BREEDING MARINE AQUARIUM FISHES: OPPORTUNITY OR THREAT FOR THE LOCAL FISHING COMMUNITY?

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Banggai Cardinalfish (Pterapogon kauderni)

From an environmental point of view, breeding marine aquarium organisms helps to mitigate exploitation of natural ecosystems and reduce the catch of non-target species as well as the use of destructive fishing methods such as cyanide. It would allow full control of the supply chain, and supplies could also be continuously available at more stable prices. Unfortunately, these breeding activities could potentially deprive family farms or small-scale fisheries of a source of additional income.

Introduction

The Food and Agriculture Organization of the United Nations (UN-FAO) defined the word 'aquaculture' as: "... the farming of aquatic organisms, in inland and coastal areas, including fish, molluscs, crustaceans and aquatic plants. Farming implies some sort of human intervention and the individual or a corporate ownership in the rearing process, to promote production, such as stocking, feeding and protection from predators" (FAO, 1995).

Further, FAO stated that "Fish are an integrated part of aquatic ecosystem, a system in which modification in one area has the potential to affect other areas. Thus, it is increasingly regarded as necessary, to monitor the state of the aquatic ecosystem and also to manage human interventions within that ecosystem. Only within such a framework it will be possible for capture fisheries to continue to be a source of food and income for future generations" (State of World Fisheries and Aquaculture, FAO, 2000).

Approximately 179 species are used for food and commercial aquaculture and more than 1 980 species for ornamental purposes (Bardach, 1997).

Corals, invertebrates and reef fish are exported from various parts of Southeast Asia, mainly to the United States, Europe and Japan (Wabnitz *et al*., 2003 from FAO Globefish n. 102). The ornamental fish sector is therefore a small but vital part of international fish trade, contributing positively to rural livelihoods in many developing producing countries (Monticini, 2010).

We can divide the market into several segments: freshwater ornamental fish, marine ornamental fish, live plants and invertebrates (both marine and freshwater). To better understand the dynamics of the market and the different origins of aquatic organisms, the above classification can be analysed horizontally. Farmed freshwater ornamental fish constitutes around 95-98% of the total share, with only 2-5% originating from the wild. The situation for marine ornamental organisms is the opposite: 98% are wild caught animals, the others are farmed. Currently, there is generally greater demand for farmed live corals and/or invertebrates (e.g. *Tridacna spp* or SPS - small polyps that have a hard-stony skeleton base, and LPS - calcareous coral with large polyps) than farmed marine fish. High mortality rates of wild-caught fish are usually the result of poor fishing methods and lack of competence at some stages in the supply chain, in particular during transport from the wild to the facility.

Breeding brings clear benefits

In recent years, the increasing popularity of marine ornamental aquaria has led to a considerable rise in the demand for aquatic organisms, both fish and invertebrates. The main problem that arose from this elevated demand for marine organisms is the continued unsustainable or destructive fishing practices in marine ecosystems which cause considerable damage to coral reefs and non-target species. These fishing methods, such as the use of cyanide (sodium cyanide*)* and dynamite (for live rocks) to stun fish, harm the delicate coral reefs and the coastal ecosystems (Olivotto *et al*. in Davin T.B. *et al*. 2009, FAO Globefish n. 102, 2010). A potential solution for protecting ecosystems from incorrect and unsustainable management of natural resources, is the breeding of marine organisms as an alternative to the capture of wild animals.

Coral reefs are easily destroyed by destructive fishing practices such as the use of cyanide, dynamite fishing, over-exploitation of coastal resources, as well as warming seas. Some species such as the crown of thorns starfish also destroy corals.

There are numerous species of marine fish whose biological life cycle has been studied. Some of these have been regularly sold on the market for years, even though at considerably higher prices than other wild caught counterparts such as clownfishes. However, until a few years ago, information about the reproduction of the most important ornamental marine species was fragmented and incomplete. Their life cycles were not known with certainty; as stated in the 1978 publication 'Butterflyfishes of the World': "spawning has never been reported from field observation for any species of *Chaetodontid* .... the time of spawning of *Chaetodontids* is not known".

Subsequently, the first studies conducted directly in the field and later in captivity, have supplied information about sexual dimorphism, breeding season and reproductive behaviour. Examples include the study by Thresher R.E. 1984: Reproduction in Reef Fishers p. 274 .... "Surgeonfishes produce pelagic eggs which, in most species are spawned in the water column.... Pair spawning has been documented in *Zebrasoma spp*. and *Naso lituratus);* and by Pratchett, M. *et al*. 2014 p. 205: " Butterflyfish spawn pelagic eggs....".

According to *reef2rainforest.com* (in webliography) in 2018, around 350 marine ornamental species are bred in captivity. Of these, 36 species are commonly available, 33 are moderately available and 53 species are scarcely available. The rest, comprising 236 species, are bred but are not commonly available in the market. Among these we can note numerous species of clownfishes *(Amphiprion spp.),* seahorses and pipefishes *(Hippocampus spp.),* and some of which are endangered or listed in Annex II of CITES such as damselfishes *(Chysiptera spp.);* Dottybacks *(Pseudochromis spp.),* cardinalfishes *(Pterapogon kauderni)* and angelfishes *(Centropyge).* The most recent production milestones are the yellow tang or *Zebrasoma flavescens* (Bennett,1828) and *Paracanthurus hepatus* (Linnaeus, 1766).

Paracanthurus hepatus

Zebrasoma flavecens

The breeding of ornamental organisms as well as the fishing activity of wild species involve a considerable number of stakeholders who are scattered throughout the entire supply chain. It is estimated that about two million people worldwide are involved in the ornamental fisheries trade. We can consider large farms that breed, import or export fish from third countries with many workers involved, such as in Singapore, Thailand etc., or we can consider family farms involved in coral fish capture and collecting activities only as a complementary or seasonal alternative to fishing for food purposes (the so-called artisanal or small-scale fisheries). All these activities certainly represent a source of income for coastal communities in the countries involved in the marketing of aquatic organisms for ornamental purposes.

Sustainability milestones

In relation to the goal of this paper, the definition of 'sustainable development' adopted by FAO both in 1995 and 1997, is particularly appropriate. It defines sustainable development as: "the management and conservation of the natural research base and the orientation of technological and institutional change……. Such sustainable development (in the agriculture, forestry, and fisheries sectors) conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technologically appropriate, economically viable and socially acceptable". In this context, ornamental fish farming could play a key role in coral reef preservation, sustainable use of natural resources and restoration. The milestones of sustainability can be summarised into:

Social development

Social equity and development are consolidated concepts that can be applied to any economic activity. Intra-generational consequences must be always considered, allowing future generations to have access to the same social resources of their predecessors.

Economic development

Ornamental aquaculture, like any other economic activity, can contribute to social and economic development, but it can also generate social ruptures, inequalities and conflicts over resources. In order to avoid negative outcomes, the major actors involved in the economic process need to contribute towards attaining a social balance. When applied to aquaculture, the important factor is social acceptability, since this kind of industry is often negatively perceived from a social, environmental and economic point of view. This is particularly true in developing countries where local workers seldom benefit from the development of the industry because revenues are not allocated or invested in situ.

In summary we could say that natural public resources are exploited for many, but benefits are shared only among few actors. Increasing the participation of local communities and ornamental aquaculture farmers' organisations in promoting ornamental sustainable aquaculture, decision-making and site selection, could create positive effects such as reducing migration, contributing to social stability and enhancing woman empowerment (especially in small-scale aquaculture and fisheries).

Environmental safeguard

This refers to the protection of the whole environment including water, energy, agriculture, biodiversity, fish, plants, forests and air. Aquaculture's negative image derives from the environmental damages caused in the past and its potential future risks. Pollution, damage of sensitive ecosystems, coastal erosion, loss of biodiversity, environmental contamination, introduction of exotic species, introduction of drug-resistant pathogens, as well as land-water conflicts are the main negative consequences attributed to aquaculture (GFCM, 2013). From a sustainable perspective, monitoring the interactions between human activities and their ecosystems has a crucial role in preventing potential negative impacts on the environment. Therefore, both national and international legislation can be key elements in protecting the environment from indiscriminate fishing potential damages. Policies should focus on combining aquaculture development and appropriate ecosystem approaches.

Protection under CITES

With regard to environmental issues, the most important international convention in the ornamental fish sector is the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which establishes the international guidelines for legislations and regulations at a national level. There are 16 ornamental fish species listed in Annex I while among the 107 species presently (2019) included in CITES Annex II are marine seahorses *Hippocampus spp* and *Holacanthus clarionensis* (Gilbert, 1890) as well as freshwater seahorses *Scleropages formosus* (Müller & Schlegel, 1844). The South American freshwater *Hypancistrus zebra* (Zebra pleco / L46) and the freshwater stingray of the genus *Potamotrygon spp* (from Brazil and Colombia) are the first pet fish listed in Annex III which includes the names of 24 species of ornamental fish.

Some hard-coral species such as *Scleractinian* and soft coral species are suitable for the aquaria market, where their classification remains uncertain. Their trade is limited to a few genera (Wabnitz *et al*. cited in Reynolds D. *et al*. 2006).

Most of them such as *Helioporidae spp, Scleractinia spp, Milleporidae spp* and *Stylasteridae spp* are included in Annex II. *Tridacnidae spp (giant clams)* are also included in this Annex.

Unfortunately, according to CITES, dead specimens are not subject to the provisions of the Convention. This detail prevents an effective and efficient investigation of the true extent of exploitation from the reef of sessile organisms, which are often anchored to hard rocks and stone.

The Banggai cardinalfish *(Pterapogon kauderni)* deserves particular attention. Already classified as an Endangered species in the IUCN red list from 2007, it hasn't been included in the CITES Annex as yet. According to Vangelli (2011), this species is found only in the Banggai Islands in Indonesia, and is a rare example of endemism with a strong limited geographic distribution. Banggai cardinalfish have become one of the most popular marine aquarium fish species and is easily kept in captivity, despite the low breeding rate. Unfortunately, the high market demand has caused indiscriminate fishing and because of the large number of specimens taken from the natural habitat and its low fecundity and resilience, this species has become vulnerable to high collection pressure. Over the years the number of specimens present in nature has decreased to unsustainable levels.

As the species conservation status is not contested, there have been efforts to list *Pterapogon kauderni* under CITES Annex II protection but these have been unsuccessful so far despite being debated during CITES CoP 14 and CoP 17. The proposed inclusion had been supported by CITES, FAO, numerous NGOs and other stakeholders. However it was opposed principally by Indonesia, the OFI (Ornamental Fish Organisation) and OATA, which asserted that "…. at the moment ... Indonesia is fully capable of managing the habitat and species well……" (CITES and OFI web page). In a compromise solution, agreement was reached on the following statement: "Indonesia should implement conservation and management measures to ensure the sustainability of trade in *Pterapogon kauderni……"* .

Conclusions

Whether marine ornamental fish breeding activities constitute a great development opportunity or a threat, is a question that cannot have a single answer. There are too many points of view, multiple perspectives, stakeholders and political and socio-economic interests involved. Moreover, it is not easy to fully identify the strengths or potential weaknesses of this market segment in the near future.

From an environmental point of view, breeding marine aquarium organisms could certainly prevent the exploitation of natural ecosystems, reduce the catch of non-target species and safeguard the environment from any destructive fishing methods such as the use of cyanide. Breeding specific ornamental fish species may also improve the quality of scientific research, disclosure and development of new breeding techniques.

Unfortunately, from the fisherman's point of view, the breeding of ornamental fish could potentially deprive family farms or small-scale fisheries of a source of additional income. In fact, ornamental fish are paid by specimen, and this could contribute to improve the fisherman's earnings aside from the standard fishing activities (e.g. for human consumption).

A possible solution from a holistic point of view, if one agrees with the definition of poaching as "to steal natural resources without benefiting the native (fishermen)", could be to organise the farms in coastal areas, giving real ownership to the local communities.

From the fish farms' point of view, ornamental fish breeding would allow full control of the supply chain, and be detached completely from seasonal trends or from any kind of mortality rate during the different steps of the chain. The price could be more stable, and supplies could be regularised for the worldwide market throughout the year.

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1. *Monticini P. (2015), Ph.D. final Dissertation: Sustainable Aquaculture and Fisheries: International Legislation, Technical Aspects, Present Situation and Future Potential Development.LAP LAMBERT Academic Publishing, Heinrich- Böcking- Str. 6-8, 66121, Saarbrücken, Germany. ISBN 978-3-659-75857*
2. *Monticini P. (2015), Report on Potential in Ornamental Fish Trade in Africa, FAO GLOBEFISH, (www.Globefish.org)*
3. *Monticini P. (2014), "Eel (Anguilla sp) Production and trade according to Washington Convention Legislation". GRP Globefish Research Programme Vol. 114, FAO GLOBEFISH (www.Globefish.org.)*