Panaquatic® Health Solutions
INNOVATIVE VETERINARY MANAGEMENT

Scientific review of the biosecurity risks associated with the importation of rainbowfish for ornamental purposes

FINAL REPORT

Prepared for Biosecurity Australia

by

Panaquatic® Health Solutions Pty Ltd

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The assistance of all contributors has been gratefully appreciated.

Foreword

This report was submitted to Biosecurity Australia by Panaquatic® Health Solutions Pty Ltd in May 2007. In 2009, Biosecurity Australia reviewed the relevant published, scientific literature to ensure the report was current before its release to the public.

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Executive Summary

The family Melanotaeniidae comprise of around 72 valid species of rainbowfish grouped into seven genera. Rainbowfish are naturally distributed throughout northern and eastern Australia and New Guinea[1].

Only live fish of the species listed on Part 1 of the 'List of specimens taken to be suitable for live import' (the Live Import List) under the *Environment Protection and Biodiversity Conservation Act* (EPBC Act), administered by the Australian Government Department of the Environment, Water, Heritage and the Arts (DEWHA) are permitted entry into Australia. Live ornamental fish imported into Australia are also subject to quarantine controls under the *Quarantine Act 1908*, administered by the Australian Quarantine and Inspection Service (AQIS). The current quarantine controls are based on the 1999 import risk analysis (IRA) of ornamental finfish (1999 IRA), which considered risks associated with those species permitted entry at the time. As new species are added to the Live Import List, Biosecurity Australia reviews the import policy and provides advice to AQIS on whether new species should be permitted entry and if so, recommends quarantine measures.

In 2005, DEWHA added *Glossolepis incisus* (red rainbowfish) to the Live Import List. Red rainbowfish and other members of the family Melanotaeniidae were not included in the scope of the 1999 IRA.

Biosecurity Australia announced the commencement of a review of import policy to consider the biosecurity risks associated with the importation of rainbowfish (all members of the family Melanotaeniidae) in March 2006. Panaquatic® Health Solutions Pty Ltd (Panaquatic) was subsequently commissioned by Biosecurity Australia to assess and report on risks associated with importation of rainbowfish.

Panaquatic conducted a comprehensive review of published scientific literature and the World Wide Web for relevant published or anecdotal information on diseases or pests associated with rainbowfish. In addition, an extensive inquiry of hobbyists and breeders of rainbowfish world wide was conducted with assistance from such associations as the Australia New Guinea Fishes Association Inc. (ANGFA) to ascertain what diseases or pests had been experienced by those involved in the keeping and growing of rainbowfish. Aquatic animal pathologists and veterinarians working with ornamental finfish in Australia were also consulted to ascertain what diseases or pests they had identified to be associated with rainbowfish in Australia (and where such personnel had worked overseas what if any diseases they had identified elsewhere).

This review was completed in 2007. In 2009, Biosecurity Australia reviewed relevant published scientific literature to ensure the report was current before its release.

Based on the outcomes of hazard identification of diseases and disease agents, and in consultation with Biosecurity Australia, the authors concluded that no disease agents or diseases not already addressed under the existing quarantine measures for the importation of live, freshwater ornamental fish were identified with respect to rainbowfish that warranted detailed risk assessment (e.g. entry and exposure assessment, consequence assessment).

[1] The island of New Guinea consists of Papua New Guinea and associated islands in the east and the Indonesian provinces of Papua and West Irian Jaya in the west.

1 Introduction

1.1 Background to the risk assessment report

Only live fish of the species listed on Part 1 of the 'List of specimens taken to be suitable for live import' (the Live Import List) under the *Environment Protection and Biodiversity Conservation Act* (EPBC Act) are permitted entry into Australia. The EPBC Act is administered by the Australian Government Department of the Environment, Water, Heritage and the Arts (DEWHA). Live ornamental fish imported into Australia are also subject to quarantine controls under the *Quarantine Act 1908*, administered by the Australian Quarantine and Inspection Service (AQIS). The current quarantine controls are based on a 1999 import risk analysis (IRA) of ornamental finfish, which considered risks associated with those species permitted entry at that time. As new species are added to the DEWHA Live Import List, Biosecurity Australia reviews the import policy and provides advice to AQIS on whether the new species should be permitted entry and if so, recommends quarantine measures.

In 2005, DEWHA added *Glossolepis incisus* (red rainbowfish) to the Live Import List. Justification for the addition of this species and a number of other non-rainbowfish ornamental species was provided in the review conducted by Kailola (2004).

Figure 1 *Glossolepis incisus* (Photo courtesy of N Armstrong).

Red rainbowish belongs to the finfish family Melanotaeniidae (rainbowfish). DEWHA has also received import access requests relating to several other species of Melanotaeniidae.

In March 2006, Biosecurity Australia announced the commencement of a review of the biosecurity risks associated with the importation of rainbowfish as ornamental fish (i.e. all members of the family Melanotaeniidae). As part of this review, Biosecurity Australia commissioned Panaquatic® Health Solutions Pty Ltd (Panaquatic) to assist in the review

of the biosecurity risks associated with the importation of rainbowfish as ornamental fish. In the context of this review 'rainbowfish' includes all members of the family Melanotaeniidae.

The objective of the project given to Panaquatic was to produce, in close consultation with Biosecurity Australia, an up-to-date risk assessment report, identifying, describing and assessing the infectious pests and disease agents associated with rainbowfish. Once finalised, the risk assessment report will form part of Biosecurity Australia's policy review on the importation of live rainbowfish for ornamental purposes.

This risk analysis report was completed and submitted to Biosecurity Australia in May 2007 by Panaquatic. While the risk assessment has been reviewed since that date, Panaquatic have not further reviewed the published scientific literature or the World Wide Web for relevant published or anecdotal information on diseases or pests associated with rainbowfish. Nor has Panaquatic consulted further with hobbyists and breeders of rainbowfish world wide since 2007.

1.2 Terms of reference of the risk assessment report

The terms of reference for this report were to:

- Report on the commercial use of rainbowfish in the aquaculture and aquarium (hobby) industries and the linkages between those industries in the movement of fish. This included the source of fish (wild or cultured), the systems used to breed, grow and hold the fish, countries where they are commercially raised and traded, and provide a description of how the fish are traded and transported;
- Report on the current knowledge of the disease status of rainbowfish in Australia;
- Document and analyse the state of knowledge world-wide of the pests and diseases carried by rainbowfish regarding the surveillance, monitoring and disease investigations that have been carried out, including consideration of the sampling procedures and testing methods used;
- Document and analyse information reported in the scientific literature, or elsewhere, on pest and disease agents of potential biosecurity concern (hazards or unwanted organisms) that may be associated with the importation of rainbowfish. This included those agents carried by rainbowfish which do not produce significant pathogenic effects in rainbowfish, but which may cause disease in other species;
- In consultation with Biosecurity Australia provide in the risk assessment report a preliminary assessment for each pest or disease agent in terms of their biosecurity concern (this preliminary assessment will eliminate from further detailed assessment those agents that clearly do not present a significant biosecurity concern);
- Include a detailed assessment of quarantine risk associated with each pest and disease agent found to be of biosecurity concern, including the likelihood of each agent entering, establishing and spreading in Australia together with the likely consequences that would result.

1.3 The Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act[2]) was enacted on 16 July 2000. It replaced six previous Commonwealth Acts and is maintained by DEWHA. The objects of the EPBC Act include protection of the environment, promotion of Environmental Sustainable Development (ESD) and the conservation of biodiversity. One Act that the EPBC Act replaced was the *Wildlife Protection (Regulation of Exports and Imports) Act 1982*. Schedule 6 of this Act (discussed in Section 1.4) included all freshwater and marine ornamental finfish species that could be imported into Australia without being subject to the provisions of the *Wildlife Protection (Regulation of Exports and Imports) Act 1982*. In its place, the EPBC Act contains the Live Import List. The freshwater ornamental finfish listed in the Live Import List (updated 17 March 2008) are included in Appendix A.

1.4 The 1999 Import Risk Analysis on Live Ornamental Fish

The Import Risk Analysis (IRA) on Live Ornamental Finfish (1999 IRA) considered the potential quarantine risks associated with the importation to Australia of ornamental (aquarium) finfish as listed in Schedule 6, Part II of what was then the *Wildlife Protection (Regulation of Exports and Imports) Act 1982* (AQIS 1999a). A brief background to this IRA is provided in the box below.

Schedule 6 included all freshwater and marine ornamental finfish species that could be imported into Australia without being subject to the provisions of the *Wildlife Protection (Regulation of Exports and Imports) Act 1982*.

The 1999 IRA considered the disease and pest risks to Australian animals and the environment associated with the importation of ornamental finfish species, from any source that were listed on Schedule 6. The pest risks posed by the fish species themselves had already been addressed by the then Environment Australia (now DEWHA) when the species was placed onto Schedule 6.

The 1999 IRA evaluated the risks associated with individual diseases and disease agents, and identified risk mangement measures that would reduce the risks presented by import of ornamental finfish to an acceptable level. Based on this evaluation, risk management measures were proposed, including health certification provided by exporting countries, post-entry quarantine and post-arrival quarantine requirements.

At the time red rainbowfish (*Glossolepis incisus*) was not on Schedule 6 of the *Wildlife Protection (Regulation of Exports and Imports) Act 1982,* nor were other rainbowfish species belonging to the family Melanotaeniidae. Hence none of this family was considered in the 1999 IRA. However, two species of finfish from families closely related to the family Melanotaeniidae were considered. These were the Madagascar rainbow (*Bedotia geayi)* which belongs to the family Bedotiidae, and the Celebes rainbow

[2] The EPBC Act is at <http://www.frli.gov.au/comlaw/Legislation/ActCompilation1.nsf/current/bynumber/019B48F4E8C92609CA25700000090254?OpenDocumentandmostrecent=1>

(*Telmatherina ladigesi*) belonging to the family Pseudomugilidae. The relationship of these two families to the family Melanotaeniidae is discussed in Section 2.1.1. Both *B. geayi* and *T. ladigesi* are now permitted entry into Australia according to the protocols outlined by AQIS Import Conditions information leaflet of 23 November 2006[3]. One of these requirements is that on arrival in Australia the fish will be ordered into quarantine at an AQIS approved freshwater ornamental fish quarantine premise (Quarantine Approved Premises or QAP) for 7 to 21 days depending on species. If at the end of the quarantine period the fish are found to be free from clinical signs of pest and disease after inspection by AQIS they can be released from quarantine.

Australia's biosecurity policy has not altered since the 1999 IRA and is not repeated in this document.

Background to the Import Risk Analysis on Live Ornamental Finfish (AQIS 1999a)

Following a request from Canada in 1997, Canada's longstanding market access request to Australia for non-viable salmon was considered by a World Trade Organization (WTO) dispute settlement panel and Appellate Body. The WTO found that Australia had not complied with its obligations under the WTO Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) with regard to the measures applying to salmon. The key findings were:

- Australia's IRA on uncooked wild-caught Pacific salmon from Canada did not fulfil all the requirements of the SPS Agreement in relation to an IRA and there was no IRA to support the restrictions on the importation of other uncooked salmon products; and
- There were arbitrary or unjustifiable distinctions in the level of protection applied by Australia in relation to salmon and other fish, and these distinctions resulted in a disguised restriction on international trade.

The WTO Arbitrator gave Australia until 6 July 1999 to address its obligations. In order to meet this deadline, and after consultation with stakeholders, AQIS adopted an accelerated approach to the IRAs on non-viable salmonids, non-salmonid marine finfish and live ornamental finfish. The policies arising from the IRAs were published on 19 July 1999 (Animal Quarantine Policy Memorandum 1999/51).

The IRA of non-viable salmonids and non-salmonid marine finfish (AQIS 1999b) are not discussed further in this report.

1.5 The Australian Quarantine and Inspection Service

The *Quarantine Act 1908* and its subordinate legislation, including the *Quarantine Proclamation 1998* are administered by the Australian Government Department of Agriculture, Fisheries and Forestry (DAFF). It provides the legislative basis of human,

[3] Viewed December, 2006 <http://www.aqis.gov.au/icon32/asp/ex_casecontent.asp?intNodeId=8192061andintCommodityId=6114andTypes=noneandWhichQuery=Go+to+full+textandintSearch=1andLogSessionID=2069911>

animal and plant biosecurity in Australia. The *Quarantine Act 1908* and the legislative framework is comprehensively discussed in the 1999 IRA and more recently in Section 1.3.2 of the Revised Draft IRA Report for Prawns and Prawn Products (Biosecurity Australia 2006) and will not be further discussed in this report.

AQIS is responsible for the administration of the *Quarantine Act 1908* and its subordinate legislation. AQIS provides quarantine services at the borders including providing import inspection and issuing import permits for live ornamental finfish. AQIS also provides operational services for other Australian Governement agencies such as DEWHA for implementing the importation of specimens subject to the EPBC Act. Biosecurity Australia provides technical advice to AQIS on quarantine risks associated with importation of animals and plants and risk management measures. This includes advice on the quarantine risks associated with ornamental finfish listed on the EPBC Act's Live Import List.

2 The rainbowfish industry

2.1 The family Melanotaeniidae

2.1.1 Classification of the family Melanotaeniidae

Rainbowfish belong to the family Melanotaeniidae, which is in the order Atheriniformes.

The terms of reference for this risk assessment were for disease risks associated with species from the family Melanotaeniidae.Therefore, it was essential to ensure that the classification used to define the family Melanotaeniidae and its relationship to other closely related families was current, scientifically acceptable and clearly documented.

To assist in identifying a suitable classification, information was sought from a number of sources, including peer reviewed journal articles (e.g. Allen and Cross 1982, Nelson 1994, Dyer and Chernoff 1996, Schmida 1997, Berra 2001) and relevant websites including World Fish Center's FishBase and the United States National Center for Biotechnology Information (NCBI)[4].

There is variation in the classification of rainbowfish in the literature. For example, other families in the order Atheriniformes that have been historically linked with the melanotaeniid rainbowfish are:

- Bedotiidae (freshwater fishes from Madagascar);
- Pseudomugilidae (blue-eyes, freshwater fishes from New Guinea[5] and adjacent islands, northern and eastern Australia, and parts of eastern Indonesia; containing the genera *Kiunga*, *Pseudomugil* and *Scaturiginichthys*);
- Dentatherinidae (marine silversides from the western central Pacific);
- Phallostethidae (brackish and freshwater fishes from South-east Asia); and
- Telmatherinidae (freshwater, brackish and marine fishes from Sulawesi and the islands of Misool and Batanta off West New Guinea).

The study conducted by Sparks and Smith (2004) was considered a key reference as this study proposed a revised classification of the Malagasy and Australasian rainbowfish based on phylogenetic rather than morphological analysis. This study indicated a close relationship between the three families (Bedotiidae, Melanotaeniidae and Pseudomugilidae) and importantly confirmed the distinctiveness of the family Melanotaeniidae and its contained members. Figure 2 shows the revised relationship as proposed in this study.

[4] The web address for NCBI is at <www.ncbi.nlm.nih.gov>.
[5] The island of New Guinea consists of Papua New Guinea and associated islands in the east and the Indonesian provinces of Papua and West Irian Jaya in the west.

Series Atherinomorpha
- Order Atheriniformes
  - Suborder Melanotaenioidei (new usage)
    - Family Bedotiidae
      - Genus *Bedotia*
      - Genus *Rheocles* sedis mutablis
      - Genus ‘‘*Rheocles*’’ new genus
    - Family Melanotaeniidae
      - Genus *Cairnsichthys*
      - Genus *Iriatherina*
      - Genus *Pelangia incertae* sedis
      - Genus *Rhadinocentrus*
      - Genus *Glossolepis*
      - Genus *Melanotaenia*
      - Genus *Chilatherina*
    - Family Pseudomugilidae new usage
      - Genus *Kalyptatherina* incertae sedis
      - Genus *Kiunga* incertae sedis
      - Genus *Marosatherina*
      - Genus *Paratherina* incertae sedis
      - Genus *Pseudomugil*
      - Genus *Scaturiginichthys* incertae sedis
      - Genus *Telmatherina* incertae sedis
      - Genus *Tominanga* incertae sedis

Figure 2 Revised classification of rainbowfish (Melanotaenioidei) based on results from Sparks and Smith (2004).

This report has used the proposed classification of Sparks and Smith (2004) as given in Figure 2, to define the family Melanotaeniidae.

Hence seven genera (*Cairnsichthys, Iriatherina, Pelangia incertae sedis, Rhadinocentrus, Glossolepis, Melanotaenia and Chilatherina*) consisting of around 72 valid species of rainbowfish (with many varieties) were directly considered in this report. A full list of these species is given in Appendix B, although this list may not be complete. For example, amongst the rainbowfish from New Guinea there is immense speciation and more than likely there will be new species and possibly even new genera identified in the future.

2.1.2 Distribution of the family Melanotaeniidae

Rainbowfish are distributed throughout northern and eastern Australia and New Guinea and some nearby islands as detailed in Appendix B and in Figure 3, which shows the approximate distribution of the many species of rainbowfish.

Figure 3 The geographic range of all species of rainbowfish considered in this report. Note that ranges are approximations only and are drawn from descriptions of locations where these species have been found. The range of some species e.g. in New Guinea, may extend beyond what is shown (courtesy of D Wilson, ANGFA, April 2007).

Importantly:

- Five of the 72 species are subspecies of *Melanotaenia splendida*.
- Two are of the genera (*Cairnsichthys* and *Rhadinocentrus*) are monotypic genera and are endemic to Australia.
- About 16 species of the genus *Melanotaenia* are endemic to Australia and 34 endemic to New Guinea.
- *Glossolepis* (eight species), *Pelangia* (one species) and *Chilatherina* (ten species) are endemic to New Guinea.
- Three species of rainbowfish *(Iriatherina werneri, Melanotaenia maccullochi* and a subspecies of *M. splendida - M. splendida rubrostriata)* occur in both Australia and New Guinea.

The geographic range of nearly all species is confined to tropical waters where the water temperature varies from 18–30 ºC. One important exception to this is the Australian rainbowfish or Murray-Darling rainbowfish (*Melanotaenia fluviatilis*). This species is

shown in Figure 4. The geographic range of this species extends further south than does that of any other rainbowfish species as shown in Figure 5.

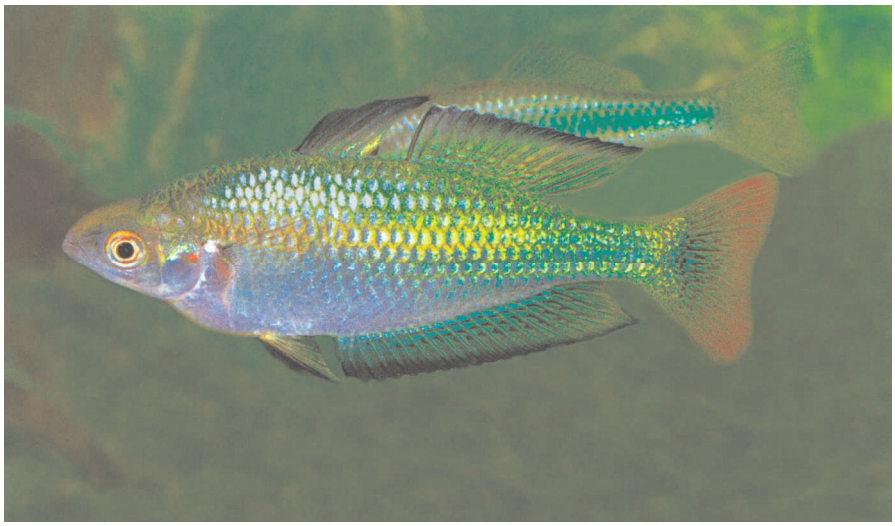


Figure 4 *Melanotaenia fluviatilis* (Photo courtesy of N Armstrong).

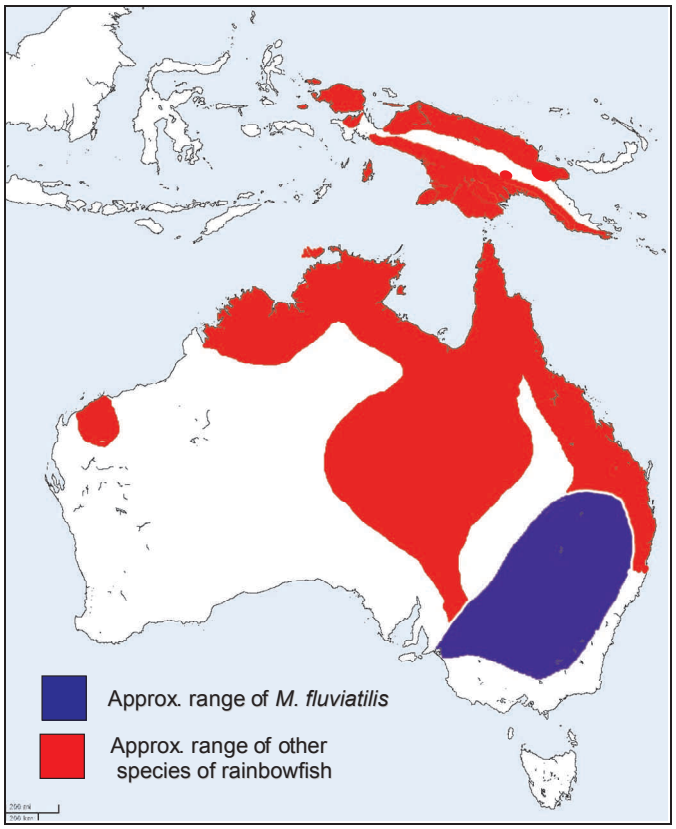


Figure 5 Approximate range of *M. fluviatilis* compared to other rainbowfish. Note that ranges are approximations only and are drawn from descriptions of locations where these species have been found. The range of some species e.g. in New Guinea, may extend beyond what is shown (courtesy of D Wilson, ANGFA, April 2007).

2.1.3 Characteristics of rainbowfish

Rainbowfish are small fishes with a compressed body, two narrowly-separated dorsal fins, a single anal fin and an emarginate caudal fin. Rainbowfish attain a maximum length of about 20 cm. They are generally considered hardy fish (Leggett and Merrick 1987) and are prized for their colours. An important feature of rainbowfish is that the male of the species is usually more colourful than the female.

Morphological keys and descriptions of Australian and New Guinea rainbowfish are provided in Allen and Cross (1982), Allen (1989), Allen (1991) and Allen *et al* (2002).

Some species of rainbowfish demonstrate local morphological varieties for different rivers (e.g. *Melanotaenia trifasciata* from Dulhunty River, Goyder River, Running Creek, Wonga Creek and Coen River; *M. splendida splendida* from Davies Creek, Hidden Valley, Wallaby Creek and Street's Creek) and local varieties may vary even within larger rivers. For example, rainbowfish from the upper section of a large river may display different colours to fish of the same species from lower sections of that river (N Armstrong, ANGFA member, pers. comm., 2006). A number of examples of the colour variation displayed by a single species coming from different rivers are shown in Allen *et al* (2002).

Rainbowfish inhabit fresh and brackish waters in a variety of habitats in their distribution range, including streams, lakes, ponds, reservoirs and swamps. Rainbowfish tolerate heavy seasonal rainfall and changing river flows and in New Guinea can be exposed to fast currents. Rainbowfish spawn year round, but there are spawning peaks at the onset of the wet season (where this occurs). Most species mature within their first year (Kailola 2004).

Generally, rainbowfish are found in soft and slightly acidic water, but can adapt to a wide variation in water chemistry. Most species can survive well in water hardness of 0–100 parts per million (ppm) and a pH between 6 and 7.5 (Allen, 1995; Froese and Pauly, 2006).

As noted in Section 2.1.2, rainbowfish (except *M. fluviatilis*) are essentially tropical, their natural water temperature range being between 18–30 ºC. The natural range of *M. fluviatilis* extends through the Murray Darling river system in south-eastern Australia where water temperatures can be as low as 10 ºC.

Rainbowfish thrive on a variety of foods (Leggett and Merrick 1987). For example, according to this text the recommended diet for the ornate rainbowfish (*Rhadinocentrus ornatus)* is an omnivorous one, consisting of insects, crustaceans and algae. Leggett and Merrick (1987) also note that this species (and many of the other rainbowfish species) will accept a variety of fresh, frozen and dried foods. Rainbowfish though can be affected by diets where ingredients are of poor quality of where the overall protein level is too high (e.g. where too much beef heart is given). In such circumstances non-specific skin lesions have been observed in fish and they appear more susceptible to parasitism and opportunistic infections (R Datodi, formerly Aquarium Industries, pers. comm., April 2007).

Information on habitat, diet and maximum size of species is included in Appendix B.

2.2 Rainbowfish – commercial trade

2.2.1 Species of rainbowfish domestically traded in Australia

As far as the authors of this report are aware no rainbowfish are produced for human consumption in Australia. All rainbowfish in Australia are bred for the aquarium (hobby) industry.

Australian rainbowfish have been maintained in home aquaria in this country at least since the beginning of the last century. McCulloch's rainbowfish (*Melanotaenia maccullochi*) is possibly the first Australian freshwater species to be bred commercially for the aquarium trade (Leggett and Merrick 1987). Until the early 1980s rainbowfish were not a popular breed for hobbyists in Australia.

During the 1970s and early 1980s, New Guinean species of rainbowfish came into Australia via Germany (N Armstrong, ANGFA, pers. comm., January 2007). The general consensus amongst enthusiasts and breeders is that it is likely the New Guinean species that are already in Australia including *Glossolepis incisus* arrived here through this route. A few specimens were also brought into Australia via South-East Asia (brought out of the western provinces of New Guinea via Jakarta, Java) and a few Singaporean fish exporters.

According to B Crockford (enthusiast, pers. comm., April 2007) he brought in dozens of New Guinean rainbowfish legally before 1986, including species such as *Glossolepis maculosus, Chilatherina axelrodi* and *Melanotaenia goldiei*. Mr Crockford acquired permits in both New South Wales (NSW) and New Guinea to allow him to do this.

Commercially, larger numbers (e.g. in the hundreds per month) were being brought in from South East Asia (predominately from Singapore and Hong Kong) before 1986. These were usually sold as "Australian rainbows". Generally they were Australian species of rainbowfish that were being bred overseas and then imported back into Australia (R Datodi, formerly Aquarium Industries, pers. comm., April 2007).

It is understood that rainbowfish have been brought into Australia on occasion since 1986 (N Armstrong, ANGFA member, pers. comm., March 2007). For example it has been alleged that an overseas enthusiast attending a trade show in Australia brought in live eggs or fish, not realising that this was an illegal activity. The number of times this has occurred has understandably been difficult to determine.

As noted in Section 2.1.3, generally the male of the species is the more colourful than the female. According to J Patrick (Bayfish, pers. comm., December 2006) the males are the most desirable in terms of colouration and finnage for hobbyists looking to purchase fish for their aquariums. Breeders[6] and hobbyists wanting to breed are understandably interested in both sexes. While local breeders generally sell rainbowfish as mixed sexes it would be possible to purchase male only batches of rainbowfish from overseas suppliers

[6] In the context of this document, the term 'breeder' refers to breeders of fish for commercial purposes, whereas the term 'hobbyist' refers to someone who may breed but only for his or her own purposes or to trade with other hobbyists. Obviously in some cases a hobbyist may supply a small number to a local aquarium shop(s).

(J Patrick, pers. comm., December 2006) as the males command premium prices. Where this occurs, overseas suppliers sell the females very cheaply as "feeder fish" or simply dispose of them. Additionally, adult rainbowfish can be difficult to sell if put in unplanted aquaria as they are not as likely to show their colours against pale backgrounds.

Large pet fish wholesalers in Australia sell species that are available within the country. Currently, this is limited to Australian species of rainbowfish and the offspring of New Guinean species that were brought into Australia before 1986. Good quality quantities of this latter group are generally in shorter supply than Australian endemic species which means they command higher prices.

The 'average' pet fish buyer looks for a fish that he/she can afford, is easy to feed and look after, and is pretty. What is 'affordable' and 'pretty' will naturally vary according to the buyer, but in general retailers in Australia limit the risk of having stock that does not sell by limiting themselves to dealing in rainbowfish that have good colour. Such species include *Melanotaenia praecox, M. boesemani, M. lacustris, M. herbertaxelrodi, M splendida* subspecies, *M. trifasciata* and *Glossolepis incisus and Iriatherina werneri*. All of these are native to New Guinea with two exceptions: *M. trifasciata* which is endemic to Australia and *I. werneri* which is endemic to both Australia and New Guinea.

Besides these more colourful varieties, other species currently sold and being traded in Australia include *Glossolepis multisquamatus, Melanotaenia parkinsoni, M. duboulayi, M. eachamensis, M. exquisita, M. fluviatilis, M. nigrans, Cairnsichthys rhombosomoides, Chilatherina crassispinosa and Rhadinocentrus ornatus*.

There is limited wild capture of rainbowfish in Australia in the Northern Territory and as far as ANGFA and the authors of this document are aware very little if any wild capture of rainbowfish is occurring in New Guinea. Hence the fish currently available commercially in Australia are predominantly captive bred and if rainbowfish were to be imported into Australia it is likely that these too would be predominately, if not all, captive bred.

A list of the New Guinea species kept in Australia up to 2002 was provided to one of the authors of this report by ANGFA in 2002 and it has been referred to in preparing this report. The list provided in Table 1 is sourced from this ANGFA list, ANGFA members, various Internet Webpages, native fish publications, and aquarist groups. The numbers and locations of individual fish are uncertain. McNee (2002) also documents those species of rainbowfish present in Australia at the time this report was published. This report identifies the species as either:

- *"Species that have previously been permitted imports but are not on the current permitted list"* (e.g. most of the *Melanotaenia* species); or
- *"Species that have never been assessed for importation" (e.g. Chilatherina* and *Glossolepis* species).

The list provided in Table 1 matches those species listed by McNee (2002) except for the inclusion of *M. maccullochi*.

It is likely that these same species are still present in Australia today.

Chilatherina axelrodi	*I. werneri**	*M. lacustris*
C. bleheri	*Melanotaenia affinis* lae	*M. lakamora*
C. bulolo	*Melanotaenia affinis* pagwi	*M. maccullochi**
C. campsi	*M. arfakensis*	*M. misoolensis*
C. crassispinosa	*M. batanta*	*M. monticola*
C. fasciata	*M. boesemani*	*M. oktediensis*
C. sentaniensis	*M. catherinae*	*M. papuae*
Glossolepis incisus	*M. fredericki*	*M. parkinsoni*
G. maculosus	*M. goldiei*	*M. pierucciae*
G. multisquamatus	*M. herbertaxelrodi*	*M. praecox*
G. ramuensis	*M. irianjaya*	*M. sexlineata*
G. wanamensis	*M. kamaka*	*M. splendida rubrostriata**

* native to New Guinea and Australia

Table 1 List of rainbowfish species known to be present in Australia in 2002 and likely to still be present in Australia today.

2.2.2 Source of domestically traded species

The geographic region where each of the different species of rainbowfish was endemic to, and from which the species was originally sourced is provided in Appendix B and summarised in Figure 3.

As noted in Section 2.2.1, almost all rainbowfish traded in Australia are captive bred and cultured in tanks or ponds, these being augmented by limited wild-harvesting in the Northern Territory (e.g. for *M. nigrans* and *M. splendida australis*).

In Australia, two major wholesalers, Bayfish and Aquarium Industries, obtain some of their stocks from a few northern Australian collectors and from breeders who may be contracted to supply certain species and numbers of fish (J Patrick, Bayfish and S Willis, Aquarium Industries, March 2007).

2.2.3 If rainbowfish were again to be imported

If rainbowfish were to be imported again into Australia, there are a number of countries from which stock could be sourced. The major ornamental wholesalers in Australia currently prefer suppliers with which they regularly source other species of ornamental fish and it is likely that rainbowfish would be sourced through these suppliers. These suppliers would most likely source stock from local producers or through established trading channels. Examples of countries from which rainbowfish may be sourced include Indonesia and Singapore. Both countries may secure stock from other countries although the extent of this is difficult to ascertain as this information is generally commercial-in-confidence. Stock may also be sourced from Germany. Rainbowfish available in Germany are usually bred in South-East Asia and imported via Singapore; some breeders in Germany source stock from Czech Republic (C Mailliet, ANGFA and Internationale Gesellschaft für Regenbogenfische [IRG] member, pers. comm., November 2006). According to D Wilson (ANGFA, pers. comm., December 2006) members of ANGFA would be unlikely to source stock from Indonesia as it would be difficult to confirm that rainbowfish that they would be receiving have not been interbred with other rainbowfish

species. Members of ANGFA are more likely to source stock from countries such as Germany and the United Kingdom, or from American hobbyists.

It is generally considered that rainbowfish rarely hybridise in their natural habitat (Allen and Cross 1982, Kailola 2004). One reference to possible hybridisation in the wild refers to the Lake Eacham rainbowfish (*M. eachamensis*). Lake Eacham rainbowfish in surrounding creeks are morphologically variable and may be the result of hybridisation between *M. eachamensis* and *M. splendida splendida* (Pusey *et al* 1997). Interestingly, Gleeson *et al* (2000) showed that hybrids of Dirran Creek rainbowfish (classified as *M. eachamensis*) and Lake Eacham rainbowfish (also classified as *M. eachamensis*) showed significantly higher resistance to infection with the parasite *Ichthyopthirius multifiliis* than did pure bred Dirran Creek rainbowfish. Zhu *et al* (1998) showed that both Dirran Creek and Lake Eacham rainbowifh contained pure *M. eachamensis* mitochondrial deoxyribonucleic acid halotypes.

Rainbowfish can and do hybridise when different species are kept communally (Allen, 1995). A member of the general public buying ornamental fish is more likely to buy on appearance of the fish, particularly colour. In contrast, the enthusiast (e.g. a member of ANGFA), while acknowledging colour is just as likely to be concerned with the purity of the fish he or she purchases. As there is the possibility that the fish being sold from an unknown source may not in fact be a pure strain, enthusiasts are unlikely to buy from unknown sources or from a source where the background of the fish being purchased/traded cannot be confirmed. As noted by G Parker (Pet City, pers. comm., November 2006): *"…crossbreeding… is frowned upon by most serious rainbow keepers. We have many hobbyists that are very picky about where they get stocks from and will go to great lengths to ensure they have a pure strain to breed with."*

2.2.4 Methods and systems of breeding and grow out in Australia

Rainbowfish breed readily in captivity. Most species attain sexual maturity before the end of their first year (Allen and Cross, 1982, Kailola 2004). As noted above, hobbyists and enthusiasts who breed and trade rainbowfish generally take great care in not mixing different species of rainbowfish if planning to breed from them. This is due to the ability of different species to hybridise when kept in captivity.

Full details on how to breed rainbowfish are given in many references including Tappin (1999) and Allen and Cross (1982). The same basic method is followed by both hobbyists and commercial breeders.

Basically, broodstock are placed in a tank either in pairs or at a ratio of 3 males to 2 or more females. Like many fish species, there are a number of environmental cues that are likely to influence the breeding of rainbowfish.

As noted in Tappin (2006):

Rainbows are extremely easy to induce to spawn, the difficult part is in rearing the fry. Unlike most egglayers, rainbows lay their eggs every day, a few at a time, as long as conditions (i.e food and spawning site) are ideal. This is known as "serial spawning". Spawning females produce between 100 and 200 eggs. Eggs adhere to water plants and hatching occurs around 6–7 days at temperatures between 24 to 28° C. Java Moss can be

used for the fish to spawn in or an artificial spawning mop can be used. A spawning mop can be made out of dark green acrylic wool. The eggs are sturdy and stand up well to handling and exposure to the air. They hatch in 10 to 14 days after being laid so if you move the mop, leave it in the hatching container for at least two weeks. As you see fry swimming at the water surface remove them with a turkey baster or plastic pipette into a tank filled with green water and Java moss. The fry will eat the organisms on the moss and in the water for the first several days.

Unlike imported ornamental fish such as cichlids (Order Perciformes, family Cichlidae) which can "colour up" and be ready for sale as early as 20 weeks, rainbowfish may not be ready for as long as twice this time depending on the species. For example, species such as *M. praecox* can get their colours when quite young, whereas species such as *M. parkinsoni* or *G. incisus* need to be 50mm in length before the males start to colour up (J Cousins, ANGFA member, pers. comm., October 2006). One breeder commented that it can take some species up to 12 months to show reasonable colours (G Thompson, ANGFA member, pers. comm., October 2006). Another breeder noted though that some species can start showing colour at about three months but at this stage it is only dominant males. The same breeder also noted that much depends on the conditions of the aquarium, the skills of the operator and a measure of good luck to get healthy fish that carry the traits of their wild parents (D Wilson, ANGFA member, pers. comm., October 2006). According to R Datodi (formerly Aquarium Industries, pers. comm., April 2007) line breeding of some species (e.g. *M. boesemani* in Germany) has resulted in fish that "colour up" when they reach 30–40mm. This is important as it can greatly reduce the time taken for the fish to be marketable.

An important point raised by one breeder was that unless you have very good breeding stock, it can be very hard with some species of rainbowfish (for example *G. incisus* females versus *G. wanamensis* versus *M. parkinsoni*) to identify different types of females in a community tank (A Thornton, pers. comm., October 2006).

As noted in Section 2.1.3, rainbowfish are not fussy eaters and will eat most of the standard aquarium feeds such as dry flakes and freeze dried products (Allen and Cross 1982, Leggett and Merrick 1987). However, they will readily take live food if available such as mosquito larvae, brine shrimp, small house flies etc. Rainbowfish can live up to four years in the wild but in captivity can live for considerably longer (Allen and Cross, 1982). As noted in section 2.2.1 feeding too much protein in the diet can cause health problems in rainbowfish.

Rainbowfish are well known for their peaceful disposition and hence are very suitable for "community" type aquariums (Allen and Cross, 1982). Aquarists keeping Rift Lake African cichlids frequently use New Guinea rainbowfish (including *G. incisus*) as peaceful community "dither" fish to reduce the cichlids' territorial behaviour.

2.2.5 Demand for rainbowfish in Australia

Relative quantities of rainbowfish species domestically traded

It has not been possible to interview all involved in the breeding, retailing or wholesaling of rainbowfish in Australia or overseas to ascertain the exact quantities of rainbowfish

traded in Australia. Even if this were done it would still be difficult to provide an accurate annual figure of rainbowfish traded as in many cases records of quantities exchanged, for example, within hobby groups, are not kept. Much information is also commercial-in-confidence.

However, it is estimated that tens of thousands of rainbowfish are traded each year in Australia. A former president of ANGFA, B Hansen (ANGFA member, pers. comm., October 2006) estimates that there are probably thousands of rainbowfish traded in Australia each week and estimates that each year over 200, 000 may be traded, half of which are species originally from New Guinea (e.g. *M. praecox, M. boesemani* and *G. incisus*). All the fish traded in Australia are bred locally, although anecdotal reports indicate that there may be, or have been, some imports of Australian species from international breeders even though such imports, if after 1986, were illegal. It is likely that most New Guinean rainbowfish bred here came from stocks imported before New Guinean rainbowfish were listed as illegal imports.

A survey in 1994 indicated that 16% of Australian households owned fish (Reark Research 1995). Rainbowfish would comprise less than 5% of the total fish sold in Australia (J Patrick, Bayfish, pers. comm., September 2006). J Patrick also estimates that on average, less than 2,000 rainbowfish are sold each week in Australia. Members of ANGFA estimate that this number is too low. For example, in Queensland, there are 200 retail pet fish shops of which about 50 sell rainbowfish (S Baines, retailer, pers. comm., October 2006) and each of them could sell more than 100 rainbowfish every week. However, one retailer in Brisbane estimates that he sells around 120–160 rainbowfish each month, of which the main species traded are *G. incisus*, *M. trifasciatus* and *M. boesemani* (G Parker, Pet City, pers. comm., October 2006). Another retailer based in Sydney sells approximately 150 rainbowfish each month; of these, approximately 30–40 are *M. praecox*, 40 are *M. boesemani*, 40 *M. lacustris* with the rest being *I. werneri*. Of these 95% or more are sold to the general public (i.e. not ANGFA members or breeders) (A Ramsay, Auburn Aquarium, pers. comm. December 2006).

It is possible that if wholesalers had access to imported rainbowfish the numbers of fish being supplied to the general aquarium fish trade may increase. B Hansen (ANGFA member, pers. comm., November 2006) notes that there are a plethora of smaller distributors who also have their regular breeders and suppliers and some of these may well have higher proportions of rainbowfish in their catalogues.

Another confounding point is that hobbyists and sellers often include blue-eyes (family Pseudomugilidae) in the general category of rainbowfish. Overall blue-eyes are not bred in large numbers judging by shop sales of these fish (A Wattam, hobbyist, pers. comm., November 2006). Species from the family Pseudomugilidae are not being directly considered in this report.

Retail sales are independent of hobby sales and exchanges. Hobby groups (e.g. ANGFA) hold regular meetings, auctions and "swap-meets" during which fish are exchanged and traded. These functions, held regularly around Australia, would boost the percentage of rainbowfish in "trade" considerably. For example, in the Australian Capital Territory (ACT) alone, approximately 2, 000 rainbowfish are traded per annum in the local aquarium society (A Wattam, hobbyist, pers. comm., November 2006). ANGFA usually

has a national conference every second year where a couple of thousand fish would be sold or traded as well as various regional groups which have monthly or bi-monthly meetings where fish are sold or traded. These fish can be supplied by various fish wholesalers or come from breeders and hobbyists within the association.

As an example of the ongoing movement of rainbowfish within the hobby associations, B Hansen (ANGFA, pers. comm., November 2006) notes that he personally would have bought less than a dozen rainbowfish from dealers in 25 years but has taken possession of hundreds from club auctions and swaps.

On average, approximately 10,000 fish are harvested from the wild on an annual basis in the Northern Territory. This harvest is usually evenly split between the Chequered (*Melanotaenia splendida inornata*) and Black-Banded Rainbowfish (*M. nigrans*) (S Matthews, Aquatic Resource Manager –NT Government, pers. comm., April 2007).

Routes of dispersion of rainbowfish in Australia

Rainbowfish are dispersed around Australia through two primary channels:

A. The aquarium commercial trade

B. The enthusiast (hobby) trade

The main difference between these two is the quantities of live fish being moved, there being far higher quantities of fish through the aquarium commercial trade. As discussed in Section 2.2.4, whilst not to the same extent as the commercial trade, fish movement between enthusiasts still occurs around the country. For both channels, rainbowfish are usually transported in sealed plastic bags containing small quantities of water and pure oxygen. Depending on distance, shipment may be by road or air. All shipments by air in Australia need to comply with the Seafood Air Transport Regulations[7] which details the requirements for sending live seafood by air. These Regulations set minimum requirements for packaging used to transport seafood (live and dead) by air. Generally the transport of live ornamental fish needs to comply with Packing Method No. 8 (Live Aquarium Fish in Salt or Fresh Water) (Appendix D).

Another method used to ship rainbowfish is transport of live eggs. This method is done mainly between enthusiasts and breeders. Rainbowfish eggs take approximately 7 to 12 days to hatch (depending on conditions). Eggs, kept moist, can be successfully shipped prior to hatching with very little effort, in a small, ideally waterproof container e.g. film canisters. Some breeders will not ship eggs until they can confirm fertilisation (by seeing eyes developing on the larvae). Eyes appear from approximately day two after spawn, again depending on conditions. Moving eggs is a simple, convenient and relatively discreet mechanism for dispersal of live genetic material. Shipping of eggs by this method is often simply done through the post (D Wilson, ANGFA, pers. comm., January 2007).

[7] Viewed December, 2006 <http://www.qantas.com.au/freight/pdf/SATRegulations.pdf>

2.2.6 Overseas market

Species of rainbowfish being traded overseas

As far as the authors of this report are aware, no rainbowfish are produced for human consumption overseas. All rainbowfish bred in other countries are bred for the aquarium (hobby) industries.

There are a large number of rainbowfish species currently traded overseas. Many of the species traded came from their original locations and habitat via Germany, where H Bleher, a German enthusiast, has been instrumental in supporting the rainbowfish enthusiasts in Germany and elsewhere. He has hand-carried numerous species out of New Guinea, and their progeny are now well distributed amongst global rainbowfish enthusiasts (Allen, 1999). These include those species identified in Table 2.

More rainbowfish species are kept and traded in Europe and America than in Australia. Allen (1995) reported that there are about 50 species of rainbowfish and closely related blue-eyes (family Pseudomugilidae) in the international aquarium hobby industry, while Hieronimus (1999) estimated that more than 100 different species and colour varieties are kept in Europe alone.

Glossolepis incisus, originally from New Guinea, is now widespread in Europe, America and Australasia, and its unique red colouration of the male of the species makes it one of the most popular rainbowfish in the hobby.

H. Hieronimus started the German-based International Rainbowfish Association (International Gesellschaft für Regenbogenfische) (IRG[8]) in Dusseldorf in 1986. IRG members have about 50 species and many more varieties that are traded within the society. However, less than 20 species are traded commercially, and some of them (e.g. female *Iriatherina werneri*) are becoming hard to get (H. Hieronimus, IRG member, pers. com., October 2006). Most species and local varieties of rainbowfish are kept by members of the IRG and are rarely seen in the trade. There is considerable exchange of semi-adult fish, often in personal meetings, but also by mail between members of the IRG.

According to H Hieronimus imports of wild caught fish from New Guinea are no longer seen in Germany (IRG member, pers. comm., October 2006).

[8] This website is at <http://www.irg-online.de/English/english.html>

Species	Year brought out of New Guinea/Australia
Melanotaenia boesemani	1982
M. lacustris	1988
M. herbertaxelrodi	1980s
M. praecox	1991
M. splendida australis	1982
M. trifasciata	1982
Chilatherina axelrodi	1982
C. bleheri	1982
C. campsi	1988
Glossolepis maculosus	1987
G. multisquamatus	1992
M. affinis, three varieties	1982–1988
M. arfakensis	1990
M. catherinae	1992
M. fredericki	1992
M. irianjaya (sold in England as *M. waikiki*, an invalid name)	1982
M. misoolensis	1992
M. monticola	1983
M. oktediensis	1983
M. papuae	1983
M. parkinsoni	1980s
M. sexlineata	1983

Table 2 Rainbowfish species brought into Germany by H Bleher and the year they were brought in.

The most commonly traded species in the pet trade in Germany are:

Melanotaenia boesemani
M. lacustris
M. trifasciata (unidentified variety, but possibly Goyder River)
M. praecox
M. maccullochi
M. herbertaxelrodi (rarely)
M. australis (under name of *M. papuae*, rarely)
M. parkinsoni (rarely)
*M. utcheensis (*as a new addition from one dealer)
Glossolepis incisus,
G. pseudoincisus (rarely)
Chilatherina bleheri
C. sentaniensis (rarely)

There are a few others in single shops where a breeder lives nearby and produces particular rainbowfish (H Hieronimus, IRG member, pers. comm., October 2006).

Additional species found in a United Kingdom stocklist (noted by H. Hieronimus) are:
M. trifasciata (Coen River)
M. eachamensis
M. duboulayi
M. splendida inornata
C. fasciata Lake Wanam (which maybe extinct in nature)

Only a few species are distributed internationally from south-east Asia. These include *Melanotaenia maccullochi*, *M. praecox*, *M. boesemani* and *Glossolepis incisus* (H Hieronimus, pers. comm., October 2006)

In Europe, Czech breeders supply good quality and rare fish species for the pet trade. Species bred by Czech breeders are generally those not supplied from Southeast Asia.

There are a large number of rainbowfish species traded in North America. Appendix E provides a list of rainbowfish species variously described as "common", "moderately common" etc. This is a qualitative list only.

2.2.7 Source of overseas traded species

The original source of all species of rainbowfish is provided in Appendix B. This identifies where the country or region from which each of the species was originally endemic.

All species now in trade and hobby overseas are tank and pond-cultured.

Original stocks of New Guinea species were wild-caught (some of them more than 50 years ago) and then distributed around the world but wild capture of rainbowfish endemic to New Guinea is rare now. The exception is when a new species is discovered and live specimens are brought out to be bred by hobbyists. Examples of these are some of the New Guinean species described in recent years (e.g. *Chilatherina alleni*, *Glossolepis dorityi)*.

There have been some interesting anecdotal stories relating to the sourcing of some species of rainbowfish. For example, hobbyists tell of the experiences with *Iriatherina werneri* and *Melanotaenia boesemani*. *I. werneri* males were sent to Germany and some females to America. H. Bleher reportedly collected *M. boesemani* from New Guinea in 1982 and took them back to Germany where they were bred and commercialised. In the mid 1980s demand was so great for this species that local villagers collected thousands (>60,000) of male fish each month from the wild and sent them to Jakarta. As all were males, the collecting activities wiped out populations in some streams and lakes. In both species, females are far less brightly coloured than the males.

As noted in Section 2.2.2, large major wholesalers in Australia obtain some of their stocks from a few northern Australian collectors and from hobbyists/breeders who may be contracted to supply certain species and numbers of fish. It is likely that the same situation is established overseas, although in countries such as Germany, wholesalers have access to rainbowfish grown in other countries such as Thailand and the Czech Republic.

The source of some rainbowfish overseas is Australia. C Mailliet, a German rainbowfish hobbyist (IRG member, pers. comm., December 2006) notes that there are occasional

exports from Australia to licensed breeders in Germany which have become more frequent in recent years. The export of native fish from Australia is controlled by the EPBC Act. The commercial export of rainbowfish may occur only where the specimens have been derived from an approved source such as an approved harvest program or aquaculture program[9]. Most of the rainbowfish exported from Australia go to enthusiasts and hobbyists and not to the general public.

2.2.8 Demand for rainbowfish overseas

Relative quantities of rainbowfish species traded overseas

There are difficulties in assessing what quantities, species and varieties are bred and sold internationally. The only freely available information (from commercial groups) is stocklists. Generally, inquiries on trade figures are confidential and not supplied. It has been suggested to the authors of this report that the major suppliers do not offer public stocklists as accommodating individual small buyers and hobbyists is uneconomic; rather, they maintain a selling chain with international wholesalers only. However, an inquiry made to a wholesaler selling freshwater ornamental finfish out of Thailand provided not only a stocklist (with prices) but also some information on the disease certification process conducted on fish being exported.

In Europe, rainbowfish are said to be among the most popular aquarium fish. Figures for overseas wholesalers are unavailable except for the estimates provided by H Hieronimus (IRG member pers. comm., October 2006) as traders only publish stocklists, and it has been difficult to obtain a reasonable estimate of the numbers of hobbyists and breeders internationally. H. Hieronimus notes that the overall quantities of the fish traded in Europe are often very low. For example, the number of *G. wanamensis* traded in one year was about 50–100 for all of Europe. South-East Asian fish (i.e. fish being commercially produced in South-East Asia) like *M. boesemani* and *M. praecox* are sold in tens of thousands, although the fish are generally of poor quality (H Hieronimus, IRG member pers. comm., October 2006). His estimate is that the majority of rainbowfish and varieties traded in Europe each year will number around 1000-2000 per species. C Mailliet (IRG member, pers. comm., December 2006) notes that species regularly offered for trade in Germany are generally bred in South-East Asia and imported via Singapore. There are some breeders in Central Europe (Czech Republic) who also supply the trade.

B Hansen (ANGFA member, pers. comm., November 2006) noted that as in Australia the international hobby clubs have big sale tables at their conventions and often arrange "car-boot" deals to coincide with their meetings. It is difficult to estimate the number of fish moved through this mechanism.

It has not been possible to determine the number of rainbowfish being traded in North America annually.

[9] Full details of how this trade occurs can be found at the Department of Environment and Water Resources website <http://www.environment.gov.au/biodiversity/trade-use/index.html> (viewed April 2007).

2.2.9 Routes of dispersion

As in Australia the main method of distribution of rainbowfish is through movement of fish by road or air. Transport by air requires compliance with the International Air Transport Association's (IATA) Live Animal Regulations (IATA 2006).

Breeders also move eggs of rainbowfish by post between and within countries as described in Section 2.2.5. As also noted in this section, transport of eggs is a simple, convenient and relatively discreet mechanism for movement of live genetic material.

2.3 Rainbowfish breeders and hobby groups in Australia

There are many pet fish hobby groups in Australia; ANGFA is devoted exclusively to native fish. ANGFA was formed in 1982. An estimate of the 2006 membership of ANGFA is 1322 members, of which 715 are overseas members, mainly from Germany (T. Tucceri, ANGFA member, pers comm. December 2006). ANGFA affiliations are shown in Figure 5.

Almost all members of ANGFA breed fish, but not all of them breed rainbowfish. In addition, there are those who are not members of ANGFA who breed rainbowfish and trade them with friends, or sell them locally. There is also a Rainbowfish Mailing List (RML), a web chat forum, through which hobbyists can exchange fish, ask questions, and so on.

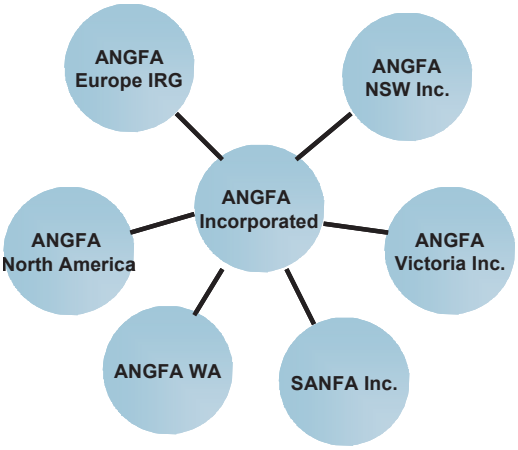


Figure 6 ANGFA affiliations.

SANFA = South Australian Native Fishes Association

J Patrick (Bayfish, pers. comm., October 2006) estimates that Australia-wide, there is probably an average of fewer than 20 rainbowfish breeders in each State, but ANGFA rainbowfish hobbyists suggest that that number is far too low. It is though difficult to assess the exact number even when examining the state licensing authorites. For example, in Queensland, of the licence group called "exotic ornamentals" (which includes both imported and native ornamentals) there are 87 licence holders with rainbowfish allowed on their license. However, not all these produce rainbowfish. For example, in 2004–05 there were eight farms that produced rainbowfish in Queensland (R Lobegeiger, Queensland DPI, pers. comm., December 2006).

2.4 Rainbowfish breeders and hobby groups overseas

The rainbowfish hobby started outside of Australia in Germany, in 1927. As noted in Section 2.2.6, H. Hieronimus started the IRG in 1986 which, based on membership numbers, is probably the most significant. In America, there is the Rainbowfish Study Group[10] of North America. Other international associations and organisations include BRAGS (British Rainbowfish and Goby society) and SRGS (Scandinavian Rainbowfish and Goby Society). Well known international rainbowfish hobbyists are G. Lange from the USA, and H Bleher and H Heironimus, both from Germany. There are also numerous hobby, contracted, and commercial breeders in the following countries:

- United Kingdom
- Poland
- Czech Republic
- Germany
- Russia
- Mainland China
- Indonesia
- Japan
- Vietnam
- Thailand
- Philippines
- USA.

[10] This website is at <www.Rainbowfish.org/>

3 Methodology of this risk analysis

As in the 1999 IRA, a methodology based on *import risk analysis* defined in the World Organisation for Animal Health (OIE) Aquatic Animal Health Code 2008 (Aquatic Code) has been used to structure this risk analysis. The OIE Aquatic Code states that:

"The importation of aquatic animals and animal products, whether of aquatic or terrestrial origin, involves a degree of disease risk to the importing country. This risk, which may be to humans or animals, may be represented by one or several diseases not present in the importing country."

and:

"The principal aim of import risk analysis is to provide importing countries with an objective and defensible method of assessing the disease risks associated with the importation of animals, animal products, animal genetic material, feedstuffs, biological products and pathological material. The principles and methods are the same whether the commodities are derived from aquatic and/or terrestrial animal sources. The analysis should be transparent. This is necessary so that the exporting country is provided with clear reasons for the imposition of import conditions or refusal to import."

There are a number of key steps that a member country must follow when preparing a risk analysis on a commodity (which in this case is live ornamental fish belonging to the family Melanotaeniidae). As noted in Figure 7 (OIE Aquatic Code) these steps are:

1. Hazard Identification
2. Risk Assessment
3. Risk Management
4. Risk Communication

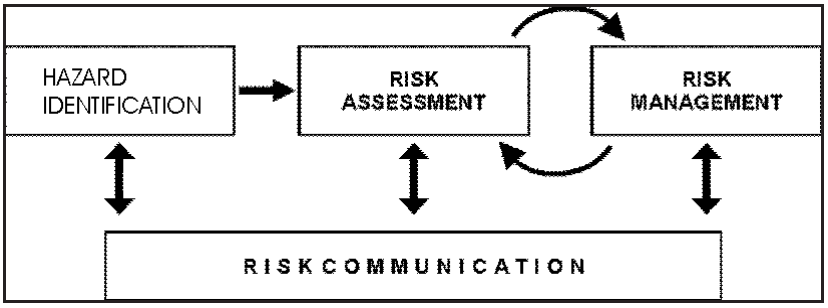


Figure 7 The four components of Risk Analysis (OIE Aquatic Code).

There is extensive discussion of the method of risk analysis provided in the 1999 IRA. This is being updated in the draft import risk analysis report for ornamental finfish with respect to iridoviruses (Iridovirus IRA) being conducted by Biosecurity Australia[11] and

[11] The draft IRA report was released on 24 March 2009, and can be obtained from <http://www.daff.gov.au/ba/ira/current-animal/ornamental_finfish>. This report was not available when the original rainbowfish risk analysis report was submitted by Panaquatic in May, 2007.

will not be further discussed here except to make specific comment on the first of these steps, Hazard Identification.

With respect to the methodology applied to Hazard Identification, the criteria for giving detailed consideration to a disease agent in the 1999 IRA were that:

1. The disease agent was carried by a Schedule 6[12] or related species of ornamental finfish;
2. The disease agent was infectious;
3. The disease agent was:
    a. Exotic to Australia; or
    b. Present in Australia but subject to official control; and
4. The disease agent was:
    a. OIE listed[13]; and/or
    b. Would be expected to cause significant harm in Australia.

The New Zealand IRA for ornamental fish (Hine and Diggles 2005) follows similar criteria for hazard identification i.e. a disease was given detailed consideration if it was:

1. Carried by a fish species on the permitted list[14]; and
2. Infectious; and
3. Exotic to New Zealand; and
4. (a) OIE-listed[15], and/or
    (b) likely to cause significant harm in New Zealand.

These criteria are currently accepted as part of the risk analysis process in these two countries.

Therefore, the following criteria have been applied to this risk analysis in identifying and giving further consideration on a disease agent associated with rainbowfish:

1. The disease agent iscarried by a species of rainbowfish;
2. The disease agent is infectious;
3. The disease agent is:
    (a) Exotic to Australia, or
    (b) Present in Australia but subject to official control; and

[12] Schedule 6 was part of the *Wildlife Protection (Regulation of Exports and Imports) Act 1982*. This Act has now been superseded by the *Environment Protection and Biodiversity Conservation Act 1999* which has a *List of Specimens Suitable For Live Import* (Live Import List) (freshwater ornamental fish from this list are listed in Appendix A)

[13] The current OIE finfish listed diseases are at <http://www.oie.int/eng/normes/fcode/en_chapitre_1.2.3.htm> (viewed April, 2007)

[14] This was considered as a host-based approach in this document

[15] This was considered a disease-based approach in this document (after AQIS 1999)

4. The disease agent is:
   (a) OIE listed, and/or
   (b) Would be expected to cause significant harm in Australia.

4 Hazard identification

A key element of this risk analysis was to report on the current knowledge of the disease status of rainbowfish in Australia and overseas in order to be able to define, using accepted criteria where possible; disease agents that would require further consideration in this assessment.

Importantly, to be able to access information on diseases of rainbowfish the information must either be:

- Published (and hence publicly available); or
- Made available by people aware of such information and who have been contacted by the authors of this report.

Anecdotal information is often never recorded and information kept in diagnostic laboratories is rarely available to the public. Hence the following approaches were taken to collect the information for this report:

A. A comprehensive search was conducted of published scientific literature and the World Wide Web for published or anecdotal information on diseases or pests found to be associated with rainbowfish.

B. Rainbowfish hobbyists and breeders globally were consulted, with assistance from such associations as ANGFA, to ascertain what diseases or pests they had experienced. In addition, aquatic animal pathologists and veterinarians working with ornamental finfish industry in Australia were consulted to ascertain what diseases or pests they had identified to be associated with rainbowfish in Australia. Further, where such personnel had worked overseas, they were consulted if they had identified any pests or diseases associated with rainbowfish elsewhere.

The following outlines the methodology used in each of these approaches.

A. Published scientific literature and the world wide web:

The services and databases of the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Australian Animal Health Laboratory (AAHL) at Geelong, Victoria were utilised. An electronic search using the public domain bibliographic databases PubMed and Aquatic Sciences and Fisheries Abstracts limited to the last 30 years was conducted.

However, as with all literature searches such as these, caution is required. As Hines and Diggles (2005) noted:

When reports of fish parasites and diseases in developing countries are published, they are often in publications that are very difficult, usually impossible, to obtain, and they are written in the national language; and

The only method available for access to the abstracts of obscure papers is to use computerised databases, which usually miss out several papers. The abstracts also often lack the details necessary to draw conclusions.

Having acknowledged this, there is very little published information on rainbowfish and associated diseases identified from countries where the national language is English (e.g. Australia, USA and The United Kingdom). It is likely that even if it was possible to easily access publications in countries where English is not the primary language and have them translated into English, there may not be a great deal of information specifically pertaining to rainbowfish. This is in large part due to the fact that rainbowfish are endemic only in Australia and New Guinea. In other countries where rainbowfish may be found (e.g. countries in South-East Asia), rainbowfish have been brought to those countries to be grown commercially, providing stock for the ornamental fish trade.

Searches using the Google™[16] and Scirus search engine[17] were also conducted with search terms "rainbow fish", "rainbowfish", "melanotaen*" combined with either/or "disease", "parasites", "disease*", "mortalit*", "parasit*" and "infect*". This led the authors to a multitude of web sites, many of which are included in the Contact List of this report. Much of the information from these sites about disease was anecdotal and not verified by diagnostic tools such as bacterial culture, histopathology or molecular tests.

B. Consultation with hobbyists, wholesalers and retailers of rainbowfish in Australia and overseas. Consultation with diagnostic laboratories in Australia.

Extensive consultation was conducted both via electronic media (e.g. via questionnaire circulated to breeders and hobbyists through associations such as ANGFA) and via face to face interviews with many hobbyists and breeders of rainbowfish in Australia and overseas.

In addition, wholesalers and retailers of rainbowfish in Australia were consulted to determine what diseases or disease agents had affected rainbowfish while in their care. Similarly, public aquariums from around the world were contacted. Aquatic animal pathologists in key diagnostic laboratories and veterinarians who had worked with the ornamental finfish industy around Australia (as identified in the Contact List) were contacted. It is possible that there may be some additional information available in diagnostic laboratories overseas. Contacting all diagnostic laboratories around the world to which rainbowfish may have been submitted was not done primarily for two reasons:

1. Results of the published literature and World Wide Web were expected to provide information on diseases of significance and the geographic region in which they had been identified. Such information would be used to prioritise the countries where diagnostic laboratories should be consulted.
2. There are many diagnostic laboratories around the world to which a rainbowfish could be submitted on occasion or as part of routine health testing. Requesting database searches at all these laboratories would involve considerable resources and take considerable time.

[16] Viewed November, 2006 <http://www.google.com.au/>
[17] Viewed November, 2006 <http://www.scirus.com/srsapp/>

Attempts were made to contact the diagnostic laboratory associated with the Ornamental Fish Section (OFS) of the Agri-Food and Veterinary Authority (AVA) of Singapore[18]. This was because it was assumed that as the OFS provides certification for ornamental fish being exported from Singapore and rainbowfish may be submitted to their laboratory from time to time. Unfortunately, despite a number of attempts by phone, email and fax there had been no reply from the OFS at the time of submission of the original report (May, 2007).

A full list of those contacted is provided in the Contact List.

4.1 Identification of disease agents of rainbowfish for further consideration in this assessment

Since an extensive review of pests and diseases associated with ornamental fish was conducted for the 1999 IRA, and prior to May, 2007, two important references describing disease agents relevant to rainbowfish have been published and are considered worthy of mention here. These are reports by Dove (2000), and Evans and Lester (2001).

Dove (2000) examined parasite richness on native freshwater fish (e.g. *Melanotaenia duboulayi*) compared to those found on exotic freshwater species (e.g. *Gambusia holbrooki*) in the same river systems in south eastern Queensland. Many of the parasites identified in Table 3 came from this study.

Evans and Lester (2002) examined five commonly imported ornamental fish into Australia for parasites immediately after being released from quarantine. This report noted that shipments had come from up to five different exporting companies the parasite prevalence was uniformly high in all fish examined. Ten parasite species were found, some of which were considered "high risk" by the authors of this study (e.g. *Camallanus cotti, Bothriocephalus acheilognatha*). No rainbowfish were examined in this study because rainbowfish were not imported post-1986. However, it is important to note that parasites were surviving the quarantine period and were present on imported fish when these fish were released from quarantine.

It is possible that rainbowfish, if imported, could carry parasites of quarantine significance to Australia. Evans and Lester's report (2002) noted that this is already occurring with other commonly imported ornamental fish. It is not possible to evaluate if the risk would change if importation of rainbowfish were allowed, compared to the risk that is occurring with ornamental species currently being imported.

4.2 Outcome of the initial hazard identification

Table 3 details the disease agents and diseases that were identified in fish of the family Melanotaeniidae during the extensive electronic searches and consultation described above. As can be seen from this table there is relatively little information available referring to disease agents and diseases specific to rainbowfish.

[18] The website is at <http://www.ava.gov.sg/AnimalsPetSector/ImportExportTransOfAnimalRelatedPrd/OrnamentalFish>. A request was made for information relating to any disease agents isolated from, or diseases identified in rainbowfish by the OFS.

As per the terms of reference of this report, Biosecurity Australia was consulted on the disease agents and diseases identified in this Table.

There were no reports in the scientific literature that identified a disease or disease agent of rainbowfish overseas that had not also been identified in Australia.

Many species of rainbowfish are indeed endemic to Australia and there are many keen hobbyists and breeders in this country - ANGFA alone has approximately 1,322 Australian members (T Tucceri, Treasurer, ANGFA Inc., pers. comm., December 2006). It would be easy to say that such findings indicate that there are therefore very few disease agents that are carried by rainbowfish. This conclusion though is considered too simplistic and cursory for a number of reasons. Of critical importance is the often cited quotation that the "absence of evidence is not necessarily evidence of absence".

For instance, as far as the authors are aware, there is no routine fish health monitoring or surveillance program of rainbowfish in Australia or New Guinea i.e. the regions where rainbowfish are endemic. Extensive consultation with hobbyists and enthusiasts both in Australia and overseas indicate that rainbowfish are rarely submitted to a diagnostic laboratory or veterinarians. Rather hobbyists tend to seek advice from other hobbyists when there is a problem with their fish. Consultations with pathologists working in diagnostic laboratories around Australia support this.

A reason for very few rainbowfish are submitted to diagnostic laboratories may be due to cost. For example, submitting a rainbowfish to a government diagnostic laboratory for pathology testing in a number of states of Australia (e.g. South Australia, Victoria, Queensland) may cost $150–$400 depending on what diagnostic procedures are conducted on the fish. This cost may deter the owner of a rainbowfish submitting a sick fish to a laboratory to confirm diagnosis.

The cost of submitting rainbowfish to diagnostic laboratories overseas was not investigated so has not been commented on in this report.

Table 3 Disease agents and diseases identified in rainbowfish

Disease/parasite agent	Disease	Source	Rainbowfish species	Country/State identified	Notes
VIRUSES	Nil reported				
BACTERIA					
Flavobacterium columnare	Columnaris disease	Numerous. Discussed on hobbyist websites[19]	Not specified	Not specified	Considered anecdotally by some hobbyists to be particularly prevalent in rainbowfish. No confirmed laboratory diagnosis found.
Mycobacterium spp (*M. marinum, M. fortuitum,* and *M.piscium*) **NOTE - Mycobacterium spp. have known zoonotic potential**	Mycobacteriosis	Numerous - includes:			
		NSW Department of Primary Industries Laboratory Reports (provided by L Reddacliff, January 2007)	Not specified	NSW	Identified from one adult female rainbowfish case in 1998 -. Multiple microgranulomas in kidney. Mycobacterium spp. isolated. Most likely *M. marinum*
		Smith (1997)	Not specified	Germany, USA, Australia	Numerous species of tropical pet fish have been reported with mycobacterial infections; however, some species appear to be more susceptible to the disease and therefore demonstrate a higher incidence of infections including rainbowfish (*Melanotaenia* spp).

[19] For example, refer to discussion at <www.aquariacentral.com/forums/archive/index.php/t-69825.html>

Table 3 Disease agents and diseases identified in rainbowfish (cont.)

Disease/parasite agent	Disease	Source	Rainbowfish species	Country/State identified	Notes
Mycobacterium spp (*M. marinum, M. fortuitum,* and *M.piscium*) (cont.)		B Jones (Department of Fisheries, Government of Western Australia, pers.comm, Dec 2006)	Not specified	Western Australia	Identifed from two cases - high probability that it was *M. marinum*
		SCFH (1991)	*M. splendida*	Queensland	
FUNGI					
Aphanomyces invadans	Epizootic Ulcerative Syndrome (EUS)	J Humphrey (Berrimah Veterinary Laboratory, pers.comm, Dec 2006)	*Melanotaenia* spp, *M. splendida*	Northern Territory	Agent not cultured but diagnosed on clinical signs and histopathology
Saprolegnia spp.	Saprolegniasis	NSW Department of Primary Industries Laboratory Reports (provided by L Reddacliff, January 2007)	"Eastern rainbowfish"	NSW	Identified from a case in 1997. Cutaneous lesions
PROTOZOA					
Chilodonella hexasticha	Gill pathology	Langdon et al (1985)	*M. splendida tatei*	Northern Territory	
Ichthyophthirius multifiliis	White spot	Gleeson et al (2000)	*M. eachamensis, M. splendida*	Queensland	Experimentally infected in laboratory
		M Abell (hobbyist and breeder, pers. comm, Nov 2006)	*Melanotaenia* spp.	New South Wales	All have identified it in rainbowfish they have kept. Visual appraisal - not confirmed by a diagnostic test
		G Thompson (hobbyist, pers. comm., Nov 2006)		Western Australia	
		N Amos (hobbyist, pers. comm., Nov 2006)		Victoria	
		B Jones (Department of Fisheries, Government of Western Australia, pers. comm, Dec 2006)	Not specified		Identified from one case submitted to laboratory

Table 3 Disease agents and diseases identified in rainbowfish (cont.)

Disease/parasite agent	Disease	Source	Rainbowfish species	Country/State identified	Notes
PROTOZOA (cont.)					
Oodinium spp	Velvet disease	A Tappin as described on the ANGFA website[20]	Not specified	Queensland	
		R Bowman (hobbyist and breeder, pers. comm., Nov 2006)	Not specified	Victoria	Commented that the fry of some species can "pick up" oodinium when young
Trichodina heterodentata	No disease reported in fish examined	Dove (2000)	*M. duboulayi*	Queensland	Identified on *M. duboulayi* collected from the wild in south east Queensland
MYXOZOA					
Henneguya sp. D	No disease reported in fish examined	Dove (2000)	*M. duboulayi*	Queensland	Identified on *M. duboulayi* collected from the wild in south east Queensland
NEMATODES					
Camallanus spp (roundworms)		A. Tappin as described on his rainbowfish website[21] B Sambell (Ausyfish, pers. comm, Dec 2006)	Not specified	Queensland	Very common in rainbowfish maintained in outdoor ponds.
Contracaecun sp.	Information not available	Beumer JP (1976) (cited in Beumer *et al* 1983)	*Nematocentris splendida* (now *M. splendida splendida*)	Queensland	
ACANTHOCEPHALANS					
Telosentis sp.	Information not available	Beumer JP (1976) (cited in Beumer *et al* 1983)	*Nematocentris splendida* (now *M. splendida splendida*)	Queensland	

[20] Viewed December 2006, <http://www.angfa.org.au/disease.html>

[21] Viewed December, 2006, <http://members.optushome.com.au/chelmon/Worms.htm>

Table 3 Disease agents and diseases identified in rainbowfish (cont.)

Disease/parasite agent	Disease	Source	Rainbowfish species	Country/State identified	Notes
MONOGENEANS					
Ancyrocephaline sp C	No disease reported in fish examined	Dove (2000)	*M. duboulayi*	Queensland	Identified on *M. duboulayi* collected from the wild in south east Queensland
Dactylogyrid sp.		B Jones (Dept. of Fisheries, Government of Western Australia, pers.comm, Dec 2006)	Not specified	Western Australia	Identified from one case submitted to laboratory
DIGENEANS					
Clinostomum austaliense metacercaria	No disease reported in fish examined	Dove (2000)	*M. duboulayi*	Queensland	Identified on *M. duboulayi* collected from the wild in south east Queensland
Clinostomum complanatum, Posthodiplostomum sp.	Information not available	Beumer JP (1976) cited in Beumer *et al* (1983)	*Nematocentris splendida* (now *M. splendida splendida*)	Queensland	
Corpuscular heterophyid metacercaria.	No disease reported in fish examined	Dove (2000)	*M. duboulayi*	Queensland	Identified on *M. duboulayi* collected from the wild in south east Queensland
Diplostomum spathaceum	Information not available	Johnston and Angel (1941) cited in Beumer *et al* (1983)	*M. nigricans*	New South Wales	
Heterophyid metacercaria Type C and G	No disease reported in fish examined	Dove (2000)	*M. duboulayi*	Queensland	Identified on *M. duboulayi* collected from the wild in south east Queensland
Neascus Type A, B, C, D	No disease reported in fish examined	Dove (2000)	*M. duboulayi*	Queensland	Identified on *M. duboulayi* collected from the wild in south east Queensland
Opecoelus variabilis	No disease reported	Cribb (1985)	*M. splendida fluviatilis*	Queensland	

Table 3 Disease agents and diseases identified in rainbowfish (cont.)

Disease/parasite agent	Disease	Source	Rainbowfish species	Country/State identified	Notes
DIGENEANS (cont.)					
Pretestis australianus	No disease reported	Angel and Manter (1970)	*M. fluviatilis*	South Australia	Identified on *M. duboulayi* collected from the wild in south east Queensland
Tetracerasta blepta metacercaria	No disease reported in fish examined	Dove (2000)	*M. duboulayi*	Queensland	
CRUSTACEANS					
Lernaea spp.	Anchor worm infestation	NSW Department of Primary Industries Laboratory Reports (provided by L Reddacliff, January 2007)	Not specified	NSW	Identified from two rainbowfish in 1999. Both fish had several typical adult female anchor worms hanging off the skin, mostly around head and fin bases

4.3 Expanding the consideration of disease agents of relevance to the family Melanotaeniidae

As noted in Section 4.2 at the initial hazard identification process, it was concluded that there was no available information on diseases or disease agents associated with rainbowfish that had been identified overseas only and not identified in Australia (i.e. the disease or disease agent is exotic to Australia). Using the hazard identification criteria discussed in Section 3 to further determine whether or not a disease agent will be given detailed consideration, it was concluded that there were no disease agents identified that satisfied these criteria. Hence no disease agents were selected for further detailed consideration.

Absence of evidence does not mean evidence of absence. While anecdotal information from hobbyists and breeders of rainbowfish both in Australia and overseas indicate that they are a relatively hardy species, the lack of evidence of disease agents in fish in the family of Melanotaeniidae could be taken to indicate that as a group this family is relatively disease free. It may also be because relatively little examination and testing of species from this family have occurred, as discussed in Section 4.2.

The authors therefore considered how a wider examination of potential ornamental fish pathogens and diseases of relevance to rainbowfish could be conducted.

A key document with respect to disease risk analysis for ornamental finfish importation in Australia is the 1999 IRA. This IRA considered the disease risks associated with the importation of hundreds of species of ornamental finfish, including two species of ornamental finfish from families closely related to rainbowfish i.e. the Madagascar rainbowfish (*Bedotia geayi)* and the Celebes rainbowfish (*Telmatherina ladigesi*) (Figure 2). These fish arepermitted species under the Live Import List. All permitted freshwater finfish species under the Live Import List are provided in Appendix A.

Assuming that there has been relatively little testing of Melanotaeniidae (and the authors' wide consultation has tended to confirm this) then the authors' considered an alternative wording for Item 1 in the hazard identification criteria i.e.:

1. Carried by a species of rainbowfish or having the potential to be carried by, or infecting, a species of rainbowfish

While more encompassing, this criteria creates its own concern in defining the term "having the potential" and providing reasonable justification to make the claim that a rainbowfish may indeed have this "potential".

Such "potential" will relate to the disease agent itself and what the host specificity of the disease agent is. Viruses tend to be reasonably host specific and hence for this class of disease agents the "potential" for rainbowfish to carry such agents or be infected by them is likely to be low. Notably no viruses infecting rainbowfish were identified in this review. Parasites on the other hand can have a wider host range. While a number of parasites have been identified on rainbowfish in Australia, none are reported to be found on rainbowfish overseas that are not already found here. Evans and Lester (2001) reported that there are a number of parasites of concern coming into Australia through the importation of ornamental finfish, despite a quarantine period. Hence for parasites it is possible that rainbowfish have the potential to either carry, or be infested with a number of species depending where those

rainbowfish are grown and imported from. There are two possible ways to consider this "potential":

A. For rainbowfish to carry or be infected by a disease agent they must be exposed to the disease agent. One way of determining the likelihood of exposure (and subsequently determining the likelihood that rainbowfish may have the "potential" to either carry or be infected with the agent) would be through considering what kind of finfish species may share common water with rainbowfish. This is based on the assumption that holding of rainbowfish and other species together in a holding aquaria (or holding rainbowfish in tanks that have previously housed other species without cleaning and disinfecting tanks between stocks) could set up conditions for transfer of disease agents. Similarly, farms that are producing rainbowfish and other species on the same site for the commercial trade could provide opportunity for disease transfer.

B. Considering what family(s) of finfish rainbowfish is/are most closely related to and making a broad assumption that rainbowfish may have susceptibility to these diseases is another way of broadening the list of disease agents and diseases that rainbowfish may have the "potential" to carry or be infected with.

Applying such relationships to rainbowfish cannot be justified if it is not also applied to other ornamental fish being currently imported into Australia. In addition, two species of fish already being imported are closely related to the family Melanotaeniidae i.e. the Madagascar rainbowfish (*Bedotia geayi)* and the Celebes rainbowfish (*Telmatherina ladigesi*). These species have been scrutinised in a previous IRA and have been approved entry.

4.4 Outcome of supplementary hazard identification

Although outside the scope of this report, the range of disease agents and diseases considered in this review was widened beyond those that had been found in rainbowfish. The primary sources of other diseases for consideration were diseases identified in the 1999 IRA (AQIS 1999a) and the more recent IRA conducted in New Zealand (Hine and Diggles 2005). In addition, finfish diseases listed in the Aquatic Code 2006 (unchanged in the Aquatic Code 2008) (Table 4) were considered.

Appendix C provides a comprehensive list of these agents that were considered in this additional review and a brief rationale as to why the agent will not be considered further as potential disease agents associated with rainbowfish. Even considering a much wider range of disease agents, there were still no agents identified that satisfied the hazard identification criteria for giving further detailed consideration in this risk analysis. That is if the disease agent was:

1. Carried by a species of rainbowfish;
2. Infectious;
3. (a) Exotic to Australia, or

   (b) Present in Australia but subject to official control; and
4. (a) OIE listed, and/or

   (b) Would be expected to cause significant harm in Australia.

It must be noted though that for all the disease agents considered in the additional Hazard Identification at no stage was any evidence identified that documented rainbowfish being either challenged or exposed to any of these agents.

As per the terms of reference of this review, Biosecurity Australia was consulted on all diseases identified in the supplementary hazard identification stage of this report.

Epizootic haematopoietic necrosis
Infectious haematopoietic necrosis
Spring viraemia of carp
Viral haemorrhagic septicaemia
Infectious salmon anaemia
Epizootic ulcerative syndrome
Gyrodactylosis (*Gyrodactylus salaris*)
Red sea bream iridoviral disease
Koi herpesvirus disease

Table 4 OIE listed finfish diseases (OIE Aquatic Animal Code 2006, 2008).

5 Conclusion

There were a number of disease agents identified in rainbowfish that were considered diseases of concern for various reasons. These included:

- *Mycobacterium* spp. - due to their potential for zoonoses;
- *Cammalanus* spp. – due to the pathogenicity of these parasites;
- *Aphanomyces invadans* – an OIE listed disease; and
- *Flavobacterium* spp. – due to the virulence associated with specific strains.

However, all these disease agents have been reported in rainbowfish in Australia, and there is no official control program for them in Australia. Hence they did not satisfy the hazard identification criteria for further detailed consideration.

Additionally, there were no exotic disease agents or diseases identified in the supplementary hazard identification that were deemed to warrant further consideration. As noted though, there was also no evidence of rainbowfish being exposed to, or challenged by, any of these disease agents. Based on the above outcomes of the hazard identification, in consultation with Biosecurity Australia, the authors concluded that no disease agents or diseases were identified associated with rainbowfish that warranted further consideration to proceed further risk assessment steps (e.g. entry and exposure assessment, consequence assessment) in this risk analysis.

Abbreviations and acronyms

AAHL	Australian Animal Health Laboratory
DAFF	Department of Agriculture, Fisheries and Forestry
ANGFA	Australia New Guinea Fishes Association Inc.
AQIS	Australian Quarantine and Inspection Service
CSIRO	Commonwealh Scientific and Industrial Research Organisation
DEWHA	Department of the Environment, Water, Heritage and the Arts
Dorsal	On, or near the back of the fish
Emarginate	Caudal or tail fin with a slightly concave margin.
Endemic	Peculiar to a certain region
EPBC Act	*The Environment Protection and Biodiversity Conservation Act 1999*
ESD	Environmental Sustainable Development
Fry	Young or newly hatched fish
Habitat	Natural home of the fish
IATA	International Air Transport Association
IRA	Import Risk Analysis
IRG	Internationale Gesellschaft für Regenbogenfische
Live Import List	List of specimens suitable for live import - under EPBC Act
Melanotaeniidae	Family of Rainbowfish
Morphological	Study based upon the form or shape of the fish
NCBI	National Center for Biotechnology Information (United States)
New Guinea	Papua New Guinea and associated islands in the east and the Indonesian provinces of Papua and West Irian Jaya in the west
OIE	World Organisation for Animal Health (formerly the *Office International des Épizooties*)
Omnivorous	Feeds on many food types - both plants and animals

Pathogen	An infectious agent capable of causing disease
Phylogenetic	Of or pertaining to phylogeny
Phylogeny	The origin and development of a group or species of organisms; the evolution of the species
QAP	Quarantine Approved Premises
Spawn	Produce eggs
SPS	Sanitary and Phytosanitary
Water hardness	Measure of the concentration of minerals in water - primarily the divalent ions Ca^{2+} and Mg^{2+}
WTO	World Trade Organization

Contact List - People, associations and organisations contacted as part of this report

First name	Surname	Affiliation/interest	Country/State/ Territory
Mark	Abell	ANGFA	New South Wales
Douglas	Allen	National Aquarium, Baltimore	USA
Neville	Amox	ANGFA	Victoria
Ian	Anderson	Department of Primary Industries and Fisheries	Queensland
Neil	Armstrong	ANGFA	Australia
Heiko	Bleher	Breeder	Germany
Ron	Bowman	ANGFA (founding member)	Victoria
Glen	Briggs	Aquarium Industries	Victoria
Steve and Aimee	Brooks	Department of Primary Industries and Fisheries (and private breeder)	Queensland
Jeremy	Carson	Department of Primary Industries and Water	Tasmania
Roger	Chong	Department of Primary Industries and Fisheries	Queensland
John	Cousins	Eastern District Aquariums Society, ANGFA	Victoria
Mark	Crane	AAHL Fish Diseases Laboratory	Victoria
Barry	Crockford	Hobbyist	Victoria
Rick	Datodi	Formerly Aquarium Industries	Victoria
Charles	Delbeek	Waikiki Aquarium	USA
Marty	Deveney	Primary Industries and Resources of South Australia (PIRSA)	South Australia
Jim	Evans	Sreinhart Aquarium	USA
Robert	Fenner	Hobbyist	USA
Jane	Francis	Department of Primary Industries	New South Wales
Prayeth	Gerabun	Siam Ocean World	Thailand
Nick	Giannou	Upmarket Aquariums	Victoria
Derek	Girkin	ANGFA	New South Wales
Judith	Handlinger	Department of Primary Industries and Water	Tasmania
Bruce	Hansen	ANGFA	Brisbane
Sean	Henderson	Washington Reptile Discovery Centre	USA
Harro	Hieronimus	Gesellschaft für Regenbogenfische [IRG]	Germany

First name	Surname	Affiliation/interest	Country/State/ Territory
John	Humphrey	Department of Primary Industry, Fisheries and Mines	Northern Territory
Jorie	Johnson	Wet Web Media	USA
Brian	Jones	Department of Fisheries	Western Australia
Bob	Kingwell	Jem Aquatics	Canberra
Malcolm	Lancaster	Department of Primary Industries	Victoria
Gary	Lange	Rainbowfish Society of North America	USA
Ross	Lobegeiger	Department of Primary Industries	Queensland
Richmond	Loh	Department of Primary Industries and Water	Tasmania
Christophe	Mailliet	Gesellschaft für Regenbogenfische [IRG]	Germany
Steven	Matthews	Department of Primary Industry, Fisheries and Mines	Northern Territory
Philippa	McLaren	Gribbles Veterinary Laboratory	Victoria
Robbie	Mort	Underwaterworld	Queensland
Gary	Parker	Pet City	Sydney
Jared	Patrick	Bayfish	Brisbane
Peter	Phillips	Gribbles Veterinary Pathology	South Australia
Yew Kwang	Poh	Ornamental Fish Section Agri-Food and Veterinary Authority	Singapore
Carmel	Pollino	Integrated Catchment Assessment and Management Centre	Australian Capital Territory
Steve	Pyecroft	Department of Primary Industries and Water	Tasmania
Anthony	Ramsay	Pet Industry Association Australia (PIAA)	Sydney
Lesley	Reddacliff	Department of Primary Industries	New South Wales
Rod	Reece	Department of Primary Industries	New South Wales
Jen	Reynolds	Vancouver Aquarium	Canada
Heidy	Rubin	ANGFA	Northern Territory
Bruce	Sambell	Ausyfish	Queensland
Matthew	Stanton	ANGFA	New South Wales
Adrian	Tappin	Rainbows-on-Line	Qld
Graham	Thompson	ANGFA	Western Australia

First name	Surname	Affiliation/interest	Country/State/ Territory
Andrew	Thornton	ANGFA	New South Wales
Tony	Tucceri	ANGFA	Victoria
Peter	Unmack	Researcher	USA
Damian	Walsh	ANGFA	Victoria
Andy	Wattam	ANGFA	Canberra
Richard	Whittington	University of Sydney	New South Wales
Shane	Willis	Aquarium Industries	Victoria
Dave	Wilson	ANGFA	Northern Territory
Roy	Yanong	University of Florida	USA

Appendix A - Freshwater ornamental finfish listed on the *List of Specimens Suitable for Live Import* (as of March 2008).

Taxon	Common name
Abramites hypselonotus	Marbled Headstander
Acanthophthalmus spp.	Kuhlii Loach
Aequidens maronii	Keyhole
Aequidens pulcher	Blue Acara
Anostomus spp.	Headstander
Aphyocharax spp.	Bloodfin Tetras
Aphyosemeion spp.	Killie Fish
Apistogramma spp.	Dwarf Cichlid
Aplocheilus spp.	Panchax
Apteronotus albifrons	Black Ghost Knife Fish
Apteronotus leptorhynchus	Long Nose Brown Ghost Knifefish
Arnoldichthys spilopterus	Arnold's Characin, Red-eye Characin
Astronotus ocellatus	Oscar
Only Albino form of *Astyanax fasciatus mexicanis "jordani"*	Blind Cave Fish
Aulonocara nyassae of length 5cm and over	African Peacock Cichlid
Aulonocara spp.	African Cichlids
Only male *Bagrichthys hypselopterus*	Black Lancer Catfish
Balantiocheilus melanopterus	Silver Sharkminnow
Barbodes everetti	Clown Barb
Barbodes fasciatus	Striped Barb
Barbodes hexazona	Tiger Barb
Barbodes lateristriga	barb
Barbodes pentazona	Banded Barb
Bedotia geayi	Madagascar Rainbow
Benthochromis tricoti	Benthochromis Tricoti
Betta spp.	Fighting Fish
Boehlkea fredcochui	Chochui's Blue Tetra
Botia lohachata of length 1.5cm and over	Reticulate loach, Yo-yo loach
Botia macracantha	Clown Loach
Brachydanio albolineatus	Pearl Danio
Brachydanio frankei	Leopard Danio
Brachydanio kerri	Kerr's Danio
Brachydanio nigrofasciatus	Spotted Danio
Brachydanio rerio	Zebra Danio
Brachygobius spp.	Bumble Bee Fish
Brochis spp.	Blue Catfish
Brycinus longipinnis	African Tetra
Campylomormyrus cassaicus	double-nose elephant nose
Campylomormyrus rhynchophorus	double-nose elephant nose
Capoeta arulius	Longfin Barb
Capoeta oligolepis	Checker

Freshwater ornamental finfish listed on the *List of Specimens Suitable for Live Import (cont)*

Taxon	Common name
Capoeta partipentazona	Tiger barb
Capoeta semifasciolatus	Golden Barb
Capoeta tetrazona	Tiger barb
Capoeta titteya	Cherry Barb
Carassius auratus	Goldfish
Carnegiella spp.	Hatchet Fish
Only bridles morph *Chalinochromis brichardi* of length 5cm and over	Lake Tanganyika Cichlid
Chalinochromis spp.	Lake Tanganyika Cichlids
Chanda spp.	Perchlets
Chilodus punctatus	Spotted Headstander
Chilotilapia rhoadesii of length 5cm and over	Rhoadesii Cichlid
Cichlasoma nicaraguense of length 5cm and over	Nicaraguan Cichlid
Coelurichthys microlepis	Croaking Tetra
Colisa chuna	Honey Dwarf Gourami
Colisa fasciata	Giant Dwarf Gourami
Colisa labiosa	Thick-lipped Gourami
Colisa lalia	Dwarf Gourami
Copeina Arnoldi	Splash Tetra, Characin, Jumping Tetra
Copeina guttata	Red Spotted Copeina
Corydoras spp.	Armoured Catfish
Only males of Corynopoma riisei	Swordtail Characin
Crenicara filamentosa	Checkerboard Lyretail
Crenicara maculata of length 5cm and over	Checkerboard Cichlid
Cyathopharnx furcifer	Thread Fin Furficer
Cyphotilapia frontosa of length 12cm and over	Frontosa, Humphead cichlid
Cyprichromis leptosoma	Yellowtail Cyprichromis
Cyrtocara moorii	Lake Malawi Cichlid
Danio devario	Bengal danio, Sind danio
Danio malabaricus	Giant danio, Malabar danio
Dekeyseria pulcher of length 1.5cm and over	Clown peckoltia
Dermogenys pusillus	Half Beak
Dianema urostriata	Stripe Tailed Catfish
Epalzeorhynchus kallopterus	Flying Fox
Epalzeorhynchus siamensis	Siamese Flying Fox
Epiplatys spp.	Killie Fish
Eretmodus cyanostictus	Dwarf Goby Cichlid
Eretmodus maculatus	Tangyanikan Clown Cichlid
Esomus malayensis	Flying Barb
Farlowella acus	Twig Catfish
Gasteropelecus spp.	Hatchet Fish
Glossolepis incisus of length 1.5cm and over	Red rainbowfish
Gnathochromis permaxillaris	African cichlid
Gnathonemus macrolepidotus	Elephant nose
Gnathonemus petersi	Elephant nose
Gymnocorymbus ternetzi	Black Widow Tetra
Gyrinocheilus aymonieri	Sucking Asian Catfish

Freshwater ornamental finfish listed on the *List of Specimens Suitable for Live Import (cont)*

Taxon	Common name
Hasemania nana	Silver Tip Tetra
Helostoma rudolfi	Pink Kissing Gourami
Helostoma temminckii	Green Kissing Gourami
Hemigrammopetersius caudalis	Yellow-tail Congo Tetra
Hemigrammus spp.	Tetras
Hemiodopsis sterni	Striped Hemiodopsis
Homaloptera orthogoniata	Indonesian Lizard Fish
Hyphessobrycon spp.	Tetras
Inpaichthys kerri	Blue Emperor Tetra
Iodotropheys sprengerae	African Cichlid
Julidochromis spp.	Dwarf Cichlid
Kryptopterus bicirrhis	Glass Catfish
Kryptopterus macrocephalus	Poormans Glass Catfish
Labeo bicolour	Redtail Shark
Labeo erythrurus	Red Fin Shark
Labeo frenatus	Rainbow Shark
Labeo variegates	Variegated Shark
Laetacara curviceps	Curviceps
Laetacara dorsigerus	Cichlid
Laubuca laubuca	Indian Hatchet Fish
Only male Leiocassis siamensis	Siamese Catfish, Bumble Bee Catfish
Lepidarchus adonis	Flagtail Tetra, Adonis Tetra
Leporinus arcus	Lipstick Leporinus
Leporinus fasciatus	Banded Leporinus
Leporinus maculatus	Spotted Leporinus
Leporinus multifasciatus	Multi-banded Leporinus
Loricaria filamentosa	Whiptail Catfish
Macrognathus aculeatus	Spiny Eel
Only male Macropodus opercularis of length 6cm and over	Paradise Fish
Megalamphodus spp.	Tetras
Melanochromis auratus	Auratus
Melanochromis simulans	auratus
Only non-Albino form of *Mesonauta festivus*	Festivum
Metynnis spp. of length 4cm and over	Silver Dollars
Moenkhausia spp.	Tetras
Monodactylus argenteus	Angel Mono, Malayan Mono, Batfish
Monodactylus sebae	African Mono
Morulius chrysophekadion	Black Shark
Only male *Myleus rubripinnis* of length 8cm and over	Red Hook
Nannacara anomala	Golden Dwarf Acara
Nannacara aureocephalus	Golden Head Cichlid
Nannacara taenia	Dwarf Lattice Cichlid
Nannostomus spp.	Pencil Fish
Nematobrycon spp.	Emperor Tetra
Neolamprologus brichardi	Princess of Burundi

Freshwater ornamental finfish listed on the *List of Specimens Suitable for Live Import (cont)*

Taxon	Common name
Neolamprologus cylindricus	Tanganyikan Cichlid
Only yellow morph of *Neolamprologus leleupi* of length 5cm and over	Lemon Cichlid
Neolamprologus meeli of length 5cm and over	African cichlid
Neolamprologus mustax of length 5cm and over	Mustax, Mask Lamprolagus
Neolamprologus ocellatus of length 5cm and over	African cichlid
Ophthalmotilapia spp.	Blacknosed Threadfin Cichlid
Oryzias latipes	Golden Medaka
Osteochilus hasselti	Bony lipped barb
Osteochilus vittatus	Bony lipped barb
Otocinclus Arnoldi	Sucker Catfish
Oxygaster oxygastroides	Glass Barb
Pantodon buchholzi	Butterfly Fish
Papiliochromis altispinosa	Bolivian Butterfly Cichlid
Papiliochromis ramirezzii	Ram
Paracheirodon axelrodi	Cardinal Tetra
Paracheirodon innesi	Neon Tetra
Paracyprichromis nigripinnis	Blue Neon Cyprichromis
Only male *Parauchenipterus fisheri* of length 7cm and over	Woodcat
Only male *Parosphromenus deissneri* of length 4cm and over	Licorice Gourami
Pelvicachromis pulcher	Kribensis
Pelvicachromis subocellatus	Kribensis
Pelvicachromis taeniatus	Kribensis
Petitella georgiae	False Rummy Nose
Petrochromis trewavasae of length 5cm and over	'Texas' Cichlid, White Spotted Peerchromis
Phenacogrammus interruptus	Congo Tetra
Pimelodella pictus	Pictus Catfish
Pimelodus ornatus	Catfish
Poecilia latipinna	Sailfin Mollie
Poecilia reticulata	Guppy
Poecilia sphenops	Black Mollie
Poecilia velifera	Yucatan Sailfin Mollie
Only male *Poecilocharax weitzmani*	Shining Tetra
Prionobrama filigera	Glass Bloodfin
Pristella maxillaris	Pristella
Pseudogastromyzon myersi	Dwarf Stone Sucker
Pterophyllum spp.	Angel Fish
Puntius asoka	Asoka Barb
Puntius bimaculatus	Two Spot Barb
Puntius conchonius	Rosy Barb
Puntius cumingi	Cummings Barb
Puntius filamentosus	Black Spot Barb
Puntius lineatus	Striped Barb
Puntius nigrofasciatus	Ruby Barb

Freshwater ornamental finfish listed on the *List of Specimens Suitable for Live Import (cont)*

Taxon	**Common name**
Puntius ticto	Ticto Barb
Puntius vittatus	Kooli Barb
Rasbora argyrotaenia	Silver Rasbora
Rasbora borapetensis	Red Tail Rasbora
Rasbora caudimaculata	Red Tail Rasbora
Rasbora dorsiocellata	Emerald Eye Rasbora
Rasbora dusonensis	Yellow Tail Rasbora
Rasbora einthoveni	Blue Line Rasbora
Rasbora elegans	Two Spot Rasbora
Rasbora hengelii	Harlequin rasbora
Rasbora heteromorpha	Harlequin rasbora
Rasbora kalochroma	Clown Rasbora
Rasbora leptosoma	Copper Striped Rasbora
Rasbora maculata	Dwarf Spotted Rasbora
Rasbora pauciperforata	Red Line Rasbora
Rasbora sarawakensis	Sarawak Rasbora
Rasbora steineri	Gold Line Rasbora
Rasbora taeniata	Blue Line Rasbora
Rasbora trilineata	Black Scissortail
Rasbora vaterifloris	Flame Rasbora
Rhodeus amarus	Bitterling
Rhodeus sericeus	Bitterling
Sawbwa resplendens of length 1cm and over	Burmese rummynose
Semaprochilodus insignis	Prochilodus
Semaprochilodus taeniurus	Flagtail Prochilodus
Spathodus erythrodon	Blue Spotted Goby Cichlid
Sphaerichthys osphronemoides	Chocolate Gourami
Only female *Sturisoma panamense* of length 8cm and over	Armoured Catfish
Symphysodon spp.	Discus
Only male *Synodontis decorus* of length 10cm and over	Catfish
Synodontis multipunctatus	African Catfish
Synodontis nigriventris	Upsidedown Catfish
Tanganicodus irsacae	Goby Cichlid
Tanichthys albonubes	White Cloud
Tateurndina ocellicauda	Peacock Gudgeon
Telmatherina ladigesi	Celebes Rainbow
Thayeria spp.	Hockeystick Tetra
Thoracocharax spp.	Hatchet Fish
Toxotes jaculator	Archer
Trichogaster leeri	Pearl Gourami
Trichogaster microlepis	Moonbeam Gourami
Trichogaster trichopterus	Golden Gourami
Trichopsis pumilus	Gourami
Trichopsis vittatus	Gourami
Trinectes maculatus	Flounder

Freshwater ornamental finfish listed on the *List of Specimens Suitable for Live Import (cont)*

Taxon	**Common name**
Triportheus spp.	False Hatchet
Tropheus spp.	African Cichlids
Xiphophorus helleri	Swordtail
Xiphophorus maculatus	Platy
Xiphophorus variatus	Variegated Platy
Yasuhikotakia sidthimunki of length 1.5cm and over	Dwarf botia, Skunk loach

Appendix B - Family Melanotaeniidae - rainbowfish[22],[23]

Name and Author	Common Name(s)	Country/Region	Localities	Environments and Ecology	Water temp (aquar) C	pH (aquar)	Hard-ness[A] (ppm)	Conserv'n status	Food	Size
1. *Cairnsichthys rhombosomoides* (Nichols and Raven, 1928)	Cairns rainbow	Australia	NE Qld: Babinda Ck drainage; Mulgrave River and tributaries; Babinda Creek; Cairns to Tully; Johnstone River system	Fw. Small rainforest creeks and streams, usually in hilly terrain with alternating sections of rapids and rocky pools varying in depth from several cm to 1-3 m. Sometimes sympatric with M. splendida and M. maccullochi	21–25	7.2–7.6	10 -	IUCN: Vulnerable; A1ce, D2:	detritus, zoobenthos (insects)	8.5 cm SL (M); 6.5 (F)
2. Chilatherina alleni Price, 1997	Allen's rainbowfish	Irian Jaya	Trib. of Aiborei R. of the Siriwo drainage, 3°38'S, 136°05'E. Near Nabire, Northern West Papua	Fw	-	-	-	Not on IUCN Red List	-	7-9 cm SL
3. Chilatherina axelrodi Allen, 1979 **Ø**	Axelrod's rainbow	Northern New Guinea	Yungkiri Creek, a tributary of Nemayer or Pual R, in the Bewani Mountains, 6 km N. of Bewani on Vanimo Rd. This is about 40 km inland from Vanimo.	Fw. Usually abundant around sub-surface vegetation, submerged logs, or branches in narrow slow-flowing rainforest streams. Sympatric with C. crassispinosa and M. affinis	24–30	7.5–8	15 –	Not on IUCN Red List	mainly algae	8–11 cm SL (unsexed)

[22] Data compiled from various sources, but mainly Froese and Pauly (2007). The references used for the distribution information is provided at the end of the list of species.

[23] Species names marked with the "**Ø**" symbol are known to have been kept by hobbyists in Australia to 2002. A full key to symbols is provided at the end of this table.

Name and Author	Common Name(s)	Country/Region	Localities	Environments and Ecology	Water temp (aquar) C	pH (aquar)	Hard-ness[A] (ppm)	Conserv'n status	Food	Size
4. Chilatherina bleheri Allen, 1985 **Ø**	Bleher's rainbow	Irian Jaya	Lake Holmes (Danau Biru), lower Mamberamo R. system	Fw. Streams and lakes.	23–28	7.5 –8	140–270	IUCN: Vulnerable A2e	terrestrial and aquatic insects, insect larvae, and small aquatic crustaceans, algae and fallen plant pollens	13 cm SL (unsexed)
5. Chilatherina bulolo (Whitley, 1938) **Ø**	Bulolo rainbowfish	Northern New Guinea	Markham and Ramu river systems; Whege R. where it is crossed by Brahman-Kausi Rd.; tributary of Ramu R., Erap, Snake and Bulolo rivers	Fw; usually found in fast flowing water of rapids or below waterfalls; also streams. Foothill mountain streams with rapid flow and coarse gravel bottoms	22–28	7.5–8.5	-	World Conservation: Data deficient.	small insects, insect larvae and algae	10 cm SL (unsexed)
6. Chilatherina campsi (Whitley, 1957) **Ø**	Highlands rainbowfish	Northern and Southern New Guinea	Markham, Ramu, Sepik and Purari river systems; Madang; Wahgi and Jimi rivers. Sympatric with M. affinis, M. pimaensis and G. maculosus.	Fw; pelagic; clear to turbid streams, 0–10 m deep; mainly in hilly or mountainous terrain,c. 200 to 1525 m elev.	21–26	7.5–7.8	180 -	Not in IUCN Red List	small insects, insect larvae and algae, fallen plant pollen and seeds	8–9 cm SL (unsexed)
7. Chilatherina crassispinosa (Weber, 1913) **Ø**	Silver rainbowfish; stiff-rayed rainbowfish	Northern New Guinea	Tawarin R to Lae; Ramu R system. May be sympatric with C. lorentzi, C. fasciatus and M. affinis	Fw; usually inhabits hilly or mountainous terrain at 100–600 m elev.; streams.	24–30	7.7–8.5	-	Not in IUCN Red List	Small insects such as ants, and algae	13 cm SL (M), 10 cm SL (F)
8. Chilatherina fasciata (Weber, 1913) **Ø**	Barred rainbowfish	Northern New Guinea	Sepik, Ramu, Markham, Lae. Sometimes sympatric with C. crassispinosa and M. affinis	Fw; both in lowland tributaries and in hilly terrain to c. 400–500 m. elev.; streams and lakes, clear and slow-flowing	27–32	7.5–8	-	Not in IUCN Red List	small insects, insect larvae and algae, fallen plant pollen and seeds	14 cm SL (unsexed)

Name and Author	Common Name(s)	Country/Region	Localities	Environments and Ecology	Water temp (aquar) C	pH (aquar)	Hard-ness[A] (ppm)	Conserv'n status	Food	Size
9. Chilatherina lorentzi (Weber, 1907)	Lorentz's rainbowfish	Northern New Guinea	Vanimo, and Sermowai River	Fw. Slow-flowing streams in dense rainforest.	26–30	7.5 –7.8	270	Not in IUCN Red List	-	12 cm SL (unsexed)
10. Chilatherina pricei Allen and Renyaan, 1996	[no common name]	Irian Jaya	Reifafeif River, Yapen Island. Sometimes sympatric with M. japenensis	Fw, demersal, 0–2 m depth, tropical streams; abundant in main channel of Reifafeif R, over rocks or boulders. Forms midwater aggregations	24–26	7.5–8.1	-	Not in IUCN Red List	algae and small invertebrates, mainly insects; also detritus	8.9 cm SL (unsexed)
11. *Chilatherina sentaniensis* (Weber, 1907) **Ø**	Sentani rainbowfish	Northern New Guinea	Mimika River, stream flowing into Lake Sentani. Sympatric with C. fasciata and G. incisus.	Fw, streams and lakes, often turbid and slow-flowing	24–32	6.2–6.8	-	IUCN: Critically endangered, A1ace	-	10 cm SL (unsexed)
12. *Glossolepis dorityi* Allen, 2001	[no common name]	Irian Jaya	Lake Nenggwambu or Kali Biru Lake, 2°30.153'S, 140°09.009'E, Grime R system	Fw	-	-	-	Not in IUCN Red List	-	11.5 cm SL (unsexed)
13. *Glossolepis incisus* Weber, 1907 **Ø**	Red rainbow; salmon-red rainbowfish	Northern New Guinea	Lake Sentani and small creeks around lake; a reported introduction to Philippines	Fw; lake in a hilly area of about 75 m elevation	22–28	7–8	160–340	IUCN: Vulnerable; A2ce	-	14.5 cm SL (M). 12 cm SL (F)
14. *Glossolepis leggetti* Allen and Renyaan, 1998	Leggett's rainbowfish	Northern New Guinea	Wapoga River system of Northern Irian Jaya	Freshwater, inhabits relatively clear, deep and quiet pools.	-	-	-	Not in IUCN Red List	-	9.3 mm SL (unsexed)
15. *Glossolepis maculosus* Allen, 1981 **Ø**	Spotted rainbowfish; black-spotted rainbowfish	Northern New Guinea	Markham and Ramu river systems, PNG	high altitude (150–800 m) swamps, creeks and streams; dense aquatic veget.; clear and slow-flowing creeks	25–28	7.8	215	Not in IUCN Red List	-	6 cm SL (unsexed)
16. *Glossolepis multisquamatus* (Weber and de Beaufort, 1922) **Ø**	Sepik rainbowfish	Northern New Guinea	Idenberg, Mamberamo, Sepik, Ramu river systems	swampy lagoons, lakes and small side channels of large rivers; turbid water. The only known floodplain dwelling	26–30	6.2–6.8	140	Not in IUCN Red List	detritus, phytoplankton, beetles, insects	14 cm SL (M). 10 cm SL (F)

Name and Author	Common Name(s)	Country/Region	Localities	Environments and Ecology	Water temp (aquar) C	pH (aquar)	Hard-ness[A] (ppm)	Conserv'n status	Food	Size
				rainbowfish.						
17. *Glossolepis pseudoincisus* Allen and Cross, 1980	Tami River rainbowfish	Northern New Guinea	isolated oxbow lake near the Tami River, about 23 km SE of Jayapura	Fw; floodplains; turbid water.	-	-	-	Data deficient	-	9.5 cm SL (unsexed)
18. *Glossolepis ramuensis* Allen, 1985 **Ø**	Ramu rainbow	Northern New Guinea	Tributary streams of the Gogol R near Madang; also known from middle Ramu system	Fw. Stream-dwelling, swift-flowing creeks, clear water.	24–27	6–7.5	-	World Conservatio n: Data deficient.	-	7.5 cm SL (unsexed)
19. *Glossolepis wanamensis* Allen and Kailola, 1979 **Ø**	Lake Wanam rainbow	Northern PNG	Lake Wanam, a roughly circular lake situated on a small plateau 24 km west of Lae.	Inhabits a high altitude lake (150 m). Sympatric with C. fasciata.	26–30	7.5–7.8	180	IUCN: Critically endangered. A1ae	-	13 cm SL (unsexed)
20. Iriatherina werneri Meinken, 1974 **Ø**	Threadfin rainbowfish; werneri	Central-Southern NG and Northern Aust (Cape York)	Jardine R, Edward R, Weipa, Qld; Arafura Swamp, Goyder R, NT; Lake Herbert Hoover and Trans-Fly region (PNG). Reported introd to Philippines	Fw. Inhabits lowland swamps, drainage ditches and streams, lagoons, that have abundant vegetation. Common around vegetation margins.	26–30	6–8	90–210	Not in IUCN Red List	micro-crustaceans and diatoms; plants, detritus	4 cm (M); 3.5 cm (F)
21. *Melanotaenia affinis* (Weber, 1907) **Ø**	North New Guinea rainbowfish; red-finned rainbowfish	Northern New Guinea. Three varieties - normal, Pagwi, Bluewater Creek	Lake Sentani, Sepik, Ramu, Gogol, Markham rivers, Lae area	Fw. Clear flowing to still water, vegetated, to 1,500 m elev. Sympatric with several spp of Chilatherina and Glossolepis	25–30	7–8	-	Not in IUCN Red List	-	14 cm SL (M), 12 cm SL (F)
22. *Melanotaenia ajamurensis* Allen and Cross, 1980	Ajamura Lakes rainbowfish	Irian Jaya	known only from Ajamaru Lakes near center of Vogelkop Peninsula	Fw: Inhabits high altitude lakes (250 m)	-	-	-	Data deficient	-	11 cm SL (unsexed)

Name and Author	Common Name(s)	Country/Region	Localities	Environments and Ecology	Water temp (aquar) C	pH (aquar)	Hard-ness[A] (ppm)	Conserv'n status	Food	Size
23. *Melanotaenia angfa* Allen 1990	Yakati rainbowfish; Angfa rainbow	Irian Jaya	known only from 2 tributary streams of Yakati R in middle of narrow isthmus connecting Vogelkop Peninsula with remainder of NG	Fw. in streams in mountainous, rainforest terrain at elevations between 200 and 400 m.; slow to rapid flowing water	24–26	6.5–7.5	-	Data deficient	-	12 cm SL (unsexed)
24. *Melanotaenia arfakensis* Allen 1990 **Ø**	Arfak rainbow	Irian Jaya	known only from tributaries of Prafi River system near Manokwari	Fw. in streams flowing through rainforest and agricultural (mainly oil palm) lands on flat, alluvial plain.	24–28	6.5–7.5	-	IUCN: Vulnerable. A2ce	-	10 cm SL (unsexed)
25. *Melanotaenia australis (Castelnau, 1875)*	Western rainbow	Western rainbow	Australia	Nthn W.A. and N.T.: widespread, throughout Pilbara region betw Ashburton and DeGrey rivers, in Kimberley region betw Fitzroy R and NT border; also NW sector of Timor Sea drainage as far as Adelaide R	Fw and br.w. Lagoons, drying pools, rapids, streams, rivers	6.5–8	Dh (22–28)	-	Not in IUCN Red List	11 cm, SL(M); 8 cm (F)
26. *Melanotaenia batanta* Allen and Renyaan, 1998 **Ø**	Batanta rainbowfish	Irian Jaya	Batanta Island	Fw. Clear, moderately fast-flowing streams	-	-	-	Not in IUCN Red List	-	8.7 cm SL (unsexed)
27. *Melanotaenia boesemani* Allen and Cross, 1980 **Ø**	Boeseman's rainbowfish; bosemani	Irian Jaya	11 cm, SL(M); 8 cm (F)	Fw. inhabit relatively clear shallow water (slow or fast-flowing, with abundant vegetation. The lakes and streams are alkaline.	25–30	6.4–9	90–340	IUCN: Endangered . A1ad	omnivore	9–12.5 cm SL (M), 7 cm SL (F)
28. *Melanotaenia caerulea* Allen 1996	Blue rainbow	Southern PNG	Kikori River system	Fw	-	-	-	Not in IUCN Red List	-	6.2 cm SL (unsexed)
29. *Melanotaenia catherinae* (de Beaufort, 1910) **Ø**	Waigeu rainbowfish	Irian Jaya	Waigeo	Fw. Streams	22–28	6–8.5	20–530	Not in IUCN Red List	-	10 cm SL (M), 8 cm SL (F)

Name and Author	Common Name(s)	Country/Region	Localities	Environments and Ecology	Water temp (aquar) C	pH (aquar)	Hard-ness[A] (ppm)	Conserv'n status	Food	Size
30. *Melanotaenia corona* Allen, 1982	Corona rainbowfish	Irian Jaya	known only from two male specimens collected in 1911 from Sermowai River	Fw. Streams and rivers. Sympatric with *C. crassispinosa*, *C. fasciata*, *C. lorentzi* and *M. affinis*.	-	-	-	Not in IUCN Red List	-	12.5 cm SL (unsexed)
31. *Melanotaenia duboulayi* (Castelnau, 1878)	Duboulay's rainbowfish; Great rainbowfish; crimson-spotted rainbowfish	Australia - colour pattern varies with locality	Northern NSW and Southern Qld: Karangi, Wooli, Lake Minnie waters, Australia range, creeks in and near Brisbane; also Fraser Is. Sympatric with R. ornatus	Fw. In rivers, creeks, drains, ponds, dune lakes and reservoirs. Usually in still or slow-flowing conditions near surface or around vegetation, log snags, or other debris.	23–28	6.5–7.2	-	Not in IUCN Red List but habitat changes are an increasing problem	-	11 cm SL (M), 8 cm SL (F)
32. *Melanotaenia eachamensis* Allen and Cross, 1982	Lake Eacham rainbowfish	Australia	Only in Lake Eacham, a circular crater lake on the Atherton Tableland in N. Qld. Now extinct in Lake Eacham but hanging on in a nearby small crater lake.	Fw. In clear, shallow water along shoreline; in lakes. Often found among aquatic vegetation, fallen logs or branches	24–30	7–7.4	-	IUCN: Vulnerable. A1ace+2ce, B1+2b, C1, D2	-	6.5 cm SL (unsexed)
33. *Melanotaenia exquisita* Allen, 1978	Exquisite rainbowfish	Australia	N.T.: Edith River Gorge, Lake Malkyyllumbo, upper South Alligator R system, Moline Pool (Mary R system), Edith R, Daly R system, Pine Ck; King George River (WA)	Fw. Steep gradient streams with many cascades and normally crystal clear water. Lakes and streams. Tends to congregate in rapid flow of pools at base of small waterfalls; also in quieter sections of streams and lakes. Prefers areas fully exposed to sunlight. Sympatric with *M. splendida australis*	24–30	-	-	World Conservation: Data deficient.	mainly on aquatic and terrestrial insects, insect larvae, green algae, detritus, phytoplankton	7.5 cm SL (M), 6 cm SL (F)

Name and Author	Common Name(s)	Country/Region	Localities	Environments and Ecology	Water temp (aquar) C	pH (aquar)	Hard-ness[A] (ppm)	Conserv'n status	Food	Size
34. *Melanotaenia fluviatilis* (Castelnau, 1878)	Australian rainbow; Pink ear; Murray-Darling rainbow; crimson-spotted rainbow, Murray River rainbow	Australia	SE Qld, NSW, Vic: Fraser Island Lake, Namoi River, Bokhara River; Murray River at Renmark	Fw. In rivers, creeks, drains, ponds, reservoirs. Usually in still or slow-flowing conditions	10–25	7 -	180 -	Not in IUCN Red List	Omnivorous	11 cm SL (M), 8 cm SL (F)
35. *Melanotaenia fredericki* (Fowler, 1939) **Ø**	Sorong rainbowfish	Irian Jaya	Sainkedoek - creeks in Sorong district and Sampson R, Vogelkopf Peninsula	Fw. Streams	24–28	6.5–7.5	-	Not in IUCN Red List	-	12 cm SL (unsexed)
36. *Melanotaenia goldiei* (Macleay, 1883) **Ø**	Goldie River rainbowfish; gold-line rainbow	Southern New Guinea	Alkmaar, Lorentz R, Goldie R, Brown R, Selcanto R, Laloki R, Goldie R, Toro Pass, Strickland Junction, Kiunga, Siniam Creek, Wai Ketu, Elevala R ENE of Kiunga, Kubuna R, Black R, Palmer R, upper Fly R, Rentoul R off Strickland R, Bamer R, Etna Bay. Also Aru Islands	Fw. Inhabits swamps, backwaters, tributary streams and large rivers; often clear streams. Sympatric with *M. papuae* and *M. splendida rubrostriata*.	25–28	7–7.8	180 -	Not in IUCN Red List	-	14 cm SL(M), 10 cm SL (F)
37. *Melanotaenia gracilis* Allen, 1978	Slender rainbow	Australia	nth W.A.: Drysdale and King Edward river systems, Kimberleys, King George R	Fw. Lakes and streams; in large water courses and isolated rocky pools generally bordered with paperbark trees, having clear waters and minimal flow during dry seasons. Sympatric with *M. splendida australis*	22–28	6.8–7	180	[No comment on status]	insects, insect larvae, small crustaceans, algae, plants, detritus	7.5 cm SL(M). 6.5 cm SL (F)

Name and Author	Common Name(s)	Country/Region	Localities	Environments and Ecology	Water temp (aquar) C	pH (aquar)	Hard-ness[A] (ppm)	Conserv'n status	Food	Size
38. *Melanotaenia herbertaxelrodi* Allen, 1981 **Ø**	Lake Tebera rainbowfish	Southern New Guinea	Lake Tebera basin, Southern Highlands. One individual collected at Karamui, 38 km N of Lake Kutubu; Purari R system. Reported from Madang area (misident?)	Fw. Inhabits highland lakes and streams (793 m) surrounded by steep mountains (1200-1500 m elev.). Clear water, vegetation.	20–27	7–8	180 –	Data deficient.	-	12–13 cm SL (unsexed)
39. *Melanotaenia irianjaya* Allen, 1985 **Ø**	Irian Jaya rainbowfish	Irian Jaya	River systems draining into Bintuni Bay; also Bomberai Peninsula.	Fw. Occurs in rainforest creeks and small rivers; slightly turbid to clear, slow or moderately fast flowing	27–28	7–8	270 -	Not in IUCN Red List	-	11 cm (unsexed)
40. *Melanotaenia iris* Allen, 1987	Strickland River rainbowfish	Southern New Guinea	Known from 5 individuals collected from near Wankipe on Logatyu R, a mountain trib of Strickland R	Fw. Collected in a mountain tributary at 1200 m elevation about 850 km from sea; streams.	-	-	-	Not in IUCN Red List	-	12 cm SL (unsexed)
41 *Melanotaenia japenensis* Allen and Cross, 1980	Yapen rainbowfish	Irian Jaya	Yapen Island	Fw rainforest streams, clear water. Sympatric with a Chilatherina species.	24–28	7–8	-	Not in IUCN Red List	-	11 cm SL (unsexed)
42. *Melanotaenia kamaka* Allen and Renyaan, 1996 **Ø**	Kamaka rainbowfish	Irian Jaya	Lake Kamaka	Fw. Lakes.	-	-	-	Not in IUCN Red List	-	6.1 cm SL (unsexed)
43. *Melanotaenia lacustris* Munro 1964 **Ø**	Lake Kutubu rainbowfish	Southern New Guinea	Lake Kutubu and its outlet, the Soro River, in Kikori R system, Southern Highlands; 800 m elev.	Fw. a highland lake and its outlet about 220 km upstream from the Gulf of Papua; vegetated cover	20–27	7–8	160–220	IUCN: Vulnerable. A1ac	-	12 cm (unsexed)
44. *Melanotaenia lakamora* Allen and Renyaan, 1996 **Ø**	Lakamora rainbowfish	Irian Jaya	Lake Lakamora, 3°41'S, 134°17'E, and nearby Lake Aiwaso.	Fw. 210 m elevation	-	-	-	Not in IUCN Red List	-	5.5 cm SL (unsexed)

Name and Author	Common Name(s)	Country/Region	Localities	Environments and Ecology	Water temp (aquar) C	pH (aquar)	Hard-ness[A] (ppm)	Conserv'n status	Food	Size
45. *Melanotaenia maccullochi* Ogilby, 1915 **Ø**	McCulloch's rainbowfish; dwarf rainbowfish	SW PNG and NE Aust	lower and middle sections of Fly R westward to Bensbach R, Lake Herbert Hoover, Cairns, Cape York – McIvor R, Daintree	Fw and br.w. Lowland swamps and small streams, usually in clear, acidic waters with ample cover in the form of log debris or aquatic vegetation	24–30	6.5–7.5	180 -	Not in IUCN Red List	-	6–7 cm SL (unsexed)
46. *Melanotaenia maylandi* Allen, 1983	Mayland's rainbowfish	Irian Jaya	small creek 2–3 km from Danau Biru (Lake Holmes, lower Mamberamo R system.	Fw. Small creek in hilly terrain at 450 m elev., dense closed-canopy rainforest.	26	7.2	180	Not in IUCN Red List	omnivore	13 cm SL (unsexed)
47. *Melanotaenia misoolensis* Allen, 1982 **Ø**	Misool rainbowfish	Irian Jaya	tributary of Tama R at Fakal, Misool Island; also Batanta Island	Fw. Clear jungle streams.	22–28	6–8.5	20–530	Not in IUCN Red List	-	8 cm SL (unsexed)
48. *Melanotaenia monticola* Allen, 1980 **Ø**	Mountain rainbowfish	Southern New Guinea	Mendi, Lake Kutubu, Purari R system, Omei Ck, streams near Pimaga (13 km SE of Lake Kutubu),.trib of Ka R nr Mendi.	Fw. High altitude headwater tributaries at 790–1600 m elevations; clear, swift-flowing creeks.	18–22	7–8	280	World Conservation: Data deficient	omnivore	10 cm SL (unsexed)
49. *Melanotaenia mubiensis* Allen, 1996	Mubi rainbowfish	Southern New Guinea	Kikori River system	Fw. Inhabits narrow, crystal clear streams in closed-canopy forest, flowing through limestone hills	-	-	-	Not in IUCN Red List	-	9.3 cm SL (unsexed)

Name and Author	Common Name(s)	Country/Region	Localities	Environments and Ecology	Water temp (aquar) C	pH (aquar)	Hard-ness[A] (ppm)	Conserv'n status	Food	Size
50. *Melanotaenia nigrans* (Richardson, 1843)	Black-banded rainbowfish; Australian rainbow; red-tailed rainbow	Australia	NT and Qld. Katherine, Oenpelli Ck and billabong, ck NW of Cape Arnhem, Upper Manton R, mouth of billabong on NE of Groote Eylandt, Lilly Lagoon, SE Qld, Moonie R, Olive R, Temple Bay, Cape York Peninsula, Flying Fox Ck, George Ck S of Adelaide River, trib of Jardine R	Fw and br.w. Rainforest streams, lily lagoons, and small and large streams, also backwaters or in bracksih waters along shoreline where flow is minimal, grassy veget. Sympatric with *M. splendida*, *M. maccullochi*, *M. trifasciata*, *I. werneri*	18–24	5.2–7.5	180 -	Not in IUCN Red List	aquatic and terrestrial insects, insect larvae, filamentous green algae.	10 cm SL (unsexed)
51. *Melanotaenia ogilbyi* (Weber, 1910)	Ogilby's rainbowfish	Southern New Guinea	Lower Lorentz R (7 individuals) at Sabang.	Fw, in Pandanus swamps	-	-	-	World Conservation: Data deficient	-	7 cm SL (unsexed)
52. *Melanotaenia oktediensis* Allen and Cross, 1980 **Ø**	Ok Tedi rainbowfish	Southern New Guinea	Ok Tedi, Ok Menga, Tabubil, Ningerum, Karamonge Ck, also other tributaries; upper Fly River system	Fw. In mountain streams of 300–500 m elevation, 900–950 km from sea	17–26	7.3–8.7	210	IUCN: Vulnerable. A2ce	omnivorous	12 cm SL (unsexed)
53. *Melanotaenia papuae* Allen, 1981 **Ø**	Papuan rainbowfish	Southern PNG	in numerous streams within 35 km radius of Port Moresby; Brown R, Laloki R	Fw. In small rainforest creeks. May be sympatric with *M. goldiei*.	22–32	7.2–7.8	180 -	Not in IUCN Red List	omnivorous	8 cm SL (M); 6 cm SL (F)
54. *Melanotaenia parkinsoni* Allen, 1980 **Ø**	Parkinson's rainbowfish	Southern PNG	Between Kemp Welch R and Milne Bay	Fw. In rainforest streams in lowland areas	26–30	7.5–7.8	140 -	Not in IUCN Red List	-	13 cm SL(M); 11 cm SL(F)
55. *Melanotaenia parva* Allen, 1990	Lake Kuromoi Rainbowfish	Irian Jaya	Lake Kurumoi, Vogelkop Peninsula	Fw. In Lake Kurumoi, in Yakati R watershed (is below level of its natural outlet w/o a visible drainage) in mountainous terrain, 400 m elevation	-	-	-	IUCN: Vulnerable. A2ce	-	4.5–5.5 cm SL (unsexed)

Name and Author	Common Name(s)	Country/Region	Localities	Environments and Ecology	Water temp (aquar) C	pH (aquar)	Hard-ness[A] (ppm)	Conserv'n status	Food	Size
56. *Melanotaenia pierucciae* Allen and Renyaan, 1996 **Ø**	Pierucciae's rainbowfish	Irian Jaya	Werfyang Ck near Lake Kamakawaiar, 3°42.6'S, 134°11.7'E	Fw. 110 m elev	-	-	-	Not in IUCN Red List	-	5.9 cm SL (unsexed)
57. *Melanotaenia pimaensis* Allen, 1981	Pima River rainbowfish	Southern New Guinea	Pima R at junction with Tua R, Purari R system, Southern Highlands; Karamui, Eastern Highlands	Fw. In headwater mountainous streams with an elevation of more than 800 m in a relatively broad (1 km width) valley	26	7.5	180	World conservatio n: Data Deficient	-	6–10 cm SL (unsexed)
58. *Melanotaenia praecox* (Weber and de Beaufort, 1922) **Ø**	Dwarf rainbowfish; Neon rainbowfish	Northern New Guinea	Mamberamo R, Pioniersbivak, tributary of Uge Stream, Mamberamo R near Dar; Markham R, Lae	Fw. Clear, swift-flowing sreams.	22–28	6.5–7	-	Data deficient	-	5–6 cm SL (unsexed)
59. *Melanotaenia pygmaea* Allen, 1978	Pygmy rainbowfish	Australia	Northern W.A.: Youwanjela Ck and Cascade Ck, both tributaries of Prince Regent R	Fw. In fast flowing streams with frequent cascades or rapids. Usually in deeper pools, often at base of waterfalls with v clear water, a solid rock bottom and little or no veget cover	24–28	6.8–7.2	-	[No comment on status]	-	5 cm SL(M); 3.5 cm SL(F)
60. *Melanotaenia rubripinnis* Allen and Renyaan, 1998	Red-finned rainbowfish	Irian Jaya	Trib. of Tiawiwa R, Wapoga River system	Fw. Rel. common, variety of habitats: tannin-stained cks in lowland rainforest, larger streams in open areas, quiet shaded pools, sunlit sections of large and fast-flowing mountain streams; to about 400 m elev.	-	-	-	Not in IUCN Red List	-	10.2 cm SL (unsexed)

Name and Author	Common Name(s)	Country/Region	Localities	Environments and Ecology	Water temp (aquar) C	pH (aquar)	Hard-ness[A] (ppm)	Conserv'n status	Food	Size
61. *Melanotaenia sexlineata* (Munro, 1964) **Ø**	Fly River rainbowfish; six-lined rainbowfish	Southern New Guinea	Few sites in upper Fly R system - near Kiunga, upstream from mouth of Elevala R; also Laloki R drainage, Rouna, Brown R drainage, Koiari, creek on Sogeri Rd, Sapphire Ck	Fw. Generally in small rainforest creeks, clear water.	24–27	7–7.5	140	Data deficient	omnivorous	7 cm SL (unsexed)
62. *Melanotaenia solata* Taylor, 1964	Emerald River rainbowfish	Australia	N.T.: Emerald R., about 6 km from river mouth; also Arnhem Land; Groote Eylandt and Bickerton Island	Fw.	-	-	-	[No comment on status]	-	-
63. *Melanotaenia splendida inornata* (Castelnau, 1875)	Chequered rainbowfish	Australia	N.T. east of Mary R and streams flowing into Gulf of Carpentaria, incl rivers and streams of western Cape York Peninsula, to Jardine R; also Prince of Wales and Badu islands in Torres Strait; also Oenpelli, Cloncurry R, Arnhem Land	Fw. Turbid waters, particularly on floodplains; also in clear streams	25–28	-	-	Not in IUCN Red List	green algae	12 cm (unsexed)
64. *Melanotaenia splendida rubrostriata* (Ramsay and Ogilby, 1886) **Ø**	Red-striped rainbowfish	Southern New Guinea; Australia	Aramia River to Etna Bay, also Aru Islands and Daru Island in Torres Strait; Fly R, Ok Mart, Lake Murray, Strickland R, Ok Tedi, Lake Boset, Fly R. Old Aust records: Cairns and Muttabarra, central Qld	Fw. Swamps to rivers, clear to turbid water, densely vegetated areas; also in lakes, dams.	24–28	5.6–7.4	-	Not in IUCN Red List	-	15 cm SL(M); 13 cm SL(F)

Name and Author	Common Name(s)	Country/Region	Localities	Environments and Ecology	Water temp (aquar) C	pH (aquar)	Hard-ness[A] (ppm)	Conserv'n status	Food	Size
65. *Melanotaenia splendida splendida* (Peters, 1866)	Splendid rainbowfish; easten rainbowfish; Kap-York rainbowfish; 'Kuranda'	Australia. Distinct colour forms from different river systems	Qld and NSW. river systems E. of Great Dividing Range from vicinity of Gladstone (Boyne R) north to eastern watershed of Cape York Peninsula; also JimJim Ck NT, Fitzroy, de Grey, Fortescue rivers (WA), Mary R, Oenpelli, Whistleduck Ck; also upper Fly R, PNG	Fw. Inhabits streams and lakes, often forming large schools at surface; water clear to turbid. Sometimes sympatric with *M. maccullochi*, *M. trifasciata*, *C. rhombosomoides.*	20–29	5.3–8.5	-	Not in IUCN Red List	detritus, phytoplankton, insects, other plants	11–20 cm SL (unsexed)
66. *Melanotaenia splendida tatei* (Zietz, 1896)	Desert rainbowfish	Australia	NT and Qld: Hermannsburg, Finke R, w of Alice Springs, Georgina R nr Camooweal	Fw and brackish w. Drying pools, streams, artesian bores, reservoirs	20–30	6–8	530	Not in IUCN Red List	-	10 cm SL (unsexed)
67. *Melanotaenia sylvatica* Allen, 1997	-	Southern New Guinea	Sapoi River, Lake Kamu basin	Fw. approx. 40 m. elev, in clear and slow-flowing water, with mud-sandy bottom	-	-	-	Not in IUCN Red List	-	5.5 cm SL (unsexed)
68. *Melanotaenia trifasciata* (Rendahl, 1922)	Banded rainbowfish; jewel rainbowfish; three-striped rainbow; 'Wonga Creek'; 'Goyder River'	Australia. Many (about 20) geographic and river colour varieties.	NT and Qld: Mary R, Pine Ck, Wenlock R, Coen R, Dalhunty Ck, North Claudie R, Cape York. Melville Island (NT) to south of Cooktown (Qld). Sometimes sympatric with *M. maccullochi*, *M. splendida inornata*, *I. werneri*	Fw. Mainly in small streams and waterholes in clear to mod turbid water; over rocky or gravel bottoms or in well-vegetated areas, freq around submerged logs and branches	24–30	5.2–8	160–340	Not in IUCN Red List	omnivore	11 cm SL (M); females smaller

Name and Author	Common Name(s)	Country/Region	Localities	Environments and Ecology	Water temp (aquar) C	pH (aquar)	Hard-ness[A] (ppm)	Conserv'n status	Food	Size
69. *Melanotaenia utcheensis* McGuigan, 2000	-	Australia	Utchee C, North Johnstone R, 17°38'30"S, 145°56'20"E.	Fw.	-	-	-	Not in IUCN Red List	-	-
70. *Melanotaenia vanheurni* (Weber and de Beaufort, 1922)	Van Heurn's rainbowfish	Northern New Guinea	Idenburg (now Taritatu) and Doorman rivers, small creeks and larger tributaries of Mamberamo Basin.	Fw. Clear streams in rainforest areas; slow to swift-flowing water. Sympatric with *C. fasciata.*	25–28	7.1–75	-	World Conservatio n: Data deficient	-	20 cm SL(M); 15 cm SL(F)
71. *Pelangia mbutaensis* Allen, 1998	-	Irian Jaya	Lake Mbuta Basin (3°58.1'S, 134°57.4'E), ca. 8 km northwest of Etna Bay, to 1.5 m.	Fw.	-	-	-	Not in IUCN Red List	-	4 cm SL (unsexed)
72. *Rhadinocentrus ornatus* (Regan, 1914)	Ornate rainbowfish	Australia	Nthn NSW and sthn Qld: Karangi, Fraser Island, Stradbroke Island, Peregian Beach near Lake Weyba, Moreton Island	Fw. In coastal streams and often found in stagnant pools or streams with little or no flow.	20–30	5.4–6.5	70–140	Not on IUCN Red List	insects, aquatic larvae, microcrustac eans, algae	5-6 cm SL(M), 3.5 cm SL (F)

Supporting references for rainbowfish distribution

Species	**Distribution Information**
Cairnsichthys rhombosomoides (Nichols and Raven, 1928)	Froese and Pauly (2007), Allen, 1989; Allen, Midgley and Allen (2002)
Chilatherina alleni Price, 1997	Froese and Pauly (2007), Eschmeyer (2006)
Chilatherina axelrodi Allen, 1979	Froese and Pauly (2007), Allen (1991)
Chilatherina bleheri Allen, 1985	Froese and Pauly (2007), Allen (1991)
Chilatherina bulolo (Whitley, 1938)	Froese and Pauly (2007), Allen (1991), Munro (1967); CAS specimens, Munro (1967)
Chilatherina campsi (Whitley, 1957)	Froese and Pauly (2007), Allen (1991), Munro (1967), Kailola (1975), Kailola (1987); USNM and AMNH specimens
Chilatherina crassispinosa (Weber, 1913)	Froese and Pauly (2007), Allen (1991), Kailola (1987), USNM and CAS specimens
Chilatherina fasciata (Weber, 1913)	Froese and Pauly (2007), Allen (1991), Kailola (1987), USNM, CAS and AMNH specimens
Chilatherina lorentzi (Weber, 1907)	Froese and Pauly (2007), Allen (1991), Kailola (1987), AMNH and MNH specimens
Chilatherina pricei Allen and Renyaan, 1996	Froese and Pauly (2007), Allen and Renyaan (1996), Eschmeyer (2006)
Chilatherina sentaniensis (Weber, 1907)	Froese and Pauly (2007), Allen (1991), CAS, MNH specimens
Glossolepis dorityi Allen, 2001	Froese and Pauly (2007), Allen (2001)
Glossolepis incisus Weber, 1907	Froese and Pauly (2007), Allen (1991), ASAP (1993), Munro (1967); MNH specimens
Glossolepis leggetti Allen and Renyaan, 1998	Froese and Pauly (2007), Eschmeyer (2006)
Glossolepis maculosus Allen, 1981	Froese and Pauly (2007), Kailola (1987), Allen (1991)
Glossolepis multisquamatus (Weber and de Beaufort, 1922)	Froese and Pauly (2007), Allen (1991), Coates (1990), Kailola (1987), Munro (1967)
Glossolepis pseudoincisus Allen and Cross, 1980	Froese and Pauly (2007), Allen (1991), Eschmeyer (2006). Known only from the type locality: an isolated oxbow lake near the Tami River, about 23 km S-E of Jayapura, Irian Jaya.
Glossolepis ramuensis Allen, 1985	Froese and Pauly (2007), Allen (1991), CAS specimens
Glossolepis wanamensis Allen and Kailola, 1979	Froese and Pauly (2007), Allen (1991), Kailola (1987), Allen and Kailola (1979)
Iriatherina wernerii Meinken, 1974	Froese and Pauly (2007), Allen (1991), Kailola (1987), ASAP (1993), Kailola (1975), Allen, Midgley and Allen (2002) Record of introduction to Philippines follows ASAP (1993) – cited in Froese and Pauly (2007)
Melanotaenia affinis (Weber, 1907)	Froese and Pauly (2007), Allen (1991), Kailola (1987), Eschmeyer (2006), Munro (1967); also CAS, USNM, MNH etc specimens
Melanotaenia ajamurensis Allen and Cross, 1980	Froese and Pauly (2007), Allen (1991)
Melanotaenia angfa Allen 1990	Froese and Pauly (2007), Allen (1991)

Species	Distribution Information
Melanotaenia arfakensis Allen, 1990	Froese and Pauly (2007), Allen (1991)
Melanotaenia australis (Castelnau, 1875)	Froese and Pauly (2007), Allen, Midgley and Allen (2002), Allen (1989)
Melanotaenia batanta Allen and Renyaan, 1998	Froese and Pauly (2007), Eschmeyer (2006)
Melanotaenia boesemani Allen and Cross, 1980	Froese and Pauly (2007), Allen (1991), ASAP (1993)
Melanotaenia caerulea Allen 1996	Froese and Pauly (2007), Eschmeyer (2006), Allen (1996)
Melanotaenia catherinae (de Beaufort, 1910)	Froese and Pauly (2007), Eschmeyer (2006), Allen (1991)
Melanotaenia corona Allen, 1982	Froese and Pauly (2007), Eschmeyer (2006), Allen (1991). Only known from type material collected from Sermowai River.
Melanotaenia duboulayi (Castelnau, 1978)	Froese and Pauly (2007), Allen, Midgley and Allen (2002), Allen (1989)
Melanotaenia eachamensis Allen and Cross, 1982	Froese and Pauly (2007), Allen, Midgley and Allen (2002), Allen (1989), Crowley and Ivantsoff (1991) The type locality of this species is Lake Eacham, a circular crater lake on the Atherton Tablelands. Now extinct in Lake Eacham but "widespread in localities on the Tablelands between the Barron and South Johnstone river systems" (Allen, Midgley and Allen, 2002: 148; also Crowley and Ivantsoff, 1991).
Melanotaenia exquisita Allen, 1978	Froese and Pauly (2007), Allen, Midgley and Allen (2002), Allen (1989)
Melanotaenia fluviatilis (Castelnau, 1878)	Froese and Pauly (2007), Allen, Midgley and Allen (2002), Allen (1989)
Melanotaenia fredericki (Fowler, 1939)	Froese and Pauly (2007), Eschmeyer (2006), Allen (1991). Known only from type material collected from Vogelkopf Peninsula.
Melanotaenia goldiei (Macleay, 1883)	Froese and Pauly (2007), Eschmeyer (2006), Allen (1991) Kailola (1987), Munro (1967), Kailola (1975); AMNH, MNH specimens
Melanotaenia gracilis Allen, 1978	Froese and Pauly (2007), Allen, Midgley and Allen (2002), Allen (1989)
Melanotaenia herbertaxelrodi Allen, 1981	Froese and Pauly (2007), Eschmeyer (2006), Allen (1991) Kailola (1987); AMNH, MNH specimens..
Melanotaenia irianjaya Allen, 1985	Froese and Pauly (2007), Allen (1991).
Melanotaenia iris Allen, 1987	Froese and Pauly (2007), Allen (1991), Kailola (1991), Eschmeyer (2006).
Melanotaenia japenensis Allen and Cross, 1980	Froese and Pauly (2007), Allen (1991), Eschmeyer (2006). Known only from type locality.
Melanotaenia kamaka Allen and Renyaan, 1996	Froese and Pauly (2007), Eschmeyer (2006). Known only from type locality.
Melanotaenia lacustris Munro 1964	Froese and Pauly (2007), Allen (1991), Kailola (1987), Munro (1967), Kailola (1975); MNH specimens. Froese and Pauly note a record from Natal in South Africa, which is clearly beyond the range of the species.
Melanotaenia lakamora Allen and Renyaan, 1996	Froese and Pauly (2007), Eschmeyer (2006). Known only from type locality.

Species	Distribution Information
Melanotaenia maccullochi Ogilby, 1915	Froese and Pauly (2007), Allen, Midgley and Allen (2002), Allen (1989), Allen (1991), Kailola (1987); CAS, USNM and MNH specimens
Melanotaenia maylandi Allen, 1983	Froese and Pauly (2007), Allen (1991)
Melanotaenia misoolensis Allen, 1982	Froese and Pauly (2007), Allen (1991).
Melanotaenia monticola Allen, 1980	Froese and Pauly (2007), Allen (1991), Kailola (1987).
Melanotaenia mubiensis (Allen, 1996)	Froese and Pauly (2007), Allen (1996), Eschmeyer (2006)
Melanotaenia nigrans (Richardson, 1843)	Froese and Pauly (2007), Allen, Midgley and Allen (2002), Allen (1989). The Froese and Pauly information is: AMNH – 20 km south of Bamaga, tributary of Jardine River, Qld; George Creek, 15 km south of Adelaide River, NT; Flying Fox Creek, Highway crossing on Arnhem Highway; Katherine, Katherine River. MNH - Olive River, Temple Bay, York Peninsula, Qld; Moonie River, Qld; St. George district, Southern Qld. USNM – Emerald River at old mission site, Groote Eylandt, N.T., about 100 m above road bridge, 200 m below falls; Lilly lagoon next to Barramundi Creek, NT; Upper Manton River near Darwin; Billabong on Fred Gray's camp, near NE end of Groote Eylandt, Gulf of Carpentaria; Oenpelli Creek about 6 km ESE of Oenpelli, NT; Little lagoon, Groote Eylandt, NT; 12 miles WSE of Darwin, creek at Delissaville Aboriginal Station, tributary of Woods Inlet, NT; Fish Creek about 12 miles east of Oenpelli, c. 130 miles E of Darwin, Arnhem Land, NT; Creekt at Yirrhala Mission, NW of Cape Arnhem, Arnhem Land. However, Allen, Midgley and Allen (2002) do not record this species from Southern Queensland either – probably records from that area represent misidentifications. Allen, Midgley and Allen (2002) state that the species occurs in Northern WA, Groote Eylandt and Northern Cape York Peninsula (QLD) and some islands in the Torres Strait.
Melanotaenia pygmaea Allen, 1974	Froese and Pauly (2007), Allen, Midgley and Allen (2002), Allen (1989)
Melanotaenia ogilbyi (Weber, 1910)	Froese and Pauly (2007), Munro (1967), Allen (1991), Eschmeyer (2006)
Melanotaenia oktediensis Allen and Cross, 1980	Froese and Pauly (2007), Allen (1991), Kailola (1987), USNM specimens.
Melanotaenia papuae Allen, 1981	Froese and Pauly (2007), Allen (1991), Kailola (1987); USNM and AMNH specimens.
Melanotaenia parkinsoni Allen, 1980	Froese and Pauly (2007), Allen (1991), Kailola (1987)
Melanotaenia parva Allen, 1990	Froese and Pauly (2007), Allen (1991), Eschmeyer (2006). Known only from the type locality.
Melanotaenia pierucciae Allen and Renyaan, 1996	Froese and Pauly (2007), Eschmeyer (2006). Known only from the type locality.
Melanotaenia pimaensis Allen, 1981	Froese and Pauly (2007), Allen (1991), Kailola (1987).
Melanotaenia praecox (Weber and de Beaufort, 1922)	Froese and Pauly (2007), Allen (1991), Kailola (1987), Munro (1967); USNM specimens
Melanotaenia pygmaea Allen, 1978	Froese and Pauly (2007), Allen, Midgley and Allen (2002), Allen (1989). Known only from type locality.
Melanotaenia rubripinnis Allen and Renyaan, 1998	Froese and Pauly (2007), Eschmeyer (2006). Known only from type locality.
Melanotaenia sexlineata (Munro, 1964)	Froese and Pauly (2007), Munro (1967), Kailola (1975), Kailola (1987), Allen (1991); USNM specimens

Species	Distribution Information
Melanotaenia solata Taylor, 1964	Allen, Midgley and Allen (2002), Allen (1989)
Melanotaenia splendida inornata (Castelnau, 1875)	Allen, Midgley and Allen (2002), Allen (1989), Froese and Pauly (2002); USNM specimens
Melanotaenia splendida rubrostriata (Ramsay and Ogilby, 1886).	Froese and Pauly (2007), Allen (1991), Kailola (1987). Australian records (from Cairns and Muttabarra, central Qld) are based on material in the USNM, identified by Ian Munro; probably they are misidentifications.
Melanotaenia splendida splendida (Peters, 1866)	Froese and Pauly (2007), Allen (1989), Allen, Midgley and Allen (2002). The two New Guinea records of this species are based on specimens in the AMNH. On closer enquiry it transpires that GRA examined this material recently and determined that the material represented *M. splendida rubrostriata*. It may be true that the two subspecies "look identical", but without undertaking a thorough genetic study whether or not they actually are identical cannot be confirmed.
Melanotaenia splendida tatei (Zietz, 1896)	Froese and Pauly (2007), Allen (1989), Allen, Midgley and Allen (2002); USNM and MNH specimens
Melanotaenia sylvatica Allen, 1997	Allen (1997), Froese and Pauly (2007), Eschmeyer (2006). Known only from type locality.
Melanotaenia trifasciata (Rendahl, 1922)	Froese and Pauly (2007), Allen (1989), Allen, Midgley and Allen (2002).
Melanotaenia utcheensis McGuigan, 2000	McGuigan (2000), Eschmeyer (2006)
Melanotaenia vanheurni (Weber and de Beaufort, 1922)	Froese and Pauly (2007), Eschmeyer (2006), Allen (1991), Munro (1967).
Pelangia mbutaensis Allen, 1998	Froese and Pauly (2007), Eschmeyer (2006).
Rhadinocentrus ornatus (Regan, 1914)	Froese and Pauly (2007), Allen (1989), Allen, Midgley and Allen (2002).

Key to symbols used in tables

Ø	-	Known to have been kept by hobbyists in Australia to 2002.
A	-	Aquarium
AMNH	-	American Museum of Natural History
CAS	-	California Academy of Sciences
Ck	-	Creek
Fw	-	Freshwater
GRA	-	Gerald R. Allen
IUCN	-	The International Union for the Conservation of Nature and Natural Resources
MNH	-	British Museum (Natural History), London
R	-	River
SL	-	Standard Length
USNM		United States National Museum, Smithsonian Institution

Appendix C - Diseases that will not be considered further with respect to the potential importation of rainbowfish

AGENT	COMMENT	SOURCE
VIRUSES		
Angelfish herpesvirus	Not identified in rainbowfish Rare and only reported in Angelfish (*Pterophyllum scalare*) Stress related and not reported to be fatal	Mellergaard and Bloch (1988) as cited in Hine and Diggles (2005) pg 30
Apistogramma virus	Not identified in rainbowfish Iridovirus reported only in Ram Cichlids - last reported 1980 Other Iridoviruses are covered separately in the "diseases to be further considered" Section	Leibovitz and Riis (1980) as cited in Hine and Diggles (2005) pg 61
Aquabirnavirus group – including Infectious pancreatic necrosis virus (IPN)	Minimal risk under 1999 IRA Broad host range affecting at least 20 fish families including purely freshwater species of fish – mainly temperate. Susceptibility of rainbowfish unknown	AQIS (1999a) pg 40 and 65-69
Aquareovirus	Not identified in rainbowfish Generally not associated with disease	Roberts (2001) as cited in Hine and Diggles (2005) pg 30
Goldfish haematopoietic necrosis virus (herpesvirus)	Not identified in rainbowfish Recorded only in goldfish (*Carassius auratus*) Carp (*Cyprinus carpio*) are not susceptible See notes re Goldfish in general	Jung and Miyazaki (1995) as cited in AQIS (1999a) pg 40
Herpesvirus cyprinid	Not identified in rainbowfish Likely to not be a serious pathogen - latent and stress-related infection hence reason for elimination from 1999 Australian IRA	AQIS (1999a) pg 42
Infectious haematopoietic necrosis virus (IHNV)	Currently not identified in rainbowfish – susceptibility unknown Rhabdovirus - Salmonid disease - OIE Listed Species infected not related to family Melanotaeniidae (though species in this family, particularly *M. fluviatilis*, have not been challenged with virus to assess suscepibility).	AQIS (1999a) pp 41-42

Appendix C - Diseases that will not be considered further with respect to the potential importation of rainbowfish (cont.)

AGENT	COMMENT	SOURCE
VIRUSES (cont.)		
Iridovirus group (Ranaviruses and Tropiviruses) This group is currently under review by Biosecurity Australia (Reference Draft Iridovirus IRA)	Not identified in rainbowfish and no reports of rainbowfish being infected during reported outbreaks. Includes Epizootic Haematopoietic Necrosis (EHN) which is OIE Listed A Gourami iridovirus has been reported in Australia for first time since 1999	Biosecurity Australia (2005) Go et al 2005
Koi Herpes Virus	Not identified in rainbowfish New since 1999 AQIS IRA. OIE Listed Only effects Koi carp and Common carp – very host specific	Hartman et al (2004) Pokorova et al (2005)
Lymphocystis virus	Not identified in rainbowfish Iridovirus family - Lymphocystivirus Benign chronic disease Already widely present in Australia	Munday (1996) pg 87-88 and authors personal experience
Pike fry rhabdovrus	Not identified in rainbowfish Affects Northern Pike (*Esox lucius*) / coldwater cyrininds Significant disease only observed in Pike	McAllister (1993) as cited in AQIS (1999a) pg 108 Stone et al. (2003) as cited in Hine and Diggles (2005) pg 32
Retrovirus	Not identified in rainbowfish Reported to cause skin tumours eg fibromas, melanomas Chronic and low mortalities only	Petry et al. (1992) and Frances-Floyd et al. (1993) as cited in Hine and Diggles (2005) pg 32
Rosy Barb virus	Not identified in rainbowfish Birnavirus. Not associated with mortalities Recorded in Australia from fish in quarantine - Humphrey rating 10	Humphrey (1995) as cited in Hine and Diggles (2005) pg 32 and 250

Appendix C - Diseases that will not be considered further with respect to the potential importation of rainbowfish (cont.)

AGENT	COMMENT	SOURCE
VIRUSES (cont.)		
Spring viraemia of carp virus	Not identified in rainbowfish Rhabdovirus - OIE Listed disease Reported in all major cyprinids Subclinical infections can occur See notes re Goldfish in general	AQIS 1999a pg 122-23
Viral encephalopathy and retinopathy virus (nodavirus)	Not identified in rainbowfish Reported in larvae and juveniles of various fish species – not reported from strictly FW fish ie mainly marine and already widespread Movement restrictions in Australia of live Barramundi. As part of a recent nodavirus project performed in Queensland, 44 *M. splendida* were sampled from the Johnstone River and 112 from the Herbert River in that State for nRT-PCR nodavirus testing with the heads being the target tissue. All 156 fish tested negative for nodavirus (I Anderson, Queensland DPI, pers. comm, December 2006)	AQIS (1999a) pg 41 and 108-9
Viral haematopoietic necrosis in Angelfish	Not identified in rainbowfish Only reported in Angelfish (*Pterophyllum scalare*) Extremely rare and no significant mortalities	Schuh and Shirley (1990) as cited in Hine and Diggles (2005) pg 32
Viral haemorrhagic septicaemia virus (VHSV)	Not identified in rainbowfish OIE Listed Rhabdovirus recorded in coldwater fish species only Species infected not related to family Melanotaeniidae (though species in this family, particularly *M. fluviatilis*, have not been challenged with virus to assess suscepibility). Cyprinids have carrier state (Hine and Diggles (2005) pg 69-71	AQIS (1999a) pg 42

Appendix C - Diseases that will not be considered further with respect to the potential importation of rainbowfish (cont.)

AGENT	COMMENT	SOURCE
BACTERIA		
Aeromonas hydrophila	Already recorded in Australia and likely to be widespread	AQIS (1999a) pg 44 and authors personal experience
Aeromonas salmonicida	Not identified in rainbowfish Typical strain (*S. salmonicida* subsp. *salmonicida*) exotic to Australia. Atypical strains can infect non salmonids and have been identified in Australia Potential to harm salmonid industry Susceptibility of rainbowfish (particularly *M. fluviatilis*) not known. Control measures currently in place in Australia for these bacteria	AQIS (1999a) pg 42 - 43
Aeromonas sobria	Already recorded in Australia	Department of Human Services (1999)
Chlamydia/ Epiltheliocystis	Not identified in rainbowfish Some species already recorded in Australia Unlikely to have a significant impact	AQIS (1999a) pg 43 and 109 and authors personal experience
Citrobacter freundii	Already recorded in Australia	AQIS (1999a) pg 44
Edwardsiella ictaluri	Not identified in rainbowfish Causative agent of "Enteric septicaemia of catfish" Exotic to Australia but has been isolated in quarantine Pathologic and economic significance only in catfish industry in the US.	Cahill (1987) as cited in AQIS (1999a) pg 43 and 109
Edwardsiella tarda	Not identified in rainbowfish Already recorded in Australia in other species but is not host specific so could potentially affect rainbowfish	AQIS (1999a) pg 45
Flavobacterium columnare	Already recorded in Australia including in rainbowfish. However, concerns raised about variability of pathogenicity of different strains of this bacteria e.g. virulent strain identified in Neon Tetras	AQIS (1999a) pg 45 Michel et al. (2002) as cited in Hine and Diggles (2005) pg 33.

Appendix C - Diseases that will not be considered further with respect to the potential importation of rainbowfish (cont.)

AGENT	COMMENT	SOURCE
BACTERIA (cont.)		
Flavobacterium psychrophilum	Already recorded in Australia Coldwater disease of salmonids	AQIS (1999a) pg 45
*Tenacibaculum maritimumor (*at the time of AQIS 1999 IRA was known as *Flexibacter maritimus)*	Not identified in rainbowfish Already recorded in Australia - marine species	AQIS (1999a) pg 45
Lactococcus garviae	Not identified in rainbowfish Already recorded in Australia	Munday (2002) and authors personal experience
Micrococcus luteus	Not identified in rainbowfish nor other species of ornamental fish	AQIS (1999a) pg 45
Myocbacterium marinum, M. fortuitum and M. chelonae	Already recorded in Australia in a number of species including rainbowfish **Zoonotic potential important**.	AQIS (1999a) pg 45
Nocardia asteroides	Not identified in rainbowfish Already recorded in livestock in Australia	AQIS (1999b) pg 210 AQIS (1999a) pg 45 - 46
*Nocardia seriolae (*includes isolates formerly described as *N. kampachi)*	Not identified in rainbowfish Considered host specific Identified in Yellowtail *(Seriola lalandi*) from Japan only (saltwater species)	AQIS (1999a) pg 45 - 46
Photobacterium damselae damselae	Not identified in rainbowfish Already recorded in Australia in other species	AQIS (1999a) pg 46 and authors personal experience
Photobacterium damselae piscicida	Not identified in rainbowfish Important pathogen of cultured marine fish Exotic to Australia	AQIS (1999a) pg 43

Appendix C - Diseases that will not be considered further with respect to the potential importation of rainbowfish (cont.)

AGENT	COMMENT	SOURCE
BACTERIA (cont.)		
Piscirickettsia salmonis	Not identified in rainbowfish Causative agent of "Piscirickettsiosis" Only reported from salmonids Reported in marine species of ornamentals. No knowledge on susceptibility of rainbowfish (or potential for rainbowfish to carry rickettsia like organisms) but probably low likelihood due to their being freshwater species	AQIS (1999a) pg 43 and 109
Pseudomonas anguilliseptica	Not identified in rainbowfish Severe losses in cultured eels in Japan Not recorded in ornamental fish	AQIS (1999a) pg 44 and 109 - 110
Pseudomonas chlororaphis	Not identified in rainbowfish nor other ornamental fish species	Austin and Austin (1993) as cited in AQIS (1999a) pg 46
Pseudomonas fluorescens	Already recorded in Australia	AQIS (1999a) pg 46
Renibacterium salmoninarum	Not identified in rainbowfish Causative agent of "Bacterial Kidney Disease" Reported only in Salmonids - host specific organism	OIE (1997b) as cited in AQIS (1999a) pg 46
Steptococcus iniae	Not identified in rainbowfish Already recorded in Australia	AQIS (1999a) pg 46 and authors personal experience
Salmonella spp.	Not identified in rainbowfish Already recorded in Australia Zoonotic potential should be further evaluated	Hine and Diggles (2005) pg 34 - 35
Vibrio anguillarum, V. cholerae (Non 01) and *V. ordalii*	Not identified in rainbowfish though possibly susceptible Already recorded in Australia	AQIS (1999a) pg 46 and authors personal experience
Vibrio parahaemolyticus	Already recorded in Australia	Department of Health and Ageing (2000)
Vibrio salmonicida	Not identified in rainbowfish Limited host range Isolated from salmonids and gadoids (eg cod, haddock etc). Host specific?	Noga (1996) as cited in AQIS (1999a) pg 46

Appendix C - Diseases that will not be considered further with respect to the potential importation of rainbowfish (cont.)

AGENT	COMMENT	SOURCE
BACTERIA (cont.)		
Yersinia ruckeri	Hagerman strain (Serotype 01A) causes Enteric redmouth (ERM) in salmonids and is exotic to Australia. This strain is highly pathogenic – temperate spp. only effected – already covered in 1999 IRA Serotype O1B has been identified in Australia (J Carson, Tasmanian DPIW, pers. comm, January 2007) Serotypes affect a wide range of fish effected - including goldfish No strains identified in rainbowfish but susceptibility of rainbowfish to these bacteria unknown	AQIS (1999a) pg 44 and pages 85-89 and authors personal experience
FUNGI		
Aphanomyces invadans	OIE Listed disease (causative agent of "Epizootic Ulcerative Syndrome (EUS)") Already recorded in Australia – evidence of disease identified in rainbowfish	Lilley et al. (1997) and Callinan et al. (1995) as cited in AQIS (1999a) pg 47 and disease notes on rainbowfish
Aphanomyces pisci	Not identified in rainbowfish No natural infections reported in ornamental fish Not reported since 1979	Srivastava (1979) as cited in Hine and Diggles (2005) pg 30
Aphanomyces pisci	Not identified in rainbowfish Opportunistic saprophyte	Mondal and De (2002) as cited in Hine and Diggles (2005) pg 30
Branchiomyces sanguinus and B. demigrans	Not identified in rainbowfish Branchiomyces of uncertain species already recorded in Australia	AQIS (1999a) pg 47
Ichthyophonus hoferi	Not identified in rainbowfish Already recorded in Australia	Humphrey (1995) as cited in AQIS (1999a) pg 47 and authors personal experience
Saprolegnia spp.	Already recorded in Australia including from rainbowfish	Reddacliff (1985) as cited in AQIS (1999a) pg 47 and authors personal experience

Appendix C - Diseases that will not be considered further with respect to the potential importation of rainbowfish (cont.)

AGENT	COMMENT	SOURCE
PROTOZOA		
Acanthamoeba sp.	Not identified in rainbowfish Previously covered in 1999 IRA and considered minimal risk Recorded to cause significant disease and economic loss in cultured fish Not recorded in Australia	AQIS (1999a) pg 47 and 110
Amyloodinium spp.	Not identified in rainbowfish Marine fish only	Munday (1996) pg 105
Brooklynella hostilis	Not identified in rainbowfish Marine fish only	AQIS (1999a) pg 48
Chilodonella cyprini and *C. hexasticha*	Already recorded in Australia (including fromm rainbowfish)	Langdon and Humphrey (1988) as cited in AQIS (1999a) pg 50 and authors personal experience
Coleps spp.	Not identified in rainbowfish Opportunistic / secondary pathogen Hosts usually immunocompromised	Hine and Diggles (2005) pg 37
Cryptobia spp.	Severe diseases in carp and salmonids Previously covered by 19919 IRA and no specific risk management measures warranted	AQIS (1999a) pg 48 and 90-92
Cryptobia salmositica	Not identified in rainbowfish Highly specific for Salmonids Very unlikely to be on imported fish	Lom and Dykova (1992) as cited in AQIS (1999a) pg 50
Cryptocaryon irritans	Not identified in rainbowfish Marine fish only	AQIS (1999a) pg 50 and authors personal experience
Eimeria spp.	Not identified in rainbowfish Intestinal coccidia Unlikely to be pathogenic Identified in Australia	Hine and Diggles (2005) pg 38 and authors personal experience

Appendix C - Diseases that will not be considered further with respect to the potential importation of rainbowfish (cont.)

AGENT	COMMENT	SOURCE
PROTOZOA (cont.)		
Glugea spp.	Some species recorded in Australia Limited disease impact Associated with immunosuppression, secondary infections are likely	AQIS (1999a) pg 50
Goussia carpelli	Not identified in rainbowfish Limited disease impact Some species recorded in Australia	AQIS (1999a) pg 50 - 51
Ichthyophthirius multifillis	Already recorded and widespread in Australia including from rainbowfish	Humphrey (1995) as cited in AQIS (1999a) pg 51
Licnophora hippocampi	Not identified in rainbowfish Ciliate of marine Seahorse No further reports since 1985	Meng and Yu (1985) as cited in Hine and Diggles (2005) pg 39
Microsporidium spp.	Not identified in rainbowfish Severe diseases in cultured fish in Japan and salmonids Considered low risk under 1991 IRA	AQIS (1999a) pg 48 and 59
Oodinium spp.	Already recorded in Australia includingfrom rainbowfish	Munday (1996) pg 105 - 106 See rainbowfish diseases
Parvicapsula spp.	Not identified in rainbowfish Already recorded in Australia Generally non-pathogenic	Lester and Sewell (1989) as cited in AQIS (1999a) pg 51
Piscioodium sp	Not identified in rainbowfish Infects temperate to tropical fish including cichlids	Martins et al (2001) as cited in Hine and Diggles (2005) pg 39
Pleistophora hyphressobryconis	Not identified in rainbowfish Already recorded in Australia Disease mainly in Tetras	Humphrey (1995) as cited in AQIS (1999a) pg 52

Appendix C - Diseases that will not be considered further with respect to the potential importation of rainbowfish (cont.)

AGENT	COMMENT	SOURCE
PROTOZOA (cont.)		
Scyphidia spp.	Not identified in rainbowfish Not considered a primary pathogen Associated with poor husbandry Not recorded in Australia	AQIS (1999a) pg 52
Spironucleus spp. formerly *Hexamita spp.*	Not identified in rainbowfish Already recorded in Australia Possible cause of "hole in the head" disease Often in immunosuppressed fish	Evans and Lester (2001) Munday (1996) pg 107
Tetrahymena spp. Especially *T. corlissi*	Not identified in rainbowfish Already recorded in Australia Pathogenic strains emerging overseas, particularly in guppies. Guppies share same water quality parameters as many rainbowfish species.	AQIS (1999a) pg 52 - but new references (e.g. Imai et al 2000)
Trichodina spp.	Already recorded in Australia including from rainbowfish Mainly marine fish affected	Su and White (1995) as cited in AQIS (1999a) pg 52 and authors personal experience
Trichodinella spp.	Not identified in rainbowfish Already recorded in Australia Usually associated with opportunistic disease	Humphrey (1995) as cited in AQIS (1999a) pg 53 and authors personal experience
Trichophrya spp.	Common parasite Minimal impact	AQIS (1999a) pg 53
Tripartiella spp.	Not identified in rainbowfish Already recorded in Australia	Humphrey (1995) as cited in AQIS (1999a) pg 53
Trypanasoma danilewskyi (carassii)	Not identified in rainbowfish Transmitted by blood-sucking vectors (leeches) Primarily a parasite of coldwater cyprinids	AQIS (1999a) pg 49 and 96–98

Appendix C - Diseases that will not be considered further with respect to the potential importation of rainbowfish (cont.)

AGENT	COMMENT	SOURCE
PROTOZOA (cont.)		
Trypanasoma murmanensis	Not identified in rainbowfish Transmitted by blood-sucking vectors Marine fish only Trypanosome spp. already identified in Australia	AQIS (1999a) pg 49 and authors personal experience
Vorticella spp.	Not identified in rainbowfish Already recorded in Australia Generally non-pathogenic	Paynter (1989) pg 161–162
MYXOZOA		
Enteromyxum leei	Not identified in rainbowfish Marine fish only	Padros et al (2001) as cited in Hine and Diggles (2005) pg 41
Henneguya spp.	Not identified in rainbowfish Serious disease in catfish and salmonid aquaculture Some species already recorded in Australia Previously covered by 1999 IRA and no specific risk management measures warranted	Humphrey (1995) as cited in AQIS (1999a) pg 48 and 110–11
Hoferellus spp.	Not identified in rainbowfish Already recorded in Australia	AQIS (1999a) pg 51
Kudoa spp.	Not identified in rainbowfish Already recorded in Australia and marine fish	Humphrey (1995) as cited in AQIS (1999a) pg 51
Myxobolus spp. (= *Myxosoma spp.*)	Not identified in rainbowfish High host specificity Multi-host life cycles (intermediate hosts) Generally not serious pathogens of ornamental fish	Hine and Diggles (2005) pg 40
Sphaerospora renicola and S. carassii	Not identified in rainbowfish Infects temperate to tropical fish (including cichlids) Previously covered by 1999 IRA and no specific risk managem,ent measures warranted	AQIS (1999a) pg 49 and pg 93–95

Appendix C - Diseases that will not be considered further with respect to the potential importation of rainbowfish (cont.)

AGENT	COMMENT	SOURCE
NEMATODES		
Camallanus spp.	Already recorded in Australia including from rainbowfish. *C. cotti* identified in five commonly imported ornamental fish after release from quarantine. No assessment conducted on impact and species as far as authors are aware	Humphrey (1995) as cited in AQIS (1999a) pg 53. Evans and Lester (2001) considered *C. cotti* a high risk pathogen
Capillaria spp.	Not identified in rainbowfish Not likely to be pathogenic Already recorded in Australia	Humphrey (1995) as cited in AQIS (1999a) pg 53
Capillostrongyloides ancistri	Not identified in rainbowfish Host specific for *Ancistrus dolichopterus* (Bristlenose Catfish) Not considered a major problem due to host specificity	Moravec et al. (1987a) as cited in Hine and Diggles (2005) pg 49
Contracaecum spp.	Not identified in rainbowfish Taxonomic studies only Non-pathogenic	Hine and Diggles (2005) pg 49
Cucullanus spp.	Not identified in rainbowfish Taxonomic studies only Non-pathogenic	Hine and Diggles (2005) pg 49
Hysterothylacium spp.	Not identified in rainbowfish Taxonomic studies only Non-pathogenic	Hine and Diggles (2005) pg 49
Mexiconema cichlasomae	Transmitted by Argulus spp. Found in *Xiphophorus helleri* (Swordtail) Rare and very unlikely to gain entry	Moravec et al (1998)
Philometroides fulvidraconi	Not identified in rainbowfish Complex and indirect Life cycle and low Humphrey score Not recorded in Australia at the time of the 1999 IRA Serious eye disease in Yellow Catfish	AQIS (1999a) pg 53 and 59–60
Philometroides cyprini (= *Philometra lusiana*)	Not identified in rainbowfish Not recorded in Australia Effects only carp (*Cyprinus carpio*)	AQIS (1999a) pg 53

AGENT	COMMENT	SOURCE
NEMATODES		
Procamallanus spiculogubernaculus	Not identified in rainbowfish Uses copepods as intermediate host Only matures in *Heteropneustes fossilis* (Asian Stinging Catfish)	Sinha (1998) as cited in Hine and Diggles (2005) pg 50
Pseudocapillaria spp.	Not identified in rainbowfish Temperate to tropical cyprinids (not in rainbowfish) Direct Horizontal transmission	Moravec et al. (1987a) as cited in Hine and Diggles (2005) pg 50
Raphidascaris acus	Not identified in rainbowfish Reported to cause pathology in a wide variety of hosts Uses planktonic crustaceans as intermediate hosts Not present in rainbowfish	Moravec et al. (1990) as cited in Hine and Diggles (2005) pg 50
Spirocamallanus spp.	Not identified in rainbowfish Uses copepods as intermediate host Not associated with disease	De et al. (1986) as cited in Hine and Diggles (2005) pg 51
Spironoura spp.	Not identified in rainbowfish Taxonomic studies only Considered non-pathogenic	Hine and Diggles (2005) pg 49
Rhabdochona spp.	Not identified in rainbowfish Taxonomic studies only Non-pathogenic	Hine and Diggles (2005) pg 49

Appendix C - Diseases that will not be considered further with respect to the potential importation of rainbowfish (cont.)

AGENT	COMMENT	SOURCE
MONOGENEANS		
Ancyrocephalus spp.	Not identified in rainbowfish Highly host specific Taxonomic studies only Non-pathogenic	Hine and Diggles (2005) pg 41
Benedenia spp.	Not identified in rainbowfish Not host specific - marine fish May cause disease Some species present in Australia	AQIS (1999a) pg 54 Hine and Diggles (2005) pg 41
Dactylogyrus vastator *Dactylogyrus extensus*	Not identified in rainbowfish Gill fluke of carp and goldfish Dactylogyrus spp. already recorded in Australia	AQIS (1999a) pg 54 and 99–101
Demiospermus anus *Dichodactylogyrus spp.* *Dicrodactylogyrus spp.* *Diplozoon spp* *Dogielius spp.* *Gussevia spp.*	Not identified in rainbowfish Highly host specific Taxonomic studies only Considered non-pathogenic	Hine and Diggles (2005) pg 41
Gyrodactylus salaris	Not identified in rainbowfish OIE Listed disease (causative agent of Gyrodactylosis) Highly host specific - Salmonids Exotic to Australia	OIE (1997b) as cited in AQIS (1999a) pg 54
Gyrodactylus spp.	Not identified in rainbowfish Highly host specific Not highly pathogenic Many species already in Australia	Humphrey (1995) as cited in AQIS (1999a) pg 54

Appendix C - Diseases that will not be considered further with respect to the potential importation of rainbowfish (cont.)

AGENT	COMMENT	SOURCE
MONOGENEANS (cont.)		
Indocotyle elegans *Lissemysia spp.* *Loxuroides fungiliformis* *Markewitschiana triaxonis* *Neodiplozoon polycotyleus* *Oligapta hyporhamphi* *Paradiplozoon spp.* *Paragyrodactylus superbus* *Philocorydoras platensis* *Sciadicleithrum spp.* *Urocleidoides corydori*	Not identified in rainbowfish Highly host specific Taxonomic studies only Considered non-pathogenic	Hine and Diggles (2005) pg 41
DIGENEANS		
Clinostomum marginatum	Not identified in rainbowfish Many fish species - wild and cultured Intermediate host(s) required. Complex and indirect life cycles and low Humphrey score Not recorded in Australia at time of 1999 IRA Other *Clinostomum spp*. recorded in Australia	AQIS (1999a) pg 54 and 59–60
Cryptocotyle lingua	Not identified in rainbowfish Marine fish	AQIS (1999a) pg 55
Sanguinicola spp.	Not identified in rainbowfish Mainly carp and salmonids Complex and indirect life cycle and low Humphrey score Intermediate host(s) required Not recorded in Australia at time of 1999 IRA	AQIS (1999a) pg 54 and 59–60
Many other digeneans were considered but none were identified as being of any significance because of the limited chance of introduction due to complex life cycles		

Appendix C - Diseases that will not be considered further with respect to the potential importation of rainbowfish (cont.)

AGENT	COMMENT	SOURCE
CESTODES		
Bathybothrium rectangulum *Bothriocephalus acheilognathi*	Not identified in rainbowfish Intermediate hosts required Taxonomic studies only Considered non-pathogenic Not identified in rainbowfish Already recorded in Australia Relatively large range of definitive hosts in Australia generally related to where exotic carp species are found. As part of a large sampling program did not detect this parasite in the three *M. fluviatilis* sampled	Hine and Diggles (2005) pg 47 Dove and Fletcher (2000). New information after 1999 IRA
Caryophyllaeus fimbriceps	Not identified in rainbowfish Affects cyprinids Economically important in carp culture Not recorded in Australia	AQIS (1999a) pg 55
Caryophyllaeus spp. *Diphyllobothrium spp.*	Not identified in rainbowfish Intermediate hosts required Taxonomic studies only Considered non-pathogenic	Hine and Diggles (2005) pg 47
Eubothrium crassum and *E. salvalini*	Not identified in rainbowfish Wild and farmed salmonids Indirect life cycle Not recorded in Australia	AQIS (1999a) pg 55
Khawia sinensis	Not identified in rainbowfish Effects cyprinids Economically important in carp culture Not recorded in Australia	AQIS (1999a) pg 55

Appendix C - Diseases that will not be considered further with respect to the potential importation of rainbowfish (cont.)

AGENT	COMMENT	SOURCE
CESTODES (cont.)		
Khawia spp. *Otobothrium penetrans* *Proteocephalus spp.* *Ptychobothrium belones*	Not identified in rainbowfish Intermediate hosts required Taxonomic studies only Considered non-pathogenic Not identified in rainbowfish Intermediate hosts required Taxonomic studies only Considered non-pathogenic	Hine and Diggles (2005) pg 47 Hine and Diggles (2005) pg 47
Triaenophorus spp.	Not identified in rainbowfish Minor pathology	AQIS (1999a) pg 56
Unicibilocularis spp.	Not identified in rainbowfish Intermediate hosts required Taxonomic studies only Considered non-pathogenic	Hine and Diggles (2005) pg 47

Appendix C - Diseases that will not be considered further with respect to the potential importation of rainbowfish (cont.)

AGENT	COMMENT	SOURCE
CRUSTACEANS		
Alitropus typus	Not identified in rainbowfish Effects wide range of tropical Asian freshwater fish Facultative pathogen - with poor water quality or high stocking rate	Hine and Diggles (2005) pg 42
Argulus japonicus	Not identified in rainbowfish Already recorded in Australia	Humphrey (1995) as cited in AQIS (1999a) pg 57
Argulus foliaceus and *Argulus spp*	Not identified in rainbowfish Fish lice - non host specific *A. foliaceus* - cyprinids and salmonids *A. coregoni* - mainly salmonids Both not recorded in Australia at time of 1999 IRA – risk assessed Susceptibility of rainbowfish unknown	AQIS (1999a) pg 56 and 127–9
Caligus spp.	Not identified in rainbowfish Worldwide on freshwater and marine Tropical and temperate fish Identified in Australia (e.g. southern bluefin tuna)	Hine and Diggles (2005) pg 42 and authors personal experience
Chonopeltis victori *Colobomatus cresseyi*	Not identified in rainbowfish Taxonomic studies only Considered non-pathogenic	Hine and Diggles (2005) pg 43
Ceratothoa gaudichaudi *Mothocya parvostis*	Not identified in rainbowfish Not associated with ornamental finfish Mainly marine fish	AQIS (1999a) pg 57
Ceratothoa imbricata *Nerocila orbignyi*	Not identified in rainbowfish Already recorded in Australia Mainly marine fish	Humphrey (1995) as cited in AQIS (1999a) pg 57
Lamproglena spp. *Lernanthropus eddiwarneri*	Not identified in rainbowfish Taxonomic studies only Considered non-pathogenic	

Appendix C - Diseases that will not be considered further with respect to the potential importation of rainbowfish (cont.)

AGENT	COMMENT	SOURCE
CRUSTACEANS (cont.)		
Ergasilus sieboldi and *Ergasilus spp.*	Not identified in rainbowfish *E. sieboldi* not recorded in Australia Mainly infection in tench - pathogenic, freshwater species (but temperate) Many *Ergasilus* spp. already recorded in Australia	AQIS (1999a) pg 56
Lernaea cyprinaceae *Lernaea spp*.	Already recorded in Australia including from rainbofish	AQIS (1999a) pg 57
Lernaea elegans	This species not recorded in Australia (at time of 1999 IRA) - this is a pathogenic strain, fatal in low numbers, has occurred in freshwater species including carp Risk assessed in 1999 IRA Susceptibility of rainbowfish unknown	AQIS (1999a) pg 53 and 12931
Lernaeocera branchalis	Not identified in rainbowfish Marine fish	AQIS (1999a) pg 57
Pseudolamproglena spp. *Tracheliastes spp.*	Not identified in rainbowfish Taxonomic studies only Considered non-pathogenic	Hine and Diggles (2005) pg 43

Appendix D - Seafood Air Transport Regulations 2006 - Packing Method No. 8: Live Aquarium Fish In Salt Or Fresh Water[24]

1. Description

Fibreboard or EPS[25] box containing live aquarium fish swimming in water.

2. Maximum Gross Weight

As per Packaging Approval up to a maximum of 15 kilograms.

3. Packing Material:

3.1 Outer Container: Fibreboard or EPS box of appropriate dimensions to allow for the normal expansion of the inner liner during flight (see Notes below). A rigid plastic container may also be suitable when used with Product Bags.

3.2 Product Bag: Two polyethylene bags of at least 75 micron in thickness. Product may be contained in multiple inner bags within a single outer.

3.3 Bag Cushion: Sheet of furnishing foam (12mm thick) or 5 sheets of newspaper (or other sheet paper).

3.4 Adhesive tape: Over 4 cm in width and/or suitable plastic strapping.

3.5 Elastic band for fish bag: approx. 50 mm dia, 6 mm width, 1 mm thickness or equivalent, one band per bag

3.6 Absorbent Pad: to absorb quantity and type (fresh, salt) of water used.

4. Packing Method:

4.1 Place the water and fish in one (or more) bag(s), oxygenate, then gooseneck the top and tie with elastic band or twine. Metal clips are an acceptable alternative for sealing bags.

4.2 Place the first bag inside a second bag lined all around with at least 12 mm of furnishing foam or 5 sheets of newspaper. Gooseneck and tie the second bag. Multiple small bags are acceptable inside one large outer bag.

4.3 Put the prepared bag with the absorbent pad in the box.

4.4 Seal the lid of the EPS box with adhesive plastic tape and tape twice around the width of the box at approx 1/3 spacing and midway around the ends (as illustrated). Seal lid and joints of fibreboard box as illustrated.

Notes:

a. These containers will not be subject to the normal seafood air transport checking procedures used when the packaging is consigned by air, that is, the boxes are not required to be opened by the airline freight acceptance areas

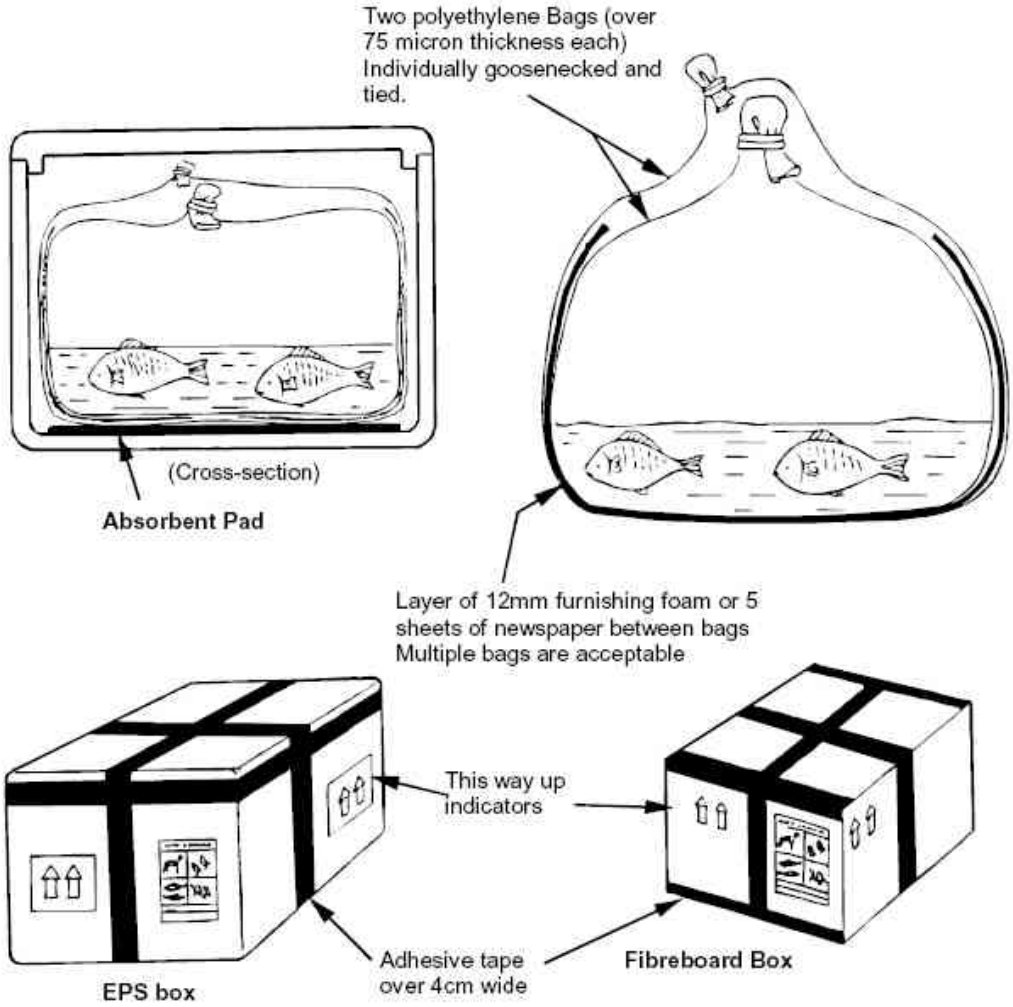
[24] Found on page PM 8-2 of the Regulations
[25] Expanded Polystyrene

b. Correct labelling is particularly important. Packages should be marked "Live Fish" as appropriate on at least two opposing sides and should have labels on all four sides that clearly and obviously state the correct orientation of the package during transport.

c. If oxygen or air is added to the bag containing the live fish then the closed bag must not fill the outside container, other wise the pressure differential at altitude (usually 3 to 4 psi) could burst the bag and/or box. The free space should be about 20-25% of the gas volume in the bag.

d. If oxygen tablets are used, provision must be made to accommodate the excess gas in the inner bag without bursting the bag or box.

e. Use “This Way Up” labels or contrasting tape to assist in loading boxes the correct way up.



Appendix E - Rainbowfish species traded in North America

The following list of species of rainbowfish has been taken from the website **"Bowheads – For North American rainbowfish lovers**[26]. The introduction to this table states the following:

The following is a list of rainbowfish that can, for the most part, be purchased in one way or another in the USA and Canada. This is not a comprehensive list, by any means. It is simply a list of the rainbowfish that I have seen for sale at one time or another via various persons or at various places.

There are many private rainbowfish breeders in the USA, and probably Canada, who occasionally offer an extremely rare or previously unavailable species' fry or egg mop up for sale.

Scientific Name[27]	Common Name	Commercial Name(s)	Max Size (Inches)	Relative availability
Melanotaenia trifasciata	Banded Rainbowfish	Goyder River Rainbowfish, Rainbowfish, Banded Rainbowfish	5–6	"Common"
Melanotaenia praecox	Neon Rainbowfish	Neon Dwarf Rainbowfish, Dwarf Rainbowfish, Turquoise Rainbowfish	2½–3	"Common"
Melanotaenia boesemani	Boeseman's Rainbowfish	Boesmani/Boeseman's Rainbowfish	4–5	"Common"
Melanotaenia splendida sp	All Melanotaenia splendida spp.	Australian Rainbowfish	5–6	"Common"
Glossolepis incisus	Salmon Red Rainbowfish	New Guinea Rainbowfish, Red Rainbowfish, Irian Rainbowfish, "Iran" or "Iranian" Rainbowfish	5–6	"Common"
Glossolepis multisquamatus, Glossolepis multisquamata	Sepik Rainbowfish	Emerald Green Rainbowfish, *Glossolepis wanamensis*, Blue Electra Rainbowfish,	5–6	"Moderately common"
Iriatherina werneri	Threadfin/Featherfin Rainbowfish		1¼–2	"Moderately common"
Melanotaenia parkinsoni	Parkinson's Rainbowfish	Pakistan Rainbowfish	5–6	"Moderately common"

[26] Website at <bowheads.org/species/hobby_availibility.html>, accessed 27 March 07. Website. Copyright © 2005-2007 Eileen Kortright, Roan Art. All rights reserved.

[27] The *Scientific*, *Common* and *Commercial* names stated in this table are as stated on the website and do not always match the terms used in the remainder of this report.

Scientific Name[27]	Common Name	Commercial Name(s)	Max Size (Inches)	Relative availability
Melanotaenia lacustris	Lake Kutubu Rainbowfish	Turquoise Rainbowfish, Neon Rainbowfish, Blue Rainbowfish	4–5	"Semi-rare"
Melanotaenia maccullochi	MacCulloch's Rainbowfish	Dwarf Rainbowfish, Black-Lined Rainbowfish	2–3	"Semi-rare"
Melanotaenia herbertaxelrodi	Lake Tebera Rainbowfish	Yellow Rainbowfish, Axelrod's Rainbowfish, Axelrodi, Herbies	4–5	"Rare"
Melanotaenia nigrans	Black-Banded Rainbowfish	Red-Tailed Rainbowfish, Dark Rainbowfish	3–4	"Rare"
Melanotaenia catherinae	Waigeo Rainbowfish		3–4	"Very rare"
Melanotaenia splendida rubrostriata	Red-Striped Rainbowfish		5–6	"Very rare"
Melanotaenia duboulayi	Crimson-Spotted Rainbowfish	Duboulayi's Rainbowfish	4–5	"Very rare"
Chilatherina fasciata	Barred Rainbowfish		4–5	"Very rare"
Melanotaenia affinis	New Guinea Rainbowfish	North New Guinea Rainbowfish	5–6	"Very rare"
Glossolepis dorityi	Dority's Rainbowfish	Zig Zag Rainbowfish	3–4	"Extremely rare"
Melanotaenia kamaka	Kamaka Rainbowfish		2½–3	"Extremely rare"
Melanotaenia sp. (Batanta)	Batanta Island Rainbowfish		4–5	"Extremely rare"
Glossolepis pseudoincisus	Tami River Rainbowfish	Millenium Rainbowfish	3¼	"Extremely rare"
Melanotaenia parva	Lake Kurumoi Rainbowfish	Flame Rainbowfish	3–3½	"Extremely rare"
Rhadinocentrus ornatus	Ornate Rainbowfish		2–3	"Extremely rare"
Chilatherina sentaniensis	Sentani Rainbowfish		3–4	"Extremely rare"
Melanotaenia irianjaya	Irian Jaya rainbowfish		4–5	"Extremely rare"
Chilatherina bleheri	Bleher's Rainbowfish		4–5	"Extremely rare"
Glossolepis ramuensis	Ramu Rainbowfish		3–4	"Extremely rare"
Melanotaenia goldiei	Goldie River Rainbowfish		3–4	"Extremely rare"
Glossolepis wanamensis	Lake Wanam	Emerald Rainbowfish	3–4	"Extremely rare"

Notes on "Availability" classification

"Common"	These are rainbowfish that are commonly found in LFS (Local Fish Shops). If your LFS does not have any in stock, chances are that they can order them in. Except in very rare cases, these will be farm bred fish. Therefore, there is always a chance that some will be hybrids sold as non-hybrids.
"Moderately common"	These are rainbowfish that are not commonly found in LFS (Local Fish Shops) however some of them will carry them or be able to order them in. Most likely these will be farm bred fish and therefore there is always a chance that some will be hybrids sold as non-hybrids.
"Semi rare"	Very few local fish shops will carry these fish. However, some do on a semi-regular basis and some may be able to order them. Those that get them in on a fairly regular basis will be stocking farm bred fish and thus there is always a chance that some will be hybrids sold as non-hybrids.
"Rare"	These are rainbowfish that not usually found in an LFS and only a few rainbowfish aficionado shops will carry or order them. Most will be farm bred and therefore there is a great chance of hybrids.
"Very rare"	The chances of a shop carrying any of these is highly unlikely, however some of them may be gotten from shops on line or from private breeders. Again, if you buy watch for hybrids.
"Extremely rare"	These are rainbowfish will not be found in an ordinary LFS. Only one that carries rare and exotic fish will have some of these. Your best bet is to hunt AquaBid and/or find a private breeder and buy directly from them.

References

Aarn and Ivantsoff W (1997) Descriptive anatomy of *Cairnsichthys rhombosomoides* and *Iriatherina werneri* (Teleostei: Atheriniformes), and a phylogenetic analysis of Melanotaeniidae. *Ichthyological Explorations in Freshwater*. 8(2): 107-150.

Allen, GR (1989) *Freshwater fishes of Australia.* TFH Publications, Neptune City, New Jersey, USA

Allen, GR (1991) *Field guide to the freshwater fishes of New Guinea.* Christensen Research Institute, Madang, Papua New Guinea.

Allen GR (1995) *Rainbowfishes. Their identification, care and breeding*. Tetra-Verlag, Germany.

Allen GR (1996) Two new species of rainbowfishes (Melanotaenia: Melanotaeniidae), from the Kikori River system, Papua New Guinea. R*evue francaise Aquariologie* 23(1-2): 9–16.

Allen GR (2001) A new species of rainbowfish (*Glossolepis*: Melanotaeniidae) from Irian Jaya, Indonesia. *ANGFA Fishes of Sahul* 15(3):766–775.

Allen GR and Cross NJ (1982) *Rainbowfishes of Australia and Papua New Guinea* Sydney, Angus and Robertson.

Allen GR and Kailola PJ (1979) *Glossolepis wanamensis,* a new species of rainbowfish (Melanotaeniidae) from New Guinea. *Revue francaise Aquariologie* 6(2): 39–44.

Allen GR and Renyaan SJ (1996) *Chilatherina pricei*, a new species of rainbowfish (Melanotaeniidae) from Irian Jaya. *Revue francaise Aquariologie* 23(1-2): 5–8.

Allen GR, Midgley SH and Allen M (2002) *Field guide to the freshwater fishes of Australia.* Western Australian Museum, Perth.

Angel UM and Manter HW (1970) *Pretestis australianus* gen. (*sic*) et sp. nov. (Digenea: Paramphistomatidae) from Australian fish, and a closely related cercaria, *Cercaria acetabulapapillosa* sp. nov., with notes on the life history. *Anales del Instituto de Biologia Universidad Nacional Autónoma de México* 41:1–10.

Aquarium Science Association of the Philippines (ASAP), Inc. (1996) Aquarium species in the Philippines. *ASAP Philippine Aquarist Database Report.* 9 p. Quezon City, Philippines (quoted in Froese and Pauly, 2007).

AQIS (1999a) *Import Risk Analysis on Live Ornamental Fish*, Australian Quarantine and Inspection Service, Canberra, ACT, Australia.

AQIS (1999b) *Import Risk Analysis on Non-viable Salmonids and Non-salmonid Marine Finfish*, Australian Quarantine and Inspection Service, Canberra, ACT, Australia.

Berra TM (2001) *Freshwater fish distribution*. Academic Press, San Diego, USA

Beumer JP (1976) The fishes of a tropical river with emphasis on the spangled perch, *Therapon unicolor* Gunther, 1859, and the east Queensland rainbowfish, *Nematocentris splendida* Peters, 1866, PhD. thesis, James Cook University of North Queensland, 361 pp

Beumer JP, Ashburner LD, Burbury ME, Jetté E and Latham DJ (1983) *A Checklist of the Parasites of Fishes from Australia and its Adjacent Antarctic Territories*. Technical Communication No. 48 of the Commonwealth Institute of Parasitology. Pg 48

Biosecurity Australia (2006) *Revised Draft Generic Import Risk Analysis Report for Prawns and Prawn Products, Part B*. Biosecurity Australia, Canberra, Australia, viewed March 2007, <http://www.daffa.gov.au/__data/assets/pdf_file/97804/2006_35a.pdf>

Coates D (1990) Biology of the rainbowfish, *Glossolepis multisquamatus* (Melanotaeniidae), from the Sepik River floodplains, Papua New Guinea. *Environmental Biology of Fishes* 29: 119–126.

Cribb TH (1985) The life cycle and biology of *Opecoelus variabilis,* sp.nov. (Digenea: Opecoelidae). *Australian Journal of Zoology* 33: 715–728.

Crowley LELM and Ivantsoff W (1991) Genetic similarity among populations of rainbowfishes (Pisces: Melanotaeniidae) from Atherton Tablelands, Northern Queensland. *Ichthyological Explorations of Freshwaters* 2(2): 129–137.

Department of Health and Ageing (2000) *Foodborne Illness in Australia*. Annual Incidence circa 2000, viewed November 2006 <www.ozfoodnet.org.au/internet/ozfoodnet/publishing.nsf/Content/reports-1/$FILE/foodborne_report.pdf>

Department of Human Services (1999) *Infectious and Notifiable Diseases in South Australia* Annual Summary, 1999, viewed November 2006. <www.dh.sa.gov.au/pehs/publications/cdcb-summary-1999.pdf>

Dove ADM (2000) Richness patterns in the parasite communities of exotic poeciliid fishes *Parasitology* Vol. 120, no. 6, pp. 609–623. June 2000.

Dove ADM and Fletcher AS (2000) The distribution of the introduced tapeworm *Bothriocephalus acheilognathi* in Australian freshwater fishes. *Journal of Helminthology* 74: 121–27.

Dyer BS and Chernoff B (1996) Phylogenetic relationships among atheriniform fishes (Teleostei: Atherinomorpha). *Zoological Journal of the Linnaean Society* 117: 1–69.

Environment Protection and Biodiversity Conservation Act 1999 Viewed February 2007 at <http://www.frli.gov.au/ComLaw/Legislation/ActCompilation1.nsf/0/31F5646F4E2C1D20CA25728F0017A803 >

Eschmeyer WN (1998). *Catalog of fishes. Vol. 1, Introductory materials, species of fishes (A-L); Vol. 2, Species of fishes (M-Z); Vol. 3, Genera of fishes, species and genera in a classification, literature cited, appendices. Pp 1-2905*. California Academy of Sciences: San Francisco, California, USA

Eschmeyer, W.N. 2006. The Catalog of Fishes online. Updated November 7, 2006. <www.calacademy.org/research/ichthyology/catalog/fishcatmain.asp>

Evans BB and Lester RJG (2001) Parasites of ornamental fish imported into Australia *Bulletin of the European Society of Fish Pathologists* 21: 51–55.

FishBase (2007) See Froese and Pauly (2007)

Froese R and Pauly D (2007) Editors World Wide Web electronic publication. <www.fishbase.org>, version (01/2007)

Gleeson DJ, Mccallum HI and Owens, IP (2000) Differences in initial and acquired resistance to *Ichthyophthirius multifiliis* between populations of rainbowfish. *Journal of Fish Biology* 57(2): 466–475.

Go J et al (2005) Molecular epidemiology of iridovirus infection in Murray cod and ornamental fish. Abstract, FRDC Aquatic Animal Health Subprogram Scientific Conference Proceedings. Cairns, 26-28 July, 2005.

Hartman KH, Yanong RPE, Petty D, Francis-Floyd Ruth and Riggs AC (2004), *Koi Herpes Virus (KHV) Disease*, Fact Sheet VM-149, Department of Large Animal Clinical Sciences (College of Veterinary Medicine), Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. <http://edis.ifas.ufl.edu> Viewed January 2007.

Hieronimus H (1999), Breathtaking rainbows. Aqualog: Special – Serie Ratgeber. Verlag GmbH, Germany. 48 p.

Hine PM and Diggles BK (2005), *Import Risk Analysis: Ornamental Fish*, Biosecurity New Zealand, Ministry of Agriculture and Forestry, pp 248–64

Humphrey J. and Langdon J (1986). *Ulcerative Disease in Northern Territory Fish* Report on Laboratory Examinations on Ulcerated Fish, July-September 1986. Internal Report, Australian Health Reference laboratory, Benalla: 13pp.

IATA (2006) Live Animal Regulations Viewed March 2007 at <www.iata.org/ps/publications/9105.htm>

Imai et al (2000) Tetrahymena infection in guppy, *Poecilia reticulata*. *Fish Pathology* 35 (2): 67-72

JASCOFD (1990) Joint Advisory Committee on Fish Diseases, Standing Committee on Agriculture/Standing Committee on Fisheries, CSIRO Australian Animal Health Laboratory, Meeting No. 6, Geelong, April 6, 7p

Johnston TH and Angel LM (1941) Life cycle of the trematode, *Diplostomum murrayense* J. and C. *Transactions of the Royal Society of South Australia* 65(1): 140–144.

Kailola PJ (1975) A catalogue of the fish reference collection at the Kanudi Fisheries Research Laboratory, Port Moresby. *Department of Agriculture, Stock and Fisheries, Port Moresby, Papua New Guinea. Research Bulletin No. 16.*

Kailola PJ (1987) The fishes of Papua New Guinea. A revised and annotated checklist. Vol. 1. Myxinidae to Synbranchidae. *Department of Fisheries and Marine Resources, Port Moresby, Papua New Guinea. Research Bulletin No. 41.*

Kailola P (2004) Risk assessment of ten species of ornamental fish under the *Environment Protection and Biodiversity Conservation Act* 1999 viewed November 2006 <http://www.environment.gov.au/biodiversity/trade-use/invitecomment/pubs/ornamental-fish.pdf>

Langdon JS, Gudkovs N, Humphrey JD, Saxon, EC (1985) Deaths in Australian freshwater fishes associated with *Chilodonella hexasticha* infection. *Australian Veterinary Journal* 62: 409–412.

Leggett R and Merrick J (1987) *Australian Native Fishes for Aquariums*, Merrick Publications.

McGuigan KL (2000) An addition to the rainbowfish (Melanotaeniidae) fauna of north Queensland. Memoirs of the Queensland Museum 46(2): 647–655.

McNee A (2002) "*A national approach to the management of exotic fish species in the aquarium trade: An inventory of exotic freshwater species*" Report for Fisheries Resources Research Fund, Bureau of Rural Sciences.

Moravec F, Jiménez-García MI, Salgado-Maldonado G (1998) New observations on *Mexiconema cichlasomae* (Nematoda: Dracunculoidea) from fishes in Mexico. *Parasite*. Sep; 5(3):289-93, Abstract viewed December 2006, <www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieveanddb=PubMedandlist_uids=9772729anddopt=Abstract>

Munday BL (1996), *Infectious Diseases in Finfish*, in Fish Health Workshop, Proceedings 265, Post Graduate Foundation in Veterinary Science, University of Sydney, Australia, pp 81–123.

Munday BL (2002) *Scientific review of significant disease agents carried by non-viable, non-salmonid freshwater and estuarine finfish and their products*. Biosecurity Australia, Department of Agriculture, Fisheries and Forestry, Australia, pg 71.

Munro ISR (1967) The Fishes of New Guinea. *Department of Agriculture, Stock and Fisheries, Port Moresby*.

NCBI – National Center for Biotechnology Information, 2007, viewed February 2007 <http://www.ncbi.nlm.nih.gov>

Nelson JS (1994) *Fishes of the World* Third edition, John Wiley and Sons Inc, New York. 600 pg.

Office International des Epizooties (OIE) *Aquatic Animal Health Code (2006)* Updated 30 July, 2006, viewed March, 2007 <http://www.oie.int/eng/normes/fcode/en_sommaire.htm>

Office International des Epizooties (OIE) *Manual of Diagnostic Tests for Aquatic Animals (2006)*, viewed March, 2007 <http://www.oie.int/eng/normes/fmanual/A_summry.htm?e1d11>

Paynter J (1989) Diseases of penaeid prawns in *Invertebrates in Aquaculture* Post Graduate Veterinary Science Committee Proceedings 117: 145–189.

Pearce M (1989), Epizootic Ulcerative Syndrome Technical Report, Dec 1987-Sep 1989. *Fishery Report No 22, Northern Territory Department of Primary industry and Fisheries,* Australia, 82 p.

Pokorova D, Vesely T, Piackova V, Reschova S and Hulova J, (2005) Current knowledge on koi herpesvirus (KHV): a review. *Vet Med – Czech* 50 (4): 139–147.

Pusey BJ, Bird J, Kennard MJand Arthington AH (1997) Distribution of the Lake Eacham Rainbowfish in the Wet Tropics Region, North Queensland. *Australian Journal of Zoology* 45: 75–84.

Reark Research (1995) Report: Pet Care Industry Statistics, 1994, *Petcare Information and Advisory Service*, Melbourne, Australia. As cited on the Petnet website, viewed March 2007, <www.petnet.com.au/openspace/2.0.html>

Saeed B, Ivantsoff W and Crowley LELM (1994) Systematic relationships of atheriniform families within Division I of the series Atherinomorpha (Acanthopterygii) with relevant historical perspectives. *Voprosi Ikhtiologii* 34: 1–32.

SCFH (1991) Minutes, Reports and Agenda Papers of the Sub-Committee on Fish Health Meeting, Standing Committee on Agriculture Hobart, 209 pp.

Schmida G (1997) What's in a name anyway? My thoughts on the genus Melanotaenia ANGFA. *Fishes of Sahul* 11(1): 481–499.

Smith SA (1997) Mycobacterial Infections in Pet Fish. *Seminars in Avian and Exotic Pet Medicine* 6(1): 40–45.

Sparks JS and Smith WL (2004) Phylogeny and biogeography of the Malagasy and Australasian rainbowfishes (Teleostei: Melanotaenioidei): Gondwanan vicariance and evolution in freshwater. *Molecular Phylogenetics and Evolution* 33: 719–734.

Stiassny MLJ (1990) Notes on the anatomy and relationships of the bedotiid fishes of Madagascar, with a taxonomic review of the genus Rheocles. *American Museum Novitates* 2979: 1–33.

Tappin A (1999) Breeding Rainbowfishes, viewed December, 2006, <http://members.optushome.com.au/chelmon/Breedbow.htm>

Tappin A. (2006) Viewed October 2006.<http://members.optushome.com.au/chelmon/Melanotaenia.htm>

Zhu D, Segnan S, Moritz C (1998). Evolutionary distinctiveness and status of the endangered Lake Eacham rainbowfish (*Melanotaenia eachamensis*). *Conservation Biology* 12: 80–90.

Additional Reading

Bomford M and Glover J (2004) *Risk assessment model for the import and keeping of exotic freshwater and estuarine finfish*. Bureau of Rural Sciences Canberra.

Humphrey JD (1995), *Australian Quarantine Policies and Practices for Aquatic Animals and their Products: A Review of the Scientific Working Party on Aquatic Animal Quarantine*, Bureau of Resource Sciences, Canberra, ACT, Australia.