA) became law in 1966 and is the only federal law regulating the treatment of animals in research, exhibition, transport and dealer environments. The act has been amended six times (1970, 1976, 1985, 1990, 2002 and 2007) and is enforced by APHIS and its Animal Care (AC) programme.

APHIS provides leadership in determining the standards of humane care and treatment of animals, implementing standards and achieving compliance through inspection, education and cooperative efforts. The AC programme administers the AWA, its regulations and standards.

AWA demands minimum standards of care and treatment for certain animals bred for commercial sale, used in research, transported commercially or exhibited to the public. "Animal" is defined as: any live dog, cat, non-human primate, guinea pig, hamster, rabbit or any other warm-blooded animal used for research, teaching, testing, experimentation or exhibition purposes, or as a pet. By definition, cold-blooded species (amphibians and reptiles) are exempt from protection under AWA. Other excluded animals are:

- birds and rats (bred for use in research);
- horses (not used for research purposes);
- farm animals, including livestock and poultry (used or intended for use as food or fibres or in agricultural research); and
- fish and invertebrates.

A person with a commercial business moving animals from one location to another (e.g. airlines and truck companies) is considered a transporter under AWA. Exhibitors' facilities, such as zoos, circuses and aquariums, are all subject to inspection by AC.

The exclusion of fish from AWA (Eiras, 2008) is a controversial issue: "welfare" is often synonymous with health, and therefore the aquaculture sector should be included. Likewise, in the EU's Council Regulation 1/2005, there is no specific mention of fish in welfare legislation; however, all importers and transporters apply the regulation also to ornamental fish (Ploeg *et al.*, 2007). This could well be the case in the United States of America, but no data are available. Worldwide legislation could be the solution.

4.3.5 Lacey Act

The Lacey Act is a conservation law, prohibiting the transportation of illegally captured or endangered animals across state borders. It was the first federal law to protect wildlife, and remains so to this day, although it has been revised and amended several times: 1969, 1981, 1989 and 2008.

The Lacey Act is administered by the Departments of the Interior, Commerce and Agriculture through their respective agencies, including USFWS, NMFS and APHIS, and it is mainly applied to prevent the import or spread of potentially dangerous and non-native species.

Definitions

- "Fish or wildlife": wild animals dead or alive, including wild mammals, birds, reptiles, amphibians, fish, molluscs, crustaceans, arthropods, coelenterates or other invertebrates, and including any part, product, egg or offspring.
- "Import": land on, bring into, or introduce into any place subject to United States jurisdiction.
- "Plant or plants": wild members of the plant kingdom, including roots, seeds and other parts (but not common food crops), indigenous to a state and listed either in the CITES appendix or under a state conservation statute.

The Lacey Act makes it illegal:

- to import, export, transport, sell, receive, acquire or purchase fish, wildlife or plants taken, possessed, transported or sold in violation of a federal law, treaty, regulation or Indian tribal law.
- to import, export, transport, sell, receive, acquire or purchase in interstate or foreign commerce: fish or wildlife taken, possessed, transported or sold in violation of a state law, state regulation or foreign law; plants taken, possessed, transported or sold in violation of a state law or regulation.
- to possess within the special maritime and territorial jurisdiction of the United States of America: fish or wildlife taken, possessed, transported or sold in violation of a state law, state regulation, foreign law or Indian tribal law; plants taken, possessed, transported or sold in violation of a state law or regulation.

However, for many states no specific regulation exists for the handling and trade of fish for ornamental purposes; this is further complicated by the fact that some states prohibit fish which are allowed in others. Certain exotic species – for example, piranhas (*Serrasalmus* and *Pygocentrus* spp.) and Potamotrygonidae (*Potamotrygon* spp.) – have been banned in some states, while other genres – for example, snakeheads *(Channa* spp.) and Osteglossidae (*Osteoglossum ferreirai*) – are accepted despite their inclusion in the CITES appendix.

There is a lack of conformity; each state has its own legislation depending on the climatic and environmental conditions. Considering the size of the United States of America and the potential danger to native stock from GMOs, this is understandable.

4.3.6 Endangered Species Act (ESA)

Several agencies are involved in the regulation of the wildlife control industry. The major agencies involved are USFWS and EPA; while APHIS provides federal leadership in addressing wildlife damage issues, it does not have a regulatory role. Regulations are implemented to manage wildlife, reduce damage to agriculture and natural resources, minimize risks to human health and safety and help protect endangered and threatened species.

The Endangered Species Act protects animal species listed by the federal government as “endangered” or “threatened”. Protected species cannot be killed, harmed or collected – except in specific circumstances, and then only with permits.

- Section 7 applies not to private parties but to federal agencies.
- Section 9 makes it illegal for anyone to “take” a listed animal orsignificantly modify its habitat.
- Section 4 contains the procedures for listing a species. An “endangered” species is defined as “in danger of extinction” throughout all or a significant portion of its range. Congress further refined this definition on the basis of the following criteria:
  - impacts to the species' habitat or range;
  - overuse of the species by humans;
  - presence of disease or predators;

- inadequacy of existing legal protection; and
- “other natural or man-made factors” affecting the species' continued existence.

When EPA determines that a species is endangered or threatened, it must specify the species' “critical habitat”. The critical habitat includes those areas within the area occupied by the species whose physical or biological features are “essential to the conservation of the species” and which may require special management considerations or protection.

Most states have their own endangered species laws, and numerous state-specific lists of endangered species exist. As a result, legislation is not always clear.

4.4 WASHINGTON CONVENTION

4.4.1 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

Established in 1975 and administered by UNEP, member countries currently number 169. CITES regulates the trade of certain endangered animal and plant species, in terms of export, re-export, import, transit, transfer and detention for any reason. It regulates the international trade of approximately 30 000 species, of which approximately 25 000 are plant species; these species are listed in three appendixes. Each country has its own management authority.

On 1 January 1984, the EU introduced legislation which for some species is stricter than the actual CITES regulations. Regulation (EC) 338/1997 (Protection of Wild Flora and Fauna Species through Trade Control) was followed by other regulations and significant modifications defining in detail the species to be protected.

The following EU regulations are currently in force:

- Council Regulation (EC) 338/1997, on the protection of species of wild fauna and flora by regulating trade therein.
- Commission Regulation (EC) 407/2009 (annexes of Regulation 338/97 with lists of protected wild flora and fauna species), repealing and replacing (EC) 318/2008.
- Commission Regulation (EC) 865/2006, indicating the method of application of Council Regulation (EC) 338/97.
- Commission Regulation (EC) 100/2008, with modifications and integrations of Regulation (EC) 865/2006.
- Commission Regulation (EC) 359/2009 (suspending the introduction in the EU of some wild fauna and flora species and annulling Commission Regulation 1037/2007 and Regulation 811/2008.

In Italy, relevant regulations are:

- Act 150-7/2/1992 (regulating crimes relevant to the application in Italy of CITES), modified by Act 59/1993, Act 426/1998 and Legislative Decree 275/2001.

- Decrees of the Ministry of the Environment of 19 April 1996 and 26 April 2001, including a list of species (live dangerous animals) whose introduction in the national territory is forbidden.

Several different administrative bodies are responsible in Italy for making sure the complex EU legislation deriving from the Convention is respected: the Ministry of Environment and the Ministry of Agriculture and Forestry which, in collaboration with the State Corps of Forest Rangers, issues certification, while the *Nuclei Operativi Cites* (NOC) control products on the territory, in coordination with the competent customs offices.

4.4.2 Protected species

The list of CITES protected species (formally referred to as "specimens") is periodically revised. The various species are listed in three appendixes based on the level of protection required:

- Appendix I: protected species in danger of extinction; trade is forbidden, use may be allowed in exceptional circumstances.
- Appendix II: protected species not in imminent danger of extinction; subject to control (trade must be compatible with their survival and is subject to authorization through CITES certification).
- Appendix III: species protected by single member states (typically for the protection of special endemic species).

Only after joint party decisions in conferences held by member states using proposal procedures, may species be added to or cancelled from Appendixes I and II or moved from one appendix to another. For inclusion in or removal from Appendix III, the unilateral decision of the relevant country is sufficient.

Appendix I

Permission to import must be requested from the state authorities and is only granted if:

- the species in question is not to be traded for commercial purposes but for the purpose of protecting the species (the same is valid for re-export requests); and
- the animal was obtained by legal means.

In the case of live animals or plants, the effects of stress during transportation must be kept to a minimum.

Appendix II

An export or re-export certificate is required from the state authorities and is only issued if:

- the species in question was obtained legally, through acknowledged channels;
- marketing of the species cannot endanger the species; and
- the species was imported in compliance with CITES regulations (in the case of re-export).

In the case of live animals or plants, transportation must be organized to increase their chances of survival and in consideration of their well-being.

Appendix III

In the case of trade from a state which has included animals or vegetable species in Appendix III, permission must be given by the authorities of that state. As above, permission is only given if the species was obtained through legal and authorized channels, minimizing the risk of injury or damage during the various phases of shipment. Exceptions are:

- species in transit and shipped using transhipping;
- species acquired before inclusion in the CITES lists;
- species which are part of private collections;
- animals bred in captivity;
- plants grown using artificial techniques;
- organisms used in scientific research; and
- circus animals.

Approximately 5 000 animal species and 2 800 plant species are protected by CITES against exploitation and trade. They are listed in appendixes and include taxonomic groups, such as primates, cetaceans, turtles, parrots, coral and orchids; in certain cases, they also include subspecies or the same species from different geographical areas (e.g. the population of a certain species, but only in one country).

There are about 15 fish species in Appendix I and 71 in Appendix II. The ornamental fish listed include *Scleropages formosus* in Appendix I, and the various species of *Hippocampus* spp. in Appendix II. Ornamental invertebrates include molluscs and bivalves (e.g. giant clams) and hard corals (e.g. stony corals, blue corals and organ-pipe corals); all are listed in Appendix II.

4.4.3 The case of the Banggai cardinal fish

Every 2 or 3 years the member states of CITES hold the Conference of the Parties (CoP), to which NGOs are also invited.

Various subjects are presented to working groups comprising delegates and specialists from the various participant countries. During the 14th CoP held in Washington, one of

the themes on the agenda was the possibility of including the Banggai cardinal fish (*Pterapogon kauderni*) in Appendix II. The proposal was made by the United States delegation, which asserted that the number of fish caught was not sustainable in the long term with regard to protection of the ecosystems.

Following declarations by a panel of experts from FAO, the Indonesian delegation, and representatives of seven international organizations in the ornamental fish sector, the Commission decided not to include the Banggai cardinal fish in any of the CITES Appendixes. Its inclusion would have created considerable practical problems, with an increase in the illegal capture and sale of the species. The Commission did, however, encourage the development and promotion of breeding and reproduction programmes in locations close to its natural habitat to create a biosustainable system.

4.4.4 IUCN Red List of Threatened Species

The IUCN Red List of Threatened Species was established in 1948 and represents the most extensive database of information and data on the conservation status of plant and animal species around the world. The list is compiled by the International Union for Conservation of Nature (IUCN, formerly World Conservation Union).

thousands of species and subspecies; it is produced annually and grades the threat of species that have been evaluated by its assessment criteria. Some 30% of all fish species have been classified as “threatened”:

- extinct (EX)
- extinct in the wild (EW)
- critically endangered (CR)
- endangered (EN)
- vulnerable (VU)
- lower risk/conservation dependent (LR/CD)
- near threatened (NT)
- least concern (LC)
- data deficient (DD) – when data are inconclusive

Freshwater fish are particularly vulnerable due to their habitat; on the other hand, marine fish (with the exception of anadromous species) are less threatened (Akcakaya, 2004). Indeed there are no documented cases of saltwater species becoming extinct as a result of human activity (Robert and Hawkins, 1999). Nevertheless, overfishing has led to local extirpation, and certain marine fish populations have declined within a few generations.

The Banggai cardinal, *Pterapogon kauderni*, is among the new additions to the 2007 IUCN Red List of Threatened Species. It has been classified as endangered (EN)

following the dramatic decline of its small population in recent years as a direct result of overcollecting for the aquarium trade.

Banggai cardinal fish

Class:	Actinopterygii
Order:	Perciformes
Family:	Apogonidae
Subfamily:	Apogoninae
Genus:	*Pterapogon koumans*, 1933
Species:	*Pterapogon kauderni koumans*, 1933

Assessment information

Red List category and criteria:	Endangered B2ab (ii,iii,iv,v)
Year assessed:	2007
Assessor(s):	Allen, G.R and Donaldson, T.J.
Evaluator(s):	Vagelli, A. and Wabnitz, C. (Coral Reef Fishes Red List Authority)

Justification:

The Banggai cardinal fish, *Pterapogon kauderni*, is a small reef fish endemic to the Banggai Islands off Sulawesi, Indonesia. Distinctive characteristics are as follows:

- Relatively small population.
- Limited distribution (EOO about 5 500 km², AOO about 34 km², two distinct geographic clades, one small subpopulation introduced accidentally in Sulawesi).
- Plasticity and ontogenetic differences in microhabitat utilization.
- Social system based on group living.
- Territorial behaviour in both males and females.
- Fixed paired courtship, spawning initiated by females.
- Low fecundity.
- Considerable investment in energy resources for reproduction.
- Paternal oral incubation of eggs and free-living embryos.
- Lack of a pelagic larval phase.
- Limited dispersal capability, localized settlement and recruitment.

4.5 JAPANESE LEGISLATION

Japanese law concerning the ornamental fish trade is based on different levels and involves two principal agencies:

- MAFF (Ministry of Agriculture, Forestry and Fisheries):
  - regulates trade and quarantine of tropical fish;
  - administrates matters related to agricultural, forestry and fisheries products, from production to consumption;
  - regulates rural development; and
  - promotes the welfare of rural inhabitants in order to achieve a stable food supply and sound development of the agriculture, forestry and fisheries industries.

- MOEC (Ministry of the Environment):
  - is responsible for animal health and wildlife legislation;
  - issues guidelines for local biodiversity strategy and new technologies for helping restore coral reefs;
  - cooperates in campaigns for reducing waste; and
  - plays an important role in the climate change policy.

Animal Quarantine Service (AQS)

AQS is the official source of information regarding the import and export of pets in Japan. Animal quarantine is implemented worldwide to prevent the incursion of animal illnesses and diseases. Japan conducts both import and export inspections for numerous animal species. However, animal quarantine inspections are not required upon arrival in Japan for frogs (amphibians), snakes (reptiles) and other minor animals from abroad. Animal quarantine is based on the following laws, government and ministerial ordinances and amendments:

- Government Ordinance No. 235 (1953)
- MAFF Ordinance No. 35 (1951)
- MAFF Notice No. 1997 (1971)
- MAFF Notice No. 1439 (1972)
- MAFF Notice No. 509 (1998)

National Veterinary Assay Laboratory (NVAL)

The main responsibility of NVAL is the assay of animal vaccines for national use. NVAL is also responsible for the distribution of reference products, examinations, laboratory inspection to ensure the implementation of good practices and technical training.

Veterinary drugs:

- are used for the prevention, diagnosis and treatment of animal diseases;
- contribute to the maintenance and improvement of safe animal products, and to the health of pets; and
- play an important role in improving public health through the control of zoonoses.

NVAL determines whether animal drugs are safe and efficacious. In Japan, the aquaculture industry uses over 29 different drugs or combinations of drugs to treat just a few fish species, while the United States industry, with over 800 different species, has only five approved drugs.

4.5.1 Law on the Protection of Fisheries Resources (Act No. 78, 1996)

This law is designed to prevent the spread of fish diseases to Japan through the importation of marine aquatic animals for use in aquaculture, as Japan imports significant quantities of marine ornamental fish and invertebrates. MAFF administers

this law, of which the most interesting section is 1-2 “Import Quarantine of Aquatic Animals” (Articles 13-2 and 13-5).

Related laws:

- Fisheries Basic Act (Act No. 89, 2001)
- Law of Maintenance of Sustainable Aquaculture Production (Act No. 51, 1999)

4.5.2 Law on the Domestic Animal Infectious Diseases Control (Act No. 166, 1951) amended (Act No. 68, 2004)

Thepurpose of this Act is to improve the livestock industry by preventing the spread of infectious diseases in pets. It defines affected animals and infectious diseases. MAFF also prepares guidelines for the implementation, inspection, disinfection and restriction of movement of pets.

4.5.3 The Pet Food Safety Law

The Pet Food Safety Law aims to:

- ensure the safety of pet food;
- protect the health of pets; and
- promote animal welfare.

Approved in 2008, it has been in force since 2009 and requires that all importers of pet foods observe standards for production methods and respect specifications set by MOE and MAFF. Maximum residue limits are established for certain substances (e.g. aflatoxin and pesticides) and standards are set to control the spread of harmful microbiological agents. In Japan, around 4% of households keep ornamental tropical fish and another 3% turtles. Ornamental fish account for around 1.5% of the pet food market.

4.5.4 Wildlife protection system

To protect wildlife and preserve endangered species, it is important to protect habitat, regulate hunting, prevent illegal killing and implement any other necessary measures. In Japan, this is done by enforcing the Wildlife Protection and Hunting Law and the 1992 Law for the Conservation of Endangered Species of Wild Flora and Fauna (LCES, Law No. 75).

However, there are still numerous problems regarding the trade of wildlife in Japan, because current laws do not curb illegal trade and are not a sufficient deterrent. Although many laws have been revised, the 1992 Law No. 75 remains ineffective (www.panda.org).

Japan became a CITES member in 1980. The Ministry of International Trade and Industry is the management authority, and the Environment Agency and MAFF are the scientific authorities. The Japanese Government applies the Customs Law and the Foreign Exchange and Foreign Trade Control Law for border control relating to CITES.

Japan also controls the transfer of CITES Appendix I specimens within the country under LCES, which recognizes that wild fauna and flora are essential to life. An outline of LCES is given below.

Objectives

- Ensure the conservation of endangered species of wild fauna and flora.
- Contribute to the conservation of natural surroundings for present and future generations.

Definitions

- National endangered species (NES): endangered species native to Japan.
- International endangered species (IES): species listed in CITES Appendix I or species listed as protected species in any of the bilateral migratory bird agreements and conventions with the United States of America, Australia, China or the Russian Federation.

National guidelines for conservation of endangered species

The Japanese Government has adopted guidelines which include the fundamental concept of and basic methodology for protection of organisms, protection and rehabilitation of natural habitats, and maintenance of viable populations for the conservation of endangered species.

Prohibition of acquisition and transfer of endangered species

- Hunting, taking, killing or injuring any living NES specimen is prohibited unless a permit has been granted by the Director-General of the Environment Agency.
- The transfer of NES or IES organisms, whether dead or alive, for commercial or non-commercial purposes, and including whole organisms, parts or derivatives, is forbidden except when:

    - permission to transfer for specific purposes has been granted by the Director-General of the Environment Agency;
    - the NES is exempt from the provisions of the law;
    - the specific IES parts or products (manufactured in Japan) are exempt from the provision of the law;
    - the IES organisms have been designated; or
    - specific materials have been previously registered.

Regulations on transfer of IES parts

Parties that intend to transfer certain IES parts (non-processed) within the country must first register them at the Japan Wildlife Research Centre. The IES parts can be registered if:

- they have been produced from captive-bred animals or artificially propagated plants; or
- they were obtained before the CITES measures came into force.

If the IES parts have not been registered in this manner, the Director-General of the Environment Agency must issue permission to transfer them for specific purposes. Registered entities may issue management cards to indicate the legality of the parts they handle. Furthermore, entities engaged in manufacturing final products made of specified materials with properly filed management cards may place on each product a mark issued by the Director-General, relevant ministers or designated public organizations.

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- www.ornamental-fish-int.org/data-area/conservation/untitled2/-respect-brazils-good-list-policy-to-avoid-biopiracy
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- www.auryfish.com/
- www.fao.org/fishery/en
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- www.fisheries.go.th/english/index.php
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- www.unep.org/
- www.ruinemans.com/montfoort/new//index?curiso=en&mid=3&a=
- www.zsl.org/conservation/regions/americas/fish-amazon/
- www.iucnredlist.org/apps/redlist/details/63572/0
- www.unep-wcmc.org/marine/GMAD/index.html
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- edis.ifas.ufl.edu/vm033
- edis.ifas.ufl.edu/fa157
- www.cnykoi.com/articles/micro2.asp
- www.defra.gov.uk/index.htm
- darwin.defra.gov.uk/about/objectives/
- darwin.defra.gov.uk/project/14060/

APPENDIX 1

ORNAMENTAL FISH EXPORTERS, THAILAND

Aeronaut Company Co. Ltd.
9 Intamara Soi 33,
Vipavadee Rd, Huaykwang,
Bangkok, 10400
Tel.: +662 2775430 / 2770532 /
6917941
Fax: +662 2766034
E–mail: aeronautbkk@hotmail.com

Aqua Biotech Innovations Co. Ltd.
406-410 Charoenkong 13,
Warajak Rd, Pomprab,
Bangkok, 10110
Tel./Fax: +662 8808793

Aqua-Thai Export Co. Ltd.
313 Ladprao 23 Rd,
Bangkok, 10900
Tel.: +662 5123661 / 9305375-76
Fax: +662 5130572
E–mail: aquathai@ksc.th.com

Asia Tropic Zone Co. Ltd.
15/160 Moo9,
Chokchai4 Rd, Ladpraw,
Bangkok, 10230
Tel.: +662 9332568
Fax: +662 9741525
E–mail: worasit@asiatropic.com
http://www.geocities.com/prommee/

Atlantic Overseas Ltd.
Part. 79/2 (G-54) Muban-Saenanivate
Soi Saenanikom 1, Phaholyotin Rd,
Bangkok, 10230
Tel.: +662 5781330 / 5781291
Fax: +662 5784418

Atthapol Trading and Service Ltd.
Part. 88 Soi Intamara 45, Suttisarn Rd,
Huaykwang, Dindaeng,
Bangkok, 10400
Tel.: +662 2778488 / 2763067
Fax: +662 2771730

B & B Aquarium Co. Ltd.
19/11 Moo 11, Ladprao,
Bangkok, 10230
Tel.: +662 5704163 / 5705395
Fax: +662 5705643 / 5704771
E–mail: choaqua@ksc.th.com

Bangkok Aquarium
P.O. Box 24-56, Chaiyapouk 29,
Sapansaung, Bungkum,
Bangkok, 10240
Tel.: +662 3738236
Fax: +662 3734904
E–mail: bkkaqa@yahoo.com

Chaichana Aquarium
115/152 Ratchaprarop Rd,
Ratchatevee,
Bangkok, 10400
Tel.: +662 2454569
Fax: +662 6425939
E–mail: fshlvr@ksc.th.com
http://www.discuspom.th.com

e-aquariumthai
500 Moo 5, Srinakorn Pattana 1,
Nawamin Rd, Klongkum, Buengkum,
Bangkok, 10240
Tel.: +662 3741214
Fax: +662 7347868
E–mail: sam@e-aquariumthai.com

Erawan Aquarium Co. Ltd.
104/1 Suwongchai Village,
Tiwanon Rd,
Bangpood, Pakket,
Nonthaburi, 11120
Tel.: +662 5842726
Fax: +662 5844912

Jeda Aquarium Ltd.
Part. 7/33 Moo 4 Soi 23 Rama 2 Rd,
Bangmod, Chomthong,
Bangkok, 10140
Tel.: +662 8490403-4
Fax: +662 8490402
E–mail: info@jedaaquarium.com
http://www.jedaaquarium.com

Kian Seng Lee Co. Ltd.
481/859 Charansanitwong 37,
Bangkok-Noi,
Bangkok, 10700
Tel.: +662 4183555 / 8644750
Fax: +662 8644751
E–mail: kslthai@asiaaccess.net.th

Lim Chareon Import & Export Tropical
Fish Co. Ltd.
35 Soi Prachasanti,
Dindaeng Rd, Dindaeng,
Bangkok, 10400
Tel.: +662 6433339 / 2481322
Fax: +662 2481323
Mobile +661 7005788
E–mail: chamarat@samart.co.th
http://www.limchareonaquarium.com

Me Aquarium Co. Ltd.
164 Soi 62 Yaek 1 Sukhumvit 62
Yaek 1,
Bangjark, Prakanong,
Bangkok, 10250
Tel.: +662 3112529
Fax: +662 7415864

Millionfarm
1/11 Moo 1, Soi Petchkasam 28,
Bangjark, Pasaecharoen,
Bangkok, 10150
Tel.: +661 9433404
Fax: +662 8684712
E–mail: sales@millionfarm.com
http://www.millionfarm.com

Nanyang Trading Aquarium Ltd.
Part. 71 Soi Suthipong, Suthisan Rd,
Bangkok, 10320
Tel.: +662 2773318, +662 2778030
Fax: +662 2761945
Mobile: +661 6519007
E–mail: nanyangth@yahoo.com

Noah-Ark Co. Ltd.
81-83 Intamara 22, Dindaeng Rd,
Dindaeng,
Bangkok, 10400
Tel.: +662 2770337
Fax: +662 3814865

P&P Aquarium World Trading Co. Ltd.
4/25 Moo 8 Nongkhaem,
Bangkok, 10160
Thailand
Tel.: +662 4293218
Fax: +662 8149422
E–mail: kworapot@ksc.th.com

P.K. Trading and Supply Co. Ltd.
81 Saengsawan Rd, Chumsaeng,
Nakhonsawan, 60120
Tel.: +662 5356115
Fax: +662 5356116

Pongsit Aquarium Ltd.
Part. 1139 Ladprao 94,
Wangthonglange, Bangkapi,
Bangkok, 10310
Tel.: +662 5390065 / 5397546-7
Fax: +662 5390599 / 5397545
E–mail: pongsit@asiaaccess.net.th

Puam Pin Aquarium & Trading Co. Ltd.
4/14 Mooban Seree Onnuch, Prakanong,
Bangkok, 10250
Tel.: +662 3215567 / 3226417-8
Fax: +662 3211262
E–mail: patco@ksc.th.com

Q.P.S. International Aquatics Co. Ltd.
19/198 Moo 7
Bangna-Trad km 17.5 Rd,
Bangplee,
Samutprakarn, 10540
Tel.: +662 7508835-7
Fax: +662 7508644-5
E–mail: qpsinter@a-net.net.th /
qpsinter@hotmail.com
http://www.qpsthailand.com

River South Station Co. Ltd.
36 Moo 4 Liab Khlong 10 Rd,
Bungba, Nongsua, Pathumthani
Tel.: +662 9041173
Fax: +662 9041198

S & P Aquarium Co. Ltd.
40/202 Muban Ratanathani Soi 9,
Bangna km 8 Rd,
Bangphli, 10540
Tel.: +662 3166343 / 7518385 /
7518386
Fax: +662 3167339 / 7517330
Mobile: +661 4853450 / 8156343

Siam Pet Fish Trading Co. Ltd.
104 Sukhumvit 62 Yeak 1,
Bangjark, Prakanong,
Bangkok, 10250
Tel.: +662 7416067
Fax: +662 3318283
http://www.ppaquarium.com/

Sompong Aquarium Ltd.
Part. 23/1 Sukumvit 58, Prakanong,
Bangkok, 10310
Tel.: +662 5422385, +662 3113376
Fax: +662 5397203
E–mail: somaqua@hotmail.com

Sunshine Aquatic Co. Ltd.
19/9 Soi Sannibadthedsaban,
Ratchadaphisek Rd, Lardyao,
Jatujak, 10900
Tel.: +662 9390354-6
Fax: +662 9390357

Suthep and Son Aquarium Co. Ltd.
65/1 Soi Ladprao 71, Ladprao Rd,
Bangkok, 10310
Tel.: +662 5381524 / 5393963 /
5382905
Fax: +662 5382849
Mobile: +661 8347870
E–mail: aquadanny@hotmail.com

T and P Advance Business Co. Ltd.
30/24 Moo 8, Khlong 1,
Khlong Loung,
Pathumthani, 12120
Tel.: +662 9029922
Fax: +662 9029921
E–mail: sp_sst@hotmail.com

Takrit Aquarium Co. Ltd.
19/468 Soi Lartpatananour,
Rimklongbangkor Rd, Jomtong,
Bangkok, 10150
Tel.: +662 8762182-3
Fax: +662 8762185

Thai Aquarium Fish Exporters
10/131 Dancharoenvilla Soi 3,
Srinakarin Rd, Muang,
Samutprakarn, 10540
Tel.: +662 3845771
Fax: +662 5704653

Thai Cat Trading Co. Ltd.
9/139 Ratchadapisek 39, Bangsue,
Bangkok, 10800
Tel.: +662 9108311-2
Fax: +662 9108310

Thai Fish Farm Co. Ltd.
30/27 Khlong 1, Khlong Loung,
Pathumthani, 12120,
Tel.: +662 9029995 / 9029933
Fax: +662 9028877

Thai Qian Hu Co., Ltd.
30/25 Moo 8, Khlong 1,
Khlong Loung,
Pathumthani, 12120
Tel.: +662 5161155
Fax: +662 5161156
E–mail: order@thaiquianhu.com
http://www.thaiquianhu.com

The Green Wave Aquarium, Part.
100/9, 345 Rd, Moo 6,
Bangkuwat, Muang,
Pratumtani, 12000
Tel./Fax: +662 9771182

The New Place Ltd.
Part. 39/7 Rangsit-Nakornnayok Rd,
Thanyaburi,
Pathumthani, 12130
Tel.: +662 9961201-4
Fax: +662 9961205-6
Mobile: +661 4990877
E–mail: thenewplace@loxinfo.co.th

Triple Three Aquarium
99/54 M00 19, Phuthamonthon Sai 2 Rd,
Thaveewattana,
Bangkok, 10170
Tel.: +662 8858714
Fax: +662 8859315
E–mail: jannjingjing@hotmail.com / rachaneew@hotmail.com

V. Aquarium Ltd. Part.
27/59 Moo 6 Nongkheam, Bangkok
Tel.: +662 4293118-9 / 8148951
Fax: +662 8148952
E–mail:
ontractus@vaquariumthailand.com
http://www.vaquariumthailand.com

Wallop Aquarium and Trading Co. Ltd.
63/1981 Mooban Kahatani 4
Ramkamhaeng Rd, Sapansung,
Bangkok, 10240
Tel.: +662 9170361-2 / 5181761
Fax: +662 5180830
E–mail: wallop@ksc.th.com

Watcharee International Co. Ltd.
2/2 Soi Suksan, Viphavadeerangsit Rd,
Lardyao, Jatujak,
Bangkok, 10900
Tel./Fax: +662 579 9385
Mobile: +669 7777208, +661 8484881

AQUARIUM PLANT EXPORTERS

Aquascape
2/18 Sakdej Rd, Muang,
Phuket, 83000
Tel.: +676 211216
Mobile. +661 5355376
E–mail:
phuket_aquaticplant@hotmail.com

Aquatic Plant Center Co. Ltd.
314/284 Donmuangvilla Soi 3
Songprapa Rd, Srikan., Donmuang,
Bangkok, 10210
Tel.: +662 9741525, +664 4297236
Fax: +664 4297235
E–mail: apcthai@cscoms.com

Pranee
102-105 Khamphengphet, Jatujak,
Bangkok, 10900
Tel.: +662 2700643 / 2784142

White Crane Aquarium (1999) Co. Ltd.
11/1 Moo 21, Saladang 5,
Bangnampraew,
Chachoungsoa, 24000
Tel.: +663 8845222 / 8593111
Fax: +663 859311

CARP BREEDERS AND EXPORTERS

Pan Pacific Koi Farms
99 Soi Prompong, Sukhumvit 39,
Klongtoey,
Bangkok, 10110
Tel.: +662 2588258 / 9966646-50
Fax: +662 2041169

CICHLID BREEDERS AND EXPORTERS

Cichlidland-Thailand
Chaiyo Building 8th level,
Rama 9 Rd, Huaykwang,
Bangkok, 10320
Tel.: +662 6431924
Fax: +662 2463315
Mobile: +661 8271940
E–mail: cichlidland@hotmail.com

Fishcovery
K. 01-04, Kampacnghet, Jatujak,
Bangkok, 10900
Tel./Fax: +662 2659244
http//www.fishcovery.com

Dr. Fish Farm
62 Lumthadang Rd, Saladang Muang,
Angthong, 14000
Tel.: +635 626375
Mobile: +661 3132425
E–mail: p_doctorfish@hotmail.com

Vangkai Aquarium
808/234, 239, 7 Day Market, Jatujak,
Soi Rongpoon TPI,
Kumphangphet 2 Rd,
Bangkok, 10900.
Tel./Fax: +662 6187859
Mobile: +661 8758289 / 4438207
Lake Tanganyika Crossbreed

DISCUS BREEDERS AND EXPORTERS

Diamond Farm
109/30-32 Moo 10 Soi Samnuksong,
Nawamin Rd, Klongkum,
Bangkok, 10230
Tel.: +662 9478100
Fax: +662 9478652
E–mail: diamonddiscus@hotmail.com

Discus Aquaria
79 Taksin Rd, Bukkalo, Thonburi,
Bangkok, 10600,
Tel.: +662 8905814
Fax: +662 4721067
E–mail: thaidiscus@thaidiscus.com
http://www.geocites.com/thaihobbyfish

Dragon Farm
24 Soi Lertpatana Nour, Jomthong Rd,
Bungkunthein, Bangkok, 10150
Tel.: +662 4771655 / 4771525

Jinda Farm
762 Terdthai 33, Ratchadapisek Rd,
Bukkalo, Thonburi,
Bangkok, 10600
Tel.: +662 4763518 / 8788703
Fax: +662 8788748

Kasem Farm
11/292-93 Soi Lertpatana Nour,
Chomthong,
Bangkok, 10150
Tel.: +662 4771765
Fax: +662 4771766

Kitti Discus Farm
171 Charoennakorn 23, Khlong San,
Bangkok, 10600
Tel.: +662 4375948 / 662 4385387
Fax: +662 8602480
E–mail: kittidis@loxinfo.co.th
http://www.kittidiscus.com

Meng Farm
282 Soi Sansabay, Sukhumvit 36 Rd,
Phakanong,
Bangkok, 10110

Pompadua House Co. Ltd.
655 Sukapibal III Rd, Bangkapi,
Bangkok, 10240
Tel.: +662 9891552 / 9891553
Fax: +662 9891554
E–mail: pom@pompadua.com

Somsak Discus Farm Ltd.
Part. 13/234-5 Rimklongbangkor Rd,
Bangkor, Jomthong,
Bangkok, 10600
Tel.: +662 8762164
Fax: +662 4768071
E–mail: farm2000@cscom.com

GUPPY BREEDERS AND EXPORTERS

Nanthawan Guppy Farm
197/15-16, Banggruy-Sainoi Rd,
Bangbuathong,
Nonthaburi, 11110
Tel.: +662 5714058
Mobile: +661 4033716

Guppy Hut
613/18 Phaholyothin Rd,
Pakpreaw, Mung,
Saraburi, 18000
Mobile: +661 8236733

GOLDFISH BREEDERS AND EXPORTERS

24K Goldfish Farm Co. Ltd.
1817/138 Pharam 3 Soi 41,
Bangpongpang,
Yannawa, Bangkok, 10120
Tel.: +662 2943900
Fax: +662 2943899
E–mail: gold24k@loxinfo.co.th
Goldfish: ranchu, black ranchu,
lionhead, ryukin, oranda, pearlscale,
black moor, panda, bubble eyes

Jaran Ranchu Group
195/5, Near Charansanitwong Soi 27,
Charansanitwong Rd,
Bangkoknoi, Bangkok, 10700
Tel.: +662 4124469
Mobile: +661 5834189 / 9016612

All Janpan Ranchu Farm
101/13 Maneeya 3 Soi 5, Thaeit, Saima,
Nonthabure
Tel.: +662 5943414

PLA KAD (BETTA) BREEDERS AND EXPORTERS

Atison Phumchoosri Betta Farm
79/721 Tararom Village,
Ramkamkhaeng 150,
Bangkok, 10240
Tel./Fax: +662 7280546
E–mail: atison@a-net.net.th
http://www.atisonbetta.com/

Interbetta
108/594 Moo 4, Bangrakpattana,
Bangbuathong,
Nontaburi, 11110
Tel.: +669 7716941
E–mail: l_sukawat@hotmail.com
http://www.interbetta.com/

Siamese Cyber Aquarium Ltd., Part.
3/5 Moo3, Omyai, Sampran,
Nakornpathom, 73160
Tel.: +662 429 0203 / 812 5408
Fax: +662 429 0203
E–mail: precha@plakatthai.com
http://www.plakatthai.com/

STINGLAY BREEDER AND EXPORTER

Watsing Farm
121 Moo 3, Macamthoug, Watsing,
Chainat, 17120
Tel./Fax: +656 430313
Mobile: +661 8867698
Motoro, focodot, jarguar, tiger etc.

ORNAMENTAL FISH
FORWARDING AGENT

Natsu International Co. Ltd.
463/74-75 Lookluang Rd,
Dusit,
Bangkok, 10300
Tel.: +662 2811941-3 / 2813872
Fax: +662 2813873
E–mail: natsu@ksc15.th.com

APPENDIX 2

ORNAMENTAL FISH, THAILAND

Scientific name	**Common name**
Balantiocheilos melanopterus	Silver shark
Barbodes altus Puntius altus	Red tail, tinfoil barb
Barbodes gonionotus Puntius gonionotus	Common silver barb
Barbodes gonionotus Puntius gonionotus	Albino common silver barb
Barbodes schwanenfeldii Puntius schwanenfeldii	Schwanenfeldii's tinfoil barb
Betta splendens	Siamese fighting fish
Brachydanio albolineatus	Pearl danio
Chitala ornata Notopterus chitala	Silver clown knife
Crossocheilus siamensis Epalzeorhynchos siamensis	Siamese fling fox
Epalzeorhynchos bicolor Labeo bicolor	Red tail black shark
Epalzeorhynchos frenatum Labeo frenatum	Red fin shark
Epalzeorhynchos frenatum Labeo frenatum	Albino rainbow shark
Gyrinocheilus aymonieri	Siamese algae eater
Gyrinocheilus aymonieri	Golden algae eater
Helostoma temmincki	Kissing gourami
Hypsibarbus wetmorei	Golden belly barb
Leiocassis siamensis	Bumblebee catfish
Leptobarbus hoeveni	Golden shark, pink tailed barb
Morulius chrysophekadion	Black shark
Mystus filamentus	Yellow mystus
Osphronemus goramy	Giant gourami
Osphronemus goramy	Albino giant gourami
Pangasius larnaudii	Black ear catfish
Pangasius sanitwongsei	Chao phraya giant catfish
Pangasianodon hypophthalmus Pangasuis suitchi	Pangasuis cat, irridescent shark
Puntius orphoides	Red cheek barb
Puntius partipentazona	Tiger barb
Acantopsis choirorhynchos	Horse face loach
Barara urophthalmoides	Least rasbora
Bararas maculata	Spotted rasbora, pygmy rasbora
Barilius pulchellus	Stream barilius
Botia beauforti	Chameleon botia
Botia eos	Red tail botia
Botia helodes Botia hymenophysa	Banded botia, tiger loach

Botia modesta	Yellow tail loach
Botia modesta	Yellow tail botia
Botia morleti	Shunk botia
Chaca bankanensis	Angler catfish
Chitala blanci	Blanc's stripe featherback
Garra cambodgionsis Garra taeniata	Stone lapping fish
Kryptopterus bicirrhis	Glass catfish
Macrognathus siamensis	Spotted spiny eel
Macrognathus taeniagaster Macrognathus circumcinctus	Zigzag eel
Mastacembelus armatus	Armed spiny eel
Mastacembelus erythrotaenia	Fire spiny eel
Nandus oxyrynchus	Black tiger fish
Notopterus notopterus	Gray featherback
Ompok bimaculatus	Butter catfish
Osteochilus microcephalus	Bonylip barb
Pangio kuhlii Acanthopthalmus kuhlii	Kuhlii loach
Puntius eugrammus	Striped barb, zebra barb
Puntius lateristriga	T barb, spanner barb
Puntius ticto	Stoliczkae's barb
Rasbora boraptensis	Red tailed rasbora
Rasbora dusonensis	Rosefin rasbora
Rasbora espei	Lambchop rasbora
Rasbora heteromorpha	Harlequin rasbora
Rasbora sumatrana	Sumatran rasbora
Rasbora trilineata	Scissor tail rasbora
Tetraodon nigroviridis	Spotted puffer
Trichogaster leerii	Diamond gourami
Astronotus ocellatus	Tiger oscar
Astronotus ocellatus	Golden oscar
Astronotus ocellatus	Albino tiger oscar
Astronotus ocellatus	Albino red oscar
Aulonocara baenschi	Sunshine peacock
Aulonocara rubescens	Red peacock
Aulonocara stuartgranti	Blue peacock
Botia lohachata	Pakistani loach
Brachydanio rerio	Zebra danio
Carassius auratus	Comet goldfish
Carassius auratus	Ryukin goldfish

Carassius auratus	Oranda goldfish
Carassius auratus	Black moor goldfish
Carassius auratus	Pearlscale oranda goldfish
Colisa lalia	Dwarf gourami
Colisa lalia	Blue dwarf gourami
Colisa sota	Golden honey gourami
Corydoras aeneus	Bronze cory
Corydoras aeneus	Albino bronze cory
Gymnocorymbus ternetzi	Black tetra
Haplochromis chrysonotus	Electric blue II
Hyphessobrycon megalopterus	Black phantom
Hyphessobrycon serpae	Serpae tetra
Hypostomus plecostomus	Pleco hypostomus
Moenkhausia scanctaefilomenae	Glassy moenkhausia
Mystus leucophasis	Upside down catfish
Poecilia latipinna	Mollies
Poecilia reticulata	Neon tuxedo guppy
Poecilia reticulata	Golden tuxedo guppy
Poecilia reticulata	Cobra guppy
Pseudoplatystoma fasciatum	Tiger shovelnose catfish
Pterophyllum scalare	Half black angelfish
Pterophyllum scalare	Marble angelfish
Pterophyllum scalare	Golden diamond angelfish
Pterophyllum scalare	Black angelfish
Puntius conchonius	Rosy barb
Symphysodon discus	Discus
Xiphophorus helleri	Swordtail
Xiphophorus maculatus	Platy
Aplocheilichthys macrophthalmus	Lamp eyed panchax
Apteronotus albifrons	Black ghost knife fish
Boehlkea fredcochui	Cochu's blue tetra
Botia macracanthus	Clown botia
Cheirodon axelrodi	Cardinal tetra
Glossolepis incisus	Red rainbowfish
Hasemania nana	Silver tip tetra
Hemigramma rhodostomus	Rummy nose tetra
Hemigrammus erythrozonus	Glowlight tetra
Hyphessobrycon amandae	Ember tetra
Hyphessobrycon erythrostigma	Bleeding heart tetra

Hyphessobrycon herbertaxelrodi	Black neon
Melanotaenia boesemani	Boesemam's rainbowfish
Myxocyprinus asiaticus	Hi fin loach
Paracheirodon innesi	Neon tetra
Phenacogrammus interruptus	Congo tetra
Phractocephalus hemioliopterus	Red tail catfish
Polypterus bichir	Bichir
Polypterus delhezi	Armoured bichir
Puntius titteya	Cherry barb
Tanichthys albonubes	White cloud
Telmatherina ladigesi	Celebes rainbowfish

APPENDIX 3

INTERNATIONAL ORGANIZATIONS

Organization	Mandate	Notes	Contact information
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	Protection of species that are or may become endangered through international trade.	With a 20-year history of influencing trade, it is a legally binding instrument with decisions implemented quickly and directly by listing species in appendixes which then restrict trade.	www.wcmc.org.uk/ CITES/english/index.html
World Trade Organization (WTO)	Liberalization of international trade.	For example, Singapore has almost no tariffs on 107 import items, including live ornamental fishes, from least-developed countries as part of an initiative to improve market access for least-developed countries.	www.wto.org
World Organisation for Animal Health (OIE)	Prevention of the spread of disease.	Maintains lists of diseases and zones of their occurrence or absence that can be used to restrict trade.	www.oie.int
International Union for Conservation of Nature (IUCN)	General conservation.	Maintains "Red List" of threatened species, including aquarium species such as dragonfish, *Scleropages formosus*. The Species Survival Commission contains specialized groups of experts working on conservation of specific taxon or habitats which include some ornamental species, such as coral reefs, freshwater fishes and sturgeon.	www.iucn.org /themes/ssc/siteindx.htm
Ornamental Aquatic Trade Association (OATA)	Promotion of responsible ornamental fish trade and consumer practice.	As an NGO, is involved in active public awareness and information programme and is a strong industry advocate in international fora.	www.ornamentalfish.org/
Ornamental Fish International (OFI)	Representation of ornamental fish industry for trade of animals, plants and equipment.	Provides a source of international trade and biological information on ornamental fish, plants and aquarium supplies.	www.ornamental-fish-int.org

Organization	Mandate	Notes	Contact information
Aquatic Conservation Network (ACN)	Conservation of aquatic life with emphasis on freshwater fish.	Maintains an international directory of aquarists to foster communication and also publishes guidelines for captive breeding of threatened and endangered fish.	www.acn.ca/index.html
Marine Aquarium Council (MAC)	Promotion and conservation of the marine aquarium industry, the marine organisms it is based on, and the habitat that supports them.	Develops “best practices” and a certification programme for sustainably harvested marine aquarium fishes.	www.aquariumcouncil.org

APPENDIX 4

DATABASE: EXPORTS

Exports of total fish for ornamental purposes from 1998 to 2007 ('000 USD)										
Country	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Singapore	43 156	42 417	43 502	41 581	41 460	41 427	49 528	54 162	61 403	66 079
Spain	4 393	3 141	3 856	4 828	3 579	14 046	18 132	17 731	26 517	31 298
Malaysia	6 541	7 769	8 219	10 583	17 559	14 147	18 361	20 069	20 064	25 127
Czech Republic	10 489	10 316	10 273	11 272	13 353	16 183	19 540	19 827	21 700	23 527
Japan	7 468	7 088	8 458	7 693	8 332	12 395	18 495	16 739	16 599	20 886
Thailand	1 663	2 084	2 446	3 370	5 245	7 392	9 864	12 534	13 697	14 113
Israel	7 086	6 083	5 399	5 540	5 603	8 525	10 790	10 975	11 370	13 593
United States of America	10 609	11 007	8 289	7 045	8 381	8 561	8 664	9 793	5 860	11 224
Morocco					644	6 475	7 136	7 629	7 966	9 244
Netherlands	4 490	3 456	1 851	2 659	1 725	2 971	4 274	6 619	6 896	8 772
Colombia	3 705	4 265	3 162	3 636	4 284	4 599	7 272	6 258	7 031	8 652
France	2 994	2 092	2 770	3 435	3 046	3 620	4 442	4 157	4 505	8 279
Sri Lanka	7 925	7 940	7 714	5 944	5 527	6 459	7 385	7 522	7 486	7 592
Philippines	6 403	6 475	6 737	6 497	6 439	6 729	7 346	7 126	7 287	7 382
Indonesia	1 122	10 286	12 841	13 722	12 648	13 372	13 389	13 863	8 892	7 305
Brazil	3 345	3 371	3 235	3 226	3 250	2 379	2 664	4 350	4 136	5 052
China	3 044	2 322	2 155	2 019	2 166	3 025	3 279	3 430	3 475	4 583
Germany	2 993	1 805	1 985	2 258	2 744	3 146	4 121	5 305	5 378	4 472
Peru	1 628	2 140	4 753	9 776	6 439	3 102	2 967	3 247	3 731	3 813
United Kingdom	1 624	1 662	1 434	1 293	1 416	1 821	2 028	2 739	3 616	3 806
Sweden	828	921	934	1 085	1 714	1 325	1 631	2 342	2 988	3 426
Taiwan Province of China	1 058	1 237	1 584	1 713	1 844	2 073	2 235	2 500	2 699	2 699
Italy	2 059	1 938	1 778	1 429	2 037	1 289	1 138	1 230	918	2 545

Exports of total fish for ornamental purposes from 1998 to 2007 (‘000 USD)										
Country	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
China, Hong Kong SAR	9 796	8 705	14 774	5 213	4 785	4 871	4 686	4 558	2 225	2 112
Belgium	4 202	4 827	4 496	4 100	4 322	5 275	3 944	2 866	500	1 725
Australia	782	1 077	912	1 372	955	1 040	1 425	1 120	913	1 554
India	601	525	824	1 285	1 363	2 369	1 360	1 170	3 809	1 503
Nigeria	434	580		1 031			1 266	1 213	1 232	1 299
Viet Nam				452	1 738	42 287	21 248	409	1 209	1 143
Greece	1 287	2 020	370	382	978	150	388	346	1 264	965
Kiribati	584	1 143	763	875	584	902	837	1	627	824
Denmark	506	509	361	500	746	2 027	1 246	734	639	667
Portugal	12	9	202	1	9	8	26	440	611	651
Slovakia	474	491	495	599	715	1 064	719	770	870	611
Austria	50	64	123	166	129	219	170	87	327	602
Maldives	296	296	411	524	508	548	566	630	688	588
Ireland	1	3 003	2 963	3 524	3 322	1 067	664	1 242	667	570
Fiji	176	178	736	659	556	691	741	613	497	546
Trinidad and Tobago	414	383	346	338	299	257	245	252	295	469
Marshall Islands	65	47	53	104	98	102	174	252	412	439
Republic of Korea	88	76	155	217	394	268	214	308	216	404
Democratic Republic of the Congo	540	408	500	318	306	395	404	346	358	401
Haiti	1 200	800	423	409	335	259	351	231	212	307
Canada	24	26	24	10	13	4	49	87	72	301
Zambia	225	123	83	140	278	435	410	304	268	281
Costa Rica	365	282	268	252	330	346	418	277	312	280
Poland	39	41	39	50	37	44	36	27	36	255
Malawi	104	191		55	85	69	73	335	1 525	254
Burundi	206	151	131	181	163	136	162	173	214	228

Exports of total fish for ornamental purposes from 1998 to 2007 (‘000 USD)										
Country	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
French Polynesia	29	72	111	194	248	249	198	856	180	147
Saudi Arabia	428	654	25	261	268	270	787	761	1 216	145
Dominican Republic	10	7	11	16	73	70	86	136	105	142
Guyana	123	118	81	107	91	87	97	38	107	134
Belize			43	20	23	44	90	95	51	116
New Caledonia	111	20	96	112	87	105	120	106	101	113
Solomon Islands	36	49	3	194	43	55	66	73	96	106
Cuba		74	83	102	56	100	108	92	107	102
Congo	77	82	96	132	187	180	128	142	131	101
Mauritius	56	55	61	62	87	79	63	96	115	95
New Zealand	12	1			6	20	276	50	118	69
Palau	3				57	105	90	62	65	66
Syrian Arab Republic				2			2	33	41	64
Cameroon										62
Netherlands Antilles	55	56	50	38	38	42	74	60	68	62
Argentina	10		17	25	23	38	30	50	60	61
Bulgaria		1	4	3	4	1	20	13		59
Mexico	22	20	73	24	66	30	47	79	58	44
Ecuador	44	36	30	42	40	28	21	41	86	42
Guinea					2		74	48	125	38
Cook Islands	115	74	115	40	98	163	90	78	92	36
Papua New Guinea	130	1			1					36
Nicaragua	9	1	4	3			12		23	35
United Arab Emirates	15						12		20	34
United Republic of Tanzania	148	83	146	127	117	263	167	156	134	29
Paraguay	13	36	25	25	9	29	48	39	29	25
Kenya						141	1 106	50	89	15

Exports of total fish for ornamental purposes from 1998 to 2007 (‘000 USD)										
Country	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Luxembourg				47	40	11	33	140	1	14
Saint Helena				4		4	2	3		9
Yemen							8	27	13	9
Suriname					8	3	6	17	19	8
Turkey	34	29	27	26	19	24	23	27	18	8
Bangladesh				4	6	3	3	86	45	7
Algeria				3	2	12	8	5		4
Guatemala	12	1								4
Bolivia (Plurinational State of)						5				2
Côte d'Ivoire	83								1	2
Egypt	96	58	97	87	56	41	28		1	2
Pakistan										2
Bermuda										1
Botswana						1				1
Finland			4	5	12				3	1
Jamaica	86	19	49	50	27	18	3	1	9	1
Samoa	11	26			1					1
Sao Tome and Principe	1								8	1
South Africa	86	46	27	31	6	75	13	3	3	1
Albania			1				4	1	6	
Angola						1				
Antigua and Barbuda					2	2				
Bahrain	3	11								
Barbados	1	2	89	26	22	24	20	9		
Belarus										
Benin										

Exports of total fish for ornamental purposes from 1998 to 2007 (‘000 USD)										
Country	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Brunei Darussalam		3		19	8	35			88	
Cambodia	24	14	13	33	37	83	17	20	3	
Chad					1					
Chile	30	2	2	2	2		1	2	2	
China, Macao SAR										
Comoros					1					
Croatia								2		
Cyprus						6				
Djibouti										
El Salvador			46							
Equatorial Guinea						3			2	
Eritrea	14	5								
Estonia	17					4			8	
Ethiopia						9				
Gabon										
Ghana										
Greenland										
Guinea-Bissau				3		4	4	4		
Honduras	44		34	72				27		
Hungary	85		87			85	1			
Iran (Islamic Republic of)	31	24	21	19	13			33	16	
Jordan			4							
Democratic People's Republic of Korea										
Kuwait					15	4				
Lao People's Democratic Republic						2		16		

Exports of total fish for ornamental purposes from 1998 to 2007 ('000 USD)										
Country	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Latvia										
Lebanon				2				2	2	
Liberia			1		16	1	13	3	2	
Libyan Arab Jamahiriya		14	72	24	20		3	3		
Lithuania	27									
Madagascar				3	3				1	
Mali										
Micronesia (Federated States of)	33	18	10	3	2	27	21	4		
Republic of Moldova										
Namibia			5		7	19	117	107		
Nepal		13								
Norway										
Oman	28	4	1	31	5	10				
Panama										
Qatar										
Romania						1		4	1	
Saint Lucia										
Saint Vincent and the Grenadines										
Senegal					11					
Serbia									1	
Sierra Leone	7	5		2	19	14	7	4	4	
Slovenia		2			5	6	2	1	5	
Somalia					2			3		
Saint Pierre and Miquelon				8						

Exports of total fish for ornamental purposes from 1998 to 2007 ('000 USD)										
Country	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Sudan	1					1				
Swaziland	1	24	7	7						
Switzerland	6		5	2						
Togo									4	
Tonga		20								
Tunisia										
Turkmenistan					3			1		
Turks and Caicos Islands										
Uganda				6				22	4	
Uruguay								10		
Vanuatu						366	475	668		
Zimbabwe						5		60		
French Guiana										
Guadeloupe										
Martinique										
Mayotte										
Mozambique							1	1		
Myanmar								144		
Serbia and Montenegro			1			1		1		
Venezuela (Bolivarian Republic of)	7	11	52	57	46	28	122	164	6	
Total	**159 308**	**167 561**	**174 556**	**175 466**	**184 524**	**252 931**	**271 250**	**263 717**	**277 705**	**314 504**

APPENDIX 5

DATABASE: RE-EXPORTS

Re-exports of total fish for ornamental purposes from 1998 to 2007 ('000 USD)										
Country	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
China, Hong Kong SAR	583	1616	2 411	3 758	4 692	3 747	2 966	4 295	4 848	4 519
United Arab Emirates			314	194	59	2		1		34
Taiwan Province of China						30	10	53	21	16
Malaysia	2 070	2 809	3 280	3 742		4 697	12	27	41	11
Oman					5			10	5	5
Jordan										3
New Zealand										1
Antigua and Barbuda								4		
Australia										
Bahamas										
Belize										
Brunei Darussalam				162						
Canada										
China, Macao SAR		32	32	9	1		1			
Cyprus										
Fiji Islands								7		
Guyana										
Maldives										
Malta										
Mauritius								10	8	
Qatar										
Saudi Arabia	13	1			1	4	40	31		
Sri Lanka			2							
United States of America							1 856			
Total	**2 666**	**4 458**	**6 039**	**7 865**	**4 758**	**8 480**	**4 885**	**4 438**	**4 923**	**4 589**

APPENDIX 6

DATABASE: IMPORTS

Imports of total fish for ornamental purposes from 1998 to 2007 ('000 USD)										
Country	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
United States of America	67 309	57 359	60 008	61 766	39 686	64 215	68 146	46 051	48 365	43 136
United Kingdom	20 113	20 104	19 954	21 040	23 646	26 506	29 785	30 022	30 802	34 078
Germany	24 759	22 515	21 954	22 539	24 373	28 662	27 263	24 827	25 155	27 567
Japan	39 340	35 525	32 873	28 398	25 618	24 724	26 450	28 679	27 201	26 971
Singapore	8 975	9 589	10 107	9 927	11 274	13 334	13 955	20 811	22 300	23 465
France	21 143	20 516	20 291	20 518	20 859	22 042	21 225	20 799	23 622	21 033
Netherlands	11 723	9 210	8 538	8 146	9 954	11 925	12 629	14 267	16 264	15 897
Italy	9 943	9 664	9 564	9 051	10 300	11 506	11 341	12 789	13 970	14 386
Belgium	10 123	11 800	9 610	9 425	10 163	11 602	11 667	11 292	10 898	13 075
China, Hong Kong SAR	5 592	6 242	7 972	7 592	9 430	9 663	10 164	11 097	11 283	11 581
Spain	6 067	5 451	4 753	4 985	5 244	6 756	10 111	8 696	10 376	10 328
Canada	5 750	6 186	6 411	6 663	6 520	6 588	7 278	7 350	7 665	8 573
Australia	1 433	1 861	2 119	2 343	2 790	2 568	3 334	5 086	4 018	6 497
Mexico	1 824	1 979	2 174	3 030	2 819	2 655	3 003	3 505	4 676	5 401
Republic of Korea	933	1 373	2 509	2 440	2 283	2 558	2 967	3 163	4 214	4 749
Norway	1 679	1 779	1 755	2 020	2 334	2 404	3 026	3 493	4 040	4 662
Sweden	1 903	1 927	1 894	2 100	2 295	2 734	2 950	3 240	3 511	4 078
Switzerland	2 935	2 846	2 613	2 630	2 702	3 174	3 704	3 346	3 235	3 940
Malaysia	3 199	3 929	4 493	3 755	4 916	3 971	3 681	3 465	2 599	3 658
Poland	888	1 031	1 184	1 569	1 739	1 734	2 124	2 132	2 382	3 304
Portugal	1 906	1 739	1 794	1 852	1 928	2 116	2 445	1 842	2 376	3 064
Austria	1 937	2 046	2 282	1 844	1 855	2 517	2 514	2 144	2 141	3 025
Denmark	1 853	2 070	1 775	2 118	2 025	2 297	2 871	2 361	2 970	2 936

Imports of total fish for ornamental purposes from 1998 to 2007 (‘000 USD)										
Country	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Czech Republic	318	298	328	393	742	874	1 480	1 670	2 141	2 870
Greece	861	986	1 312	922	916	1 076	3 945	1 521	2 098	2 641
Israel	1 155	1 151	1 328	1 635	1 369	1 416	1 753	2 015	2 206	2 447
United Arab Emirates	136	785	1 367	1 285	509	562	620	1 108	1 133	2 363
Iran (Islamic Republic of)	74	54	96	101	282	543	683	966	657	2 142
Turkey	281	394	376	222	354	458	777	1 262	1 591	1 981
Russian Federation			190	312	392	630	853	959	1 437	1 877
Ireland	91	179	495	415	404	438	1 131	1 051	1 402	1 735
South Africa	836	660	616	445	408	588	787	1 120	1 238	1 264
Taiwan Province of China	178	322	135	222	489	450	742	1 028	1 195	1 052
Kuwait			385	290	315	368	550	611	857	935
Cyprus	66	140	151	218	230	244	283	365	554	815
Hungary	173		243	187	168	183	362	498	503	580
Luxembourg			192	235	254	280	334	557	398	567
Finland	384	312	279	320	367	417	395	420	367	481
China	88	224	80	673	276	244	131	303	377	480
Bulgaria		4	8	16	41	20	34	42	67	444
Indonesia	62	153	205	402	236	464	747	350	172	392
Iceland	86	93	92	97	130	163	267	275	219	379
Jordan	69	39	61	52	45	49	78	169	285	361
New Zealand	178	193	209	227	249	272	334	340	355	357
Sri Lanka	192	119	260	257	284	295	239	309	117	357
Croatia	48	78	69	73	125	164	201	255	275	352
Qatar			27	35	31	55	115	135	312	319
Saudi Arabia	302	272	295	381	192	82	97	142	231	300
Romania	39	16	11	15	19	31	57	95	135	298

Imports of total fish for ornamental purposes from 1998 to 2007 (‘000 USD)										
Country	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Thailand	319	349	185	28	40	128	647	936	845	279
Slovenia	126	153	118	134	136	162	145	160	210	213
Malta	132	133	100	106	74	127	189	175	169	204
Lebanon	125	100	80	144	123	121	160	158	157	171
Cayman Islands			37	1	1				104	162
Costa Rica	17	19	27	39	34	51	69	76	121	152
Latvia	19	19	13	40	29	28	55	53	75	151
Brunei Darussalam	621	92	129	126	133	218	145	62	345	144
Argentina	313	258	255	212	24	71	71	96	151	137
Morocco	33	36	18	42	61	47	57	73	84	133
Mauritius	111	130	112	98	139	176	161	172	162	126
Democratic People's Republic of Korea	10	14	21	3	16	32	41	146	208	123
Guatemala	57	51	46	61	79	94	112	109	105	121
Lithuania	3	12	13	38	27	28	76	60	139	119
Philippines	2		30	4		83		59	75	119
Slovakia	80	72	68	154	172	260	217	286	221	119
Chile	9	4	24	15	22	101	97	122	106	104
Brazil	199	133	304	110	53	56	258	83	197	95
Serbia									77	86
Bahamas		28	70	71	67	78	92	88	75	81
Estonia		16	6	8	29	46	51	56	125	79
China, Macao SAR		107	105	90	94	83	138	14	112	78
Pakistan	3	2	3	8	32	66	83	56	33	72
New Caledonia	84	77	70	80	74	73	70	63	73	69
Maldives				10	13	16	17	19	32	67
Kazakhstan				7	17	71	53	28	168	60
The former Yugoslav	7	5	3		13	7	17	28	49	59

Imports of total fish for ornamental purposes from 1998 to 2007 (‘000 USD)										
Country	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Republic of Macedonia										
Oman	100	38	49	198	159	23	57	47	44	57
Tunisia		3	1	12	11	16	21	22	27	54
Panama	11	27	23	21	48	54	52	37	52	51
French Polynesia	27	36	38	30	40	48	63	84	76	48
Ukraine				4	18	31	35	33	31	48
Algeria	13	18	21	21	19	25	31	29	33	44
Libyan Arab Jamahiriya									1	41
Trinidad and Tobago	14	8	10	17	15	25	24	34	41	41
Venezuela (Bolivarian Republic of)	12	22	34	16	12	2	4	9		41
El Salvador	9	7	8	9	13	20	15	22	30	38
Dominican Republic		10	12	34	78	57	10	32		35
Barbados	4	34		4	16	24	18	15	58	26
Honduras	32	13	16	19	10	23	21	21	32	26
Viet Nam	47	8			1	2		3	11	25
Peru	3	2	1	3	9	13	19	13	14	22
Cambodia							5	2	5	14
Azerbaijan								2	4	12
Guyana				2				1	5	12
Botswana	3		81	13		26	4	8	6	11
Faroe Islands (Associate Member)	13	7	6	7	7	9	14	11	13	9
Netherlands Antilles	3 282	4	13			1	1	11	9	7
Suriname				9	11	14	31	44	1	7
Jamaica	2		5	4	13	3	2	6		6
Saint Lucia	3	2	3	5	3	3	4	4	5	6

Imports of total fish for ornamental purposes from 1998 to 2007 (‘000 USD)										
Country	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Ethiopia			1						1	5
Nigeria	65	83		1 392				1	1	5
Saint Kitts and Nevis		2		26		2	2	2	4	5
Uzbekistan	4		2	1	4				5	5
Albania			5			10	11	14		4
Nepal		15			1	5	4		4	4
Saint Vincent and the Grenadines	1	3	3	4	4	3	4	3	2	4
Sudan					2				4	4
Antigua and Barbuda		5	3	4	1	1		2	4	3
Bangladesh		26		7	1	1	4	7	3	3
Fiji	29	17	50	53	26	2	13	8	5	3
Gabon		1		2	1	2		14	13	3
Kenya						3	10	10	2	3
Kiribati				1						3
Kyrgyzstan								1		3
Swaziland	21	3	10	2		22	28	3	1	3
Zambia		2	2	3	1	2		1	1	3
Zimbabwe	1		16	1	1				1	3
Bolivia (Plurinational State of)	8	4	4	2	3	5	6	3	3	2
Dominica		1	1	1	2	1	1	1	1	2
Ecuador	9		3	3	4	10	2	2	1	2
Egypt	79	53	56	23	52	31	4		1144	2
Namibia			6	9	3	11	39	33	10	2
Nicaragua	7	34		8		9	7	3	2	2
Yemen				34			1	1	2	2
Cook Islands		1				15		1	1	1

Imports of total fish for ornamental purposes from 1998 to 2007 (‘000 USD)										
Country	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Lesotho										1
Madagascar		4	4	5	2	3	3	4	3	1
Papua New Guinea	1	3						5		1
Solomon Islands					1					1
Vanuatu				1						1
Angola	14	9	3			1		1		
Armenia		4	7							
Bahrain	8	5	16	13	37	11	24	197	69	
Belarus		49							6	
Belize										
Bermuda						5				
Bosnia and Herzegovina			5							
Burkina Faso										
Burundi									6	
Cameroon								5		
Cape Verde					7	10	8			
Colombia			6	2	5			1	4	
Comoros							1			
Democratic Republic of the Congo			15			4				
Congo			3							
Cuba				1						
Equatorial Guinea									7	
Eritrea										
Falkland Islands (Malvinas)							1		2	
Georgia					2		18		13	

Imports of total fish for ornamental purposes from 1998 to 2007 (‘000 USD)										
Country	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Greenland	2	1	3	3	3	1	2	4	1	
Grenada	2			1						
Guinea	2									
Haiti		7			9					
Iraq							5			
Lao People's Democratic Republic	2				1		1			
Malawi		1						1		
Marshall Islands				1	1	87	1			
Micronesia (Federated States of)				1					3	
Paraguay	3			1						
Samoa						1				
Senegal	1	5	11							
Seychelles	2		4	14	4		2			
Sierra Leone		1	2	2	1	2				
Saint Pierre and Miquelon			1							
Syrian Arab Republic			14	7		25			6	
Tajikistan							11		1	
United Republic of Tanzania									2	
Togo					6	13	3	4		
Tonga		14								
Turkmenistan				8						
Uganda			1	1				1		
Uruguay	18	8	3	6	1	1		1		
Côte d'Ivoire	3									

Imports of total fish for ornamental purposes from 1998 to 2007 (‘000 USD)										
Country	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
French Guiana										
Ghana	2	1	5	28	148			141		
Guadeloupe										
India			20					11	4	
Martinique										
Myanmar										
Niger								4		
Réunion										
Serbia and Montenegro	58	16	15		21	2	95	71		
Yugoslavia SFR										
Total	**263 131**	**245 640**	**247 895**	**248 909**	**235 920**	**279 560**	**303 391**	**292 252**	**310 443**	**327 283**

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