Current status and the need for immediate conservation of the Red Lined Torpedo Fish, an endangered and endemic cyprinid from Western Ghats (global biodiversity hotspot), India

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Status and Conservation of Red Lined Torpedo Fish

Abstract

A ‘Boom and Bust’ fishery and associated decline in wild stocks of the red lined torpedo fish, *Puntius denisonii*, Day an endangered and endemic cyprinid, from the streams of Western Ghats – a global biodiversity hotspot in peninsular India is documented. Study results based on extensive field surveys, traditional knowledge and published data reveal that the species is being exploited on a large scale from the rivers of the region for international trade. A highly restricted distribution, rare availability，lack of credible scientific data and absence of a captive breeding technology point towards the need for immediate conservation of this endemic and endangered species. The present paper seeks to set off a much needed debate and discussion on what is considered to be one of the major challenges to ichthyodiversity conservation in Western Ghats.

Keywords: Conservation, Cyprinid, Endangered, Endemic, India, *Puntius denisonii,* Western Ghats

Introduction

The streams and rivers of Kerala, part of the Western Ghats (8º 20º N & 73º 77º E), one of the 34 global biodiversity hotspots (Anon, 2006a) is considered to be an exceptional hotspot of freshwater fish diversity (Kottelat & Whitten, 1996). The state of Kerala, on the south western corner of the Indian peninsula is crisscrossed by fourty four rivers- fourty one west flowing, and three east flowing having an immensely rich and diverse fish fauna of around 207 species (Gopi, 2000), including food, ornamental and sport fishes (Gopalakrishnan & Ponniah, 2000). Among them, ornamental fishes form the most important component of regional biodiversity from an eco-biological and socio-economic viewpoint. Ramachandran, Mini Sekharan & Pramod (2002) collected 110 indigenous fishes from the different water bodies of Kerala, maintained them in aquaria for a period of two years (2000-2001) and studied the feasibility of test marketing them as ornamentals. Simultaneously, they carried out market studies and listed 57 indigenous fishes of Kerala in the ornamental fish trade. A recent checklist of fish diversity of Kerala lists 106 ornamental species (Kurup & Radhakrishnan, 2006a), including those in the trade (Anon, 2005) as well as those having future marketing potential (Kurup & Radhakrishnan, 2006 b).

Among the native ornamental fishes of the region, no species has received global fame and hobbyist attention as much as the Red Lined Torpedo fish, *Puntius denisonii* (Day), an endemic cyprinid. Locally known as "*Chorakanni*" literally meaning bleeding eyes, and more popular as "Miss Kerala", this native barb has become one of India's biggest exports in recent times (Anon, 2006b). Sekharan & Ramachandran (2006) classified the traded indigenous ornamental fishes of Kerala based on market preference by hierarchical clustering and noted that *Puntius denisonii* occupied the first cluster -

namely high preferred species in the export market. This species had an increasing demand in international markets, requested in all trade enquiries and hence exported in consistent numbers, very regularly from India. The high popularity of the species in the international trade has led to its overexploitation in most of the rivers in the region and the fish being listed as endangered (Kurup, Radhakrishnan & Manojkumar, 2003). Despite being the most celebrated and perhaps the most threatened native fish species, *P. denisonii* has not been well documented in literature. Lack of reliable scientific database regarding its population, biology and threats has significantly affected conservation efforts. A pioneering attempt has been made via the present study to document the current status of this endemic and endangered species in the streams and rivers of Kerala with regard to its distribution, abundance, life history, fishery characteristics and trade. Immediate conservation and management measures that need to be adopted for sustaining the wild stocks of this species have also been discussed.

Methods

A mix of primary and secondary data has been used in the present contribution. The primary data were the results of our field surveys carried out as part of the ACSI – USNSF Project 04-17 during 2004-2006. Collections were undertaken in five major rivers (Periyar, Chalakudy, Bharatapuzha, Kabini and Chaliyar) and its associated streams in Kerala (Table 1). In addition, published data (journal papers, reports, books, thesis and conference proceedings) and internet search tools were also utilized for compiling the necessary information for the study. The quality of the secondary data was not accounted for because peer reviewed references pertaining to this topic was more or less unavailable. In the absence of adequate scientific knowledge regarding most aspects of this species, local/indigenous traditional knowledge (Johannes, 1998) was also used as a major source of

information for the present study. This included personal meetings and unstructured interviews conducted with key informants and relevant stakeholders including ornamental fish collectors, exporters and others connected with the trade. Details regarding market prices were obtained from exporters, relevant websites of major importing aquaria's in USA, Europe and Asia and personal contacts with traders in Singapore.

Results

Distribution

We located wild populations of *P. denisonii* from three river systems (Chalakudy, Chaliyar and Periyar) and its associated streams (Vettilapara, Chalipuzha and Pooyamkutty), (Table 1) although with significant differences in abundance patterns (Figure 1). As in the case of typical cyprinids, *P. denisonii* was also observed to be a gregarious species, and usually a single haul via a cast net resulted in capture of individuals of the same age class – mostly fingerlings. The fish was found to be extremely vulnerable to capture by both cast net and/or other simple local gears. It was also practically easy to locate their fishing grounds making use of specific microhabitat features (in the form of rocky pools with thick vegetation along its banks), an indication/sign which is now being used widely by most collectors.

Fishery

Personal observations of key informants as well as published evidence point out to the fact that the species has shown a marked decline in population in recent years and its abundance fluctuates from rare (Gopi, 2000) to very rare (Kurup & Radhakrishnan, 2006 a, b). However, no precise details on the

extent or degree of population decline are provided in any of these reviewed sources. The catch per hour for *P. denisonii* in the various rivers of Kerala, was found to be very low ranging from 0.002 (Chalakudy) to 0.042 (Achencoil and Chandragiri), probably indicative of the extreme fishing pressure that the species is being subjected to (Kurup & Radhakrishnan, 2006b).

Responses from key informants suggest that Pooyamkutty (Periyar River), Vettilapara (Chalakudy River) and Iritty (Valapatanam River) (Table 1) have become the epicenters of mass scale collection of this species in view of the comparatively large populations that the locale sustains. The fact that Pooyamkutty Stream of Periyar River supported a good population of the species was apparent from the results of our study (Fig 1).

Large shoals of *P. denisonii* was encountered during our field trip to Chalipuzha, a tributary of the Chaliyar river located in Calicut District (11º 15º N & 75º 46º) of Kerala in October 2004. A re-examination at the same study site in March 2006 showed that the population drastically declined, with not a single individual being located in spite of detailed sampling. Subsequent personal meetings and interactions with local communities residing on the banks of the stream at the study site revealed that the species was routinely collected and supplied to the traders over the previous year.

Biology

Even though *P. denisonii* has been the focus of much trade attention, very little is known regarding its biology and life history. Lack of any data on this species is evident from Fishbase – the world's largest encyclopedia on fishes. Preliminary information from grey literature (Radhakrishnan & Kurup, 2005) on

the diet of *P. denisonii* from the wild indicates that the species is an herbivore feeding on filamentous algae, diatoms and plant matter. The spawning season is known to more or less correspond with the regional monsoon (June-August), since mature specimens have been observed in the wild from May, with peak maturity seen in June and continuing till July (Radhakrishnan & Kurup, 2005). The fact that the fish breeds during the monsoon has been also suggested by key informants among the local communities. Length-weight relationship of the species from Bharatapuzha River (Table 1) followed the Cubes Law (Mercy, Thomas & Jacob, 2002). Apart from these two published works, not much is known on either the bionomics or life history traits of this species. A skewed sex ratio favouring females was also observed during most of our collections.

Trade

P. denisonii was collected for the very first time in 1996 and sent to Germany, and since then the species has been a regular among the native ornamental fishes exported from Kerala. The following year at 'Aquarama 1997' (World Exhibition on Ornamental fishes), the fish won the third prize in the 'new species category' competition (Anon, 2006c). The opening up of the Cochin International Airport at Nedumbaserry in 1999 probably stimulated an increased trade, as the region became connected to Singapore (the single largest market for native ornamental fishes from Kerala) by daily flights. Sekharan (2006b) recorded the total number of exports of the popular native ornamental species during 1996-2004 by compiling the customer invoices of all exporters of India, trend analyzed the data and noted that the export of *Puntius denisonii* showed an alarming and predictable increase in recent years. Excepting this study, no statistical data is available on the quantity of exports of *P. denisonii*

from the streams of Kerala, as in the case of other native ornamental species. Those available from traders are more or less unreliable and under-report the catches by several orders of magnitude.

As with other wild animal products (Milner-Gulland & Leader-Williams, 1992), only a relatively small number of traders (middle men) organize and control the trade in *Puntius denisonii* in Kerala. On the other hand, fishing and collection (equivalent to poaching and trapping in wildlife) tend to be distributed among locals belonging to tribes and forest communities who survive on subsistence level. Given the nature of marketing involving various stakeholders like collectors, intermediaries, wholesalers and exporters, engaged in what can be described as a clandestine and surreptitious trade, it is extremely difficult to track and precisely quantify the trade in *P. denisonii*. We also believe that a large share of the exports are channeled through non-conventional routes and are seldom documented and recorded, even by the customs authorities in the region. Therefore, the most reliable way to ascertain the trade statistics of the species would be to document the import records at the Singapore Airport! Sekharan (2006) suggests that if the State government, the Marine Products Export Development Authority (MPEDA) or the Customs Department take initiatives, the recording of the number of all indigenous fishes exported from India including *P. denisonii* can be carried out in a systematic way.

The retail prices for *P. denisonii* have increased over the years (Figure 2) probably as a result of the saturation in supply due to decline in catches. The species which had a retail value of US$ 8 (Ramachandran, 2002) per piece is now worth US$ 20-30 (Anon 2006b, d). Several case studies exist to substantiate the fact that the average market price for a fish species will increase as it becomes

scarce (Murawski & Serchuk, 1989; OECD 1997). The gradual increase in prices for *P. denisonii* witnessed over the last few years (Figure 2), has certainly driven the flow of more catches from the wild turning the stock position into a downward spiral.

Another reason that may be cited for the increasing market prices of *P. denisonii* is the fact that number of fishes which reaches the final consumer is apparently less due to the high mortality of the species during capture, transportation and captive survival (Rajeev Raghavan Per Observation)**.**

Discussion

Although *P. denisonii* is known to be found in as many as nine rivers in Kerala (Table 1), viz. Chalakudy (Kurup *et al*., 2003; Shaji & Easa, 2001; Shaji, Easa & Gopalakrishnan, 2000), Periyar (Biju, Thomas & Ajithkumar, 2000), Achencoil (Kurup *et al*., 2003; Shaji & Easa, 2001), Pampa (Shaji & Easa, 2000), Valapatanam (Biju *et al*., 2000), Chaliyar (Shaji & Easa, 2001; Shaji *et al*., 2000), Kallar (Shaji *et al*., 2000), Chandragiri (Biju *et al*., 2000; Kurup & Radhakrishnan, 2006 b) and Bharatapuzha (Kurup & Radhakrishnan, 2006 a; Mercy *et al*., 2002), their distribution is highly restricted to certain specific locales of the rivers and most stocks are known to be extremely fragmented.

There have also been reports (although not backed by relevant data) suggesting that the wild stock of the species has dwindled at a rate of 70% during the years 2000 to 2004 (Sudhi, 2004). Our observations on the rapid decline in stocks at Chalipuzha also indicate such a trend. We thus believe that continuous exploitation for trade has been the single major factor that has led to the decline of this species in the rivers of Kerala during the last few years. There are no direct measures of the population status of the Denison's barb as no population assessments have been conducted till date.

However, there exists a general consensus among scientists and researchers in the region that the fish has become rare and its population has declined precipitously. Although, key informants suggested that Pooyamkutty (Periyar River), Vettilapara (Chalakudy River) and Iritty (Valapatanam River) are the major centers of indiscriminate collection, our observations on the drastically depleted populations in Chalipuzha, show that supply sources are changing as stocks are being over exploited.

It has to be agreed that *P. denisonii* presents a complex challenge to conservation biologists of the Western Ghats. Firstly, because the entire volume of exports for the last ten years have been based on collections from the streams of Kerala and subsequently by the fact that no realistic data is available on aspects of its population, fishery or life history.

Strategic trade theories have been applied to environmental economics since the mid nineties (Ulph, 1996). For example, to manipulate poaching intensity, conservation of endangered species have been addressed by “supply side” policies, such as increasing supply to meet market demands by flooding the market with captive bred individuals and other alternatives (Damania and Bulte in Press). This, in theory, would lead to fall in prices and make wild collection unprofitable. However, as discussed in a very recent paper (Damania and Bulte in Press), there can be also be a negative side to adoption of ‘supply side’ policies in conservation of endangered species.

Even though captive breeding technology has been standardized for thirteen native ornamental species of Kerala (Mercy, 2006), no breakthrough has yet been achieved with *P. denisonii*. High rates of female mortality in captivity and a skewed sex ratio favouring males are the major factors that

are known to have hampered the development of a captive breeding technology (Sudhi, 2004). It is also of interest to comment that, the adoption of captive breeding technologies that has been developed and standardized for the thirteen native ornamental species, by interested entrepreneurs has been delayed for unknown reasons. We would like to mention here that captive breeding and small scale aquaculture may act as an alternative to wild collection and/or fishing only if it is able to provide sufficient incentives (i.e., returns) to “displace and not supplement” the capture. Our interaction with collectors in the streams of the region who supply the species to middlemen and/or traders has revealed that they enjoy fishing and collection, and the income generated through it. They also may not consider captive breeding or aquaculture as an alternate livelihood strategy because these are often technologies that are more complicated and time consuming than wild collection, and also because the costs of such technologies are often high and the ensuing income low. Problems such as unavailability and/or high costs of land for setting up breeding and rearing units in the region also will greatly hamper possible shifts from wild collection to rearing. Many, if not all of the collectors who are involved in capture fishing would resist a shift to captive breeding and rearing. Such conflicts have been documented in marine reef fishing communities in many regions of the world (Pollnac, 1982, 1990 cited by Pomeroy, Parks & Balboa, 2006).

As opined by Damania and Bulte (in press), captive breeding programs in biodiversity conservation can also be detrimental if it induces aggressive competition. We would like to mention that there are every chances of a highly popular species like *P. denisonii* ending up being collected at even higher levels from the wild even when a captive breeding technology is available, as has been witnessed in the case of the Banggai cardinal fish, *Pteropogon kauderni* (Tlusty, 2002). Likewise, if broodstocks of

P. denisonii are difficult to maintain (Sudhi 2004) their mass scale production in captivity would have to invariably reply upon repeated wild collections of mature individuals. For such elite species, a total ban on exports including both wild caught and captive bred individuals, at least for the next few years could also be an ideal recommendation. Such outright export bans are not uncommon in the fisheries sector with Project Seahorse (Project Seahorse, 1999) being one such successful endeavor. An ideal recommendation would also to include the species under the Convention of International Trade in Endangered Species (CITES) and regulate the illegal exports currently in practice.

Another major drawback concerning the development of a captive breeding technology for a highly sought after species like *P. denisonii* would be with regard to the long term loss of control over biological property and issues related to bio-piracy and Intellectual Property Rights (IPR). If a captive breeding technology is developed, a shift in regional focus would be inevitable with developed nations like Singapore and Israel gradually rising to become the most important suppliers, and, India, the country of its origin would invariably lose its claim over the species. Although the Convention on Biological Diversity (CBD) of 1992 assures that some economic benefits return to the country of origin, this treaty has not achieved its intended success to date. The indigenous African Malawi cichlids which are now being mass produced from Florida and Singapore, and the Amazonian Neon Tetra which is being currently bred on a large scale in Hong Kong could be taken as classical examples of such regional shifts concerned with ornamental fish breeding and exports (Watson, 2000).

We also agree with Damania and Bulte (in Press), that conservation of endangered species in a developing country is indeed an expensive task and that the opportunity costs of both in-situ as well as

ex-situ conservation strategies could be high. However, given the risk of losing an endangered and strictly endemic species from a global biodiversity hotspot, we are compelled to recommend conservation and management guidelines, many of which maybe harsh or insensitive to a developing region like India. Based on our understanding of the species and the nature of its trade, we have listed a set of management practices to help guide the fishery of *P. denisonii* and direct it into a sustainable enterprise. Fishery management strategies based on input and output control, technical measures, ecologically based management and indirect economic instruments (Charles, 2001) can be used with necessary modifications to suit local needs. Regulating catch and effort through granting licenses and access rights can be one of the most successful strategies that can be enforced in the present scenario. The process of granting export licenses and collection permits should be streamlined and the number of such orders issued strictly regulated by the Government agencies concerned. As suggested by Woods (2001), a meaningful way of reducing overall collection pressure and maintaining status quo is by limiting the volume of stock that can be exported. However this can be successfully enforced only after detailed stock assessment of this species in the rivers of this region are carried out. Results of such studies can subsequently form a baseline for setting up restrictions on export volumes in the future.

Output control measures including fixing total allowable catch (TAC), regulating the total harvest and the use of quotas (individual or community based), are also ideal management strategies. However, they have never been tested and/or implemented with any fishery in this part of the world, and therefore in-depth studies on the feasibility as well as implications of each need to be carried out before they are enforced.

Use of technical measures of management such as restrictions on gear, fixing meaningful size limits and promoting spatial closures could arguably be the best strategies that can help in conserving this endangered species. With regard to collection of fish for aquarium holding, it is known that much rests on the competence and attitude of the collectors. Presently, collectors in this part of the world comprise unemployed youths and members of forest dwelling communities who supply fish to middlemen or in some cases directly to the exporters. They use various local gears to catch the species from the streams and rivers. Strict regulations may be hence enforced on the type and overall size of net as well as on the mesh size that are used for collection. The aim of these regulations should not only be to limit the catch but also the size of the individuals caught. The international trade in *P. denisonii* like other aquarium fishes is more or less dependent on the collection and marketing of fry and early fingerlings, which have a vivid colour pattern unlike adults that are paler in appearance. This pressure on fingerlings whereby insufficient quantities of the stock are left in the wild to reach maturity and spawning size is certainly one of the major issues affecting the sustainability of *P. denisonii* fishery in the region. Although size regulations can clearly play a significant role in aiding conservation of stocks and preventing overexploitation, an exhaustive database is required, regarding the life history traits, growth and mortalities of different size groups before any meaningful limits are imposed. Such a database is however, currently unavailable. Educating the collectors on best management practices including use of non-damaging collection methods can also go a long way in conserving the species, since a large share of the catch are known to die before they are transported, mostly due to damaging collection techniques (Rajeev Raghavan. Per Observ).

Introducing concepts of ecologically based fisheries management like sanctuaries and protected areas can also be initiated. Strong legislation can be bought forward to declare ‘collection hotspots’ like Pooyamkutty, Vettilapara and Iritty as aquatic sanctuaries/refugia’s and/or no-take zones. However, as discussed in an earlier part of this section, the opportunity costs of conserving habitats maybe high and would need policy interventions from the concerned government agencies to study the feasibility of such strategies.

Indirect economic instruments like levy of taxes and royalities based on both catch as well as effort can also certainly bring the exploitation to a desired economic optimum (Charles, 2001). However in regions like Kerala, where strong inland fishery management strategies have never been implemented, such economic management measures may not be a practical option at least in the immediate future. However, taking into account the nature of the industry and the stakes involved, we are forced to suggest such harsh regulations also, as a means of controlling the indiscriminate exploitation of the species, which has currently led to a conservation crisis in the Western Ghats.

Conclusion

The organized fishery for *P. denisonii* in the streams of Kerala part of Western Ghats, can be more or less described as a “boom and bust fishery” (Panes *et al.*, 2004), where a newly discovered population is being rapidly exploited for trade resulting in its eventual collapse. In an open access fishery (like the one being practiced for *P. denisonii*) devoid of any quotas or access restrictions, the race to exploit and market the product has no doubt led to a rapid collapse of the wild stock. This is evident from our

observation with regard to the population at Chalipuzha which were subjected to high levels of exploitation leading to a drastic population decline in just a few months. In spite of being the focus of a flourishing trade, it is highly disappointing that the species has received rather poor attention from the concerned government authorities and conservationists. An urgent consideration is therefore needed from scientists, policy makers and relevant government agencies to take up the cause of the species, conduct baseline studies and promulgate the importance of conservation and sustainable utilization among the concerned stakeholders. Immediate enforcement of strict conservation strategies like the ones suggested and discussed in the present study would be probably the only key to save this endemic species from further endangerment and possible extinction.

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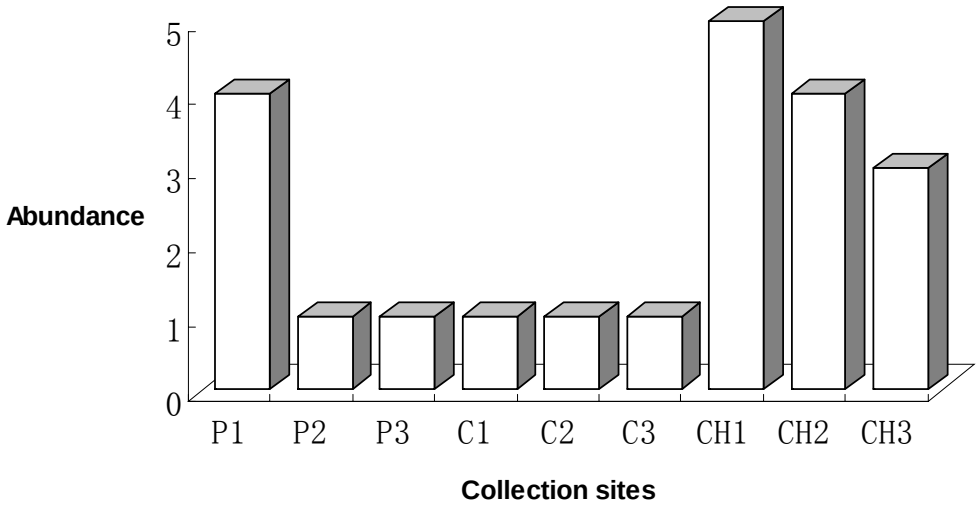
Table 1. Distribution of *Puntius denisonii* in the Rivers of Kerala

River	Present Study	Previous Studies	Latitude & Longitude
Achencoil	-	X	9^0 00' -9^0 20' N; 76^0 20' -77^0 20' E
Bharatapuzha	-	X	10^0 25' -11^0 15' N; 75^0 50' -76^0 55' E
Chalakudy	X	X	10^0 05' -10^0 35' N; 76^0 15' -76^0 55' E
Chaliyar	X	X	11^0 05' -11^0 40' N; 75^0 35' -76^0 45' E
Chandragiri	-	X	12^0 20' -12^0 35' N; 74^0 55' -75^0 30' E
Kallar/Neyyar	-	X	8^0 15' -8^0 40' N; 77^0 00' -77^0 20' E
Pampa	-	X	9^0 10' -9^0 40' N; 76^0 15' -77^0 20' E
Periyar	X	X	9^0 15' -10^0 20' N; 76^0 05' -77^0 25' E
Valapatanam	-	X	11^0 50' -12^0 15' N; 74^0 55' -75^0 30' E

Fig 1. Abundance (number of individuals per haul) of *Puntius denisonii* from different collection centers along three river systems



P1 – Pooyamkutty (Periyar), **P2** – Poru (Periyar), **P3** – Malayatoor (Periyar); **C1** – Vettilpara (Chalakudy); **C2**- Vazhachal (Chalakudy); **C3**- Malakkapara (Chalakudy), **CH1**- Chalipuzha 1 (Chaliyar); **CH2**- Chalipuzha 2 (Chaliyar); **CH3**- Chalipuzha 3 (Chaliyar).

Figure 3. Market Prices of *Puntius denisonii* over a six year period (2000-2006)